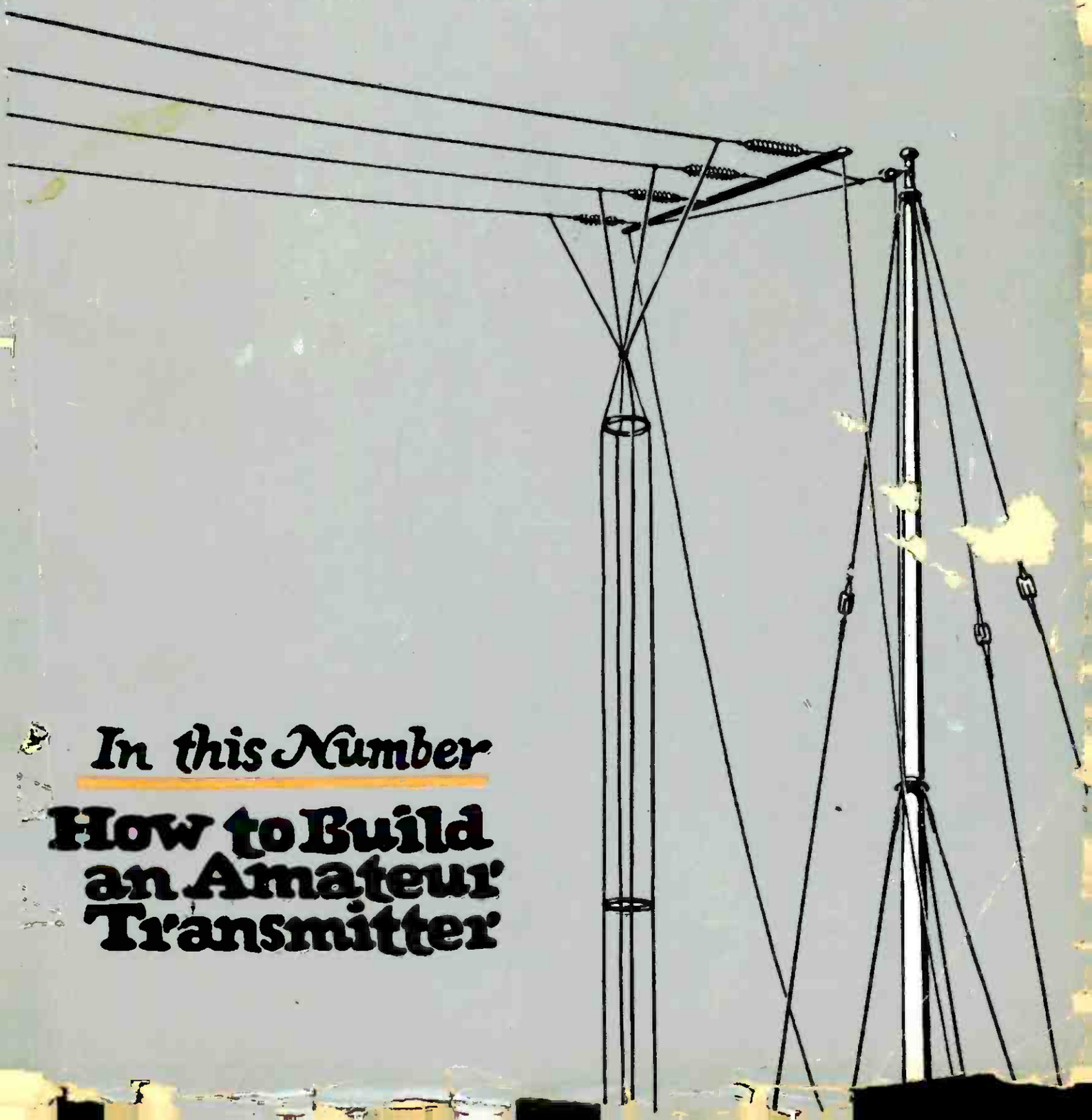
Popular Radio

Edited by KENDALL BANNING

25¢

MARCH
1924



In this Number

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Radiola III, an improved two tube receiver of antenna type, sensitive and selective. Complete with two WD-11 Radiotrons and headphones (everything except batteries and antenna) . . . . $35.

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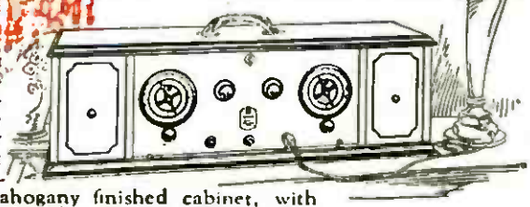
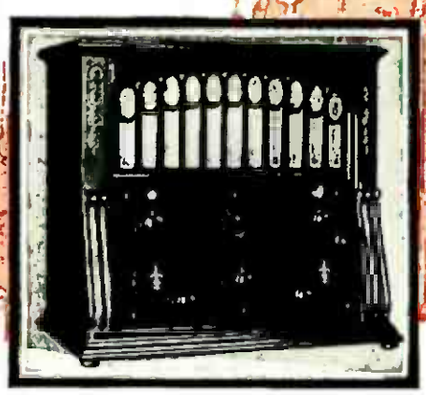


Radiola Super-Heterodyne, same as Super VIII but semi-portable in mahogany finished cabinet, with Radiola Loudspeaker. With six UV199 Radiotrons, but without batteries . . . . $286.

Same as above, but without Radiotrons or Loudspeaker . . . . . $220.

Radiola X— selective and non-radiating. Remarkable for distance reception. Built-in type loudspeaker. Complete with four WD-11 Radiotrons—everything except batteries and antenna. $245.



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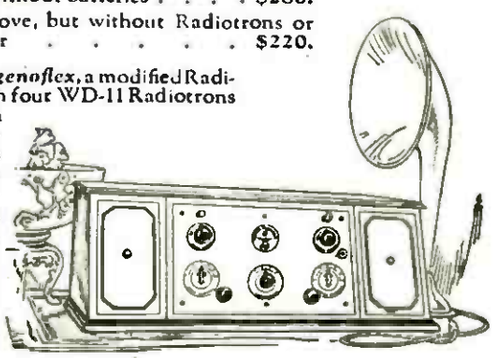
Same as above, but without Radiotrons and Loudspeaker $150



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Send this coupon for an illustrated booklet that tells the story completely, with detailed description of every set.

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REG. U.S. PAT. OFF.

POPULAR RADIO

EDITED *by* KENDALL BANNING

CONTENTS *for* MARCH, 1924

(Cover design by Frank B. Masters)

VOLUME V NUMBER 3

DEPARTMENTS

VOLUME V MARCH, 1924 NUMBER 3

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

Built to Grace a Drawing Room

Grebe Broadcast Receiver Type CR-12. A 4-tube Receiver combining Regeneration and Tuned R. F. $175.00
(Accessories extra)

"There is no calamity greater than discontent; no vice more sickening than covetousness."
—*Lao Tze.*

Contentment comes with possession of the best. Covet not thy neighbor's Grebe Receiver, acquire one for thyself.

Doctor Mu

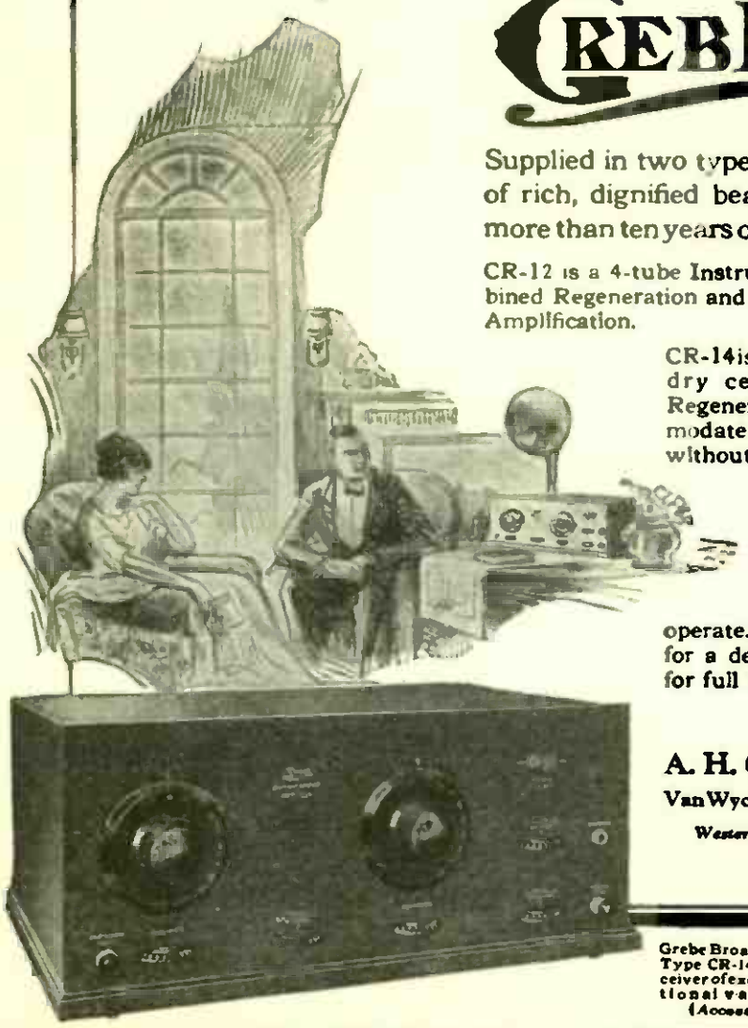
WHAT delight for all in the ever-fresh programs during the long, wintry evenings to come. Today's broadcasting better than yesterday's; tomorrow's more fascinating than today's. Tune in on this realm of entertainment, with a

GREBE Broadcast Receiver

Supplied in two types, each an Instrument of rich, dignified beauty—the product of more than ten years of skillful development.

CR-12 is a 4-tube Instrument in which are combined Regeneration and Tuned Radio Frequency Amplification.

CR-14 is a popularly-priced 3-tube dry cell Receiver employing Regeneration. The sockets accommodate UV-199 or C-299 tubes without adapters.



Both have beautiful walnut cabinets, employ concealed dry batteries and are extremely simple and economical to operate. Ask your quality dealer for a demonstration, or write us for full particulars.

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PAGES WITH THE EDITOR

THE next issue of POPULAR RADIO will contain an important contribution to the art and to the practice of radio—a complete, detailed "how to build" description of the latest product of the technical staff of this magazine—a simplified and extraordinarily efficient neutrodyne receiver.

* * *

THIS new development is a non-regenerative radio-frequency set. It has been designed by Albert G. Craig, the assistant technical editor of POPULAR RADIO, with the assistance of the technical editor, Laurence M. Cockaday, the creator of the famous four-circuit tuner, or as it is now internationally known, the "Cockaday Circuit."

* * *

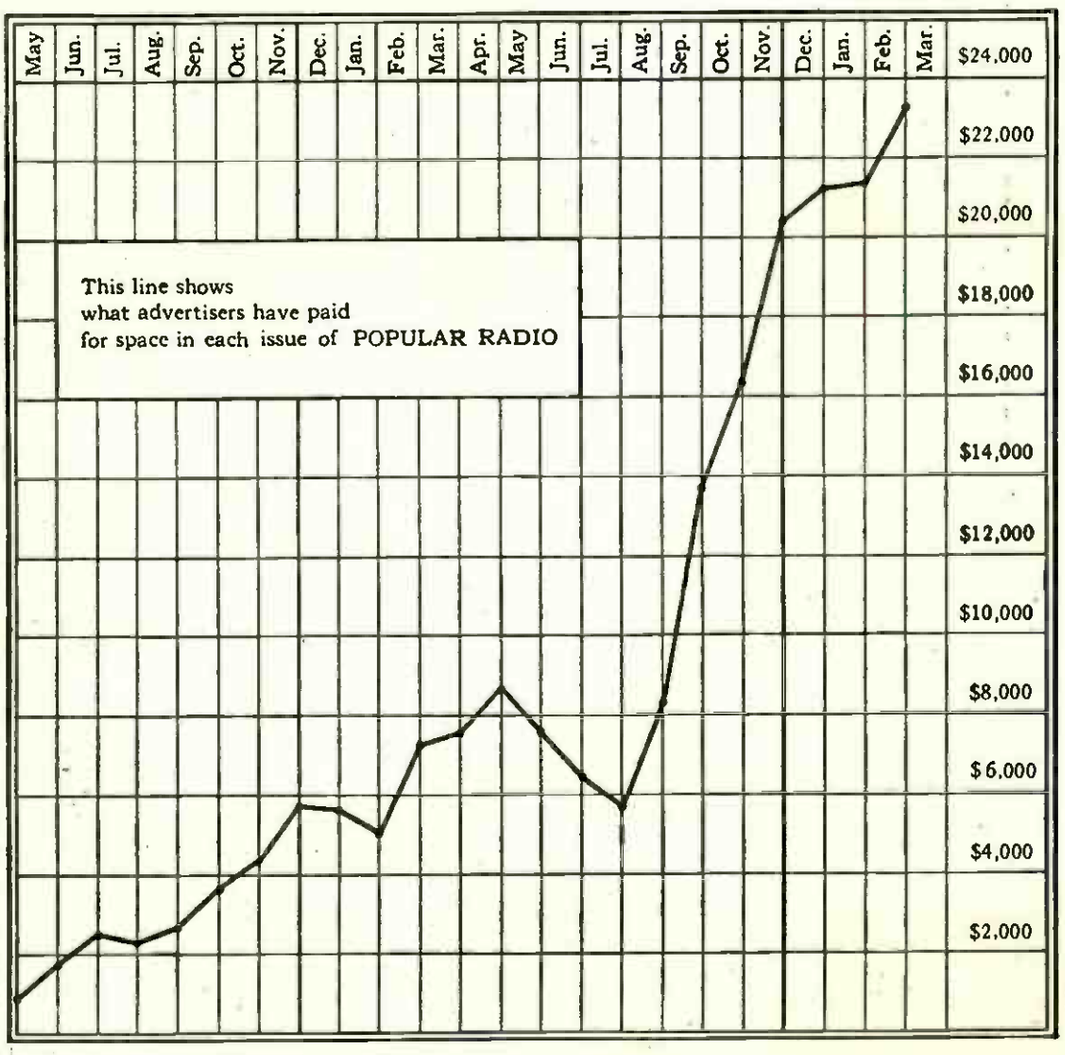
TESTS of this new receiver, which have been carried on over a period of several months, have revealed three outstanding features that will commend the set to radio fans:

1. Exceptional sensitivity for long-distance work;
2. Remarkable clarity of reception;
3. Ease of construction and operation.

* * *

IT is not at all unlikely that this new receiver will take its place with the best and most popular of the sets that have first been announced to the radio world in the pages of POPULAR RADIO; "How to Build the New Armstrong-circuit Receiving Set" by L. M. Cockaday, (September, 1922); "How to Build a Real DX Receiver" by L. M. Cockaday, (January, 1923): "How to Build the New Four-circuit Tuner" by L. M. Cockaday, (May, 1923); "How

(*Continued on page 6*)



HOW POPULAR RADIO HAS GROWN IN 22 MONTHS

Some idea of the remarkable development of this magazine since the May 1922 issue (which was the first one published) up to and including the March 1924 issue (which you are holding in your hands) may be obtained from this illuminating chart—which is one of a series that have been prepared by the business office as graphic evidence of the magazine's rapid increase in size, circulation and influence.

(Continued from page 4)

to Build a Tuned Radio-frequency Receiver" by L. M. Cockaday, (August, 1923); "How to Build the Haynes DX Receiver" by L. M. Cockaday, (September, 1923); "How to Build the New Regenerative Super-heterodyne Receiver" by L. M. Cockaday, (November and December, 1923); "How to Build the Improved Four-circuit Tuner" by L. M. Cockaday, (January, 1924), and "How to Build a Three-tube Reflex Receiver" by Walter A. Remy, (February and March, 1924).

* * *

READERS of POPULAR RADIO will be interested to learn that S. Gordon Taylor, whose essentially practical and helpful articles have been featured in this magazine, has just joined the technical staff. Mr. Taylor started out as a real "ham" fifteen years ago, and has been a contributor to numerous publications since then. He has taken special courses at both Columbia University and New York University, and is a licensed commercial radio operator.

* * *

"WHY," asks a practical-minded reader, Mr. C. Hartz of Minnesota, "are radio circuit diagrams always drawn left-handed? Why aren't they drawn the other way around, from right to left, so that the parts are indicated as they actually go into the set?"

* * *

POPULAR RADIO wonders why, too. Certainly it would appear to be more sensible to reverse the standard arrangement, (who originated it anyhow?) and to draw the circuits "the other way around" as Mr. Hartz suggests; certainly this would seem to be a more practical plan—particularly for beginners.

* * *

THE advantages of the proposed new arrangement are obvious. A home-built radio receiver, for example, is always wired from the *back* of the set; the experimenter, therefore, has to go through the mental process of reversing the conventional diagram when he does the wiring, because the wiring progresses from the antenna and the ground connections at the right, through the tuning units to the amplifier units at the left. The conventional wiring diagram starts with the antenna and ground connections at the left, and ends up with the amplifiers at *the right.*

Why not make the diagram read exactly as it applies to the set?

* * *

THE best way to find out what the radio fans think about the proposed new arrangement of circuit diagrams is to test it out and let the fans decide for themselves. In the next issue, accordingly, the article describing how to build the new and simplified neutrodyne receiver will be illustrated with a circuit diagram that is exactly the *reverse* of the conventional—and which will indicate the various parts and connections in the order in which the experimenter actually makes use of them.

THE opinions of our readers on this innovation are cordially invited.

* * *

JUST as we burst into print with the assurance that "if you see it in POPULAR RADIO it's so" some observing reader is destined to call our attention to an inaccuracy that covers us with confusion. In justice to our readers, the only honest course is to admit the errors frankly. Here are two corrections—for which we extend thanks to the good friends who make them.

* * *

THE first comes from Harry Goodall of Chicago, who writes: "In the list of broadcasting stations on page 97 of your January issue, station KFCL is listed as *San Antonio,* California. There is no such place in the United States according to the U. S. Postal Guide. Your list is the fourth one that I have seen that has had this mistake in it. It seems to me that some stenographer made a mistake in typing the list and others have copied from that incorrect list. This station should be in *Los Angeles,* California, for it is the Los Angeles Union Stock Yards station."

* * *

THE second correction comes from Dorman D. Israel of Cincinnati, whose illuminating article "Amplification without Distortion" in the January number has attracted nation-wide attention. He states:

"In checking over the text of my article I have found one or two minor errors. On page 73, in the first column, there is an addition sign consistently omitted from the denominator of the fraction. The three equations should be

$$I_p = \frac{kE_{g1}}{R_p + R_1} \qquad \frac{E_{g2}}{E_{g1}} = \frac{kR_1}{R_p + R_1} \qquad I_p R_1 = \frac{R_1 kE_{g1}}{R_p + R_1} = E_{g2}$$

"On page 75, in the first column and third line from the picture, the text should read 'tube to negative filament, and adjust e_2 to give, etc.' At the top of the next column, the first two lines should be 'first tube to negative filament and adjust e_1 for normal plate current, etc.'"

* * *

IN response to hundreds of requests from our readers for actual-size working plans of the improved four-circuit tuner (described in our January, 1924 number), POPULAR RADIO has had prepared a full set of blueprints—including the actual-size panel pattern, the instrument layout and a picture diagram of all parts, showing the wiring. The set of three will be sent to readers, postage prepaid, upon receipt of $1.10.

Kendall Banning

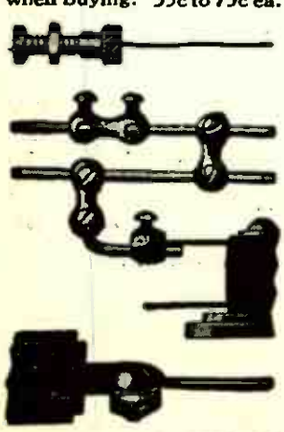
Editor, POPULAR RADIO

Exit Variocoupler

Enter Erla Selectoformer

Superior worth of Erla audio transformers, shown in their exclusive ability to amplify three stages without distortion, improves any set. $5

Erla condensers alone carry a certificate of accuracy on their labels. Look for the words "Tested Capacity" when buying. 35c to 75c ea.



Assembly of radio apparatus is enormously simplified by Erla solderless connectors, made in sizes and styles for every purpose. List, 3c to 5c

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Again Erla contributes notably to radio advancement. Erla Selectoformer, replacing alike variocoupler and wavetrap, greatly increases volume and selectivity in radio receivers, at the same time reducing cost.

Selectoformer, as the name implies, operates simultaneous as a selector and transformer, picking off of the antenna the one wavelength desired and amplifying it to normal strength.

Thus is avoided the interference common to receivers that depend for selectivity upon tuning the coarse antenna system. Also, because of the amplification brought to bear, there is eliminated the loss of energy encountered in wavetraps of conventional type.

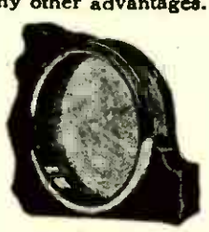
With Selectoformer, distant signals come in loud and clear, even with powerful local broadcasting in progress. Tone quality, likewise, is greatly improved, through reduction of static and other disturbances.

For complete details regarding this and other Erla improvements, including latest reflex circuits, ask your dealer for Erla Bulletin No. 20, or write, giving your dealer's name.

Electrical Research Laboratories
Dept. R 2515 Michigan Ave., Chicago

ERLA

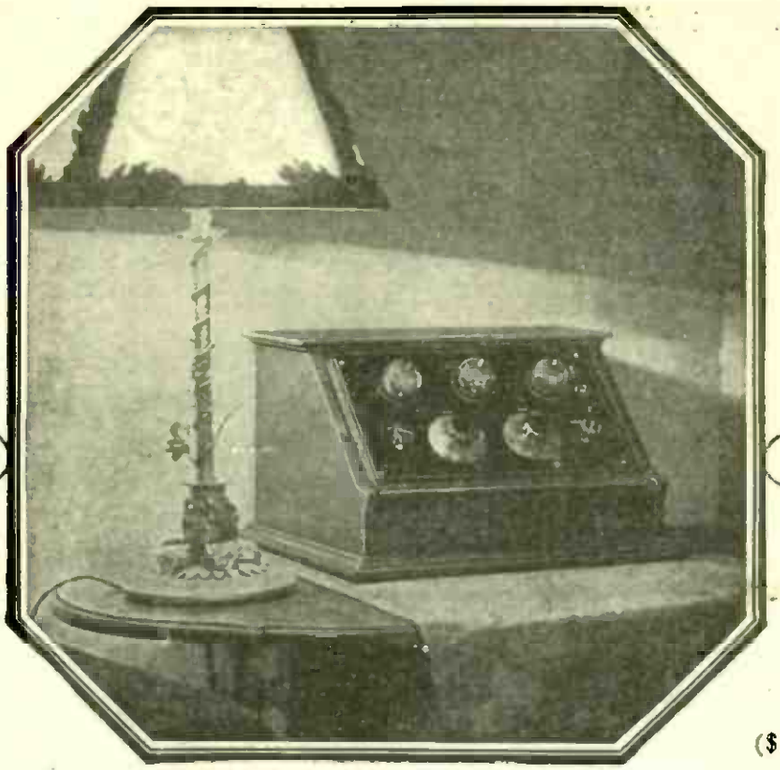
Supreme beauty and strength are combined in Erla sockets, with heavy, nickeled shell cast into moulded Bakelite base. Many other advantages. $1



Patented telescoping rim of Erla bezels fits any ⅛" to ¼" panel, neatly screening openings required for tube ventilation. Nickel or enamel, 20c

Reliable and clear reception is assured through the Erla fixed crystal rectifier, requiring no adjustment and lasting indefinitely. List $1

Erla semi-fixed crystal rectifier enables accurate initial adjustment to individual circuit characteristics. No attention required. List $1



$125
fully equipped
($127.50 west of Rockies)

New Kennedy Radio Receiver, Model V

Simple to Operate—Selective—Mechanically Excellent!

This new Model V Kennedy Radio Receiver has established a high standard of tuning simplicity—combined with the same precision and selectivity formerly associated only with the more complicated Kennedy models. Added to this are all the characteristics of mechanical perfection that have made Kennedy "The Royalty of Radio."

Anyone can operate this new product of the Kennedy Engineering Staff. After a preliminary setting has been made, tuning is controlled by a single dial. Dial settings are always the same for a given station, regardless of where the receiver may be operated or the kind of antenna that may be used.

Model V is particularly free from "re-radiation." It reproduces music and voice with unsurpassed purity and operates on any ordinary antenna—outside type preferred. Embraces the entire broadcast wave range.

Selectivity is one of the outstanding features of this new Kennedy model. It will clearly differentiate between distant and nearby stations only a few meters apart—local interference can in most cases be eliminated as satisfactorily as with older Kennedy models.

Mechanically, Model V bears the same high stamp of excellence that has characterized Kennedy Receivers during the past twelve years. In every detail of construction the highest standards of precision and accuracy are rigidly adhered to.

Model V is an exquisite piece of furniture. The cabinet is of mahogany, hand rubbed to a beautiful satin finish. Its proportions are pleasing. The highly polished black Formica panel lends an elegance of finish—its height and angle have been established, after much thought and study, to provide comfort and ease in tuning.

The price of Model V, completely equipped with all tubes, dry batteries and individual Kennedy 3,000-ohm phones, with plug, is only $125.00 ($127.50 west of Rockies)—marking it as a feature value in radio equipment. Other Kennedy models range from $285.00 to $825.00 (slightly higher west of Rockies), completely equipped, including built-in loud speaker.

See the new Kennedy Model V at your dealer or write us direct for fully illustrated literature on this and other Kennedy Radio Receivers.

All Kennedy receiving sets are regenerative.
Licensed under Armstrong U. S. Patent No. 1,113,149.

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS SAN FRANCISCO

KENNEDY

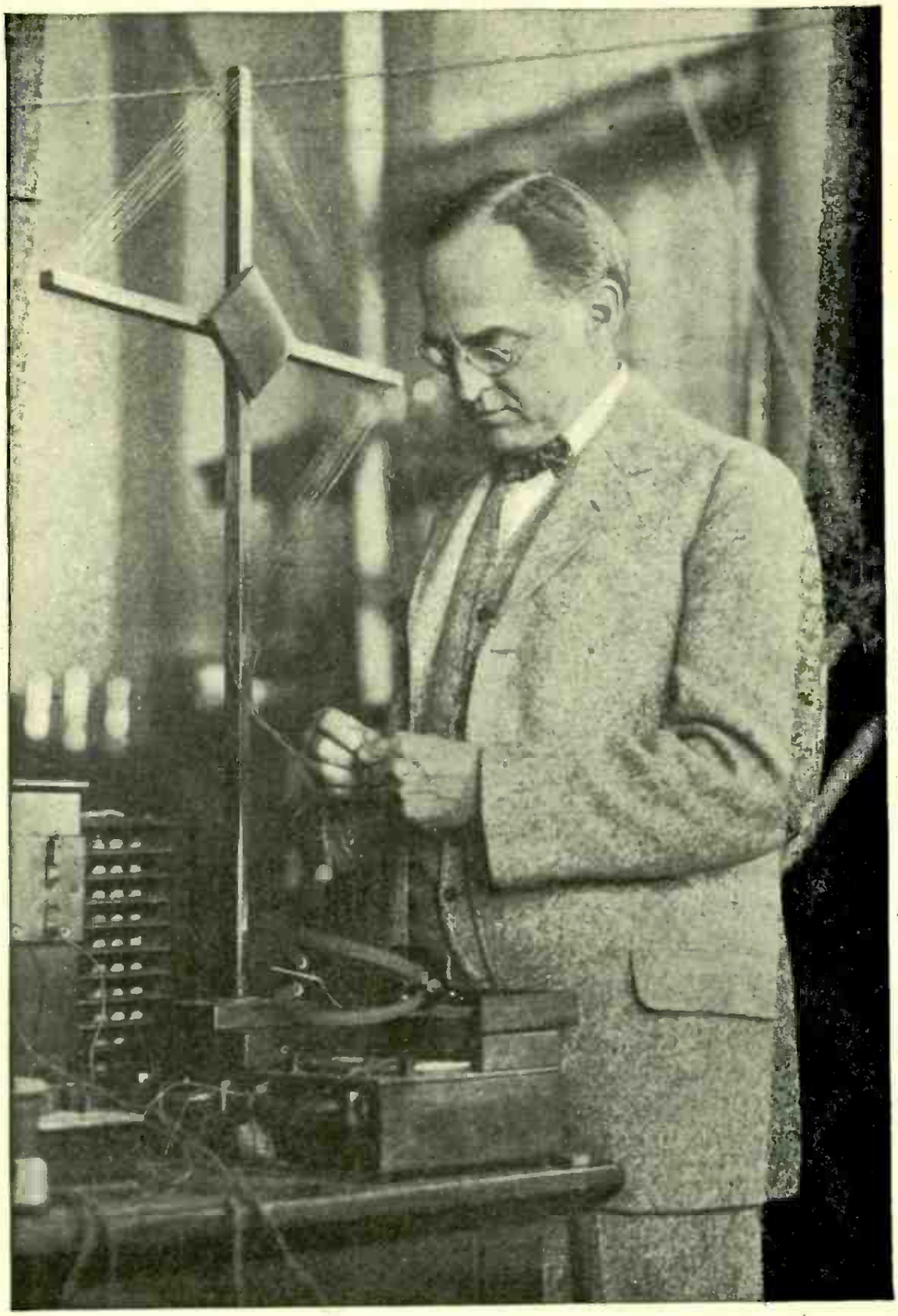
The Royalty of Radio

From a photograph made for POPULAR RADIO

"A Remarkable Achievement," States One of the World's Great Scientists

"I CONGRATULATE all wireless workers on the fact that in POPULAR RADIO they have a publication which is absolutely independent of all commercial interests. This means a great deal in these days of propaganda. As a rule, I do not read many of the so-called 'popular articles,' but yours are so up to date and so authoritative that I am very glad indeed to get them, and the fact that they are so lucid that anyone can understand them without previous technical training is a remarkable achievement in your field of work."

—REGINALD A. FESSENDEN



"Radio, the Open Sesame of Electricity"

So states Dr. Willis R. Whitney—and few authorities are better qualified to say what mental habits are necessary for a scientist. Dr. Whitney used to be a professor in the Massachusetts Institute of Technology; during the War he was a member of the Naval Consulting Board; now he is the head of the great research laboratories of the General Electric Company at Schenectady. In the article (beginning on the facing page) he points out what these habits are and how radio is helping to develop them in American young men.

Popular Radio

VOLUME V MARCH, 1924 NUMBER 3

Is Radio Changing Our Mental Habits?

While the amateur is experimenting with his set he is acquiring something more than a mere technique; *he is learning how to think*—and learning in a way that is significant both to him and to the world of science.

By WILLIS R. WHITNEY, Ph.D.

TO a man whose business is scientific research one of the most important features about radio is its promise as a training school for future scientists.

The high-school boy who has been experimenting for a year or two with home-made radio sets probably has already a better working knowledge of electrical science than was possessed by the average college graduate of twenty years ago. He has awakened a wide group of scientific interests. He has acquired, almost unconsciously, many of the essentials for a life of useful scientific research.

This seems to me a fact of extraordinary social and economic importance. We want America to go ahead. We want our industries to prosper and the inventiveness for which our countrymen are famous to continue. And we want the world to become a better place for our having taken a part in it.

This means that we must have much scientific research—even more research than we are doing now. It means the continual study of scientific problems carried on in hundreds of laboratories; sometimes because of definite industrial needs; more often, perhaps, because of love of knowledge for its own sake. It means, too, that we must provide a continual supply of men who are competent to do this work; men who are not only trained in the *facts* of science, but who have that equally necessary asset of inquisitiveness, who possess the undimmed curiosity and lively imagination of those on whom the shackles of established precedent have not yet been fixed.

If I were asked to set down what seems to me the most important single asset of a scientific research worker, I would say, I think, that it is just this attitude of free inquisitiveness, this willingness to start off into new lines of

thought that no one has ever followed before.

Think, for example, of the history of the transmission of speech over long distances. The first effort to do this, I suppose, was by finding men who could shout loudly, or by lining up a number of such men, and having them all shout at once. This way of doing it is still used, we are told, by some savage tribes. Other savages use drums or gongs. Travelers report that messages can be sent long distances in the African jungles very quickly by being relayed in this fashion from one drum-telegraph station to another.

Gilliams Service

AN INTEREST IN RADIO DEVELOPS INGENUITY

Experimenting with radio taught this New York fan, Mr. Henry Farkouh, enough inventiveness so that he built this entire receiving set, containing three tubes, tuners, batteries and all, on a belt that he can fasten around his waist. The antenna wires are rolled up when not in use.

Civilized men, some thousands of years ago, began a somewhat different improvement, the speaking tube. By confining the sound of the voice in such tubes, it was possible to transmit it through walls or over distances somewhat greater than could be covered by a mere shout.

Now all these devices—the man who could raise a loud shout, the beaten drum, the speaking tube, and (I might add) the modern megaphone—are perfectly natural extensions of ordinary speaking. It required no great inventive genius, no really new thinking, to devise these things.

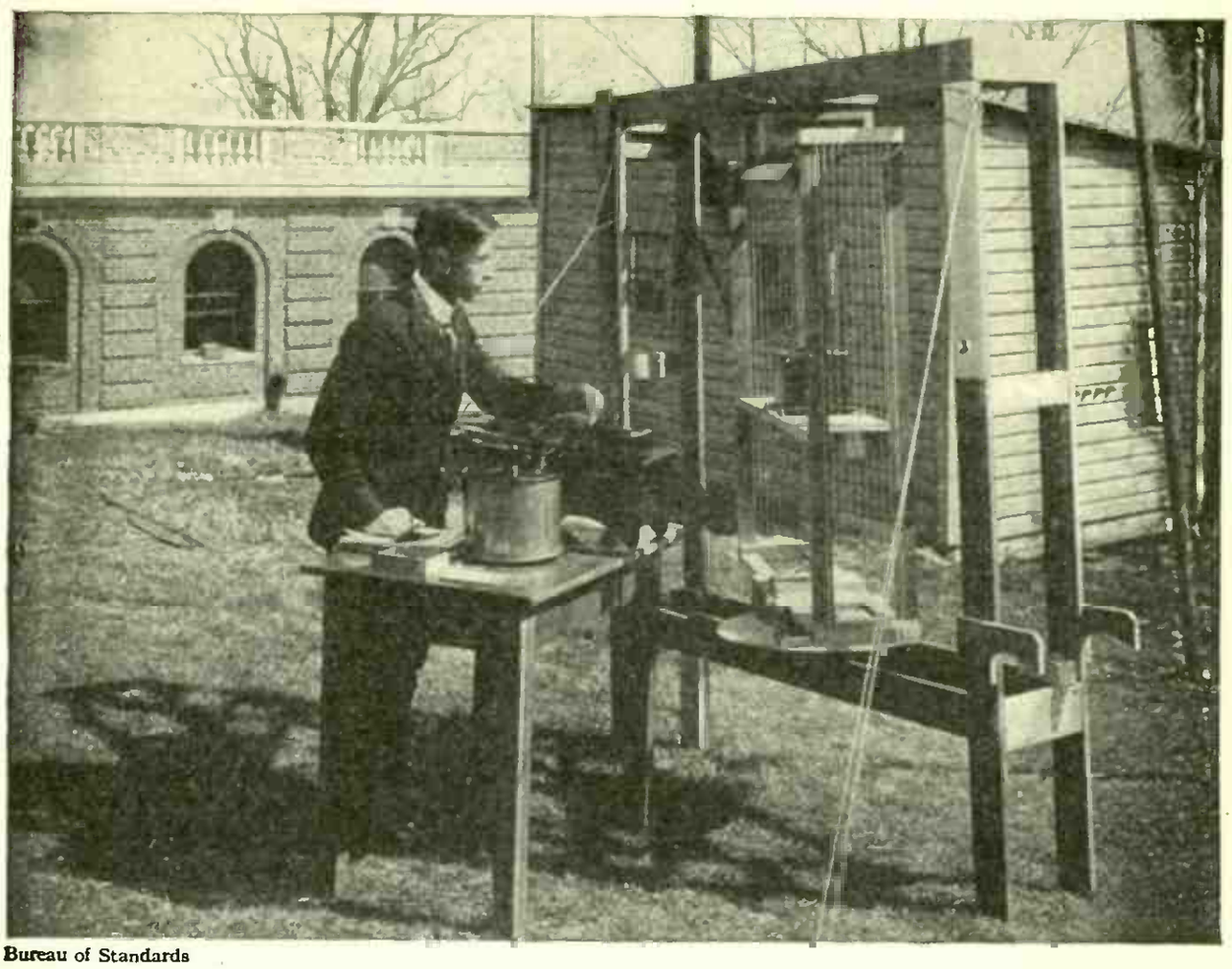
But the next step *did* require new thinking.

If you wanted to work a speaking tube over a longer distance than usual, your natural thought would be to make the tube larger. But this was not, as it proved, the actual path of advance. What was really done, was to make the tube *smaller;* to make it so small, in fact, that the tube part of it disappeared entirely and it became a wire. Then speech was sent through this wire in a totally new way, an electrical way. It became the telephone.

The point of this is that the invention of the telephone came through a new way of thinking.

Progress along the old lines of thought, the attempt, that is, merely to improve the speaking tube, would never have got us anywhere. Some one had to break away altogether from this usual way of thinking and start out in a new way.

Every once in a while this has to be done in any line of research and here is where the real research man proves his worth. He is the man who can escape from precedent and who has new knowledge, often before he has the problem, or who can attack whatever problem confronts him in a totally new way.



Bureau of Standards

SCIENTIFIC RESEARCH THAT ANY RADIO FAN CAN DO FOR HIMSELF

Radio not only trains a man for scientific work, it gives him many opportunities to do valuable research for himself. With portable loops and accessories (such as this outfit of the Bureau of Standards) any radio amateur can make valuable observations on the behavior of radio waves in the ether; on the effect of buildings, mountains and other obstacles on transmission; and on many similar problems the true solutions of which are still unknown even to the scientists.

Scientific research might be defined as the continual search for the unexpected, the continual possibility of doing what was believed to be impossible—not only not considered possible, but frequently not even considered *at all* because at the time it was impossible to consider.

The young man who enters science by the path of radio is exceptionally likely, I think, to retain this desirable open-mindedness and freedom from the rule of precedent. Most of the facts about radio have no precedents. Many of them are still unclassified or poorly understood and it is just such unclassified facts in all branches of human knowledge which are the most interesting and which give us, when they are followed up, the most fruitful scientific advances.

The development of the vacuum tube, for example, involved more than a score of inventions that were once considered to be hopelessly impossible. The chief of them perhaps was ductile tungsten. When Dr. Coolidge was trying to work this out most of the scientific men in the world thought that we were following a foolish dream. Tungsten, they said, was by its very nature a brittle metal. The system of academic pigeonholes had no place for a kind of tungsten that could be drawn into wire; therefore, no such metal could exist. This was the attitude, it usually is the attitude, of the conventional mind.

But ductile tungsten was made to exist and Dr. Coolidge found out how to make it. The result was the modern electric lamp and, more recently, the radio vacuum tube. Without a willingness to think along new lines in spite of supposed impossibilities this would never have been done and today's broadcasting might have had to get along without the vacuum tube, if, indeed, it could be done at all.

The daily history of radio is full of similar instances. Even the receiving of broadcast concerts is encouraging, I think, to a habit of open-mindedness. Tuning in on a distant station is a good deal like hunting for an unknown scientific fact. You have the conviction that the fact is there, you enjoy immensely the uncertainty and suspense as you try to find it. Finally you have the thrill of picking up out of the ether the tones of a voice that is speaking two hundred or two thousand miles away. Anything might happen after this. Anything is worth trying.

This is the true and necessary spirit of scientific research, the spirit of "try it and see what happens." If you graduate from radio and move on into a college, university or technical research laboratory somewhere you will find that the mental habits you formed in working out the details of your set will be exactly the mental habits most in demand in the larger field of general research.

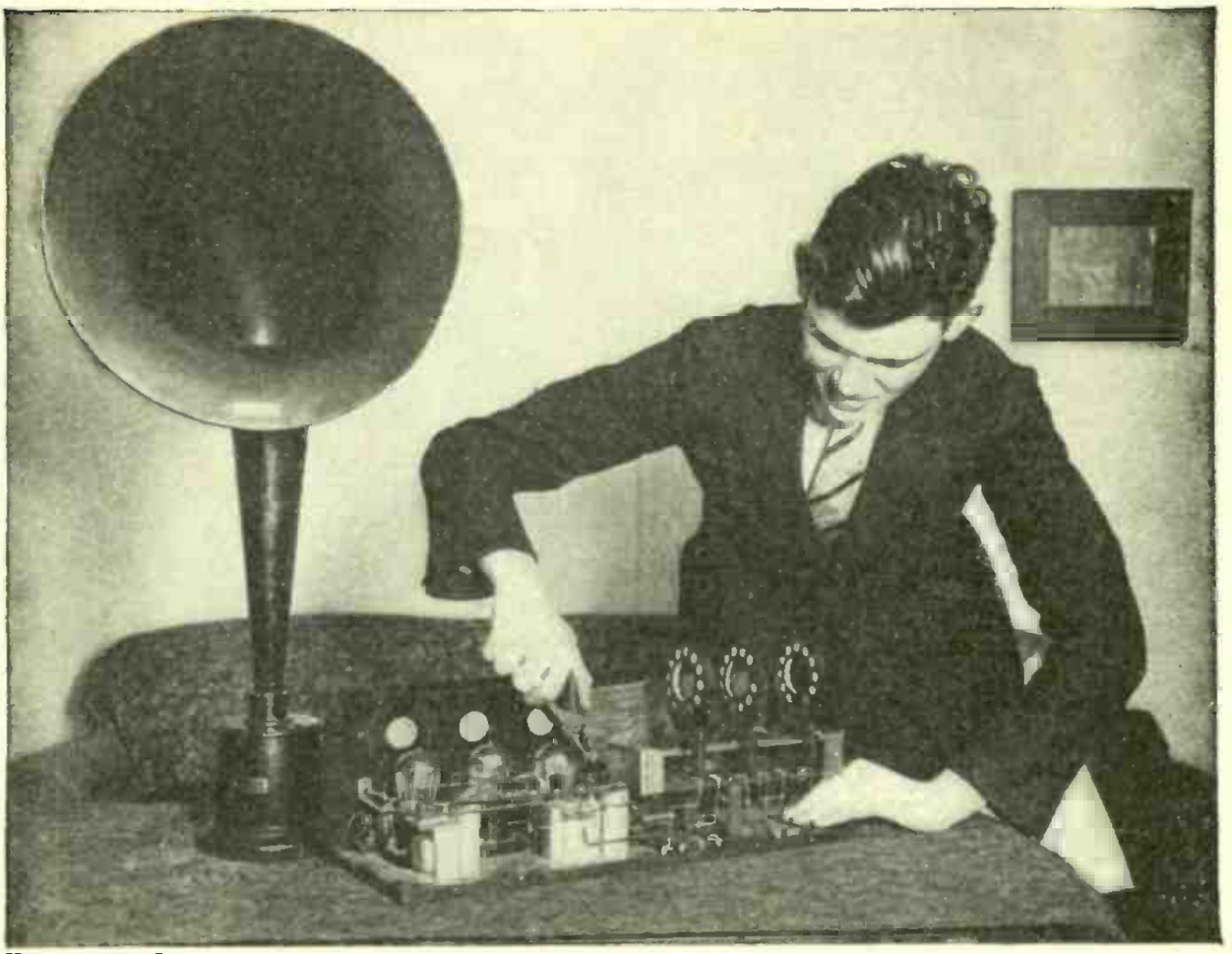
Another aspect of amateur radio that is significant from the educational point of view is the fact that it seems to have succeeded in doing what it seems so difficult for schoolmasters to do. It has made education interesting.

The mathematical principles of inductance and capacity, of interference and tuning and the heterodyne, are not by any means easy to understand. If the average youngster were compelled to learn these principles in school he would

Keystone View Co.

TINKERING WITH "HOOK-UPS" MADE THIS RADIO AMATEUR WORLD-FAMOUS

Mr. John Reinartz is well known to American amateurs as the originator of the famous Reinartz circuit and of many other radio devices. It was a transmitting circuit devised by him that was used by Captain Deloy in the recent transatlantic transmission on a one-hundred-meter wave. Like many others, Mr. Reinartz owes most of his scientific training to his long interest in American amateur radio.



Keystone View Co.

THE BOY WHO READ DIME NOVELS A FEW YEARS AGO IS NOW "BUILDING HIS OWN"

A young man who designs and builds his radio set is acquiring, says Dr. Whitney, a working knowledge of science as well as a training in those mental habits which are especially needed in scientific work.

consider, no doubt, that he was being grievously oppressed. Yet when these same principles concern his beloved radio set he tackles them not only without protest but actually with eagerness. And, what is more important, he succeeds in learning them.

Why is this true? Just why does the fact that something has to do with radio increase so largely the ease and interest with which young people learn it?

There are, I think, two reasons. They are the same reasons that explain the fact, so often lamented by the professors, that most students are more interested in athletics than they are in their studies. This fact does not seem to me an unnatural or even a deplorable one. It is a normal reaction to the fact that athletics possess to a high degree two characteristics that never fail to be appealing to the human mind; they involve the interest of a contest and they mean doing something by team-work.

These are the reasons why baseball and football have so strong a hold on the youthful mind and these same reasons apply with equal force to amateur radio. The element of contest in radio happens to be a contest against the forces of Nature, a mental golf bogey against static or fading or the physical imperfection of one's apparatus. But it is none the less a real and perceptible contest. The satisfaction of winning it, of overcoming the succession of obstacles that Nature puts in the way, for

From a photograph made for POPULAR RADIO

THE SAME SCIENTIFIC RESEARCH DEVELOPED BOTH X RAYS AND RADIO

The small tube held by Mr. Killefer of the American Chemical Society is a model of the original X-ray tube devised by Professor Roentgen. Its modern brother is the large tube on the left. The research leading to the development of this modern tube (much of which was done under the direction of Dr. Whitney), has also led to the modern thoriated filament for vacuum tubes and to many features of the methods used in producing the vacua in hard tubes for radio use.

example, of hearing a program broadcast from the other side of the continent, is quite as thrilling as the joy of winning a football game or making a home run.

This satisfaction, by the way, is exactly the same as one gets out of successful scientific research of any kind. It is winning one's fight against the unknown that constitutes, I think all scientists will agree, the chief of the many satisfactions that scientific work affords.

The second attractive element of athletics, that of team-work, is also an element of radio. Radio is necessarily a co-operative business. It requires, at the least, a sender and a listener. It extends itself, very soon, to the group of kindred enthusiasts who form the local radio club. How vital an element this is in the radio world is sufficiently attested by the hundreds, probably thousands, of amateur radio organizations that are active all over the world.

All these things are matters of attitude, of habit of mind. They mean, I think, that the general mental outlook of the radio amateur is prepared, unconsciously, for scientific research. But

we must not forget, also, the preparation which he acquires, also unconsciously, in the way of actual knowledge of facts.

The amateur starts out, let us suppose, with some simple kind of receiving set. He learns, by mere imitation, how to twiddle the dials or jiggle the catwhisker until the set gives him what he wants. Like all true scientists he is never quite satisfied and he keeps readjusting. For a time the why of it all doesn't interest him.

Then gradually this mental horizon widens. To our beginner electricity is merely a rather mysterious something that comes through wires into the house to light lamps and that will sting you if it gets out and bites you. A vacuum tube is merely a special kind of electric lamp with some little doo-dads inside it.

But one cannot play with radio very long and remain incurious. The why, for example, of the vacuum tube demands insistently to be answered. This opens up the wonderful and romantic story of the electron, and from that our fan goes on, step by step, into the mysteries of the atom and its structure and into the whole new world of modern physics.

This gradual training of the radio amateurs in scientific thinking and in the facts of science is going to prove, if I am right about it, a matter of very great importance to the scientific professions and to the country.

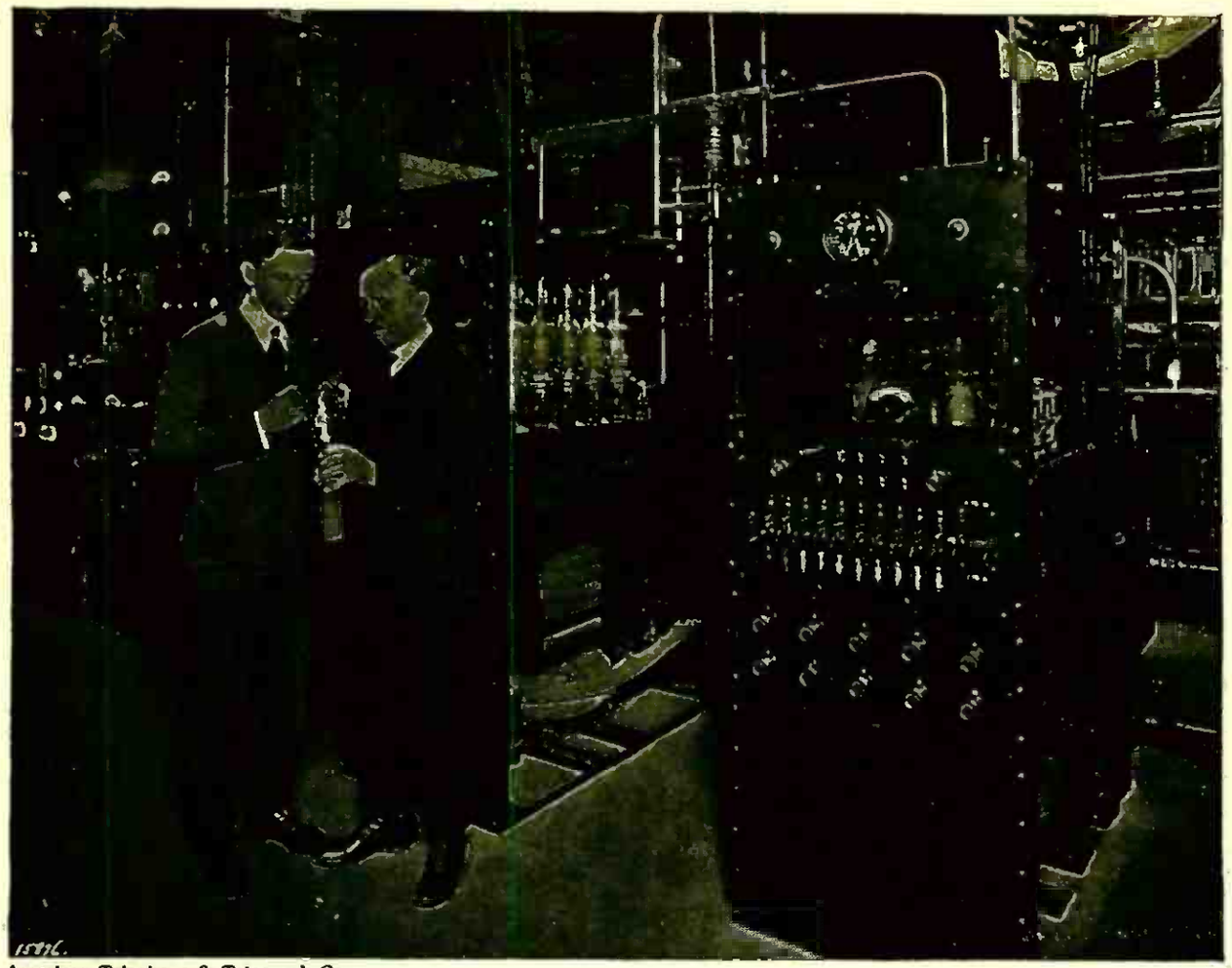
The world is more ready now for new undertakings than it has been before. It is learning by experience how it may advance through added knowledge of physical facts. While it is difficult to foresee improvements in our ways of living, it is not difficult to recognize them after the event. nor determine their laws.

We probably think of Champlain's first use of gunpowder against the American Indians as a natural outcome of the stinkpots of the ancients. We can look backward with boldness and certainty. We have myopia only on looking ahead.

It may be quite in accord with possibilities to consider the great army of American radio fans as the conquerors of future wars. With a people who are anxious to test the elasticity of human intellect, is it out of the question that our radio amateurs may yet teach foreign nations the American language? Even the English say they already hear and understand our broadcasting and amateur radio. The whole world can soon call and carry on a general conference about as quickly as a Kansas town could call a constable a few years ago.

Probably not one man in a thousand ever realized what the discovery and development of printing meant to the race. Most of us take it as a matter of course, but in the history of man it is a very recent event. It covers only the last two or three tenths of one percent of his existence. But see what a rapid development it gave the man. For the future the best guess we could make involves a still greater uplift because of radio, strange as it may sound, because we are already on a much superior plane for utilization and appreciation than the folk of five or six hundred years ago.

All other nations are watching our radio experiments. No other country has advanced half as far. Broadcasting is only starting abroad. Amateurs, the heart and backbone of our radio, are almost unknown abroad. The European laws will probably continue to discourage amateurs. Here everything will certainly be done to help them. What will we do with it? It is a great opportunity for every ingenious independent thinker or worker.



American Telephone & Telegraph Co.

WHERE THE RADIOPHONE TEST SIGNALS WERE TRANSMITTED IN NEW YORK—

Notice the great banks of tubes used in the transmitter that was employed in the daily transoceanic tests for determining field strength measurements for different periods of the day and night throughout the year.

Charting the Ether Lanes

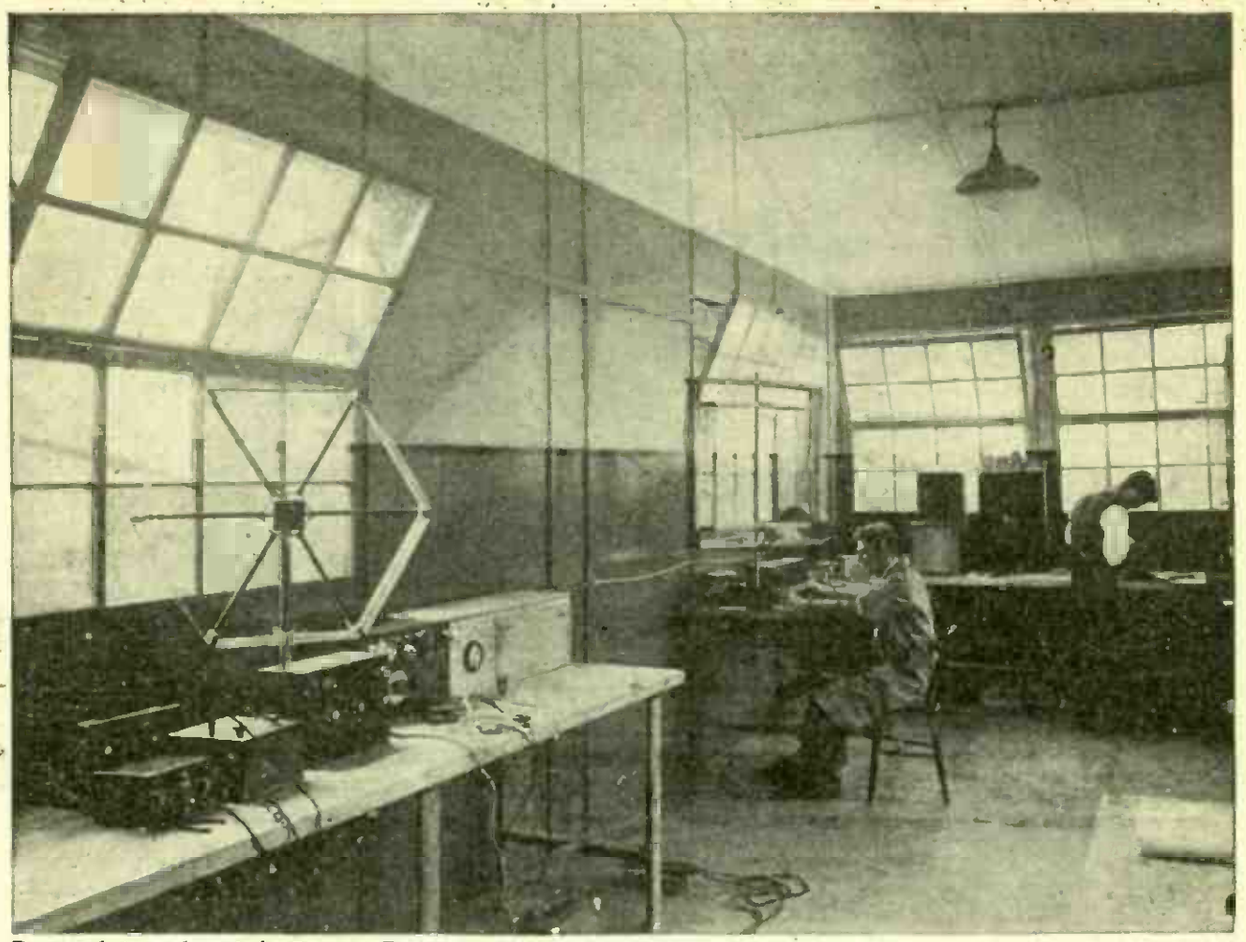
FOR TRANSATLANTIC CONVERSATION BY RADIO

It is only a matter of time when we will talk across the ocean by radio as easily as we now talk short distances over wires. Scientists are preparing the way for this new link between the peoples of the world. The experiments carried on quietly during the last year show that the conditions of transmission between the two sides of the Atlantic vary from time to time with night and day, and from season to season, and that varying amounts of power are necessary to transmit clear speech across the ocean in accordance with these variations in transmitting conditions. This article tells of these tests.

By HARRY A. MOUNT

THE day is not far distant when the radio telephone will enable the President of the United States to exchange greetings by word of mouth with the King of England across 3,000 miles of water.

There is perhaps no single event which is looked forward to with keener interest on the part of radio enthusiasts and which will be considered more significant by the public at large than the establishment of transatlantic radio-



From a photograph made for POPULAR RADIO

—AND WHERE THEY WERE RECEIVED IN LONDON

Here is the laboratory in which the receiving data was compiled and tabulated. The data here compiled is summarized in the graphs which are reproduced in Figures 1 to 5, that accompany this article.

telephone service. When this event comes it will, of course, enable anyone who desires to talk to Europe to do so, just as anyone can now use a local or long-distance telephone. Indications are that such a service is not far in the future.

Some months ago a successful demonstration of transatlantic telephony was given which involved the continuous transmission of messages from New York to London for a period of over two hours. It was a one-way circuit, however, and the recipients in London had to reply by cable. Many steps remain to be taken between this one-way demonstration and two-way service which is continuously available during the twenty-four hours of the day.

One of the most essential steps leading to a complete two-way system is an extensive knowledge of the transmission characteristics of the ether from hour to hour, day to day and season to season. This knowledge is as necessary in the laying out of a successful radio-telephone system as a knowledge of the topography of the proposed route of a railroad would be to the laying out of the road-bed. The engineers in charge of locating the track must know the exact whereabouts of hills and valleys, streams and marshes, and similarly, the radio engineers in designing a vast transatlantic telephone system must know, in as minute detail as possible, all of the characteristics of the ether and the variations to which it is subjected because of the influence of the earth's atmosphere.

Several months have now been spent in gathering facts concerning transmis-

sion through the ether of transatlantic radio-telephone messages. In this work the equipment which was successfully used in talking across the Atlantic last winter was supplemented by apparatus designed to measure the strength of the signals, and the interference and noise received in London.

The following data is summarized from an engineering paper prepared by H. D. Arnold and Lloyd Espenschied, and recently presented before the Institute of Electrical Engineers.

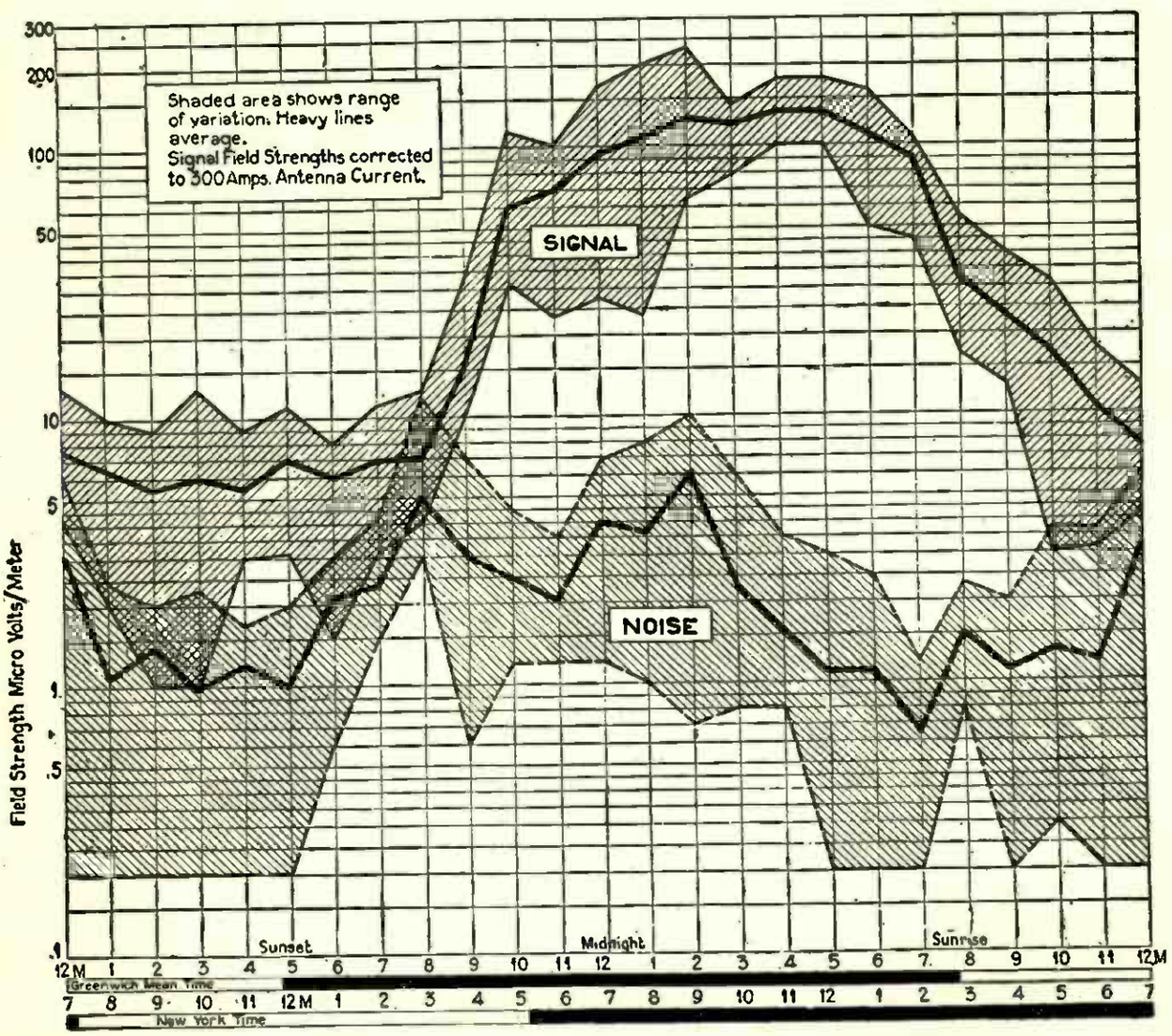
With the test set installed in London data was collected on the strength of signals sent out from Rocky Point, Long Island. The three quantities which are included in the transmission measurements, namely the signal strength, the noise strength and the percentage of words received correctly, are observed one after another in what might be termed a unit test-period. The following program is representative of such a period:

Five minutes of tone-telegraph identification signals for receiving-adjustment purposes.

Ten minutes of disconnected spoken words.

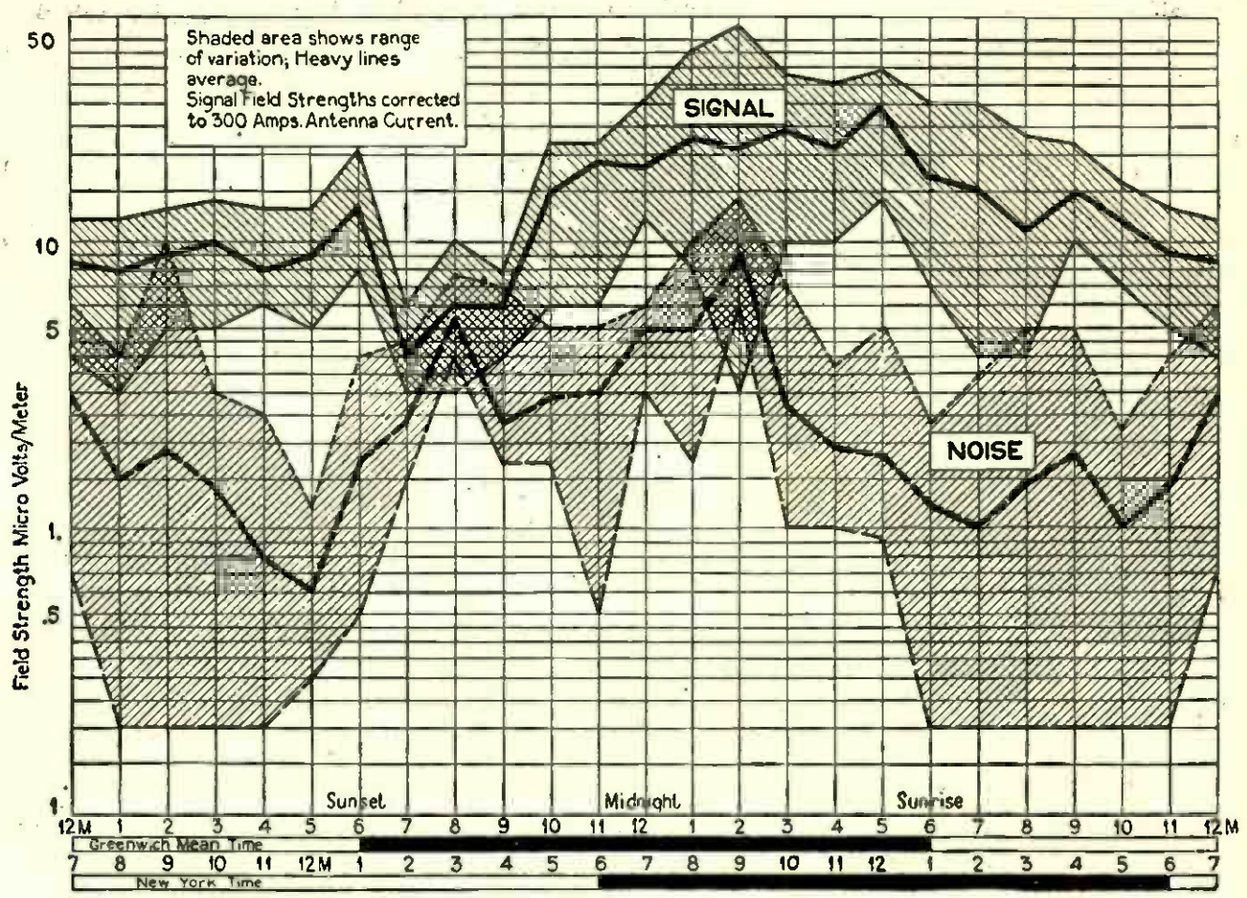
Ten minutes of a succession of five-second, tone dashes separated by five-second intervals for measurement of the received field strength.

Immediately following this test, the



THE DIURNAL VARIATIONS IN "SIGNAL AND NOISE"

FIGURE 1: *This graph shows the variation of received signals and noise during each day at various times, beginning on January 1st and ending February 23rd. The top portion of each shaded section indicates the highest values obtained; the lower portion shows the lowest values. The heavy center lines give the average values.*



A CHECK-UP ON FIGURE 1

FIGURE 2: *This curve gives the same sort of data on the field-strength measurements as Figure 1, except that the measurements were made between February 25th and April 9th.*

London observers measured the noise level.

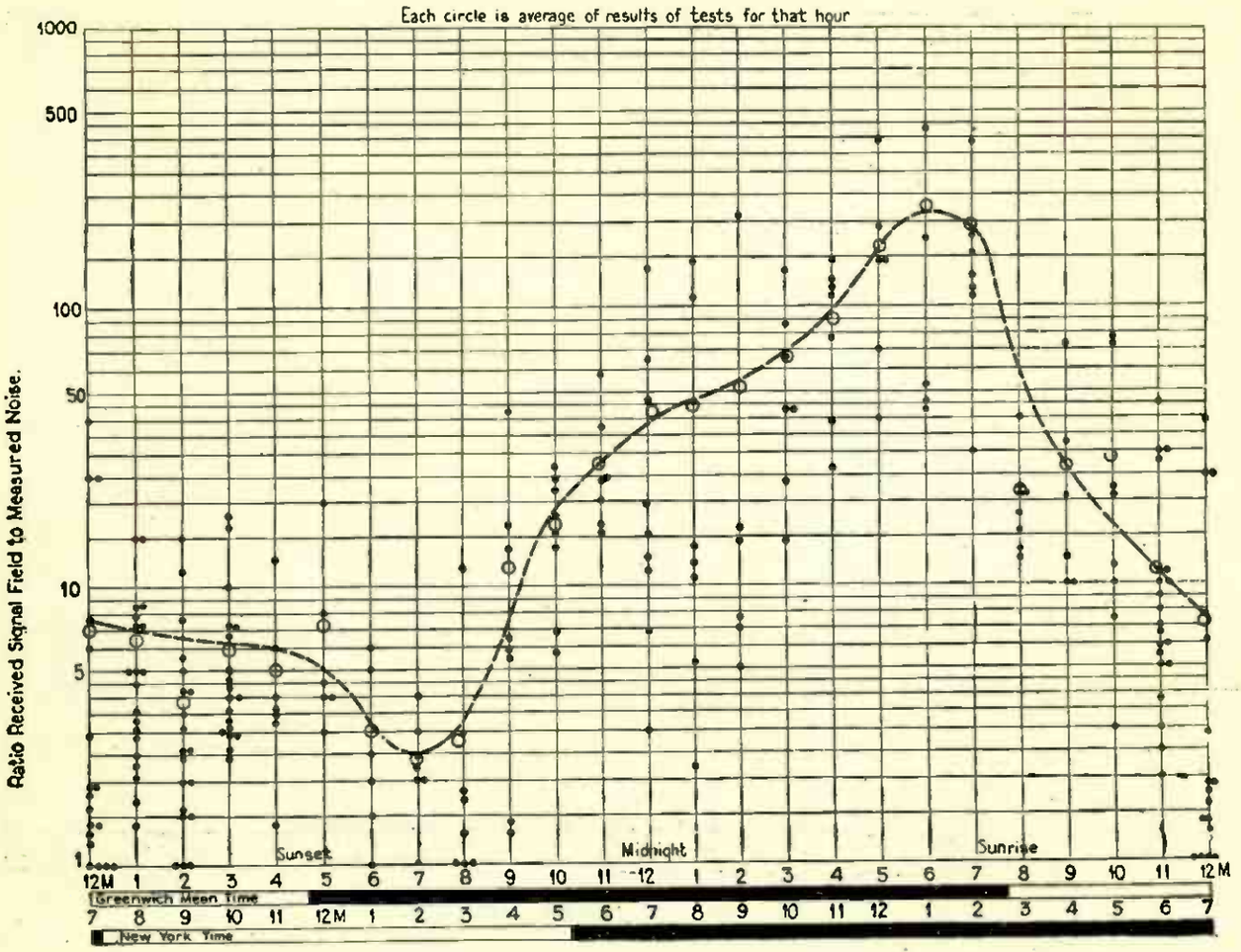
This unit test-period was repeated every hour over a period which varied from several hours to as long as two days and usually ran for about twenty-eight hours. The measurements which started on January 1, 1923 are still in progress.

The data obtained during these months of testing is summarized in the curves given in this article.

Figure 1 shows the variation of received signals and noise for the winter period between January 1st and February 23rd. The range of signal strength is indicated by the cross-hatched area. The upper boundary of this area gives the strongest signals received during the period under consideration; the lower boundary gives the weakest signal, and the heavy intermediate curve gives the average of all the observations. The time of day at which the observations were made is given along the horizontal axis in both Greenwich time and New York time, and the black strips indicate the hours of night at London and at New York. The overlapping of these strips corresponds to darkness extending across the Atlantic and including both New York and London. It is evident that this condition accompanies the maximum intensity of signals.

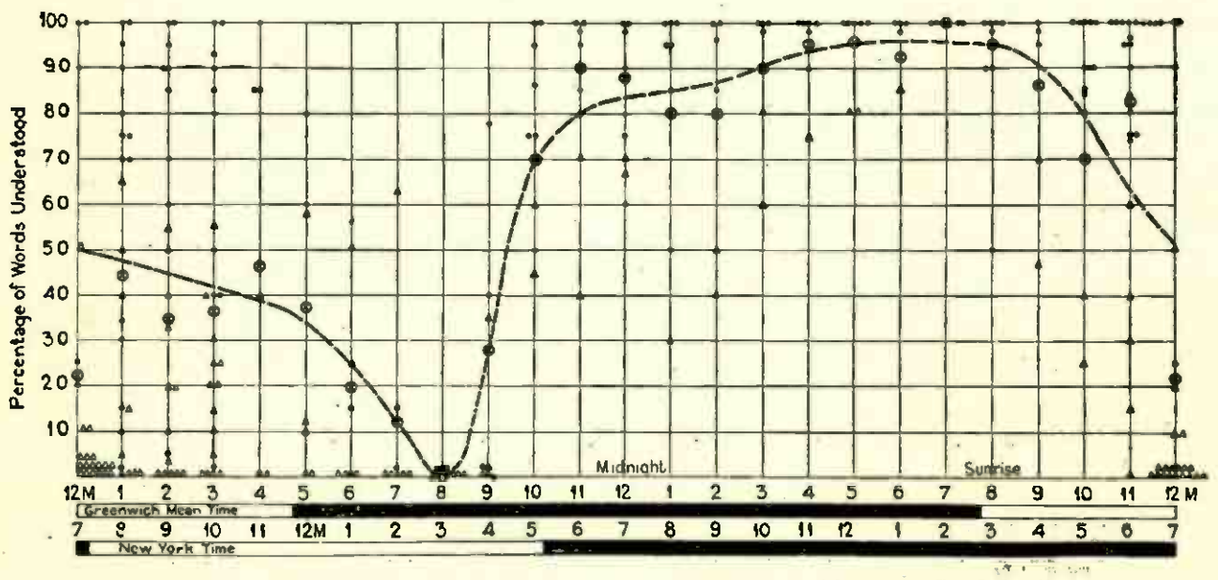
The time scales for New York and London bring out another important fact; assuming that the business day at New York begins at 9 A.M., we see that it overlaps the business day at London by only three hours. During these three hours the strength of received signals is practically at its lowest value.

Figure 2 is drawn on the same basis



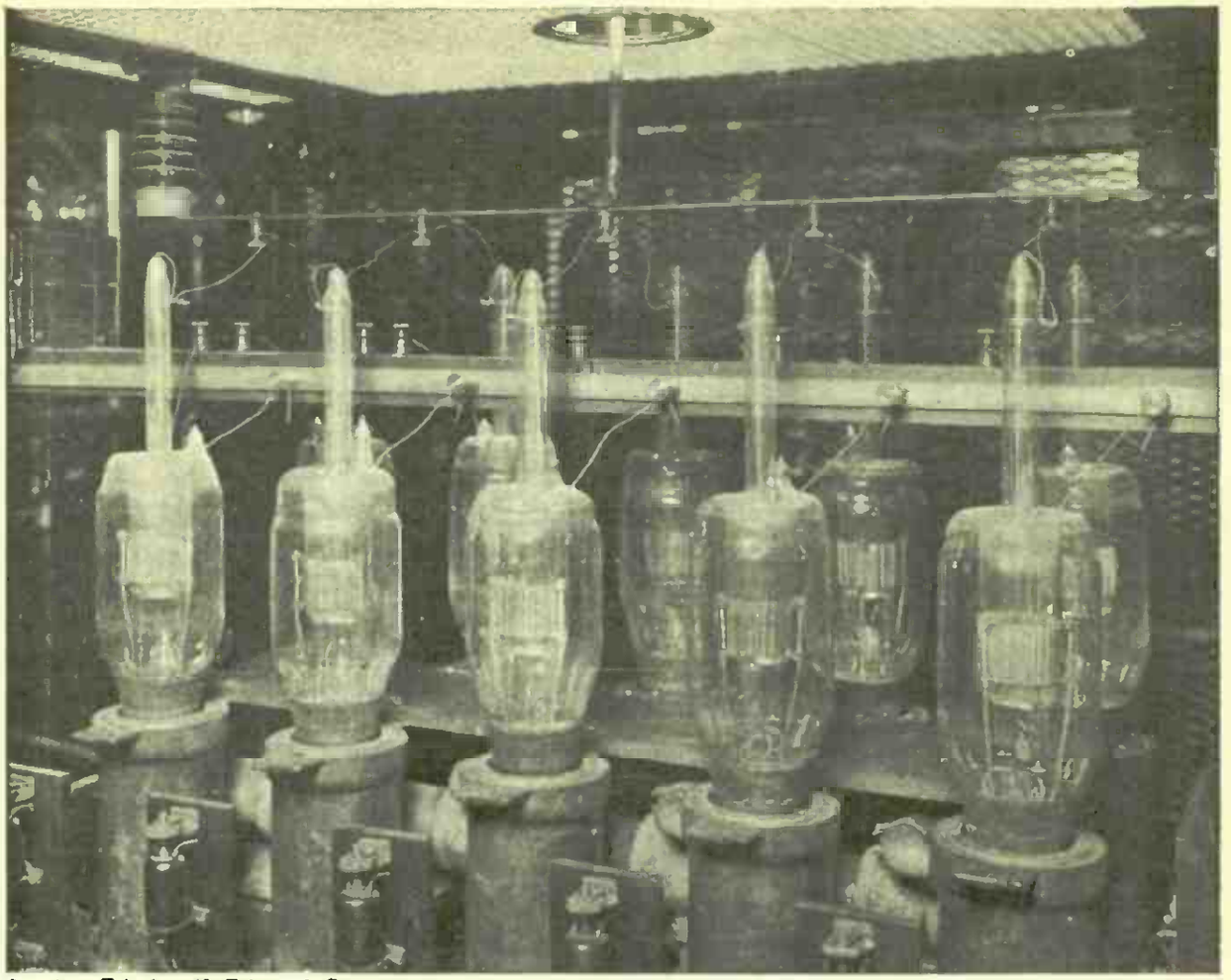
THE DIURNAL VARIATIONS OF "SIGNAL TO NOISE" RATIO

FIGURE 3: *The curve in this diagram shows the diurnal variation of the ratio of received signals to noise during the same period as occupied for the measurements in Figure 1; this graph was made from the same data.*



THE DIURNAL VARIATION IN "WORDS UNDERSTOOD"

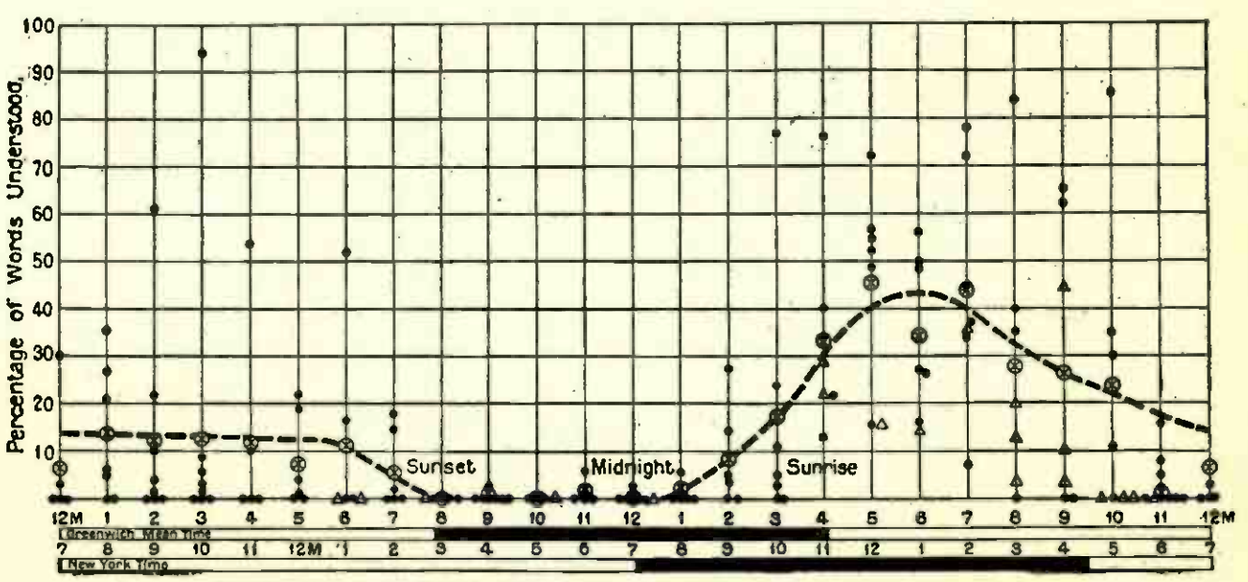
FIGURE 4: *This curve shows the variation, throughout the hours of the day and night, of the percentage of words accurately received. Notice that the best period lies throughout the late dark hours of the morning, with a minimum towards the afternoon and evening.*



American Telephone & Telegraph Co.

THE HUGE VACUUM TUBES THAT FURNISH THE POWER

This is a close-up view of a bank of ten powerful water-cooled vacuum tubes. The whole bank is rated at a power of 200 kilowatts.



ANOTHER VARIATION OF "WORDS UNDERSTOOD"

FIGURE 5: *This curve shows the same variation as Figure 4 except that the data was collected between April 15th and June 11th. Each circle is average of all tests for that hour, including triangular points. The latter are known to be cases in which the low percentage is due to unnatural causes.*

as Figure 1 but represents observations made between February 25th and April 9th. Two differences show up at once between this curve for the spring months and the curve for the winter months. First, the strength of received signals is (on the average) less in the spring, and second, the large variation between day and night has disappeared.

On the lower part of each diagram the values of the strength of interference (or noise) are plotted.

The term "noise" may need a word of explanation. It includes both interference from static and interference from other stations. Much of the noise before 6 P.M. London time is due to interference from neighboring stations but that which is shown between 6 P.M. and 4 A.M. London time consists mainly of static.

The cross-hatched area of the noise curve gives the range of variation, the upper boundary representing the maximum and the lower boundary the minimum while the heavy median line gives the average of all observations.

Both Figures 1 and 2 indicate that the maximum noise is reached at about 2 A.M. London time. Up to this time the night period extends over London and a sector on the earth considerably to the east and including Europe, Africa and Asia. The noise begins to drop off shortly thereafter and reaches its minimum at sunrise at London. This could be accounted for on the assumption that the major source of the noise lies considerably to the east of London and that transmission of stray electric waves to London is gradually diminished in efficiency as daylight overtakes the path of transmission. It will be noticed that the average noise level is noticeably higher during the spring months than during the winter.

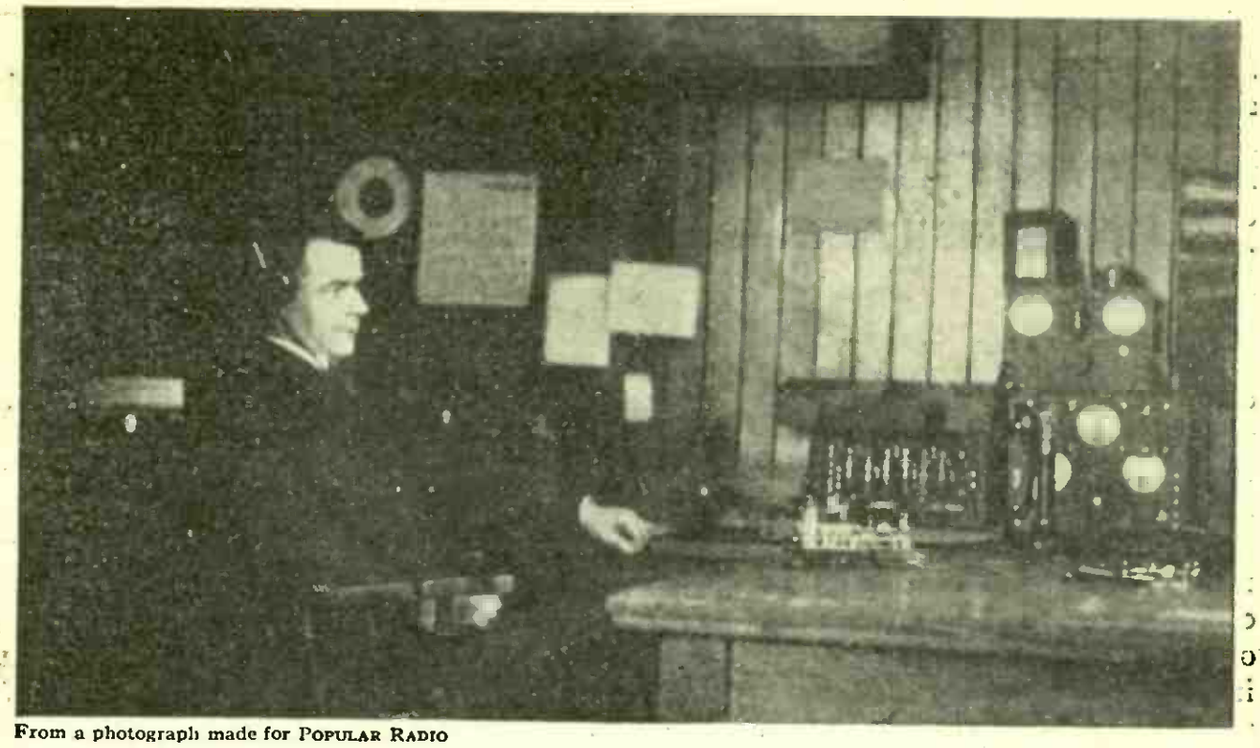
In Figure 3 are plotted the diurnal variation of the ratio of signal strength to noise strength over the same period as is covered by Figure 1. This ratio is, indirectly, a measure of the understandability of received speech and is derived from the observations used in plotting the curves of Figure 1.

Figure 4 shows, directly, the variation through the twenty-four hours of the percentage of words which were accurately received. Each point corresponds to the percentage of words accurately received during one unit test-period. In many of these tests the interference was caused by radio-telegraph stations and in these cases the data is indicated by triangular dots. The dashed curve is a smoothed curve for the points plotted. It indicates that reception is best during the late night and early morning, that it drops off during the day, reaching a minimum during the evening.

As might be expected, the night reception is shown to be considerably better during the winter months than during the summer. This is seen by comparing Figures 4 and 5—the latter giving data collected between April 15th and June 11th. Remember that the period during which the business days on the two sides of the water overlap, are the three hours between 9 A.M. New York time and 5 P.M. London time. Figure 5 shows the need of extra-powerful sets to maintain commercial service at this period of the day, when the demand for service will be particularly heavy. In this connection it may be pointed out that observations indicate that a more favorable showing could be made by the use of longer wavelengths, and it may be possible to take advantage of this fact in establishing a real commercial service.

Will Radio Run Our Street Cars?

THIS *query is not as fantastic as it at first appears to be; the possible transmission of power by radio has long occupied the serious attention of scientists. What has been done and what may be done in this field of research will be told in* POPULAR RADIO *by Dr. E. E. Free.*



From a photograph made for POPULAR RADIO

The author of this article, who has long been an advocate of the essentially practical broadcasting alphabet described below, at his radio station in Prince Rupert, B. C., Canada

"This Is Station William-Have-Nan"

Did you ever listen to a distant broadcasting station signing off—only to be left uncertain whether the announcer said "WCAD," "WZAB" or "WDAP"? Here is described a unique word-letter alphabet system that would eliminate this doubt: it has been tried and adopted in both the American and British naval circles where it has been fully worked out and has proven its worth.

By W. T. BURFORD

IF we live within easy range of a broadcasting station we know well enough, when we have set the knobs of our receiver at their proper adjustment, whether the sounds we hear are or are not the signals of that particular station. Indeed, if we confine our efforts to the reception of broadcast programs from any near-by and familiar station, the problem of identifying the transmitting point will seldom present itself.

But if we switch on our amplifiers and tune for more distant signals, occasions will arise when the call-letters of the transmitting station may be a matter of uncertainty. For the broadcast announcer, no part of the program requires more care in the delivery (particularly as to enunciation) than the three or four letters of the alphabet which identify his station. His well-rounded accents may be trained to pronounce unerringly the title of a foreign operatic aria, but no combination of efficient equipment and faultless diction can be depended on to carry through space those few letters that mean so much.

Was that an A or a K—or an H? Was that a P or a B? Was it a G or a V?

We know that, separated from the

speaker by only a few yards, or in the same room, we might have difficulty in recognizing these letters; we can hardly hope, then, that when the slight margin of mechanical error which must accompany the very best microphone is added to the human element, to hear better by radiophone than by direct audition.

The difficulty does not exist in the case of all letters; if the call-sign happens to consist of such letters as W, Y, F, X (or a few other distinctive letters) there would be little chance of confusion. But in the pronunciation of a few of the letters of our alphabet the consonantal sound has to have an *-ee* or an *-ay* sound attached to it to make it readily audible. In addition to this, another difficulty consists in the similarity of certain consonantal sounds.

As stenographers well know, there are certain letters that may be regarded as pairs. They might be called "parallel sounds," and in some systems of shorthand writing this similarity is embodied in the characters which represent the consonants by the employment of thick and thin strokes respectively for the thick and thin sounds (technically, the continuants and explodents) which form the pairs of parallels. Thus T is the thin brother letter of D, as P is of B; therefore, to enunciate a T so that it will not sound like a D, or a P so that it will not sound like a B, our broadcast announcer has to overcome, not only the difficulty of the similar *-ee* ending, but also that of the basic similarity of the consonants.

It is not only in radio broadcasting that this trouble has arisen. Long ago the problem confronted telephone users and they overcame it by the familiar but roundabout method of saying "G for George," "A for Algernon," "M for Mary," and so on. Though cumbersome, it was an easy solution, for it possessed the advantage of being self-explanatory and needing no prearrangement. A somewhat similar but more systematic way has from time to time been devised by large organizations, such as military forces.

The United States Navy, for instance, has developed a special list of spelled out names for the letters, both for telephone work and for visual signaling, thus enabling those who are familiar with the list to recognize quickly the identifying word, and thereby its initial letter.

The U. S. Navy official alphabet is as follows:

A	Affirm
B	Baker
C	Cast
D	Dog
E	Easy
F	Fox
G	George
H	Have
I	Inter (rogatory)*
J	Jig
K	King
L	Love
M	Mike
N	Nan
O	Option
P	Prep (aratory)*
Q	Quack
R	Roger
S	Sail
T	Tare
U	Unit
V	Vice
W	William
X	X-ray
Y	Yoke
Z	Zed

The system is easily and quickly learned, and its use eliminates the possibility of errors.

There is no need for the speaker to hesitate in choosing the word; he has already got it firmly fixed in his memory, and is sure that the listener will recognize the sound. The words used have been selected with the utmost care to eliminate confusion between either their vowel or their consonantal sounds.

The British military signal service years ago also developed a nomenclature for the alphabet which removes practically all chances of error in reading the letters as they are spoken. By giving certain letters syllabic form—giving them bulk, one might say—the depend-

*This part of the word is eliminated in actual practice.

Form 772 a.

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
RADIO SERVICE

INTERNATIONAL RADIOTELEGRAPHIC CONVENTION

LIST OF ABBREVIATIONS TO BE USED IN RADIO COMMUNICATION

ABBREVIATION	QUESTION	ANSWER OR NOTICE
PRB	Do you wish to communicate by means of the International Signal Code?	I wish to communicate by means of the International Signal Code.
QRA	What ship or coast station is that?	This is.....
QRB	What is your distance?	My distance is.....
QRC	What is your true bearing?	My true bearing is.....degrees.
QRD	Where are you bound for?	I am bound for.....
QRF	Where are you bound from?	I am bound from.....
QRG	What line do you belong to?	I belong to the .....Line.
QRH	What is your wavelength in meters?	My wavelength is.....meters.
QRJ	How many words have you to send?	I have.....words to send.
QRK	How do you receive me?	I am receiving well.
QRL	Are you receiving badly? Shall I send 20? . . — for adjustment?	I am receiving badly. Please send 20. . . — for adjustment.
QRM	Are you being interfered with?	I am being interfered with.
QRN	Are the atmospherics strong?	Atmospherics are very strong.
QRO	Shall I increase power?	Increase power.
QRP	Shall I decrease power?	Decrease power.
QRQ	Shall I send faster?	Send faster.
QRS	Shall I send slower?	Send slower.
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready. All right now.
QRW	Are you busy?	I am busy (or: I am busy with .....). Please do not interfere.
QRX	Shall I stand by?	Stand by. I will call you when required.
QRY	When will be my turn?	Your turn will be No.....
QRZ	Are my signals weak?	Your signals are weak.
QSA	Are my signals strong?	Your signals are strong.
QSB	Is my tone bad? Is my spark bad?	The tone is bad. The spark is bad.
QSC	Is my spacing bad?	Your spacing is bad.
QSD	What is your time?	My time is.....
QSF	Is transmission to be in alternate order or in series?	Transmission will be in alternate order.
QSG	.....	Transmission will be in series of 5 messages.
QSH	.....	Transmission will be in series of 10 messages.
QSJ	What rate shall I collect for?	Collect.....
QSK	Is the last radiogram canceled	The last radiogram is canceled.
QSL	Did you get my receipt?	Please acknowledge.
QSM	What is your true course?	My true course is.....degrees.
QSN	Are you in communication with land?	I am not in communication with land.
QSO	Are you in communication with any ship or station (or: with.....)?	I am in communication with..... (through.....).
QSP	Shall I inform.....that you are calling him?	Inform.....that I am calling him.
QSQ	Is.....calling me?	You are being call by.....
QSR	Will you forward the radiogram?	I will forward the radiogram.
QST	Have you received the general call?	General call to all stations.
QSU	Please call me when you have finished (or: at.....o'clock)?	Will call when I have finished.
*QSV	Is public correspondence being handled?	Public correspondence is being handled. Please do not interfere.
QSW	Shall I increase my spark frequency?	Increase your spark frequency.
QSX	Shall I decrease my spark frequency?	Decrease your spark frequency.
QSY	Shall I send on a wavelength of..... meters?	Let us change to the wavelength of..... meters.
QSZ	.....	Send each word twice. I have difficulty in receiving you.
QTA	.....	Repeat the last radiogram.
QTE	What is my true bearing?	Your true bearing is.....degrees from....
QTF	What is my position?	Your position is...latitude...longitude.

*Public correspondence is any radio work, official or private, handled on commercial wavelengths.

When an abbreviation is followed by a mark of interrogation, it refers to the question indicated for that abbreviation.

THE NUCLEUS OF A UNIVERSAL LANGUAGE

These abbreviations are observed internationally; they constitute what is, in effect, the beginning of a world tongue. Every amateur who applies for a license to transmit must pass an examination on this list.

ance upon hearing the letter itself is lessened, as the letter is recognized by its close association with others.

The British official alphabet is as follows:

A	Ack
B	Beer
C	C
D	Don
E	E
F	F
G	G
H	H
I	I
J	J
K	K
L	L
M	Emma
N	N
O	O
P	Pip
Q	Q
R	R
S	Essus
T	Toc
U	U
V	Vic
W	W
X	X
Y	Y
Z	Zed

It will be seen that the few alterations that are made in the names of the letters are such as can be committed to memory in a short time by any one, and practical experience in the field for which they were designed has shown that they are effective. Applying this signal alphabet in the case of call letters KDTP, all that it is necessary to say is "K—Don—Toc—Pip." Clearness is assured at no sacrifice of brevity. KABP is simply "K—Ack—Beer—Pip;" WMSV is "W—Emma—Essus—Vic;" KICD is "K—I—C—Don." But KCEF, WGY, and many other combinations are not modified in any way, yet they are equally safe, by contrast with the letters in which we know a change is made. It is not necessary, for example, to make any change in the letter N, when we use Emma in place of M.

In the event of one of these alphabets being adopted for broadcasting, there would be some degree of danger of arbitrary change being introduced before the altered letters gained general acceptance. Possibly some of those interested, prompted by a desire to improve, but giving insufficient thought to the matter, would suggest the change of certain letters. It must therefore be pointed out that both of the suggested alphabets have already gained something like international currency, and both of them stood the gruelling test of use in the field during the great war.

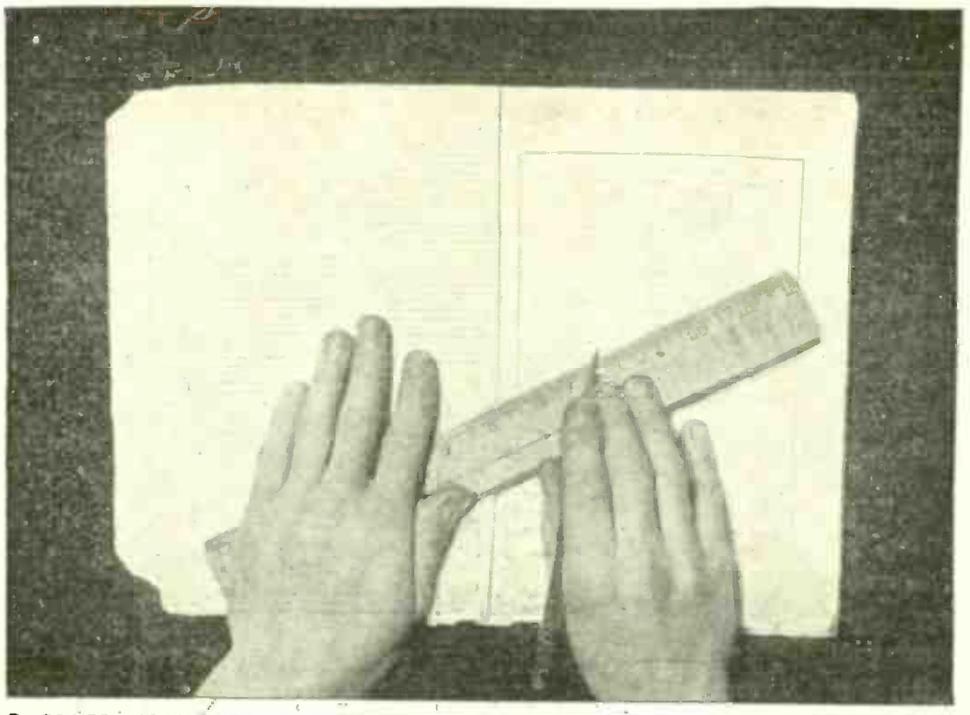
The value of such an "unmistakable" alphabet would of course not be confined to radio broadcasting alone. It could be applied with equal advantage for radio-telephone purposes generally, in calling between stations and for "spelling out" such words as happened to present difficulty at the receiving end. And its use in radio would soon popularize it sufficiently to make it a boon to the ordinary telephone using public.

But, when all is said, one can have no idea of the advantages in the use of a radio alphabet until one *tries it*.

Try it when the speaker has a cold!

Will Radio Bring About a World Language?

MANY of the best minds both here and abroad believe that it will—or at least, that it will be an important factor in developing a form of communication that can be understood by the many peoples of the world and that will assist in material ways in bringing about a better era of understanding between the nations. What is being done to encourage this significant development will be told in POPULAR RADIO *by Mr. Henry D. Hubbard of the International Research Council and by Dr. Edwin E. Slosson.*



ALL YOU NEED IS A RULER, A PENCIL AND A PAIR OF HANDS

By means of the table on the opposite page the amateur who builds his own apparatus may calculate in an instant the design for a condenser that will have a pre-determined capacity, or find out the capacity of a condenser that is already built.

A MEASUREMENT CHART

FOR USE IN DESIGNING A TRANSFORMER

ARTICLE NO. 6

The previous articles contain charts *For Determining the Constants of Radio Circuits and Calculating Capacities of Condensers in Series,* in February, 1923; *For Determining the Dimensions of Your Coil,* in March, 1923; *For Determining the Capacity of a Condenser,* in May, 1923; *For Determining the Capacity of Your Antenna,* in July, 1923, and *For Determining the Constants of a Loop Antenna* in August, 1923.

By RAOUL J. HOFFMAN, A.M.E.

ALTERNATING current may be transformed from one voltage to another by the use of a transformer that consists of a primary and secondary winding wound on an iron core.

The transformers are used to "step up" or to "step down" the voltage of the current.

The "step up" transformer may be used for the CW (continuous wave) transmitting stations; the "step down" transformer may be used for supplying low-voltage current for charging storage batteries. Some form of rectifier must be used in the latter case.

The fundamental formula for the transformer is

$$E=4.44\ f\ F_m\ n100{,}000{,}000.$$

Where E =the effective value of the impressed voltage.
f =the frequency.
F_m=the maximum value of the magnetic flux.
and n =the number of the primary turns.

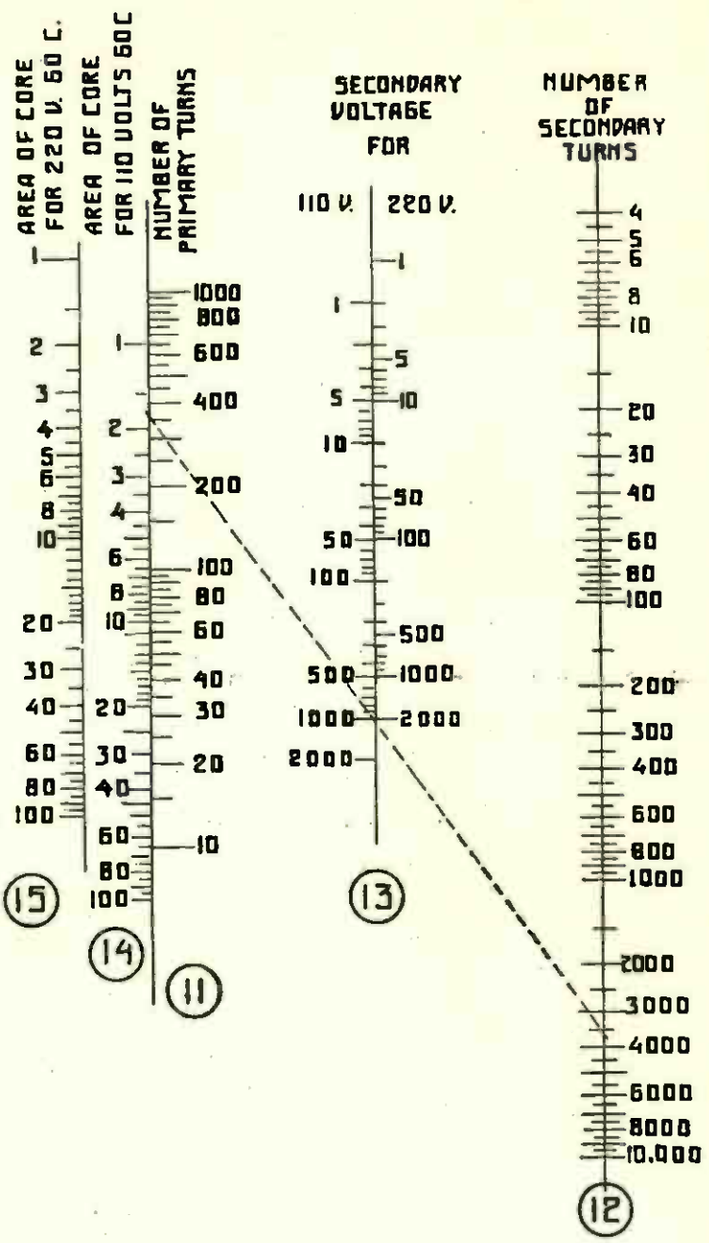
The magnetic flux is

$$F_m=A.\ df \qquad \ldots\ldots 2$$

where A =the area of the cross-section (½ square inch for ½ KW, 1 square inch for 1 KW).
df_a=suitable flux density per square inch to be assumed as 60,000.

THE TRANSFORMER CHART

This mathematical chart enables you to calculate the proper design for your transformers for alternating-current work. How to use the chart is fully described in the text.



From equation (1) and (2) and assuming a frequency of 60, we will have the number of primary turns:

P_n=6.3 Volts/Core Area.....3

The efficiency in a well designed transformer is very high, but for simplicity we will assume a 50 percent efficiency, so that a rheostat can be connected in series with the primary.

The ratio of the secondary voltage and the primary voltage is equal to the ratio of the number of the secondary turns and the primary turns.

In order to simplify the above mathematical operations and the evaluations of the equations, a chart has been substituted and is here illustrated with the aid of an example:

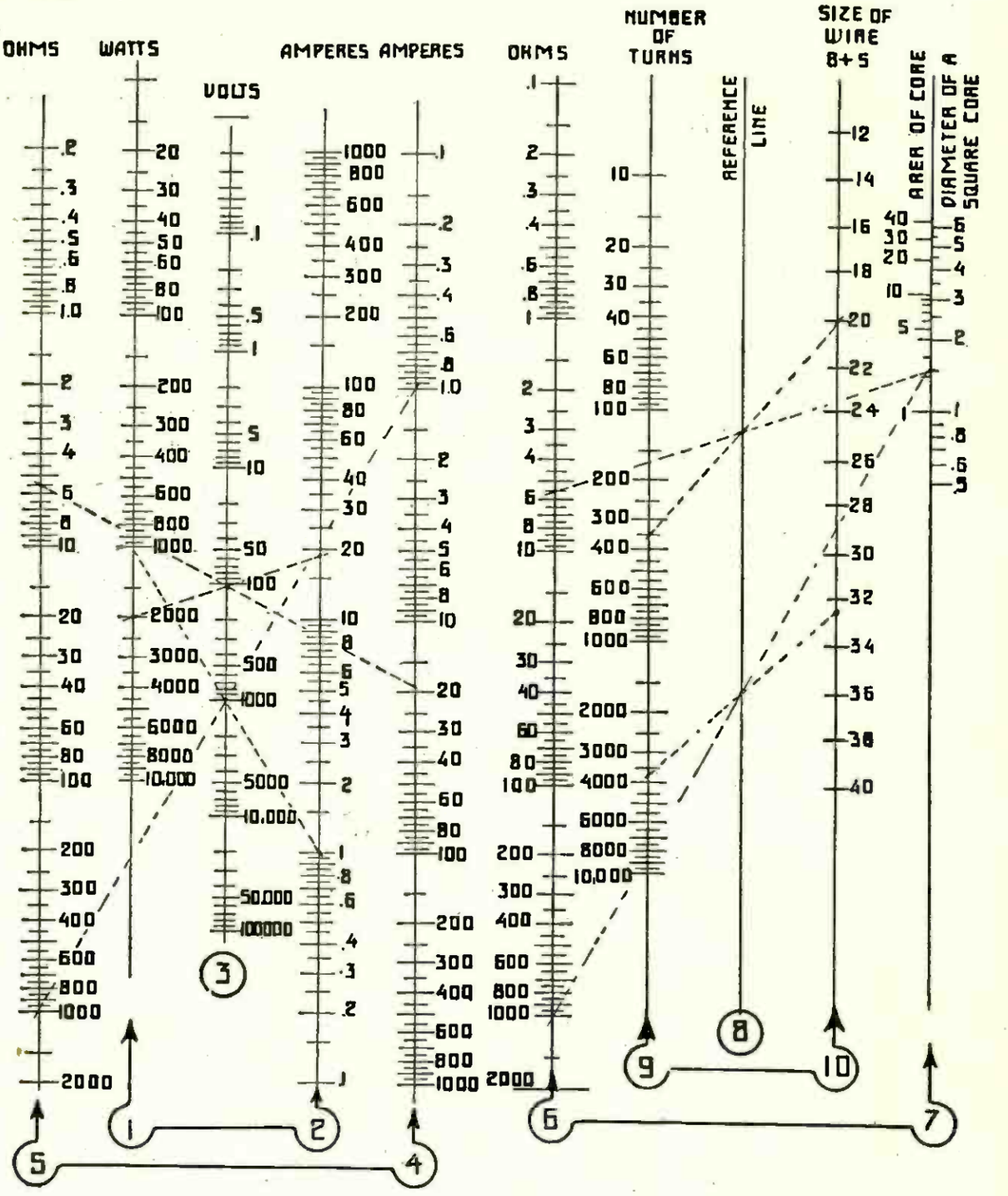
The example is to design a transformer having a 1,000-watt input from a lighting current of 110 volts, 60 cycles, an output of 1,000 volts, at 50 percent efficiency. The area of the core is assumed to be 2 square inches. The current to be calculated for the primary will be then 2,000 watts.

Connect 2,000 on scale No. 1 with 110 on scale No. 3 and read at the intersection with scale No. 2 the resulting 18 amperes; then connect 18 on scale No. 4 with 110 on scale No. 3. You will find the line intersecting scale No. 5 at 5.5 ohms which will be the maximum resistance in the primary circuit.

Looking at scale No. 14 we find the cross-section of 2 square inches connected with 350 on scale 11, which is the number of the primary turns.

Connect 5.5. on scale No. 6 with 2 on scale No. 7, then connect the intersecting point on the reference line No. 8 with 350 on scale No. 9. We find the line intersecting scale No. 10 at 20 which is the minimum thickness of the wire in B & S gauge to prevent overheating. We can take No. 14 to 16 wire.

The secondary unit will give us 1,000 watts with a voltage of 1,000. Connect 350 on scale No. 14 with 1,000 on scale No. 13; the line will intersect the scale No. 12 at 3,700 which is the number of the secondary turns. Connect 1,000 on scale No. 1 with 1,000 on scale No. 3; the line will intersect scale No. 2 on 1; then connect 1 on scale No. 4 with 1,000 on scale No. 3. We find the line inter-



secting the scale No. 5 at 1,000 which is the resistance permissible in the secondary circuit.

Connecting 2 on scale No. 7 with 1,000 on scale No. 6, the line will intersect the reference line No. 8; this intersecting point connected with 3,700 on scale No. 9 gives us the required wire, No. 33 B & S gauge on scale No. 10. For efficiency a wire of No. 34 to 36 could safely be employed.

For 220 volts read values on scale No. 15, but take point of calculation across to scale No. 14.

The next MEASUREMENT CHART—*No. 7 of this series—will enable you to determine the maximum capacity of your variable condensers.*

My FOOL-PROOF SET

A first-hand account of what really happened when a real novice put up his first radio receiver

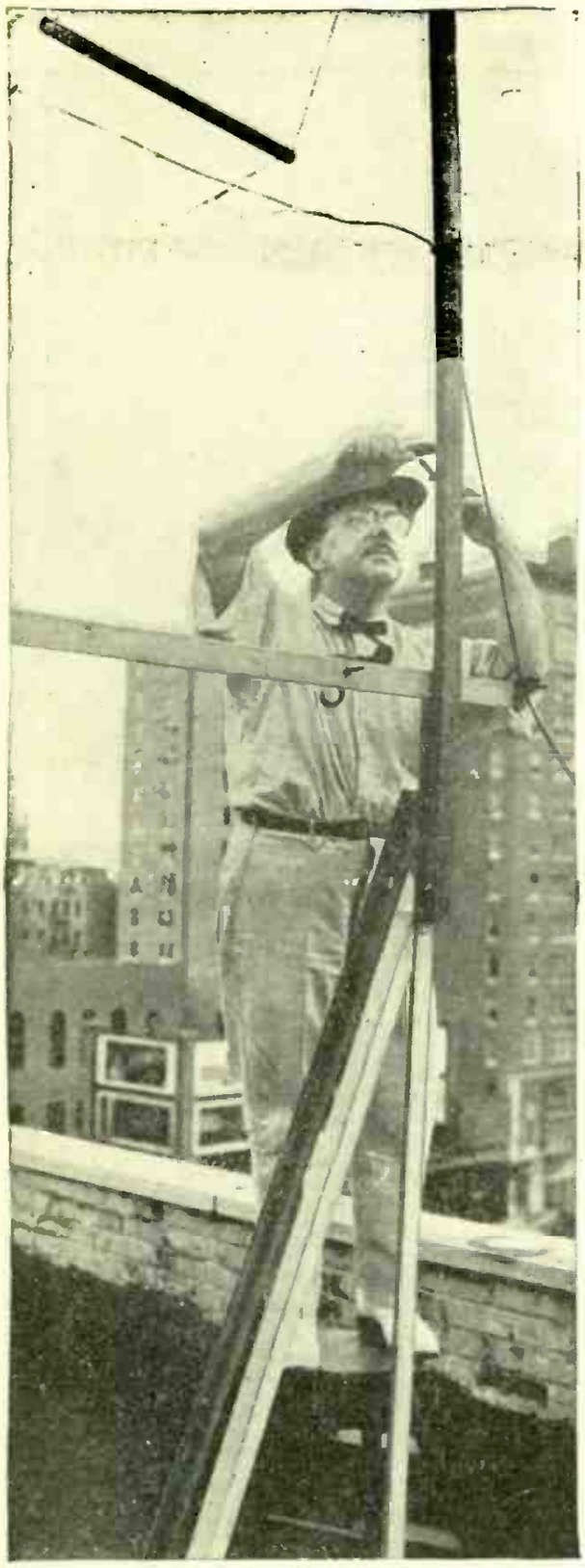
By GELETT BURGESS, B.Sc.

YES, I am a Bachelor of Science. With shame I admit it. I was graduated from one of the most polysyllabic scientific schools in the United States. Why, then, was I chosen by the editor of this magazine as the typical ignoramus to tell of my blundering attempts to install a radio set? Listen, my children, and you shall hear, of how he tried, this volunteer.

I know nothing, absolutely nothing, about electricity. Moreover, I don't want to know anything about it. I hate electricity.

It came about this way. At seventeen all I knew of the unpleasant subject was that electricity, somehow, rang bells. Oh, yes, I was also aware, through childish experiments, that if you hitched a piece of copper to a piece of zinc with a wire, and dipped them into a tumbler of blue vitriol solution (get that, so far?), you could copperplate a dime so that it might be passed off by the dishonest as a cent. A slow and impractical way of making money, that seemed to me.

However, at the Massachusetts Institute of Technology—my Junior year, it was—I was rather excited. The great mystery, electricity, was to be revealed. How I looked forward to batteries, dynamos, telephones, arc lights! Wouldn't everything now be made plain to my wondering mind? Came the fatal day



From a photograph made for POPULAR RADIO

I Carry My Battle to the Roof

For vicious cussedness, give me three snaky, temperamental coils of hardened copper wire. "Damn you," said I, "I'll stretch you flat and pin you down!" And I did.

when Professor Cross mounted the platform. Out came my notebook. But, alas for my stillborn hopes! Never once did that erudite professor condescend to touch the earth. Why, for six long, soul-sickening months, in those terrible lectures, he got no nearer bells and batteries than elephantine formulas like this:

$$V = 2\int_0^{l/2} \frac{2\pi r\sigma}{\sqrt{(r^2+x^2}}\, dx$$

Isn't it horrible?

Years and tears it was before I could look at a copper wire without blenching and turning pale. . . . And then came the automobile.

Now, you can be a baseball fan without even knowing how to hurl a spit ball. A movie fan, too, you may be without ever having heaved your chest in front of a camera. But to be an automobile fan—in those pristine days when owners were still to be seen lying greasy, sweaty and profane on their backs under recalcitrant cars—you really had to know something about machinery—yea, even a little about that dread Nemesis, electricity. To my horror, I found on my first machine, wires, batteries, sparks! And so, like a medical student dissecting his first cadaver, mastering my disgust, I had to handle those fearsome copper wires, handle them till, in the fullness of time, I got, somehow, so that I could make them do my will. I had to, or the darned thing wouldn't work.

And so it was with this craze of millions, this world fad, radio. That's the worst of a receiving set. You simply can't own one without, in spite of yourself, learning a few simple things about electricity. Insidiously, like kissing widows, it gets you in its clutches. And the first thing I knew, I was turning up those innocent little lamps, twirling apparently harmless black knobs, and grinning like a wise owl as I handed the telephone headpiece to an admiring friend, saying, "Want to hear a fox trot from Camden?" just as if I were Steinmetz himself.

But those mysterious black boxes! How they work, I give you my word I haven't the faintest idea. I hope I never shall have. To be sure, I have burglarized them and peered into their entrails. As a self-respecting boob I had to do that. But I was well paid for my inquisitiveness. What I expected to see, naturally, was something like the diagram my technical friend gave me in explanation.

But what did I find? Reader, believe me, it wasn't a bit like that. If wasn't the third cousin to it. Where were those fascinating coiled snakes? Where those arrows shooting Northeast? A few bird-cages and mouse-traps I found, and worm-like wires only. Hastily I screwed down the coffin lid.

* * * * * * * *

The first section that arrived of my radio set was fairly simple. A modest $45 worth of fun and amusement. When they were disemboweled, those three big cartons, I found—let's see—a vacuum tube receiver, two "B" batteries, telephones, insulators and many, many miles of copper wire. But to me the apparatus was as terrifying as an infernal machine. In fact, our maid, being half Patagonian, thought it was an infernal machine—knew it was—and fled the room. But I was brave; I stayed on right at the switch. Others had handled them and lived. So, please God, would I.

Now you have read, doubtless, of that boy prodigy who contrived a radio set so small that it could be packed into a match box. That monstrous boy, I verily believe, has been the author of more inferiority complexes than even Sigmund Freud. Poor me, at least, he at first sight reduced to a consciousness of electrical ignorance

comparable only to that of an earthworm. Glowworms, naturally, know far more than I. So base, indeed, he made me feel, that had I ever erected (as I have in humble moments planned) a statue to that most precocious genius, I knew that, inevitably, some dark night I would steal forth and with my own inept hands revengefully smash the memorial of that super-kid.

But there were other boys, I was to find, many other boys, almost as terrible. In fact it seems to be only boys of fourteen who really understand inside radio. Adults fool with it; they guess and experiment. Professors and engineers conceal their stupidity behind mathematical equations. But boys read those columns of *Answers to Radio Questions* in the newspapers as if they were dime novels or baseball reports. To me those inscriptions are almost pure cuneiform.

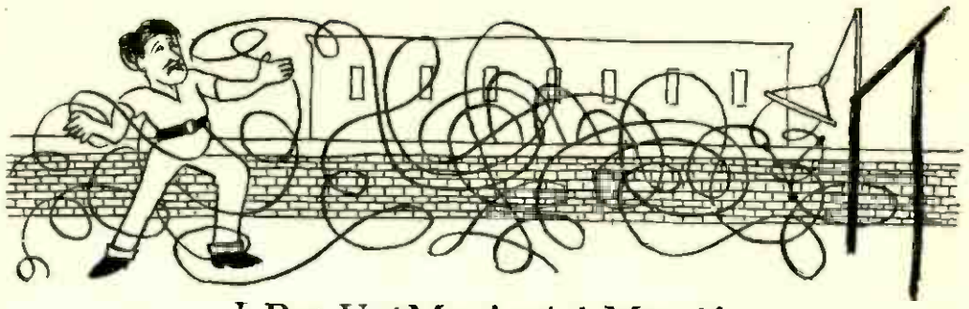
Half-way, I confess I got into Mr. Cockaday's wonderful book. But, like the lurid memory of a rough channel passage when I was young, it only brought back my sophomoric nausea. I not only hated electricity with all the whilom bitterness, but I now fairly despised it. I'd hate to tell you what I really think of an electron, positive or negative. A creature that will submit to be forced to run along a wire, jump spark-gaps, crawl through white-hot filaments and be condensed and amplified and inducted and everything at the behest of a fourteen year old boy I consider unworthy of my respect And when it does escape, to wave through miles of free air, it's caught like a half-witted mouse by the first boy with a variocoupler he has made himself.

Still, here was my outfit, right in the house, and I was pledged to investigate its tricks and its manners. Moron I might be, but I had to install the thing all alone, and make it work if possible. The prospect depressed me, but I drew a deep breath, the way you do before you jump into a deep pit of New Orleans molasses, shut my eyes and——

First, and least awful, in my ignorance I thought, came the construction of my antenna. That I felt sure that I could accomplish. After a scientific inspection of my roof (it was Civil Engineering, you know, I studied) I decided on a double sixty-foot affair, with lovely spreaders and turnbuckles complete just like the pictures.

Reader, gentle reader, have you ever tried to measure off sixty feet of hardened, agile, springily-writhing wire in a dining room bedecked with rare and costly china? That wiry serpent of copper was everywhere at once; it was death-dealing. And when, at last, I had swept up the broken vases and Florentine glass candlesticks, and, with my weak, childish hands had painfully, patiently bent backwards each lithe, persistent curve, I was confronted with the task of joining the lead-in and soldering the connections.

Now the brass soldering irons to be found at the ten-cent store, I cannot conscientiously recommend. Not, that is, if you intend to construct the neat, professional joints so eloquently described in Mr. Cockaday's radio book, as a part of an elegant museum piece. Still, if, like a man with a moustache cup, you prefer practicality to beauty, and follow my own artless technique, you will find a ten-cent affair as good as any. You scissor out, then, a little trough of tin. You place in its protecting walls your not-too-pretty connection. You heat your iron to a forbidden red, and you melt rosin and solder over and into that joint in one solid, primordial gob. Of course it takes time. A hot night in July, it was. The kitchen was small— But at last the deed was done. It was not graceful like the gazelle, but it was strong, like a woodchuck. Any truant ions or electrons would have a hard time escaping from that junk of solder. Whew!



I Put Up My Aerial Myself

I tried to straighten out the puzzle—a complicated arrangement of coils of wire as self-willed as eels.

I now was the proud possessor of a complicated arrangement of three coils of wire as temperamental and self-willed as eels. This, somehow, with curses, I transported to the roof where, under a smiling sun, I attempted to straighten out the puzzle.

Well, I have rowed a boat against wind and an ebb tide round a rocky point. Five pieces of a broken china plate I have cemented together at one masterful operation. I have succeeded in stage-managing three pretty and quick-witted sweethearts at the same time, and kept them all apart. But, for vicious, versatile and vermicular cussedness, give me three snaky coils of hardened copper wire fighting like Kilkenny cats.

"Darn you," said I, "I'll quail your temper, I'll stretch you flat, I'll pin you to those darned spreaders!"

And I did.

I wired one end to an unwilling brick chimney, and one to an impermissible iron fence. I got them both taut, and approximately of equal length before any fire commissioners could hinder me. But radio is hot work. It is dirty work. It is a nightmare.

A hole straight through the window sash I boldly bored. The landlord had raised my rent, and I was going to move, anyway. Then, with a sigh and a broom, I captured the dangling lead-in, and with trembling but dirty fingers I attached it to the binding post.

All was now ready for the "A" battery. Four dry-cells, the directions said, would be sufficient. Mine required eight. The first four, I found, were by this time almost hot enough to fry eggs on; and by the time I had discovered why—that the two terminals had met, embraced and made eager, tropical love to each other for some hours—their passion had completely exhausted them.

By all the rules of the amateur game, I suppose, I should now, after coupling up, have taken down my telephone and heard—nothing. Then, after a disappointed silence I should have toiled and tinkered for hours before the first sound came. Alas, I was not to get my story so easily. The moment I capped my head with that telephone, lo! I heard a lordly voice announcing. "The next musical selection will be—" and, obedient to his invocation, to my delighted ears a lively fox-trot came dancing in over the wires. The darned thing actually worked! I began to lose a little of my awe for that match box radio boy. I, too, could achieve.

For a week I listened to fox-trots mild but persistent. My sister listened. Even the Patagonian maid listened until on the third day she tempestuously refused to be lured to the radio more. "Aw, I ban got a phonograft by my house home!" said declared, "fox-trots we got by the dozens already without no scratches yet."

And then came another installment of my set, a wondrous two-step amplifier that raised those fox-trots from *piano* to *forte,* sent them fairly crashing into

my ears. Twirl that rheostat as I might, from 1 to 100, I couldn't discourage them. The twin boxes were full of them—running over. I heard them at 10 P.M., weary and ill at ease; and I heard them coffee cup in hand at 9 A.M. I was soon sure that I had already received my $150 worth of fox-trots; but still they came.

Having thus won the victory single-handed as an electrical boob, I now consented to have in an expert to examine my work and show me just exactly what a fool I was. He came. Bearing a heavy storage battery he came, imploring me to help him lug it in. He staggering, almost exhausted, at one handle, and I tugging heroically at the other, we managed to get it into the room. It must have weighed at least ten pounds.

Then he sat him down to rest. He wrenched off a beautiful blue paper shade I had made for my glaring vacuum tube. He crushed it thoughtfully to pieces. Professionally he began to twirl the black knobs. He stopped. He scowled.

"Say, that rheostat sticks," said he. "And that three-way switch is no use at all. The thing's all wrong, see? Those clips don't hold the coils fast, do they? Pretty bum set. We had to fire our engineer, you know, and get another. Why, you can't tune the antenna at all with this—only the secondary coil. I'll have to send you a condenser to put on the aerial side."

"But it seems to work, though," I ventured, timidly, "Don't you hear that fox-trot?"

And, after I had hitched up the new condenser he sent next day, even that seemed to be wrong, too. I could still hear those fox-trots.

Any amateur will of course see at once what had happened. I had made connections with WJZ. That usually means imprisonment for life.

For, to every one of the tens of thousands of radio fans in and about Greater New York, WJZ and WEAF are the Gods of the electro-aerial universe. They are omnipresent, omniscient, omnipotent, paramount, and supreme, drowning out all electrical competition. When WJZ and WEAF speak, all other waves are impotent. Garrulous on the grand scale, continuous, consecutive and consummate, like a he-talker in a club, always on the job, heeding neither applause nor objections, they hourly shoot forth their indomitable, irresistible rays of information, entertainment and fashion hints. For WJZ and WEAF radio sets are bought and thousands sit up on warm evenings with receivers to their eager ears to hear fox-trots and how little Bessie Butterfly flew over the butter.

And, like a high priest at this mass of sound, dignified as an electric refrigerator, calm as a heavenly traffic cop regulating the auto-waves along 360th Street, presides a heroic personage at WJZ, one OLN, breathing his stately, syllabified dicta into the immeasurable voids of space with a voice like the Angel Gabriel or E. H. Sothern.

Once in London, long, long ago, I came across one of those soap-box fanatics who, in Hyde Park, abound in elocution and whiskers. He was an opinionated old bird; but all I remember of his verbiage was this: "I don't hate God; I like him."

And so, I don't really hate OLN. But, at times, listening to his deliberate, cold-blooded edicts, his massive, preternatural equipoise, when, as Master of the Fox Trots, he augustly superintends his concerts, I cannot quite feel that he is mortal. He is too far from life's vicissitudes, too unconscious of care or temper or stomach aches. I almost long, sometimes, to have someone stick a pin into OLN, and bring forth at least one nervous, human *cri-de-coeur*. Anything with a Gosh or a Darn in it would reconcile me to his infinite calm. But I am sure it would do no good. I am sure his mother taught him, when

angry, always to count ten before speaking.

Least of all, perhaps, I care for OLN when he announces the weather predictions. He has the stoic phlegm of a mastodon.

"Thurs-day . . . . . fair . . . .Fri- - -day . . . . part- - - ly. . . cloudy . . . . with . . . .south . . . . west . . . .winds."

It is almost unbearable, his deliberation. And, when you think that at last the tooth is out and you can try to forget his sempeternal serenity, comes the horrible threat:

"I will repeat . . . . Thurs- - - day . . . ."

and I slam down my telephone, turn off the lamps and crawl wretchedly to bed and try to forget.

New visitors, however, at last began to arrive. After setting up a new and exquisitely soldered 40-foot double aerial on the roof, WOR and WVP and WAAM favored me with an entirely new and fervid selection of phonographic fox-trots. And a mysterious 2XR began to count, rhythmically, "One, two, three, four. . . . . " up to ten; and then backwards to one again. It disturbed me, this message; it was undoubtedly a communication in cipher, and should be promptly looked into by the police or federal authorities. It sounded to me as if someone were counting cases of wood alchohol whisky.

Also, like a string of boys playing leapfrog right through a circus procession of elephants, ever and anon came code messages, in snarling or bleating dots and dashes of all pitch, punctuating the ubiquitous fox-trots. The alluring secrecy of those Morse characters —I got them on all coils, the big, fat 250 and the thin anæmic little 25—high, tin pan, soprano dashes, to wooden, barytone dots—made me increasingly desirous of hearing the talking amateurs.

Strange provocative tales I had heard, of men proposing to women by radio, and being picked up and accepted by a dozen beautiful girls at once. Ladies,

From a photograph made for POPULAR RADIO

I Become a Wire Tamer

Have you ever tried to measure off sixty feet of agile, springily-writhing wire in a dining room? I have.

I read, often made rash confessions into the ambient air, to be jeered at by inquisitive listeners. Where was all this airy conversation, I wondered. Why didn't a few delicious indiscretions come trickling into my set between the fox-trots and baseball scores and stock quotations?

My friend the expert shook his Solomon-wise head. "Probably your aerial is too long to pick up the waves the amateurs use," he said. "You might try cutting it down."

Cutting it down! That's what I've been doing ever since.

First, I nipped off my 40-foot double wire to 23 feet. Well, a few more amateurs did indeed consent to entertain me, but I found them dull. Mainly, two men I got to know as Frank and Bill.

"All right . . . now try the other plate condenser . . . go ahead." And, after impatiently eavesdropping for ten weary minutes, I was rewarded with an "All right, I get about 265. What you say? No, I don't get your voice yet. Go ahead!" A long, dismal silence while I read how two girls made a pocket radio outfit out of hairpins, very discouraging. Then, "Say, feller with a buzzer on the same wave you are. Try No. 2. All right, go ahead." No, I didn't much care for Bill.

Alas for romance! Never once a feminine voice. Night after night I tuned in and listened, night after night of fox-trots and Condition of the Steel Trade, and then—Oh, that night! Was all my waiting at last to be rewarded? Out of the stillness and the dark, through secret fastnesses of air came:

"Hello, sweetheart! Hello, sweetheart! Sweetheart, sweetheart! haloooooooooo, sweetheart!" clear and haunting.

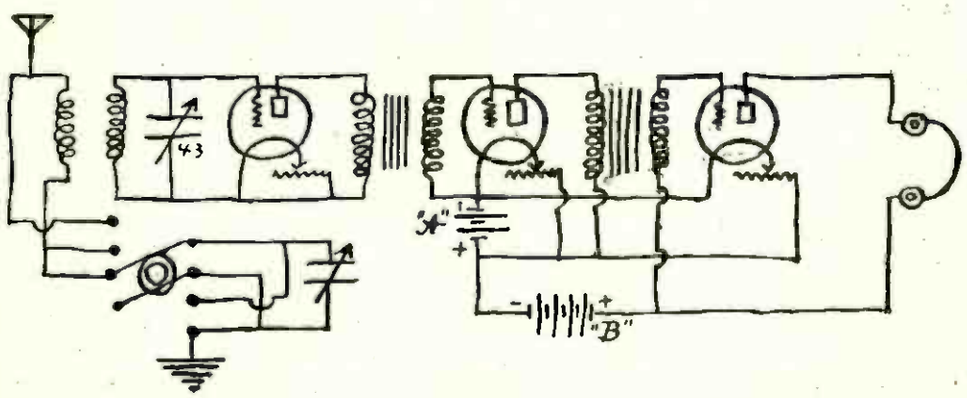
Sssh! Adventure had visited me. Sitting alone, miles away, or perhaps only two blocks, I was to partake, unasked, of an amorous dialogue. Separated by space, yet cooing happily together on the same sweet wave were two fond lovers—and then—

"Hello, sweetheart! On board the *Sweetheart!* Calling Dr. Burkhart on board the yacht *Sweetheart!* Confound you, if you don't answer pretty damned quick I'm going to turn off, *Sweetheart!*"

No, the nearest I got to poetic eavesdropping was when I heard 2CBY calling. He was calling 2CMG; and if 2CMG is not a woman, and a pretty one, I don't want to know it. Please don't tell me. I prefer to believe that, when 2CBY said, "I'll meet you at George's. I'll motor round and blow my horn outside. O.K., 2CMG, what'd you say? Oh, I'll be right over,"—it was nothing less prosaic than an elopement.

Evidently, however, these small time radiobugs used short antennas, as my expert had so cleverly guessed. And so, to sift them out from the fox-trots, I decided to cut down my aerial again—this time to ten feet.

But why bother to put them way up on the roof? My dining room was seventeen feet long, and electric waves could go right through anything, couldn't



THIS IS HOW THE DARNED THING SHOULD LOOK

According to the Technical Expert. But where were those fascinating coiled snakes? Where those arrows shooting northeast? A few bird-cages and mouse-traps I found, and worm-like wires only!

they? They could even go through the insulation on wires that was put on to keep the electricity in. And so, rather decoratively, from wall to wall, I hung a four-wire, ten-foot aerial from the picture mouldings, making the room like an aviary or angel trap.

No painstaking niceties, this time. Long ago I had abandoned both plain and fancy soldering. I merely twisted the wires together. If I had just hooked them, or stuck them together with chewing gum, I knew that my long-suffering, marvelous set wouldn't mind at all. Insulators? I doubted if even they were necessary; my good old vacuum tubes would stand for anything. But anyway, I'd never pay fifteen cents apiece. Why wouldn't sarsaparilla bottles do? They did. Round their pretty unsuspicious blue necks I softly tied a cotton string and soaked it in wood alcohol. I touched a lighted match and let Nature take its course. Snap! Off went their heads. This piece of practical electrical engineering, however, I did not learn at the Tech. I got it out of Hostetter's Almanac.

My two-step amplifier just fell in love with this inside aerial. Fox-trots came floating in over those ten-foot wires as nimbly as with the ponderous contraption on the roof. How in the world was I ever going to keep them out of the house?

I grew desperate. I'd beat those fox-trots if it took a year. How much abuse would the set stand, anyway? What was its speed limit? And so, to show it I meant business, I rigged up a baby aerial. Only three feet long, it was. "There!" I said to those three black boxes, I guess that'll hold you. Don't you *dare* work! Then I coupled up and listened. Blithely as ever a fox-trot greeted my shocked, incredulous ears.

Would nothing faze that set? The thing was incredible. I had taken every mean advantage of its confidence, but it was like a peevish wife who hangs

I BECOME AN AERIAL

The horrible truth is borne in upon me that I myself, have become a part of the mysterious apparatus as the waves flow through me.

on just for spite and *won't* get a divorce. I would have to resort to cruelty. Savagely, I decided to amputate.

No lead-in, now. Into the binding post I screwed a single wire, just two feet long. Lonesomely it stuck out into the empty air. But, at the first turn of the rheostat, those fox-trots, only slightly chastened, came. Then one foot of wire I tried. Diminished, as if far away, or half asleep, came the too familiar strains. Exhausted, I tried nine short inches, a mere little finger of wire—naked, No. 14 wire, only nine inches long. Weak, but still hellishly cheerful that fox-trot lived and sang.

Eight inches. At last, thank God, it had died away.

Eureka! I had at last conquered. I had forced that darned set to strike. But, just as I was taking that final wire away—hark, what was that? Like a ghost came those merry cadences. That fox-trot, like a skinned eel, was still alive and wriggling. Infuriated, I threw the wire out the window. All was still.

But then, my fingers still lingering on the binding post, came the final miracle. Listen; as an honest boob, I swear that, with no aerial whatever, no lead-in, no spreaders, no insulators, no anything but your humble servant, I heard again that same old immortal tune! Through my own arm and fingers—horrible though it sounds—that fox-trot was pulsing out of my demonaic machine.

At my frantic telephone call—as one who summons the Society for Psychical Research to announce a new spook—my expert tried to calm me by telling me that I had become the "ground" and the radiator was now my aerial. But I knew better. Hadn't I stood, the while, in two expensive Canton china soup plates and still heard the unspeakable thing? No, the truth was borne in upon me, and I had to accept it, like an attack of measles. I was a part of that magic machine. I had become my own aerial. My fingers were mere antennas.

And so, you see, as I told you, you simply can't own a radio set without learning something about electricity. Perhaps, after all, it is I, and not that match box boy, who should have a statue erected to my genius. For I had demonstrated what the Institute of Technology had taught me, that electricity belonged, really, not in my brain. It belonged in my wonderful fingers.

There remains but one step more. I dare not take it, I might poison a faithful dog, or torture an innocent blue-eyed baby, but my long-suffering receiver has so touched me with its pathetic willingness to serve that I shrink from putting it to the test. Let me keep my faith in it without proof, then, for I am sure that, though I smashed all its vacuum tubes, busted the rheostat, and abolished the storage battery, like the departed spirit of some loyal friend, WJZ's fox-trots would somehow find a way to communicate with me from Newark.

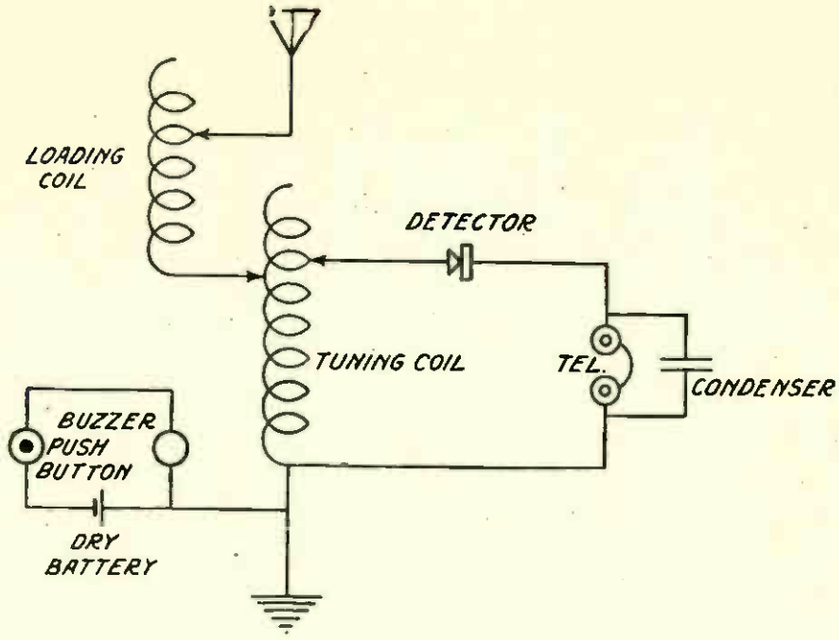
And, frankly, that's precisely why I dare not try it.

Dear reader, I was given this story to write as an ignoramus. "You'll have lots of trouble," said the editor, "and it ought to be funny." Well, as you see, I've failed, miserably failed. I haven't had any trouble at all. In spite of every outrage inflicted upon it that darned set has always worked. Frank and Bill and Joe, every night, juggle wretchedly upon their sets. "All right," I hear them calling, "Now try it on No. 2. No, I don't get that, sounds thick. Go ahead." On the roof opposite, I have watched two boys putting and taking their antennas a dozen times. The newspapers are full of anxious queries about variocouplers and things that don't work. But I have had no such luck, and I tinker no more. I simply can't make it fail.

And so, reader, I ask you: Doesn't that prove that I am a *bona fide* ignoramus?

How I Built a Crystal Set for $12.00, Though I Am 34 Years Old

If you have ever built your own radio set, you know something of the trials and humors that confront the novice at his first attempt. And if you haven't, you can learn about them from Don Herold, *the well-known humorist—who will take the readers of* Popular Radio *into his confidence in a near issue.*



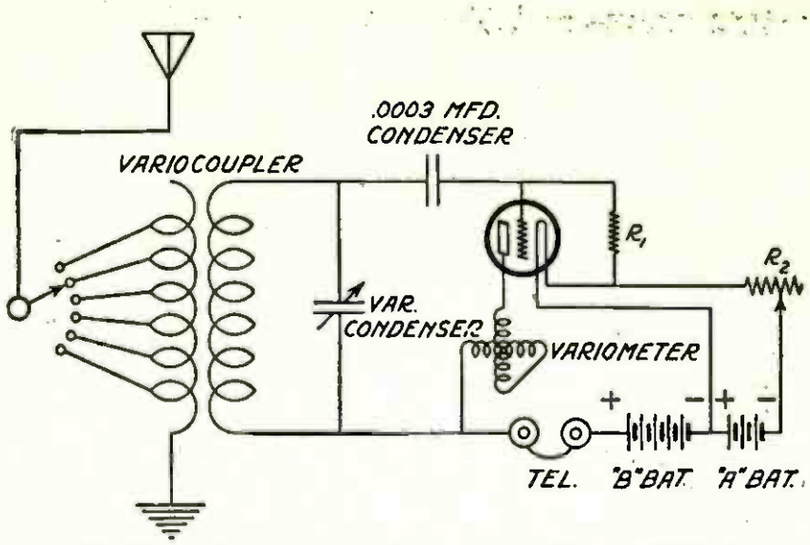
CONDUCTIVELY COUPLED CRYSTAL SET WITH LOADING COIL AND BUZZER TEST

Cost of parts: Not more than $14.00.
Selectivity: Fair.
Operation: Simple. The buzzer test simplifies the adjustment of the crystal detector.
Ease of construction: Not difficult. The whole set can be mounted on a board and wired up ready for use in an hour or so.
Approximate range: 15 miles.
Outstanding feature: A simple set for a young beginner to help him obtain his first knowledge of radio.

100 BEST HOOK-UPS

INSTALLMENT NO. 5

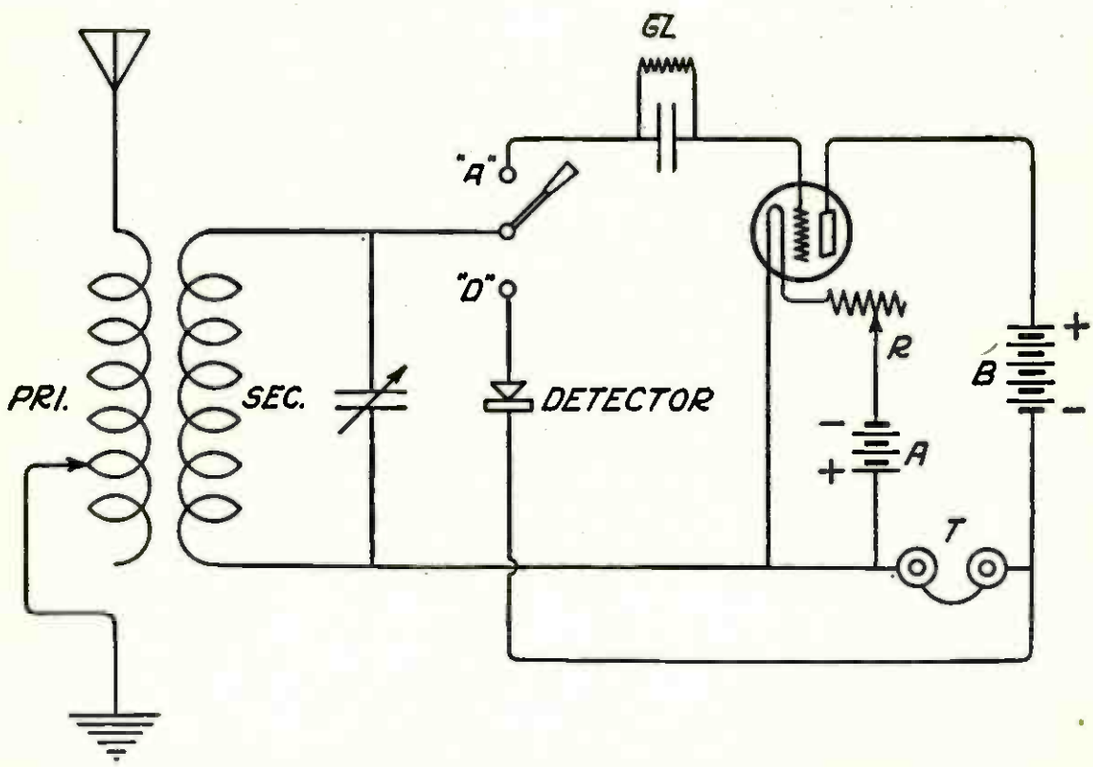
IN this series of hook-ups is being published—for the special benefit of the radio novice who is undecided as to just what circuit he wants—100 of the best radio receiving circuits, each thoroughly tested. The approximate ranges given here are averages based on actual records made with receiving sets throughout the country. During the summer the actual ranges may fall to 50 percent of the value given, while in the winter, in the best of conditions, the actual ranges may exceed the values given by as much as 500 percent. All of these circuits have been described in detail in previous issues of POPULAR RADIO.



TUNED-PLATE ULTRA-AUDION CIRCUIT

Cost of parts: Not more than $23.00. (Note: The costs of tubes and batteries are considered "extras" and are not included in the costs given in these descriptions.)
Selectivity: Excellent.
Operation: Fairly simple.
Ease of construction: Not complicated.*
Approximate range: 1,000 m les.
Outstanding features: Noted for DX, amateur and broadcast reception and for its exceptionally sharp tuning.

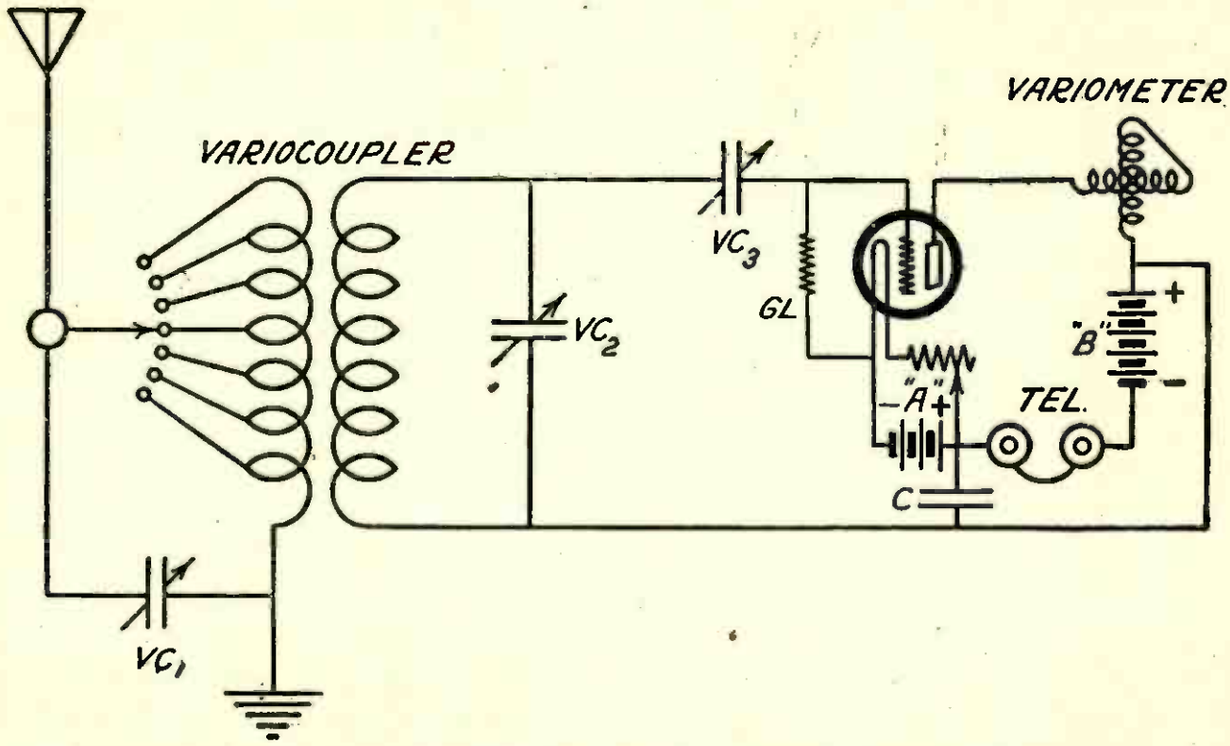
**(See* POPULAR RADIO, *September, 1922, page 62, for constructional details.)*



COMBINATION CRYSTAL AND VACUUM-TUBE SET

Cost of parts: Not more than $21.00.
Selectivity: Fairly good.
Operation: Very simple.
Ease of construction: Simple to make.*
Approximate range: 15 miles on the crystal detector. 100 miles on the vacuum-tube detector.
Outstanding features: Here is the circuit for the man who already has a crystal receiver and wishes to find out what the vacuum-tube detector will do for him in the way of increased signals. The crystal may be used for strong local stations and the vacuum tube may be used for the more distant and weaker ones.

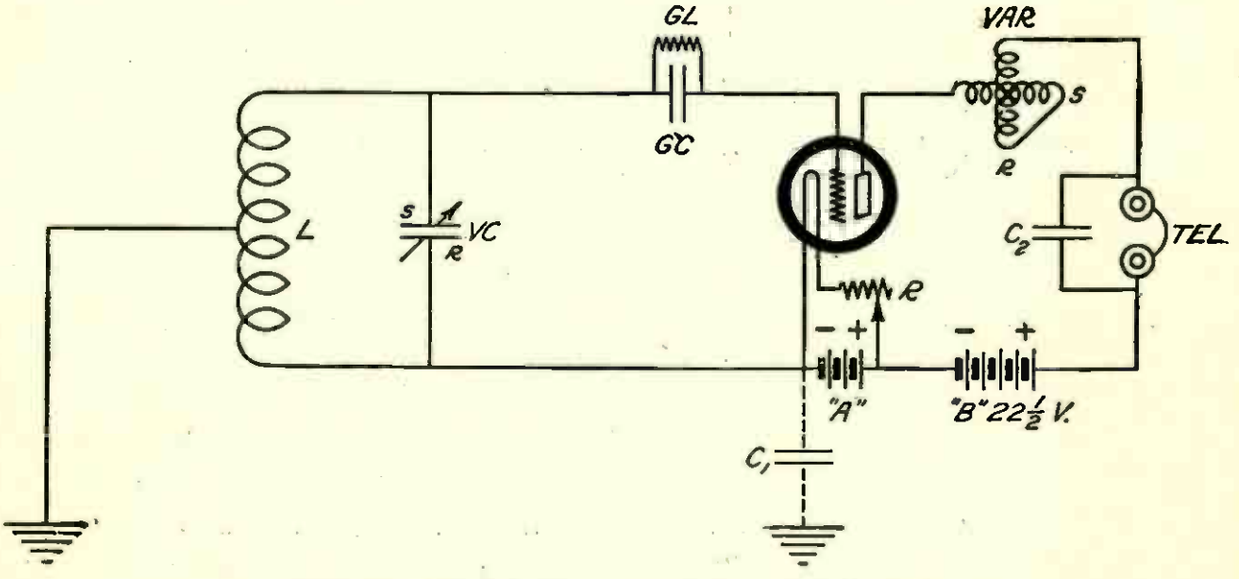
**(See* POPULAR RADIO, *July, 1922, page 222, for information about use.)*



TUNED-PLATE ULTRA-AUDION CIRCUIT WITH FINER CONTROLS

Cost of parts: Not more than $34.00.
Selectivity: Excellent.
Operation: Fairly simple. This adaptation of this circuit contains variable tuning elements such as a variable grid condenser, variable grid-leak, and a variable condenser in the antenna circuit which will enable the more experienced operator to get maximum results out of the receiver.
Ease of construction: Just an ordinary acquaintance with tools and some ability in wiring up the circuit are necessary.*
Approximate range: 1,000 miles.
Outstanding features: A real set for the advanced man who wants selectivity and sensitivity at reasonable cost.

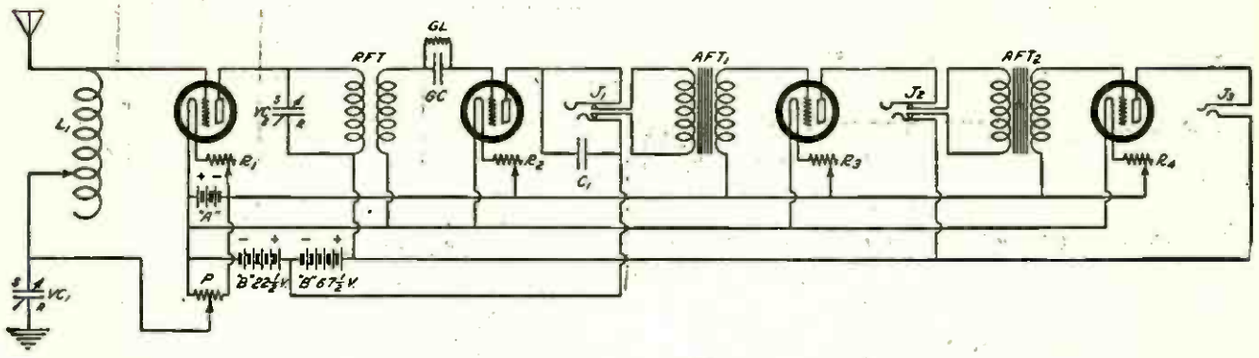
*(See POPULAR RADIO, *February, 1923, page 142, for constructional details.)*



ANTENNALESS REGENERATIVE CIRCUIT

Cost of parts: Not more than $21.00.
Selectivity: Excellent.
Operation: Very simple. One control for wavelength and one for regeneration.
Ease of construction: Not difficult to make.*
Approximate range: 20 miles.
Outstanding features: Works without an antenna. Reduction in static. Fine for local reception.

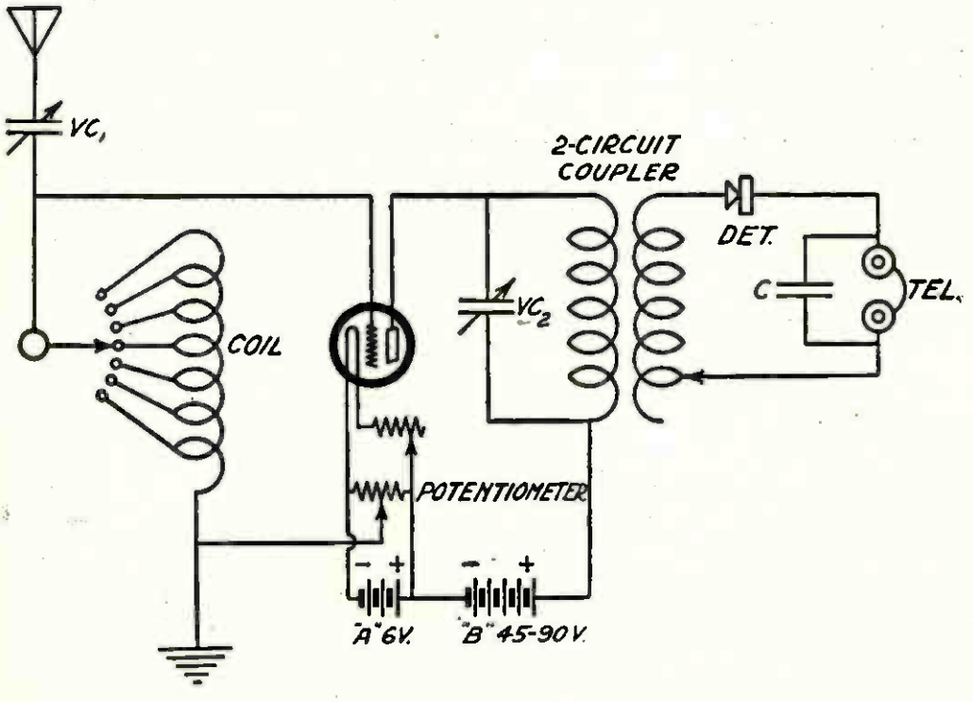
*(See POPULAR RADIO, *November, 1923, page 372, for constructional details.)*



SINGLE-STAGE RADIO-FREQUENCY AMPLIFIER WITH TUNED-PLATE CIRCUIT DETECTOR, AND TWO-STAGE AUDIO-FREQUENCY AMPLIFIER

Cost of parts: Not more than $45.00.
Selectivity: Very good.
Operation: Simple.
Ease of construction: Not any more complicated than the regular regenerative 3-tube circuit.*
Approximate range: 2,000 miles.
Outstanding features: Particularly good for DX reception of broadcasting. Simple to handle and truthful in reproduction of musical programs.

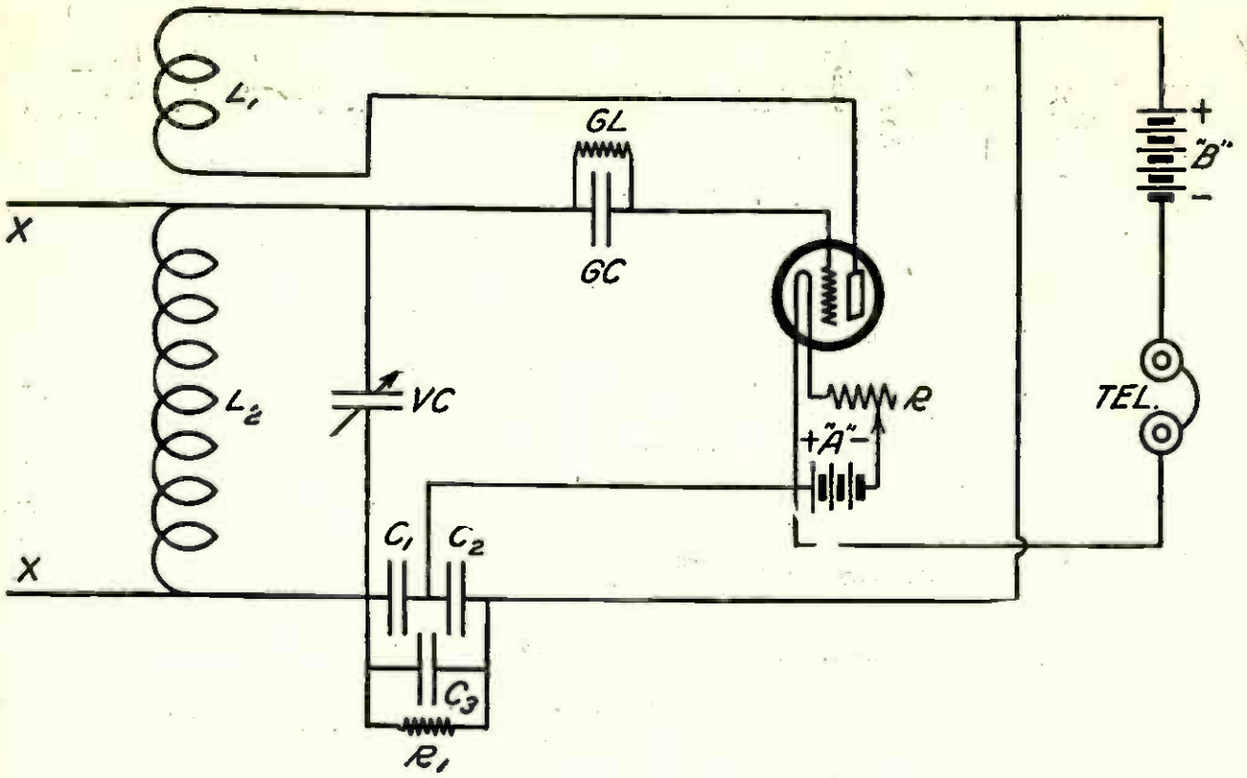
(See POPULAR RADIO, November, 1923, page 420, for constructional details.)



SINGLE-STAGE RADIO-FREQUENCY AMPLIFIER WITH CRYSTAL DETECTOR

Cost of parts: Not more than $26.00.
Selectivity: Fairly good.
Operation: Not complicated. There are two controls for antenna wavelength, a variable condenser and a tapped coil. The plate circuit is tuned by a second variable condenser, and the inductance tap on the secondary of the 2-circuit coupler controls the wavelength of the crystal circuit.
Ease of construction: Just an ordinary acquaintance with tools and some ability in wiring up the set are necessary.*
Approximate range: 500 miles.
Outstanding features: Clear, crisp reception. A short antenna may be used (such as an indoor antenna strung behind the picture molding).

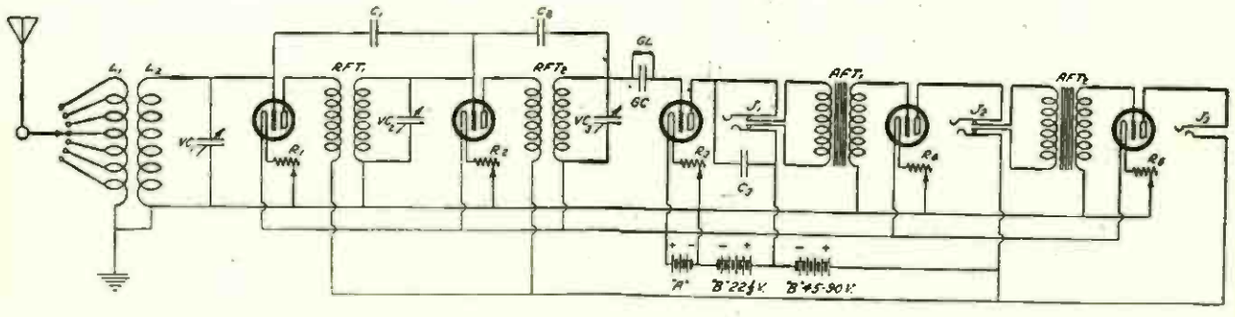
(See POPULAR RADIO, February, 1923, page 142, for constructional details.)



FLEWELLING MODIFIED SUPER-REGENERATIVE CIRCUIT

Cost of parts: Not more than $22.00.
Selectivity: Fair (on outdoor antenna). Good (on loop).
Operation: Not hard to operate when the circuit has once been adjusted properly. When used on an outdoor antenna, however, it is liable to produce bad interference to neighbors, due to re-radiation.
Ease of construction: Easy to make but not easy to get adjusted right.*
Approximate range: Local (on loop). 500 miles (on an outdoor antenna).
Outstanding features: Simplest super-regenerative circuit. Can be made to operate a loudspeaker on one tube. This is only true when all conditions are satisfied. Actually, many experimenters do not get very good results on account of some mistakes they have made and have failed to locate. Reception is accompanied with a high-pitched whistle.

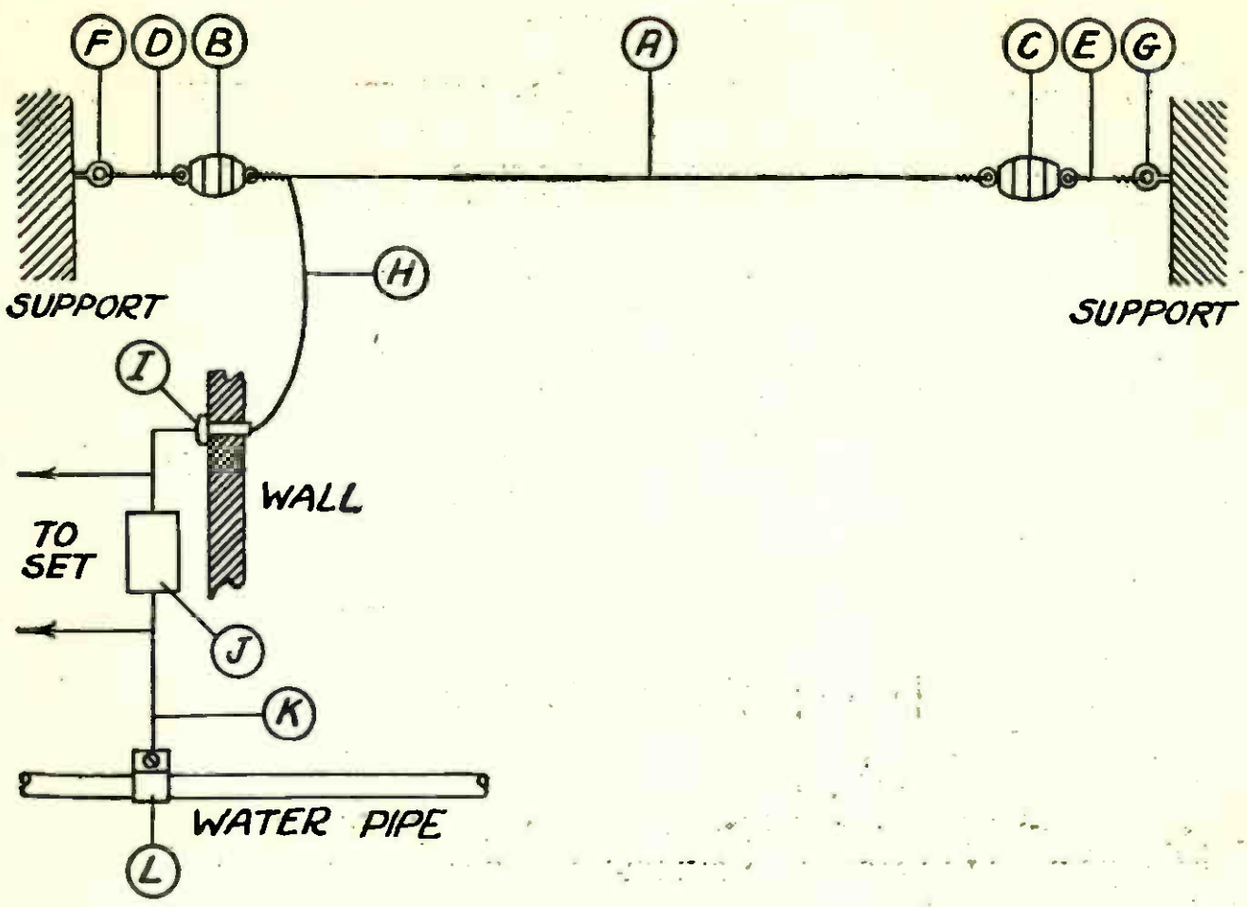
*(See POPULAR RADIO, *May, 1923, page 393, for constructional details.)*



FIVE-TUBE NEUTRODYNE

Cost of parts: Not more than $60.00.
Selectivity: Very good. There are three controls for wavelength.
Operation: Simple, if the set is tuned by means of a chart. In fact this is the only way to tune this receiver successfully.
Ease of construction: More or less complicated. There are a number of precautions that must be taken to get the circuit to function properly, especially in the matter of eliminating feedback. The set will operate more efficiently when the neutralizing condensers are upset slightly so that the set will regenerate without readily bursting into uncontrolled oscillation.*
Approximate range: 2,400 miles.
Outstanding features: The wavelength can be calibrated. The set will not re-radiate. Anyone can operate the set by means of the tuning chart.

*(See POPULAR RADIO, *September, 1923, page 248, for constructional details.)*



THE DETAILS FOR THE SINGLE-WIRE ANTENNA

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

HOW TO PUT UP AN

OUTDOOR RECEIVING ANTENNA

By ALBERT G. CRAIG

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

COSTS OF PARTS: *About $5.00*

HERE ARE THE ITEMS YOU WILL NEED—

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

A TRANSMITTING antenna is usually designed to fit the transmitting station, after due consideration has been given to its effective height and length in order to secure maximum radiation. On the other hand, a receiving antenna is often designed to fit the location, which is generally a satisfactory solu-

tion of the problem, as losses in the receiving antenna may be compensated by amplification, whereas any increase in transmitting power is necessarily costly.

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

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

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

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

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

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

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

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

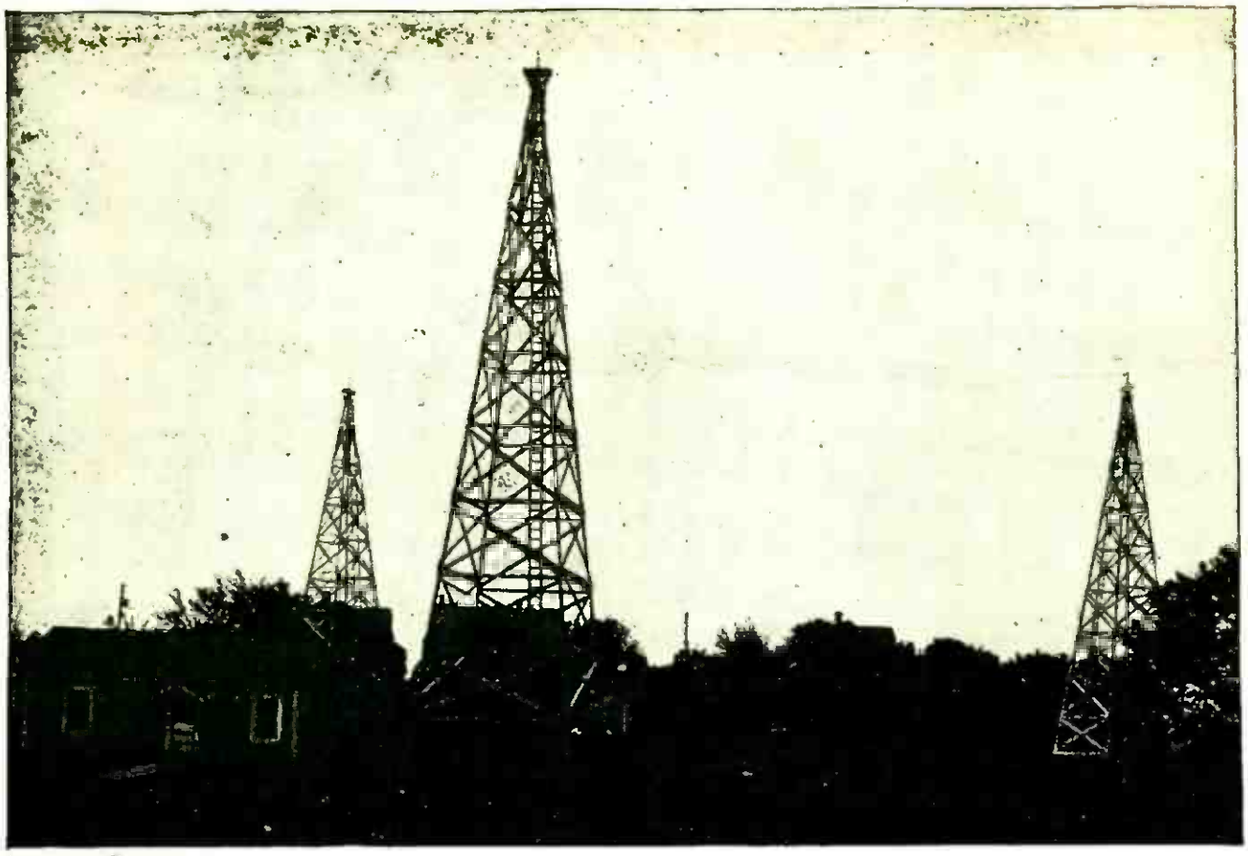
Next, choose a point of entrance for the lead-in wire. This may be in the window frame, in the sash itself, or in the wall nearby.

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

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

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

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



Armstrong Perry

THE BROADCASTING STATION OPERATED BY PENNSYLVANIA STATE COLLEGE

The lecture courses are not confined to small groups of undergraduates; some of them are made available to the people of the entire state through station WPAB

A College with a Radio Faculty

"The need of continuous education is so great, and the necessity for sending out information is so pressing as to make highly desirable some means of popular information in addition to the sometimes long-delayed government bulletin. Radio furnishes the means of reaching this audience quickly and regularly." So states the U. S. Commissioner of Education. This article tells what one of the more progressive colleges is doing to carry this modern idea into effect.

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THE slogan "The college of the state for the people of the state" led Pennsylvania State College, years ago, to add to its lecture and classroom courses many that any citizen of the state could pursue without leaving his own fireside.

These courses were called "extension courses" and the instruction was given by correspondence. Early in the spring of 1923 inquiries began to come in from Pennsylvanians who wanted radio instruction by mail. The Engineering Extension Department investigated the possibilities of a correspondence course, comprehensive, useful, yet not too difficult for the average man.

A course was prepared. It was announced in short paragraphs in the newspapers of the state and attracted the attention of radio magazines, which made it known nationally. Before any feature article had appeared, inquiries were coming into Penn State by hundreds, and

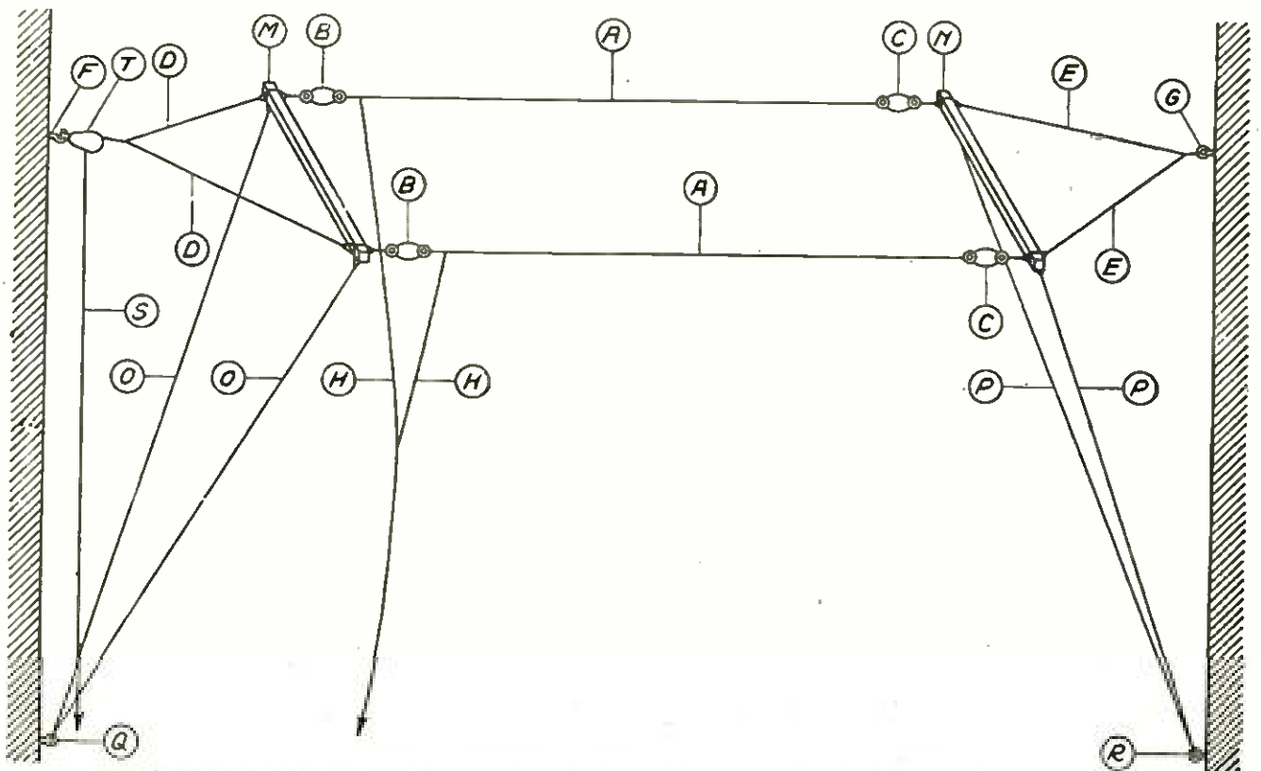
tenna or lead-in touches the house.

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

Ordinarily the one-wire antenna described here will be perfectly satisfactory, but the two-wire type may serve to bring up some particular station which it is difficult to receive. If the two-wire type is decided upon, consult Figure 3 for the assembly. Provide two hardwood spreaders M and N (two inches square and four feet long), four insulators B and C, one pulley T with a small hook F for fixing same to support, three screw eyes G, Q and R, and enough additional wire for the double antenna, the guy wires O and P, and the pulley wire S.

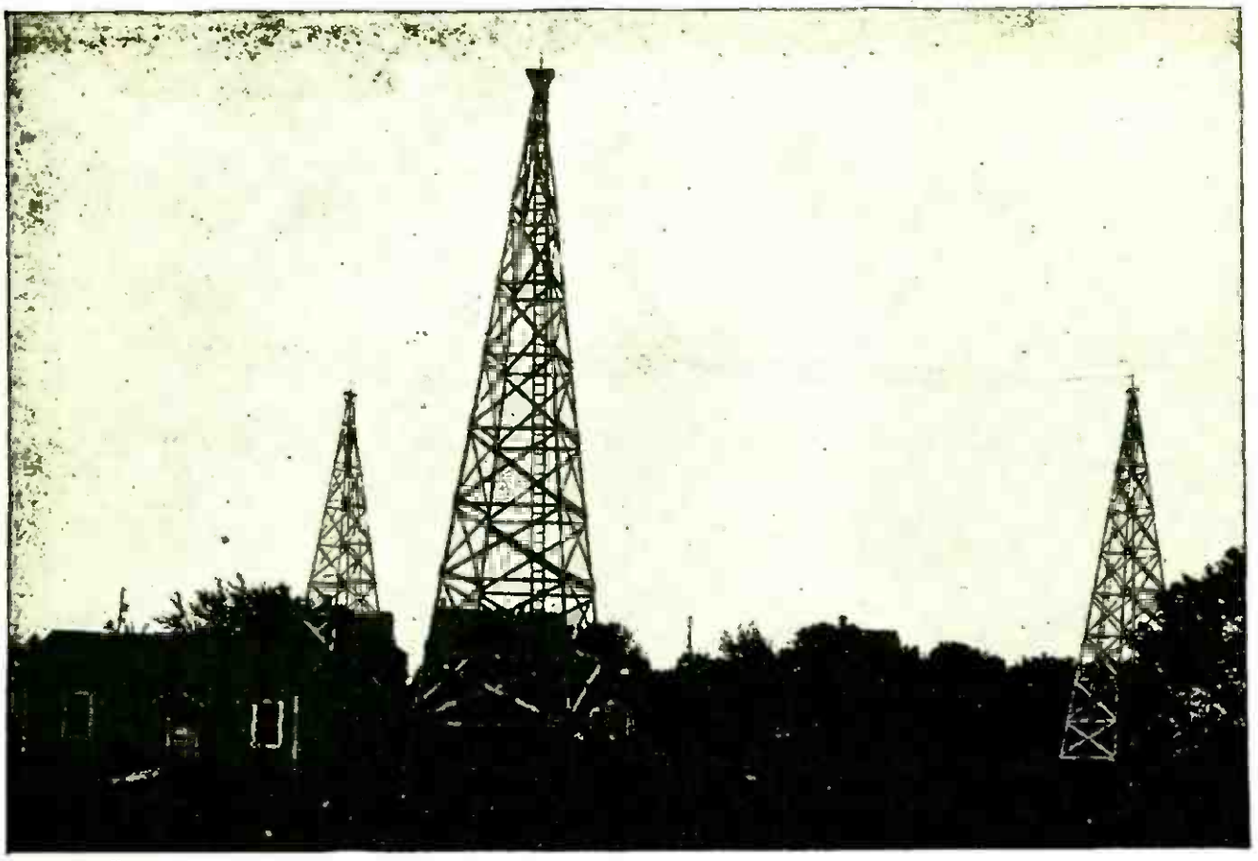
The two-wire antenna had better be assembled complete on the ground and hoisted into place. First, notch the spreader N about one inch from each end and connect, in the notches, insulators C (by means of a short length of wire), supporting wires E and guy wires P. Join supporting wires E about four or five feet from the spreader and join guy wires P about ten or fifteen feet from the spreader. Connect insulators B, supporting wires D, and guy wires O in the same manner to spreader M. Solder wires H at the ends of the two antenna wires A and bring them together a few feet below the antenna to form a single lead-in. First raise the far end of the antenna into position, connecting supporting wires E to screw eye G; then connect pulley wire S to supporting wires D and raise the other end of the antenna into position. Attach guy wires O to screw eye Q, and guy wires P to screw eye R.

The remainder of the installation is the same as for the single-wire antenna.



TWO-WIRE ANTENNA FOR EITHER RECEIVING OR TRANSMITTING

FIGURE 3: *This diagram gives the specific data for erecting an inverted L-type antenna. The supports may be two poles set up especially for this purpose or they may be two trees or other natural supports. If trees are used the spreaders should be set out about 15 feet from the branches or there will be a certain amount of absorption of energy by the tree.*



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Brown Bros.

THE RECEIVING ANTENNA INSTALLED

FIGURE 2: *This typical installation shows how two natural supports (in this case a chimney and a tree) may be used for the single-wire receiving antenna. For a residence this method of supporting the antenna is much less conspicuous than the use of poles or brackets.*

lightning arrester J, may be one of the small indoor vacuum-gap type and should be marked "Approved by the Underwriters' Laboratories." L is a good grade of ground clamp.

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

We may now proceed with the installation of the antenna.

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

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

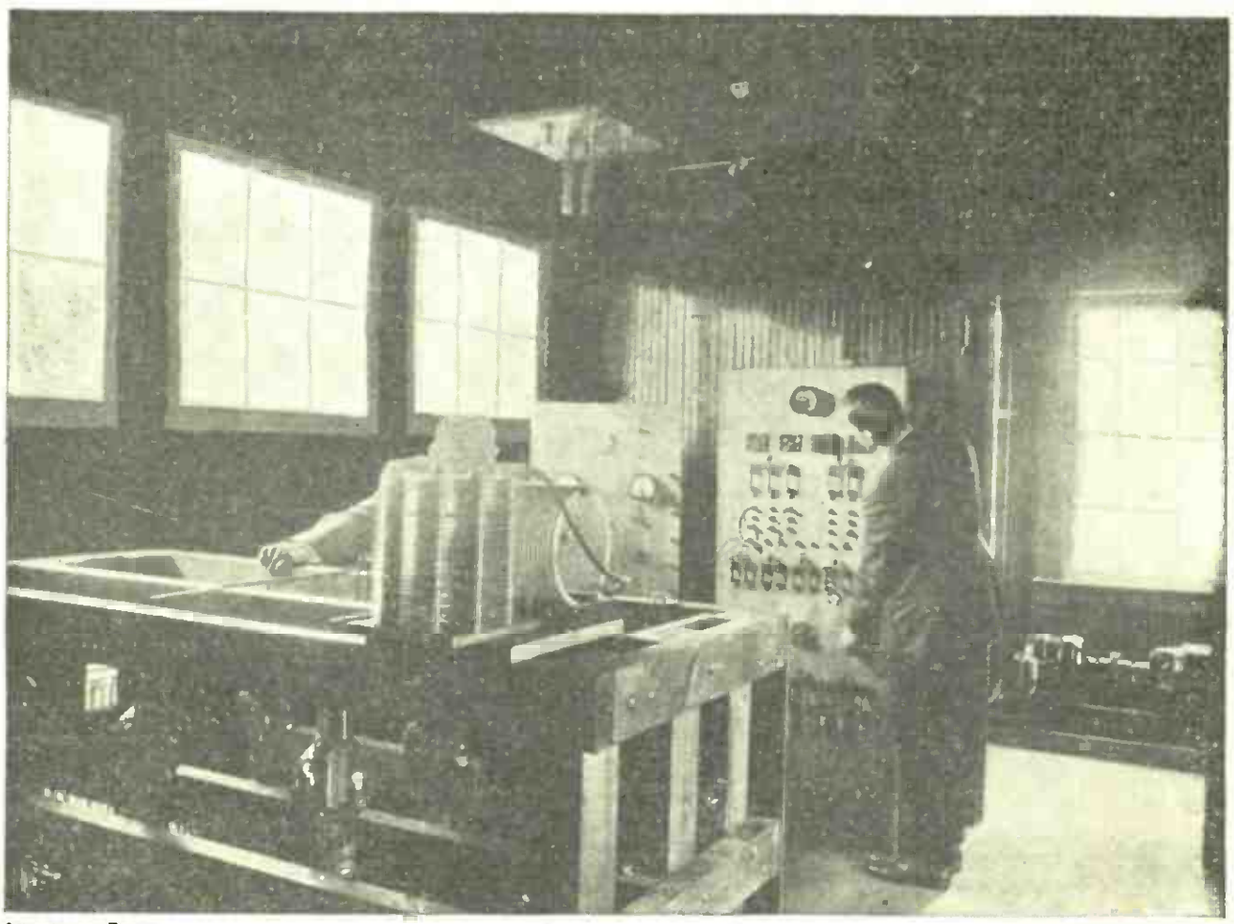
Next, bore a hole for the lead-in bushing with a slight slope downward toward the outside of the house, so that water will drip off instead of running inside; insert the bushing and pass the lead-in wire through it. Fasten the lightning arrester to the wall nearby and connect the lead-in to the top side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

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

early in the fall the registration exceeded that for any other course offered by the department. At the last report 32 per-cent of the corresponding pupils registered by the Engineering Extension Department were studying radio. Many of them are residents of other states. Every section of the Union is well represented.

The first man to register for radio was a newspaper editor. Several farmers, disproving the alleged slowness of the rural mind, were near the head of the list. Accountants, typists, postal clerks, radio salesmen, mechanics, steel workers, boiler makers, licensed commercial radio operators, a doctor of philosophy and a dentist were among the early applicants. As the enrollment lengthened, all the leading professions and lines of business were represented, and many of the trades. A high-school teacher, intent on organizing a radio club, asked for the assistance that the course would give her in keeping ahead of her pupils in the new subject. An aged physician applied just too late—death overtook him before his first lesson was prepared. His widow wrote that his interest in the marvelous new science was strong until the last. A youth in Montana filled the vacant place. He is but fourteen and the course is not designed for boys, but he showed that he was qualified, even to the securing of his father's permission to add the correspondence course to his first year's work in high school. Cubans and Canadians have applied for registration.

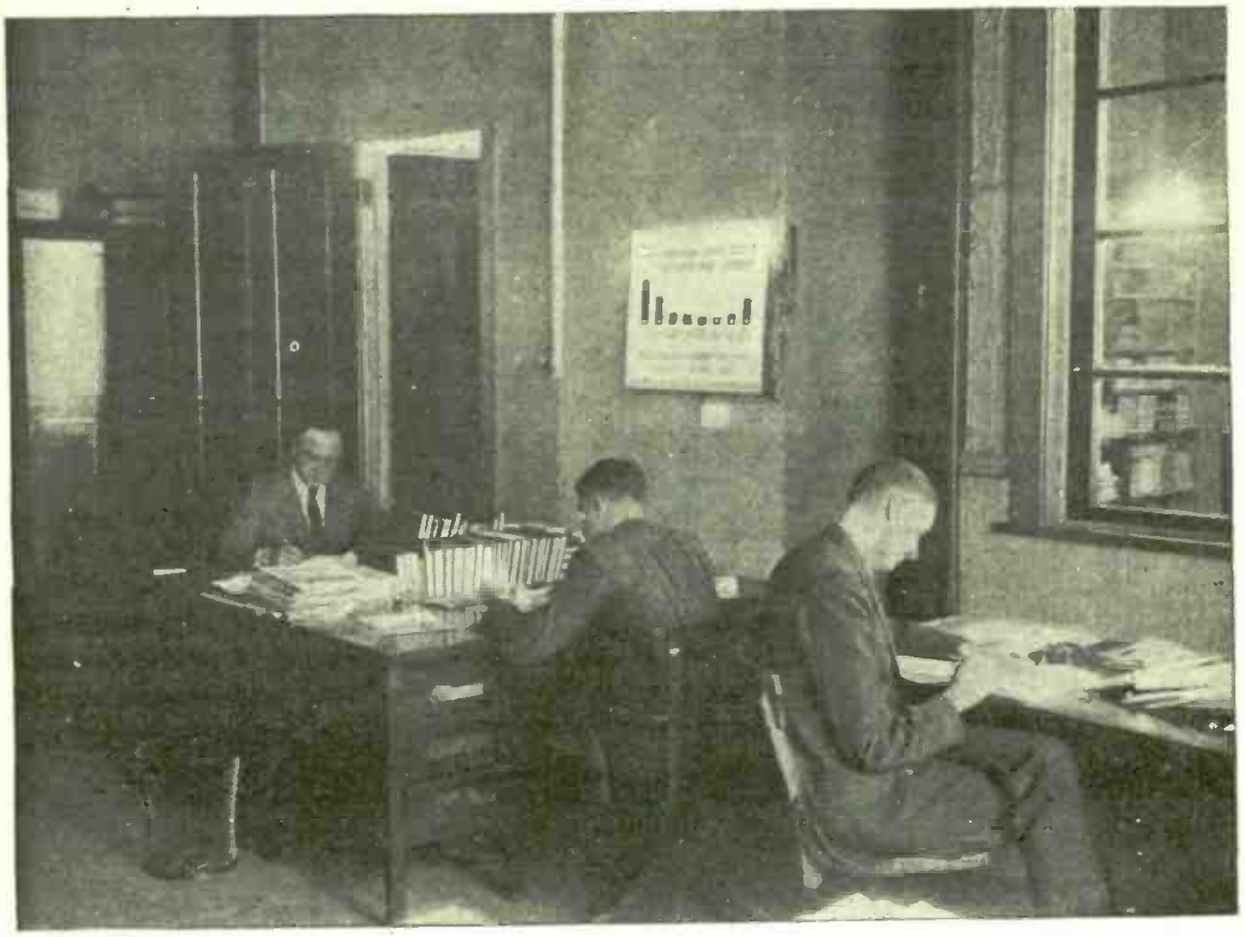
If the five continents and the islands of the sea have not added their quota of pupils by this time, the mails must have been delayed.



Armstrong Perry

BEHIND THE SCENES IN A MODERN EDUCATIONAL INSTITUTION

Here is the apparatus used for transmitting by radio some of the lectures that supplement the correspondence courses maintained by Pennsylvania State College. Part of the generator equipment is seen in the rear.



Armstrong Perry

THE "RADIO FACULTY"

Here is Prof. G. C. Gaum (at left), with his two assistants, who is in charge of the courses of instruction conducted both by radio and by correspondence. The chart on the wall shows that the registrations for the radio course overtop all others.

Penn State is well prepared to care for her pupils in the radio correspondence courses—better prepared than she is to admit applicants to her classrooms. Four thousand students have been turned away in seven years for the lack of room. The college has had a radio station since the time, fifteen years ago, when a forward-looking graduating class gave her a 130-foot steel tower for the aerial, and an operating room. For years her station, 8XE, has been one of the reliable relay stations of the American Radio Relay League. It has been heard in all parts of the United States, in the English Channel, in Switzerland and 1,700 miles off our Pacific coast. The professors and pupils have had broadcasting experience also. The alumni residing in the Pittsburgh district gave the money for the installation of a broadcasting station to be used for educational purposes. It opened up last May. The pupils who operate and study it, under the supervision of the radio faculty, gain practical experience while the listeners hear the president, Dr. John M. Thomas, talk on subjects of general interest, the deans of the five colleges tell of the work accomplished in their respective fields, and strong-voiced announcers follow the battles waged on gridiron and diamond.

The broadcasting station, WPAB, adds interest to the work of the men's and women's glee clubs and quartets, the mandolin club, the soloists and the student dance orchestra. Distance lends enchantment, and no matter how the folks back on the farm may have kicked when Bill first tackled the saxophone and Mary hurdled high C, they are

mighty keen on calling in the neighbors when the kids' college-bred music slides down the antenna and spills out of the loudspeaker. Even in the days before the radio telephone, when the baseball and football scores were sent out in dots and dashes, there were interested listeners all over the state, but under the present method their numbers have multiplied faster than rabbits in a back-yard pen. The programs are adapted to both city and rural residents. All this experience had helped to make the radio correspondence course something more than a mere academic arrangement of dry facts—the professors know what it is to be up against practical situations.

When Farmer Smith cannot separate the cream of the ether from the blue milk, as he sits with his text-book in one hand, his tuning knob in the other, and his ears full of assorted concerts and information from radio stations at all points of the compass, on Penn State's "Farm and Garden Night," the instructor who receives his lesson paper knows just what he is talking about and what advice he needs. If a farmer follows the advice that he receives, he will eventually be able to build his own set (though the course does not cover construction) and bring in the frost warning, the advice on the apple scab that threatens his orchard, and other things broadcast by the college for the fattening of the farmers' pocketbooks.

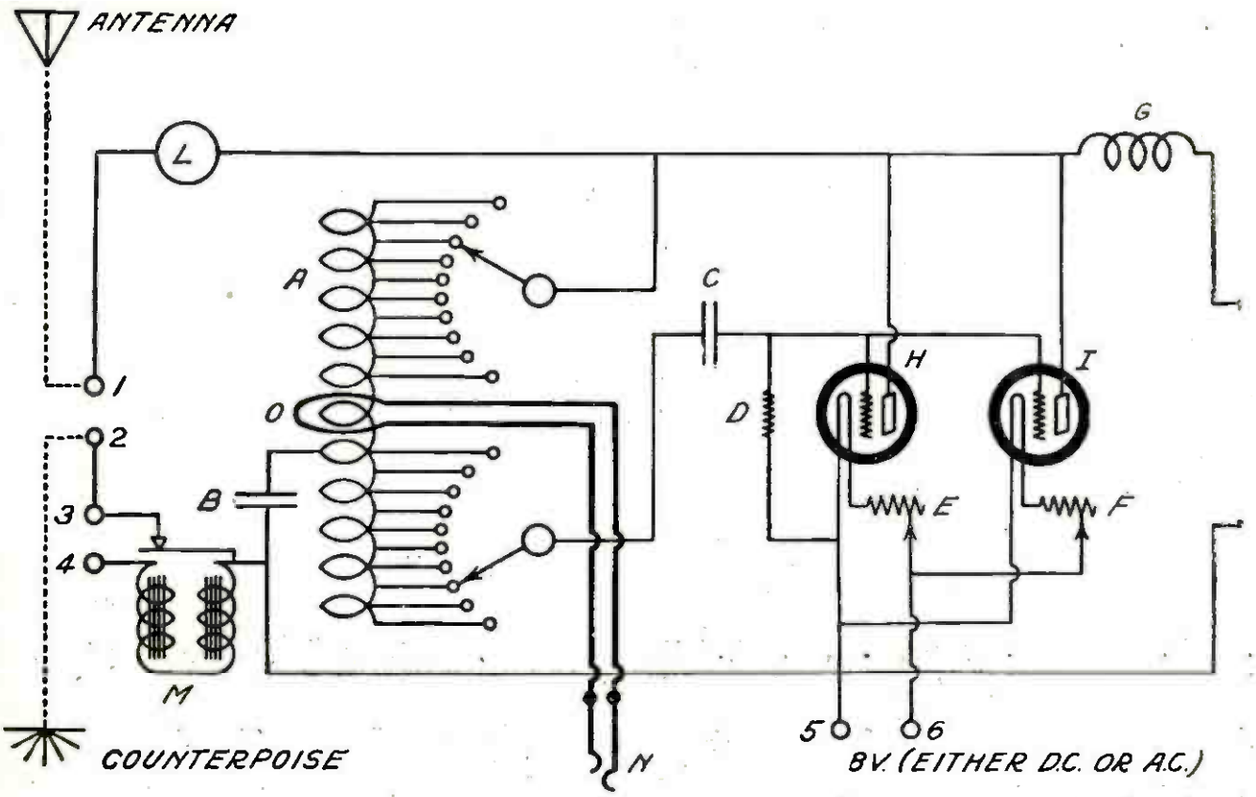
The correspondence course in radio is under the general supervision of Professor Charles Kinsloe. Professor N. C. Miller of the Department of Engineering Extension, who has specialized in correspondence instruction for the past ten years, has immediate charge of this and other mail courses. Professor C. G. Gaum gives the instruction. He has several assistants. The course is divided into two parts, each with its own text and ten assignment pamphlets. The first part, designed to meet the needs of beginners and amateurs, establishes principles, and studies common electrical phenomena, radio circuits, the vacuum tube, amplification, sources of power, transmission circuits, and applications of radio. The second part delves more deeply into the theory of electricity and leads up to detailed consideration of electromagnetic waves, radio circuits and the apparatus employed in the transmission and reception of radio messages. The first part costs the corresponding student $10.00, and the second part $15.00. Text-books and pamphlets are furnished without additional charge.

"How to build it" has been omitted, after careful consideration, for the pupil can buy such information in the radio books and in the radio periodicals. The instruction given by mail may be supplemented by lectures delivered *via* radio.

Pupils who find it possible to visit the college will find a welcome and see many things that are impressive. The broadcasting station looks dwarfed beneath the towers that support the star-cage antenna, but it contains three ample apartments: one for the studio, one for the operating room and one for the generating plant, which delivers a full kilowatt to a row of 250-watt transmitting tubes. Much of the apparatus has been built by resident students, directed by Gilbert L. Crossley, an undergraduate, and underneath the antenna system is buried, eight feet deep, a ground system with a network of wires.

Will Radio "Revolutionize" Our Educational Methods?

SOME *of the best minds believe that it may—including that of the progressive president of Antioch College, who is making a significant experiment in "broadcasting education" that may lead to far-reaching results.*



THE ELECTRICAL WIRING DIAGRAM FOR THE TRANSMITTER

FIGURE 1: *This drawing shows how to connect the various instruments and parts in the electrical circuit so that they will function in the manner described in the article.*

HOW TO BUILD

AN AMATEUR TRANSMITTER

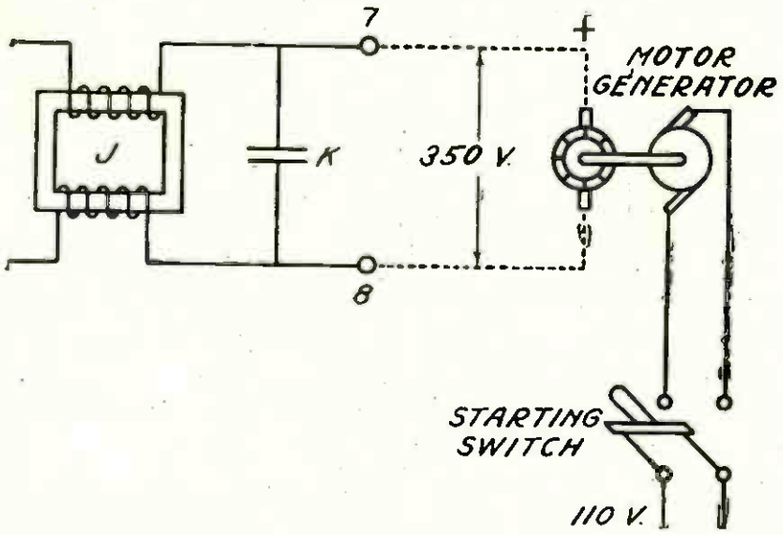
By LAURENCE M. COCKADAY, R. E.

COSTS OF PARTS: *About $150.00*

TRANSMITTING RANGE: *About 25 miles*

HERE ARE THE ITEMS YOU WILL NEED—

A—inductance coil (see Figure 5);
B—antenna fixed condenser, .0015 mfd. (Any standard make of high-voltage mica condenser can be used in place of the home-made one);
C—grid condenser, .0008 mfd. (Not critical, a .0005 mfd. can be used);
D—Ward Leonard resistance, 7,000 ohms;
E and F—filament rheostats (resistance values to suit tubes used);
G—honeycomb coil, size L200, used as a radio-frequency choke;
H and I—vacuum tubes, either VT-2 tubes or UV-202 tubes can be used;
J—Acme double-coil iron-core choke, 1½ henries, 150-milliampere carrying capacity;
K—Federal paper condenser, No. 58-B, 2 mfd.;
L—General Radio hot-wire ammeter, scale reading from 0 to 2.5 amperes (for mounting on front of panel);
M—Century buzzer (H-F);
N—single-circuit jack (well-insulated type);
O—single-turn modulating loop wrapped tightly around inductance coil A;
P—composition panel;
two switch levers;
eight binding posts;
twenty switch points and four switch stops;
cabinet;
Esco 350-volt motor generator;
DPDT starting switch, 25-ampere carrying capacity;
connection wire, solder, etc.



THERE are a number of designs for a small transmitter that could have been picked out for description; there are also a number of circuits that still find each their adherents among the transmitting amateurs. But the author has decided to stick to the circuit known as the Colpitts, as it is so easy to build and to get into operation.

Anyone who is given the description of this set can easily make it and have it working to perfection within a week's time—after he secures the necessary parts.

The transmitter selected consists of two 5-watt tubes, which are mounted in a neat cabinet with the inductance, the filter circuit, the chokes, condensers, and the other pieces of apparatus. The front of the panel will have the controls for the wavelength, the rheostats and the buzzer. The only external apparatus necessary comprises the motor generator, the key, the dry battery for the buzzer and the antenna and counterpoise.

In operation the set should have a range of about twenty-five miles for telephony; about fifty miles with the buzzer and as much as a thousand miles for CW, with a good antenna system and a fair location.

The electrical wiring diagram is shown in Figure 1. The wiring in dotted lines is located outside of the cabinet, as is also the motor generator and the starting switch.

The Parts Used in Building the Set

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

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

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

How to Construct the Set

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

First of all the panel should be cut to the correct size, 11 by 15 inches.

Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 3.

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

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

Next, mount the two rheostats E and F, with two screws each, and attach the two small knobs.

Then fasten on the two switch levers, and the two sets of switch points as shown in Figure 4.

Now mount the hot-wire ammeter L by inserting the two screws on the instrument through the panel and fastening with nuts on the rear. (See Figures 2 and 4.)

Then place the jack N in the hole drilled for it in the panel and fasten tight in the regular manner.

The buzzer M may now be mounted in the position shown in Figure 4, by two screws. The cap of the buzzer will have to be removed for this operation.

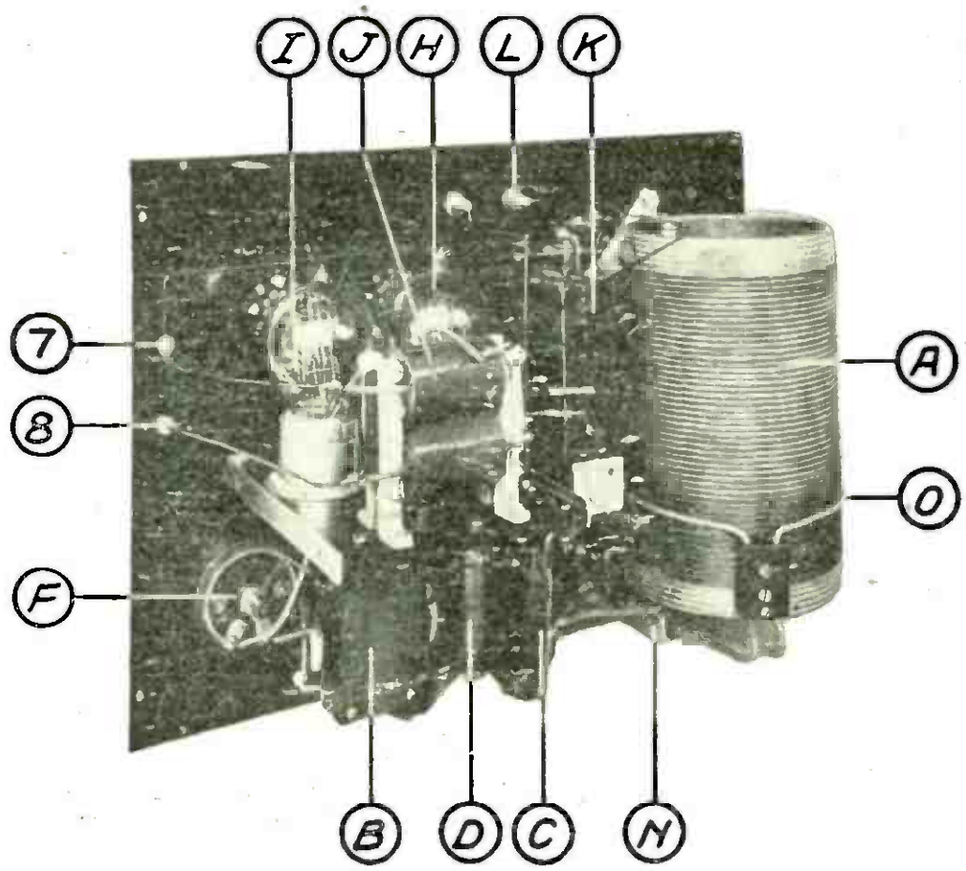
About the only thing left to do on the panel will be to mount the binding posts as indicated in Figure 4.

How to Make the Inductance Coil

Now consider the making of the inductance coil A.

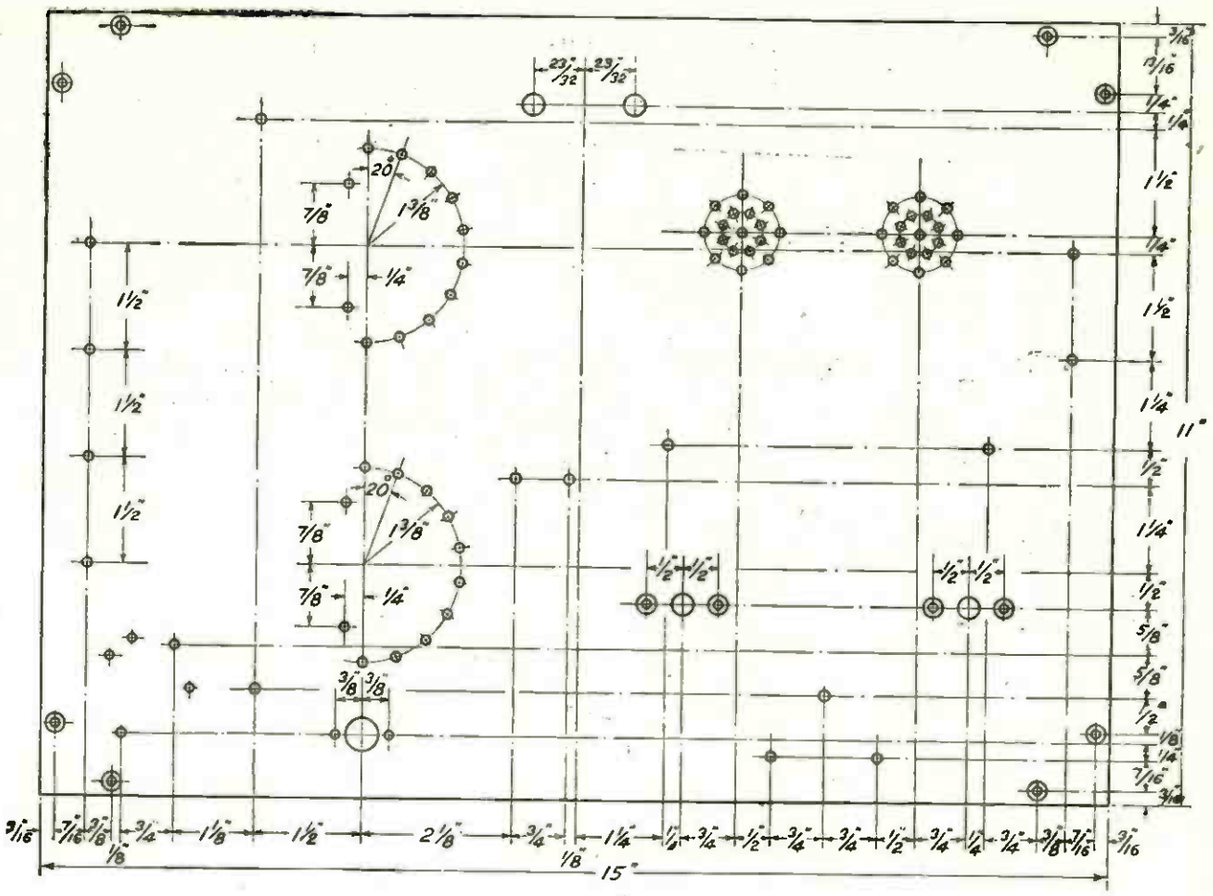
This coil should be wound on a composition tube 4 inches in diameter and 6 inches long. The wire used for the winding is No. 14 bare or enameled copper wire. The turns should be spaced approximately ⅛ inch apart.

The winding should have ten taps spaced



AN INTERIOR VIEW OF THE SET

FIGURE 2: *This picture shows the general arrangement of the apparatus which is mounted directly on the main panel and on the shelf panel. The parts are designated by letters which reappear in the text and in the list of parts at the head of the article.*



HOW TO PREPARE THE MAIN PANEL

FIGURE 3: *This drawing gives the drilling data for the holes for the screws which are used to support the instruments, switch levers and the binding posts.*

one tap every turn from the bottom of the coil, for the grid voltage control, and ten taps spaced every other turn from the top of the coil, for the wavelength control. The remaining ten turns at the center of the coil are left untapped.

Before winding the coil, the tube on which the coil winding is made should be threaded to fit the wire, the groove being about $\frac{1}{16}$ inch wide and deep and having about 8 turns around the coil, to the inch along the coil. This job can be done in a neighboring machine shop at a very small cost to the builder. The wire should be wound tightly in the groove, as shown in Figures 2 and 5, and the taps made as shown in Figure 5.

These taps should be staggered slightly on the coil, and when the coil is completed the taps should be squeezed together so that the wire will pinch tightly against the tube and cause it to bind permanently and securely.

When the coil winding is complete it may then be fastened to the panel along with the other instruments already mounted. The coil is fastened to the panel by two screws as shown in Figures 2 and 4.

How to Make the Fixed Condensers

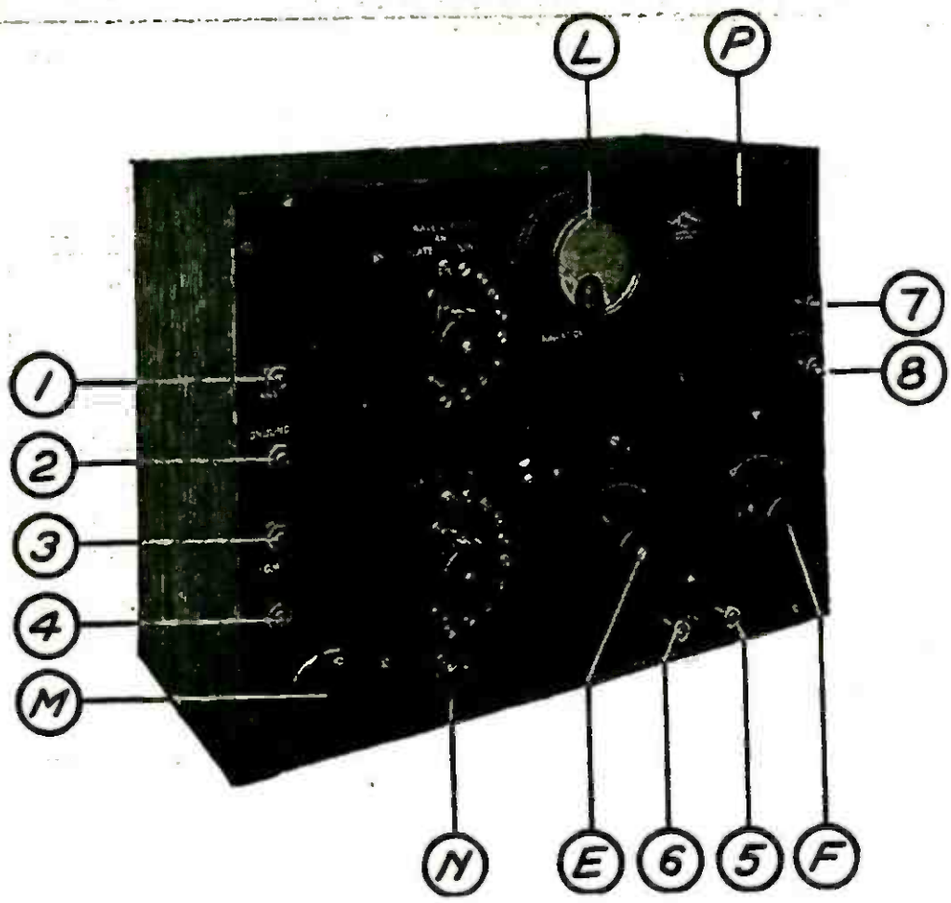
The next construction job will be to make the two fixed condensers B and C.

These can be made as shown in Figure 6. Two heavy plates of brass (about a quarter of an inch larger all around than the condenser plates) are cut and bent as shown and drilled for 4 screws.

The plates for the grid condenser C consist of two plates of copper foil 1¼ inches square with a connecting flap, and separated from each other by one sheet of mica .003 inch thick by 1½ inches square. The capacity of this condenser should be somewhere in the neighborhood of .0008 mfd.

The antenna condenser B has three plates and is otherwise constructed in the same manner as the first condenser. The two outside copper plates are connected electrically together and form one terminal and the flap on the middle plate forms the other terminal. Of course, the middle plate is insulated from the two outside plates by two squares of .003 inch mica sheet. This condenser may have a capacity of about double that of the condenser C.

The copper plates are insulated in turn from the outer brass pieces by two squares of thin composition sheeting. The whole construction is shown so clearly in Figure 6 that further consideration is unnecessary. However, for those who do not wish to make the condensers, they may be purchased. Just ask for mica condensers of about the capacities specified.



A VIEW OF THE SET FROM THE FRONT

FIGURE 4: *Showing the panel layout with the location of the switches, jack, rheostats, meter, buzzer and the binding posts.*

They *must be* for transmitting purposes.

The small shelf panel should now be cut to size and the three brass brackets made as shown in Figure 7. When this is done the two condensers are mounted underneath it together with the grid-leak D and the radio-frequency choke coil G. On top of this panel should be mounted the two tube sockets and the double-coil, audio-frequency choke J.

This whole shelf-panel assembly is then fastened to the main panel with three flat-head machine screws with nuts on the rear of the panel.

Then, to mount the filter condenser K, another brass bracket will have to be made as shown in Figure 8 and also two strips of composition insulation will have to be cut as shown in the same figure. This drawing shows how the condenser should be mounted and fastened to the panel.

This completes the construction work on the set and it is now ready for wiring.

How to Wire the Transmitter

The set should be wired with care and it would be well if the radio-frequency circuit is connected with the same kind of wire as used for the inductance coil A. This keeps down the resistance of these circuits and therefore, the utmost in power will be supplied to the antenna. No insulating covering should be applied to any of these wires except through the filament circuits. For the audio-frequency circuit this is not important.

The radio-frequency circuit comprises the leads to the coil A, the taps, the plate circuits of the tubes, the grid circuits and the connections to the antenna system.

It would be best to start with the two binding posts 7 and 8 and wire to the condenser K and the two opposite coils of the double choke J. Then follow the diagram in Figure 1, wiring up the other terminal of the lower choke coil J to the filament circuit of the two tubes including the two binding posts 5 and 6, and the rheostats E and F, one side of the grid-leak D and also over to the condenser B and the buzzer M. Then wire the other contact posts of the buzzer to the posts 2, 3, and 4. Then a lead should be run from the remaining terminal of the condenser B, to the top tap of the lower set of taps. This constitutes the fixed ground tap.

Now run a wire from the post 1 to the plates of the two tubes, including in series the two terminals of the ammeter L. From the plate circuit a wire should be run to the top switch lever, and its respective switch points should be wired up to the upper set of taps on the coil A.

Then wire up the lower set of switch points to the lower set of taps on the coil A, and connect the lower switch lever over to the condenser C. The other terminal of this condenser is then connected to the remaining terminal of the grid-leak D and the grids of the two tubes H and I. Now connect up the radio-frequency choke G to the plate circuit and finish this connection to the remaining terminal of the upper winding of the audio-frequency choke J.

The last job in wiring will be to connect up the single turn of heavily insulated wire around the coil A. The two ends of this turn of wire should be connected to the two terminals of the jack N. This is the absorption loop for modulating the output of the set for telephony. The wiring is then complete.

How to Set up the Transmitter

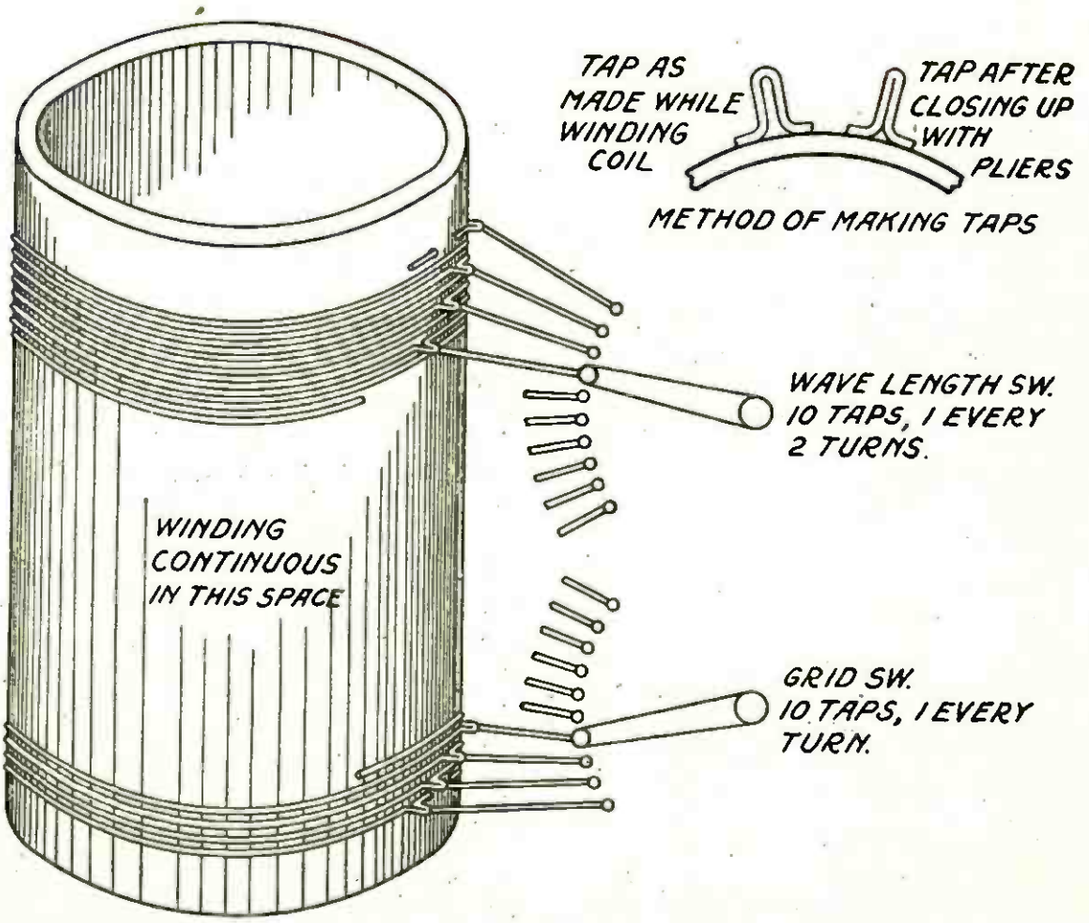
First of all, get the materials together for a short single-wire antenna and a short three-wire fan counterpoise. This will require about 500 feet of No. 12 seven-strand copper wire and 6 or 7 antenna insulators. The counterpoise should run in three directions, the middle wire should be suspended about 10 feet above ground and run straight out from the spot where the lead-in is to be located. The other two wires of the counterpoise should be placed on the same level as the middle wire and should run at an angle of about 22½ degrees on each side of the middle wire.

The antenna wire should be located as high as possible directly over the middle wire of the counterpoise. It should also point in the same direction as the middle wire. Both the antenna and the counterpoise should be about 65 feet in length. Be sure that the two lead-in wires, from the counterpoise and the antenna proper, do not run close to each other or parallel for any considerable distance.

The person setting up the antenna will have to use his own judgment in adjusting it to his own local conditions but the plan outlined above will probably be the best.

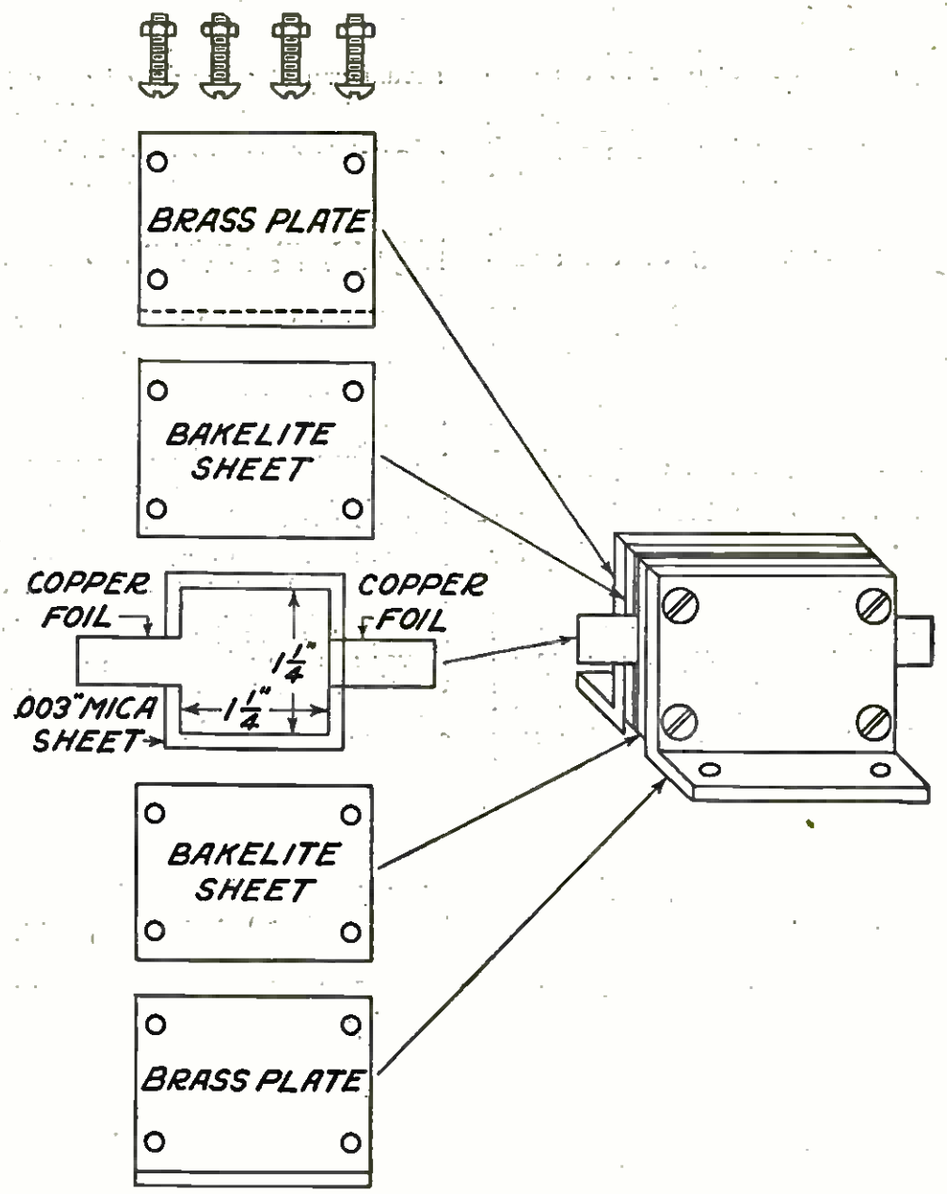
When the antenna work is completed and the proper lead-in bushings put in place, the work inside of the house can be started. Choose a place in the room that you have already picked so that the table will come right opposite the window or the lead-in bushings. This will give you short leads and added efficiency. Never run the wires to the antenna and counterpoise any distance through the house.

Set up the apparatus on the table, leave the cabinet off until the set has been in operation a few weeks and you have got it tuned to per-



HOW TO MAKE THE TAPPED INDUCTANCE

FIGURE 5: *The coil is wound on a composition tube as shown and the taps are made and wired to the 20 switch points on the panel.*



HOW TO MAKE THE MICA FIXED CONDENSERS

FIGURE 6: *These condensers can be made by any amateur who is handy with tools, but condensers of this capacity may be obtained from the dealers. If you buy them, be sure that they are for transmitting.*

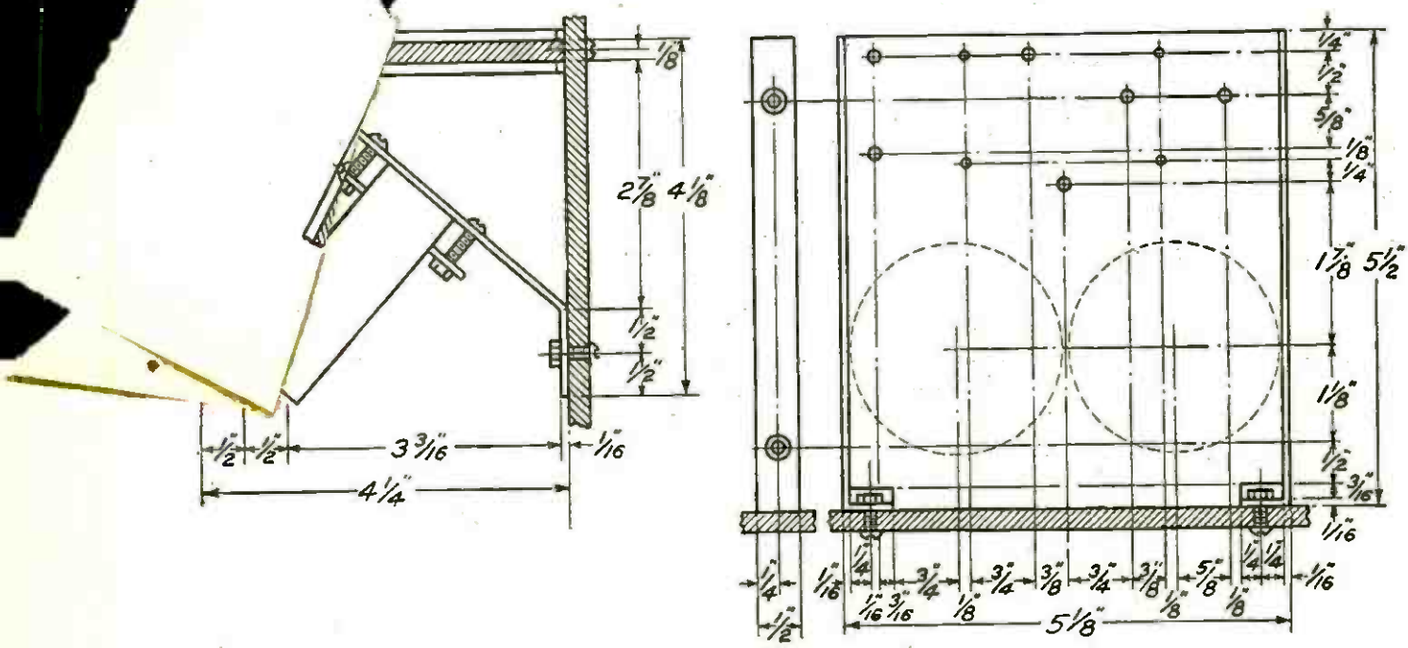
fection and understand its operation better.

Connect up the starting switch on the table in a convenient position to the hand. This switch may be wired direct to the lighting circuit. Then connect the motor (of the motor-generator set) to the switch. Next, connect the positive terminal of the generator to the post 7 on the set. The negative terminal of the generator should be connected to the post 8 on the set.

Next, connect the two posts 5 and 6 to an 8-volt storage battery or an 8-volt toy transformer. If a toy transformer is used for lighting the filaments on A. C., the primary of this transformer may be connected to the starting switch of the motor generator so that the same switch can be used for starting the generator and turning on the filaments. This makes for a quick change-over.

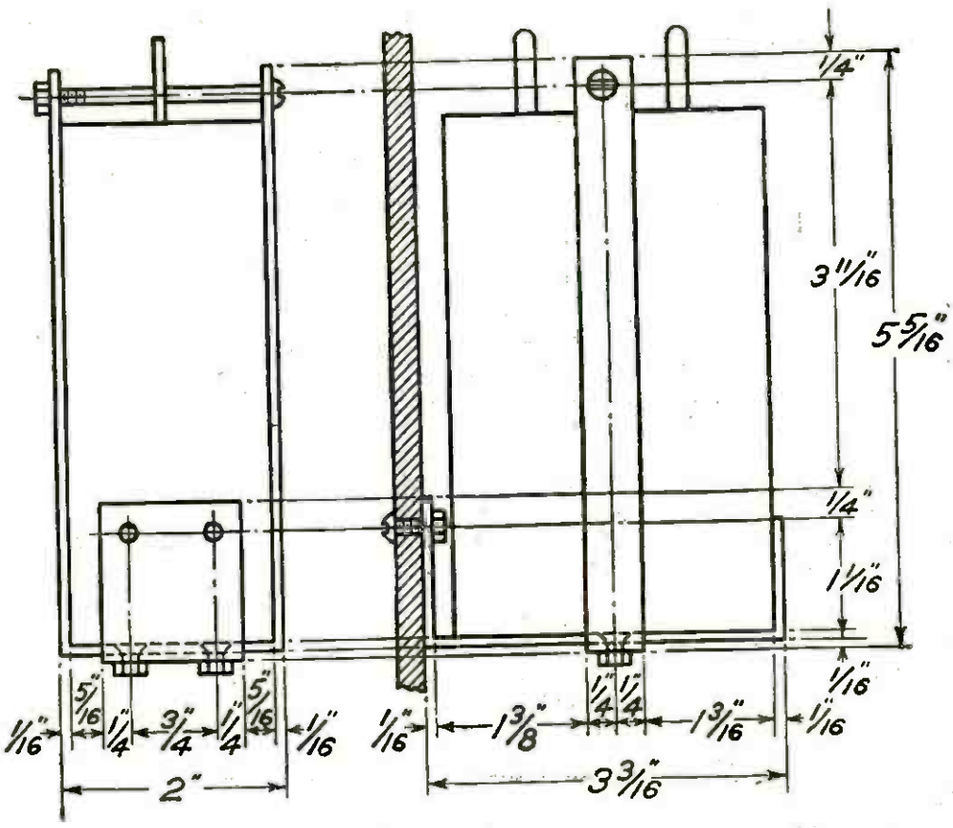
Now connect the antenna lead-in wire to the post No. 1 and the counterpoise lead-in wire to the post No. 2. For operating the buzzer, two or three dry cells should be connected in series with a key to the posts No. 3 and No. 4.

It would be advisable to ask some neighboring amateur friend to come over to the station to help you get the set into operation for the first time. Get an amateur who has a vacuum-tube transmitter of his own. Ask him to bring over a D. C. milliammeter and insert it in the positive plate lead of the transmitter. (This is the wire running from the positive terminal of the generator to the binding post 7.) The milliammeter will tell you just how much plate current the tubes are drawing and will give a pretty good indication as to when the set is functioning properly. When the set is once tuned you can take the meter out of the circuit



THE DIMENSIONS FOR THE SHELF AND BRACKETS

FIGURE 7: *At the left is shown the side view of the shelf with the honeycomb coil G, mounted on the slanting bracket by means of a small strip of composition and two screws and nuts. At the right is given the dimensions for the shelf and the side brackets.*



HOW TO MOUNT THE FILTER CONDENSER

FIGURE 8: *This drawing shows the end view of the condenser and bracket (at the left) and the side view after it has been attached to the panel by means of the brackets.*

and the hot-wire ammeter will tell you if the set is working right or not.

The first thing to do in tuning up is to get the filaments of the two tubes burning at the correct brilliancy. This should be done without supplying any plate voltage to the tubes. Connect the batteries (for lighting the filaments) without connecting the generator to the supply lines. Or, if A.C. is used for lighting the filaments, disconnect the 110 volts A.C. from the input to the motor generator, so that when you close the starting switch, only the transformer will get a supply of alternating current and only the filaments will be energized. Then regulate the two rheostats, one for each tube, until you have them both burning at the correct brilliancy. The UV-202 tubes should be lighted up nearly all the way on the rheostats, but the VT-2 tubes (which are preferable in this set) should only be lighted a dull red color. If the latter tubes are lighted up brightly they will burn out!

Now adjust the top set of taps, say at the third tap from the top, and put the switch lever of the bottom set of taps on the bottom tap.

Now replace the connection to the generator and turn on both the filament current and the plate current. If all the connections have been made according to standards, the hot-wire meter should immediately begin to climb until it reads somewhere between .5 and 1.5 amperes. This is a measure of the high-frequency current being supplied to the antenna.

Now get out the wavemeter and find out what the wavelength is. (By the way, this test should be made at a time of day when it will not interfere with the broadcasting, lest you may exceed the allowed wavelength. It will take a few minutes in getting the set tuned. Better do it at night, when broadcasting is in full swing!)

If the wavelength is too high during this first test, keep coming down on the upper set of taps; the lower the tap you use the lower will be the wavelength upon which the set will radiate.

When you have the wavelength correct, adjust the lower set of taps so that you get the highest radiation with the smallest plate current in the borrowed milliammeter. When this is done you can take the meter out of the circuit and return it.

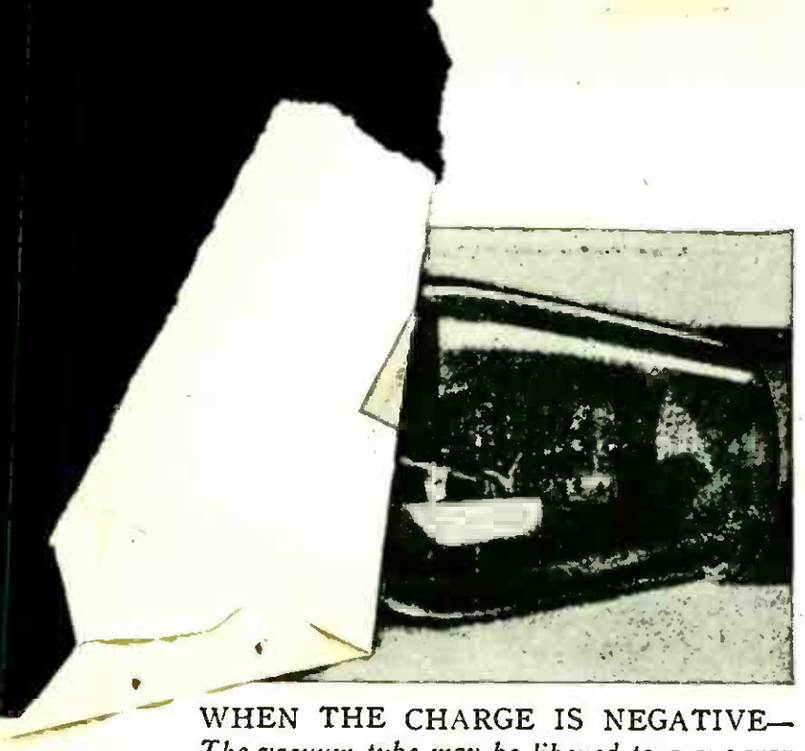
If you wish to use *telegraphy* on the buzzer all you need do is to press the key in the buzzer circuit. When the key is depressed the buzzer contacts will interrupt the antenna current, thus modulating it at the buzzer's frequency.

If you wish to use *telephony*, connect the microphone to a telephone plug and insert the plug in the jack on the set and speak into the microphone. The antenna current as recorded by the hot-wire meter will fall off, both when the key is depressed and when the voice is impressed on the microphone. This is a proper indication that the set is modulating.

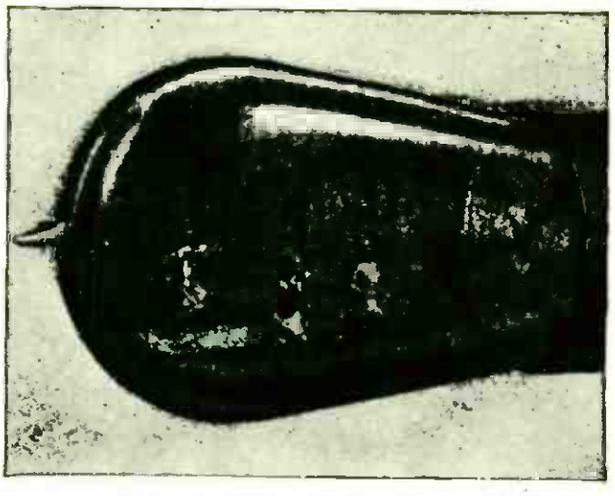
Foto Topics, Inc.

HOW ONE PRINTER USES RADIO TO AVOID STRIKES

Overtime work in a New York printing concern caused so much difficulty in holding workmen that the manager finally hit upon the idea of installing a receiving set for the entertainment of his men while they work. Now he reports that he cannot induce them to leave the shop at all!



WHEN THE CHARGE IS NEGATIVE—
The vacuum tube may be likened to a one-way street in which there is a gate that is closed, when the grid of the tube is negatively electrified, blocking the roadway.



—AND WHEN IT IS POSITIVE
This gate, however, is immediately lowered when the grid is electrified with a positive charge, thus allowing the electrons (our runners) to pass through.

How the Vacuum Tube Works

ARTICLE NO. 3: THE TRIODE AS AN AMPLIFIER

This series of articles is designed to explain, in non-technical language that the layman can understand, some of the basic principles of radio phenomena

By ALFRED M. CADDELL

THE art of magnifying something small into something big so that it may be perceived better by the human senses, is a most helpful one.

Sound is magnified by ear trumpets and megaphones; vision is magnified by an arrangement of lenses that converge rays of light. With the telescope we may search out celestial bodies in the heavens; with the microscope we may search the secrets of the infinitesimal. But one of the most helpful devices in the magnifying art came into being with the invention of the three-electrode vacuum tube—the triode.

Under the heading of "detection" or "rectification" we used the analogy of heat (electrons) flowing in a one-way street*; the filament at the east end of the street radiating the heat; the cold plate symbolized as a fan drawing the heat through the street and delivering it on the outside; and the grid, or valve-gate, introduced to impress the radio-frequency oscillations of the carrier wave on the one-way current, and at the same time controlling its flow.

Then, in describing regeneration, we likened the incoming signal to a runner coming weakly into a town, bearing an all-important message.** We pictured in our mind an outpost established by the citizens of the town, a sort of extension of the town's facilities, arranged to greet the runner and furnish a stimulant to help him into the town with increased vigor. By this system of help, the runner not only received an initial but also a continuous sort of stimulant. Through the help of the local battery circuit his strength became amplified enormously, and he was able to impress

*See POPULAR RADIO for April, 1923

**See POPULAR RADIO for July, 1923

more pointedly his message on the peo ple (electrons) of the town.

Now we will follow the impressed message to its destination, through the highways and byways of circuits, transformers, condensers and tubes, through the phones and into the listener's ears.

No matter what else its task may be, the vacuum tube is essentially a device that magnifies received radio signals—amplification is going on continuously while the set is at work. One tube will amplify from five to thirty times according to the hook-up, while several tubes arranged in cascade will amplify hundreds and thousands of times.

The received message is magnified in the same way that a chorus magnifies the volume of a song. Then this chorus passes out of that tube (through the output circuit of the tube) into a lane (coupling circuit) to be conveyed to another town (tube), and then to another and possibly another, and so on until what was once an imperceptible little "whisper" becomes a mighty shout.

But how is the chorus output of one tube conveyed to another tube? How is it handled electrically? How is it magnified without confusion, or distortion?

First of all, the voltage of the rectified speech-current must be stepped up, for the greater the voltage introduced to the grid of the second tube, the greater will be the response. Therefore, the united chorus (the rectified output of detector tube) must pass through a step-up transformer, so that the voltage may be made higher, more decisive—a flexible trigger capable of releasing a larger source of power.

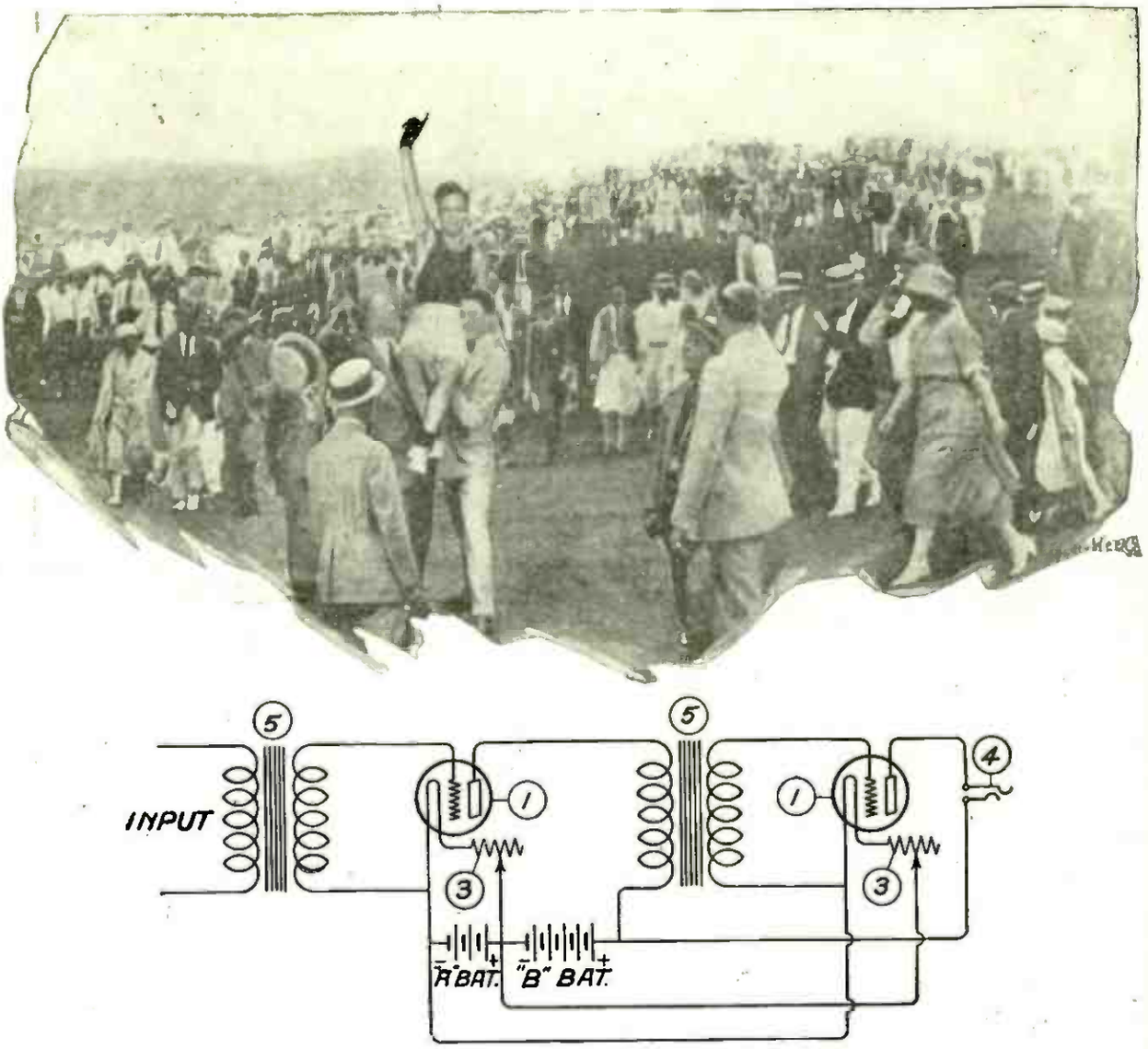
But what is a transformer? What is the principle upon which it works?

Almost everyone has what may be called the "ratio sense." That is, he knows something about gear ratios, how a large gear driving a small one, as in the case of a bicycle, results in a transmission of speeds, from low to high. If the pedal gear has 72 teeth wheel sprocket 9, the ratio of 1 to 8—one revolution of the b to eight of the smaller. In ste up the voltage of an electric current, different arrangement is used—that o numerous turns of wire wrapped around a closed core made up of soft iron laminations. Around one section of the core is the primary winding and around the opposite section the secondary, and the ratio of step-up is according to the ratio of turns of wire. In a step-up transformer, the primary has, say 100 turns and the secondary 800. Therefore, the ratio is 1 to 8—if you had an alternating electric current with the voltage of 1 to begin with, on leaving the transformer the voltage would be 8.

But now our chorus has left the detector tube; it has been carried by the rectified current through the transformer, where the voltage is considerably increased. Now it is introduced to the grid circuit of the next tube, another one-way street through which there flows a fresh stream of electrons evaporated from the filament and drawn down the street by the suction fan (cold plate). The strengthened voltages control the flow of electrons as in the former case, and the result is a greatly magnified voice current that will now be strong enough to "work" a pair of phones, or probably a loudspeaker is desirable so that many may hear. In that case another step of amplification will be necessary to accumulate sufficient strength to overcome the resistance of the magnets of the loudspeaking device and cause the diaphragm to fluctuate.

Therefore the runner (the carrier wave bearing the incoming signal), after having his message rectified and amplified into a chorus, has at last reached the point where the message is about to be translated into a language that we can sense—sound waves.

Thus the runner goes through many modifications before the message he is

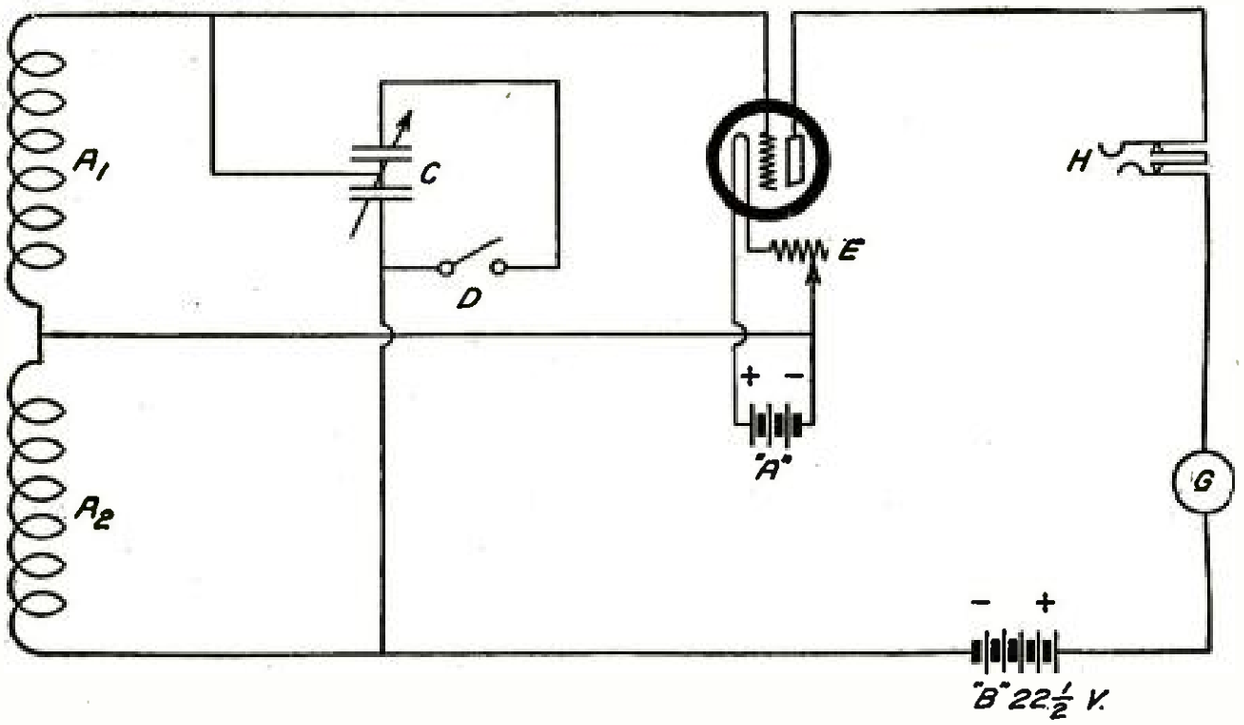


HOW THE CURRENT IN THE TUBE IS REFRESHED AND STRENGTHENED

After being strengthened by the stimulants (regeneration) given by the crowd (plate current) in the first town (detector tube), the runner (message) is carried by the crowd through a lane (transformer 5) leading to the next town (tube 1). Here he is again refreshed and strengthened and met by a larger crowd which joins in the chorus and helps him on his way to the next town. Thus the message is amplified from a feeble whisper to a mighty shout from the multitude.

carrying becomes audible. Indeed, there are many electrical highways not mentioned herein through which he might travel and receive still further amplification. For instance, radio-frequency amplification—magnifying the strength of the radio waves before rectifying, a method which embodies many good features for long-distance receiving.

So now, as our picture stands, we have a runner (incoming signal) coming weakly toward a town with a one-way street (the tube), bearing a message. Before he gets there and while passing through, he is assisted by friends (the regenerative circuit) and ushered into town through the gate-valve called the grid. Thereupon, the message he is carrying is taken up by the townfolk (the electrons) who join in the chorus and pass out of that town into a lane (the coupling circuit, transformer and other apparatus) to be conveyed to another town, and so on; so that what was once an inaudible flow of radio-frequency impulses becomes a mighty shout.



THE ELECTRICAL WIRING DIAGRAM FOR THE OSCILLATOR

FIGURE 1: *This drawing shows the proper connections for the instruments in the electrical circuit.*

HOW TO BUILD A

THREE-TUBE REFLEX RECEIVER

PART II

By WALTER A. REMY

Here is a simple vacuum-tube oscillator that can be used for heterodyne reception with *any* non-regenerative receiver. It can also be calibrated for wavelength and then can be used as a wavemeter. It is a useful piece of apparatus for any radio experimenter to own.

COST OF PARTS: *About $28.00*

HERE ARE THE ITEMS YOU WILL NEED—

A1 and A2—2 25-turn honeycomb coils;
B1 and B2—2 single-coil mountings;
C—1 balanced variable condenser. Two capacity ranges .0005 and .001 mfd.;
D—1 jack-type single-pole, single-throw filament switch;
E—1 6-ohm rheostat;
F—1 vacuum-tube socket;
G—1 D. C. milliammeter, range 0-10 milliamperes;
H—1 double-circuit telephone jack;
1 tube bezel;
1 3-inch dial;
1 2-inch rheostat dial;
1 Bakelite panel, 7 inches by 10 inches by $\frac{3}{16}$ inch;
1 Bakelite panel, 2½ inches by 3 inches by $\frac{3}{16}$ inch;
1 Bakelite panel, 1 inch by 2 inches by $\frac{3}{16}$ inch;
Brass strip for tube-shelf support (½ inch by $\frac{3}{16}$ inch).

THE heterodyne method for CW makes use of a small oscillator which is loosely coupled to the receiver. The frequency of the oscillations of the oscillator is variable.

When a signal from a CW transmitter is received it is of a frequency which cannot be heard by the human ear. The oscillator is adjusted so that it oscillates at a frequency of from 100 to 500 cycles

lower or higher than the signal frequency. The result of these combined frequencies is the frequency difference of from 100 to 500 cycles, which can be readily heard by the human ear. This method is by far the most efficient way of receiving continuous waves.

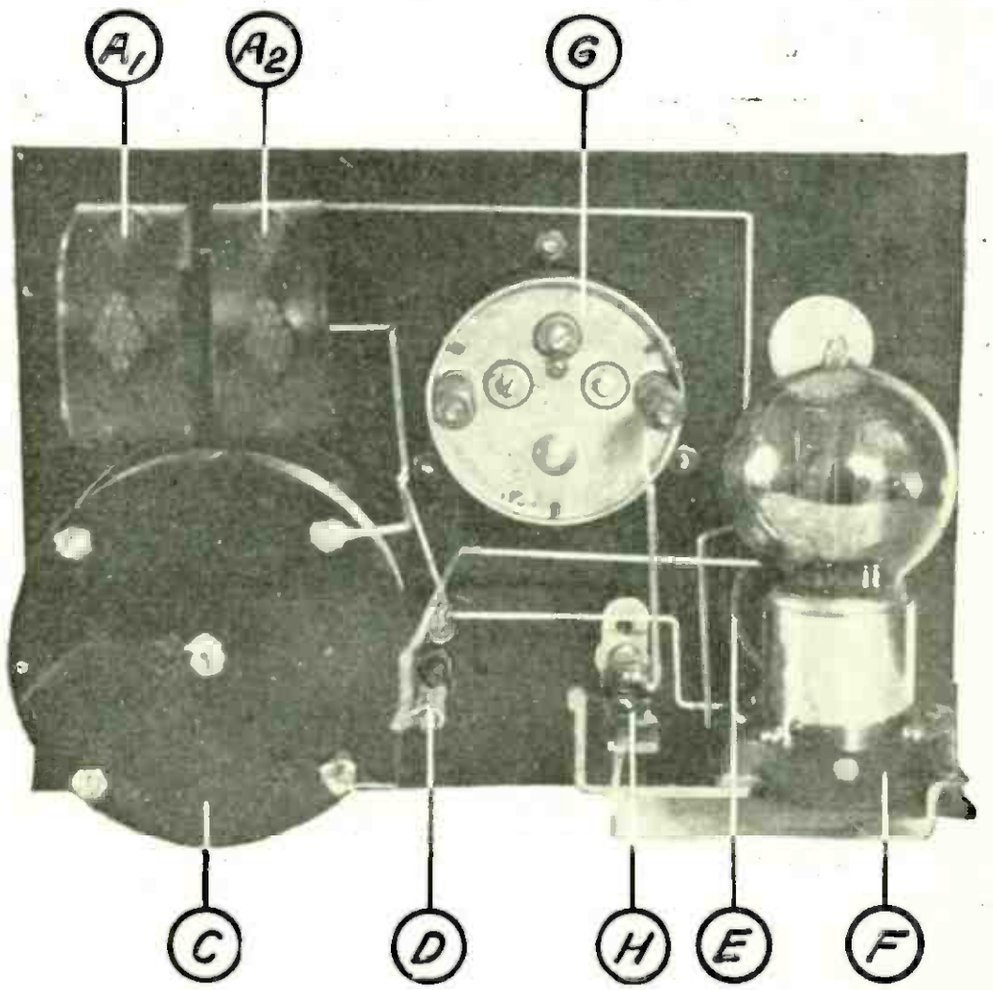
This is only one of the uses to which an oscillator such as is here described can be put. It can be used as a wavemeter, in calibrating receiving sets and in other measurements which are described in various books. It is surprising that such a useful instrument is as little known and used by amateurs today.

With the receiver described in the last article,* using Acme R-1 radio-frequency transformers and the oscillator described herein, the following amateur CW stations were heard at station 2KV during last winter: 6EN, 6KA, 6EA, 6NX, 6ZZ, 6XAD, 6ABX, 6AWT, 6BOE, 6BRS, 6BSQ, 7BH, 7NA, 7LU, 7IY, 7SC, 7ABB, 7ZO, 7ZU, 7ZV. The signals were strong and easily readable in every case.

The circuit used in the oscillator is a regular Hartley circuit in which a split inductance and a variable condenser, controlling the frequency of the oscillations, are used. The diagram of connections is shown in Figure 1.

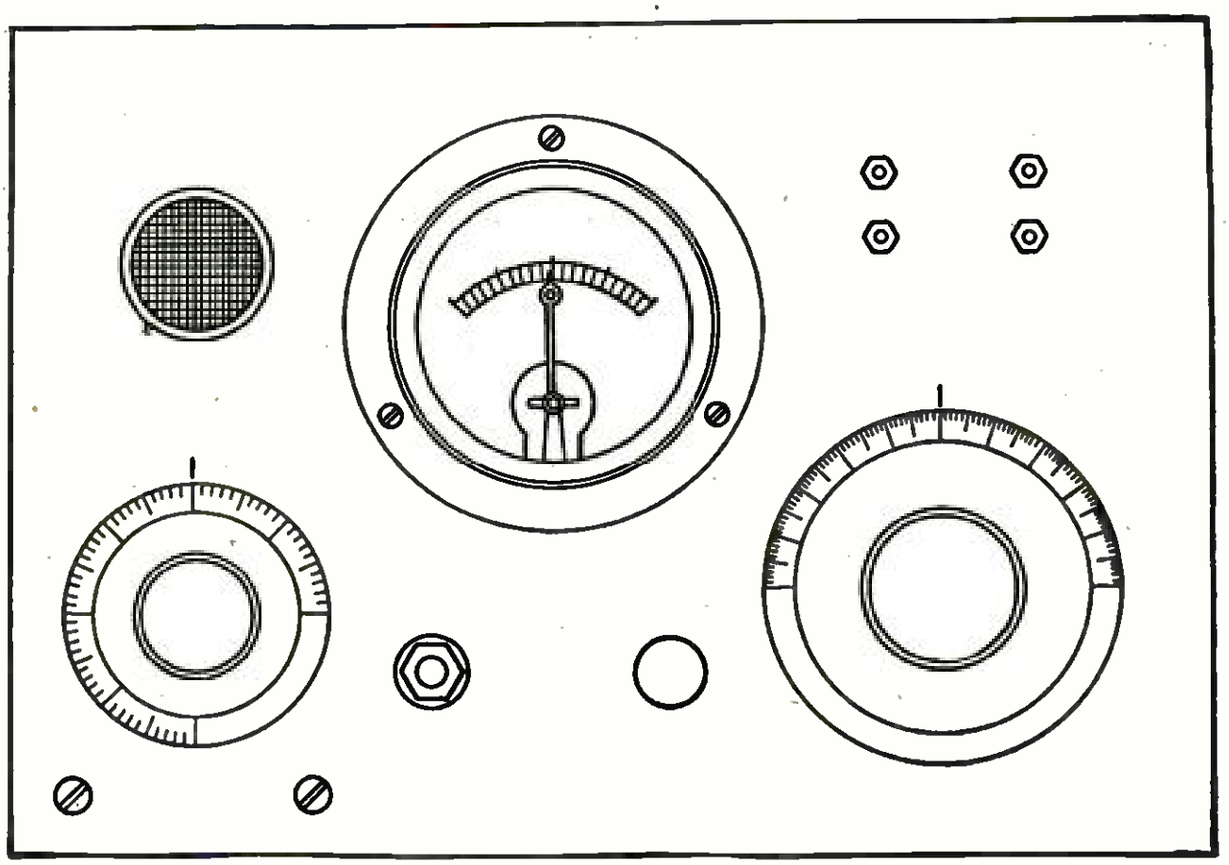
Figure 2 shows the rear view of the completed instrument. A front view of the instrument can be seen in the illustration at the head of Part 1 of this article.

* See POPULAR RADIO for February, 1924.



VIEW OF THE OSCILLATOR FROM THE REAR

FIGURE 2: *This picture gives the arrangement of the instruments, the honeycomb coils, the variable condenser, jack, switch, meter and the rheostat and tube socket.*



THE PANEL LAYOUT

FIGURE 3: *This drawing shows how the front of the panel looks when completed. The left-hand small dial is the rheostat control and the right-hand dial is for the variable condenser which controls the frequency of the generated oscillations.*

How to Construct the Set

In the construction of the instrument the parts specified in the head of this article are necessary and are lettered in the diagrams.

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

Practically the only construction necessary is the tube-socket shelf; the rest is merely assembling. The 2½-inch by 3-inch panel is drilled as shown in Figure 7. The two brass angle pieces are cut and drilled as are also shown in Figure 7. The unit is then assembled and the tube socket held to the sub-base with two 6/32 brass machine screws.

The panel drilling is shown in Figure 6. The large hole for the milliammeter is made with a lathe and a fly-cutter, as is the smaller one for the tube bezel. Any machine shop will do this cutting for a nominal sum. A more laborious procedure is to drill a series of holes in a circle and then cut out the circle with a keyhole saw. (The author made three holes for a CW transmitter in this manner and has never repeated the performance.) If desired, a series of small holes may be drilled in place of the bezel to view the tube. When the panel is drilled it is rubbed with emery cloth or fine sandpaper to give it a grained finish and is then polished with ordinary machine oil.

The shelf panel is fastened to the main panel by means of the two angle pieces with 8/32 flat-head machine screws. The rheostat is then mounted with 6/32 machine screws. The telephone jack and the jack-type switch are next put in place. The switch is one of the type that have recently appeared on the market for use in the filament circuits of vacuum tubes.

The condenser is mounted next. This condenser is of the double-capacity, balanced type. The plates are mounted on the rotary shaft so that an equal number of plates are on each side of the shaft, thus balancing the weight. There are two sets of stationary plates mounted in the proper relation to the rotary plates. A Broun condenser was used in the oscillator described.

The honeycomb-coil mountings should now be mounted. The regular De Forest-type mountings are not well adapted for this work because the connections are to be made between the plug and the panel. It is almost impossible to make such a connection on the De Forest-type mounting because of the two

pieces at the top and bottom, which prevent the entire surface of the mounting from lying flat up against the panel. Two plug mountings having perfectly flat backs were used and were fastened to the panel with cap nuts. The milliammeter is next mounted on the panel.

A small 7-inch by 10-inch cabinet may be purchased at almost any radio store. The only external connections required in the oscillator are the filament-battery connections.

The small 1-inch by 2½-inch panel is drilled as shown in Figure 7 and holds two binding posts for the filament battery connections. The panel is screwed directly to the back of the cabinet after two holes have been drilled through the cabinet to allow the threaded part of the binding posts to come through. A small 22½-volt "B" battery is contained in the cabinet itself. The oscillator is now ready to be wired.

How to Wire the Oscillator

The set is wired with square tinned bus-wire from the diagram of connections in Figure 1. The only unusual part of the wiring is that of the condenser.

On the condenser there are two terminals for the stationary plates, one for each set, and one for the rotary plates. The terminal for the rotary plates is connected to the grid end of the coil mounting. One stationary plate terminal is connected to each of the switch contacts of the jack-type switch. When the plug is pushed in only one set of stationary plates is in use and the .0005 mfd. capacity is obtained. When the plug is pulled out the other set of plates is connected to the first set and the .001-mfd. capacity is obtained. Usually there is a metal strip connected across the back of the condenser connecting both sets of plates. *This connection should be removed.*

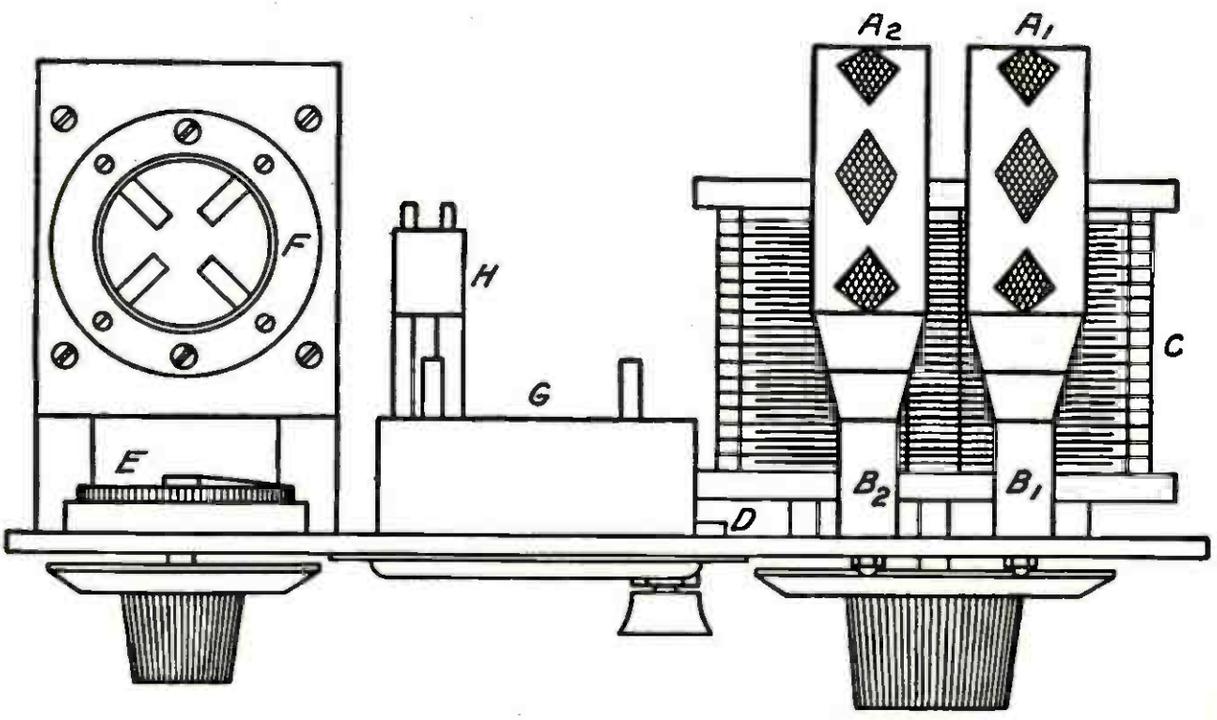
The two coil mountings are connected in series and a connection is made from the negative filament to the wire common to both mountings. It should be noted that the two inside springs on the telephone jack *are connected together* so that the current will flow when the phones are out of the circuit.

Operating Data

The oscillator is now ready for operation. The only tube which gives reliable service in this work is the oxide-coated filament type, such as the Western Electric "E" or "J" type tubes. Such tubes give a copious electron flow and oscillate readily at the high frequencies necessary in short-wave work. A UV-201 was used with fair results, although it would not work well below 200 meters.

The oscillator is set from two to four feet from the receiver and the tube is lighted. The author used the oscillator set two feet away from the receiver and at right angles to it. With an "E" tube the milliammeter should read from three to four milliamperes.

The condenser dial is then turned from the zero mark up. When the plate current drops the tube is oscillating. If the plate current *rises* the filament battery leads should be reversed. The receiver is set at a certain wavelength and the oscillator condenser is turned until a signal is heard. The receiver is then



VIEW OF THE OSCILLATOR FROM ABOVE

FIGURE 4: *A more detailed idea of the way the instruments and parts are mounted on the panel is given in this diagram. By comparing this drawing with figures 2 and 3 the prospective builder may get a complete idea of the construction.*

adjusted until the signal is at its greatest strength. This procedure seems a bit awkward at first but soon it becomes natural to operate the receiver and oscillator at the same time. If the receiver seems to tune broadly the oscillator should be placed further away from it.

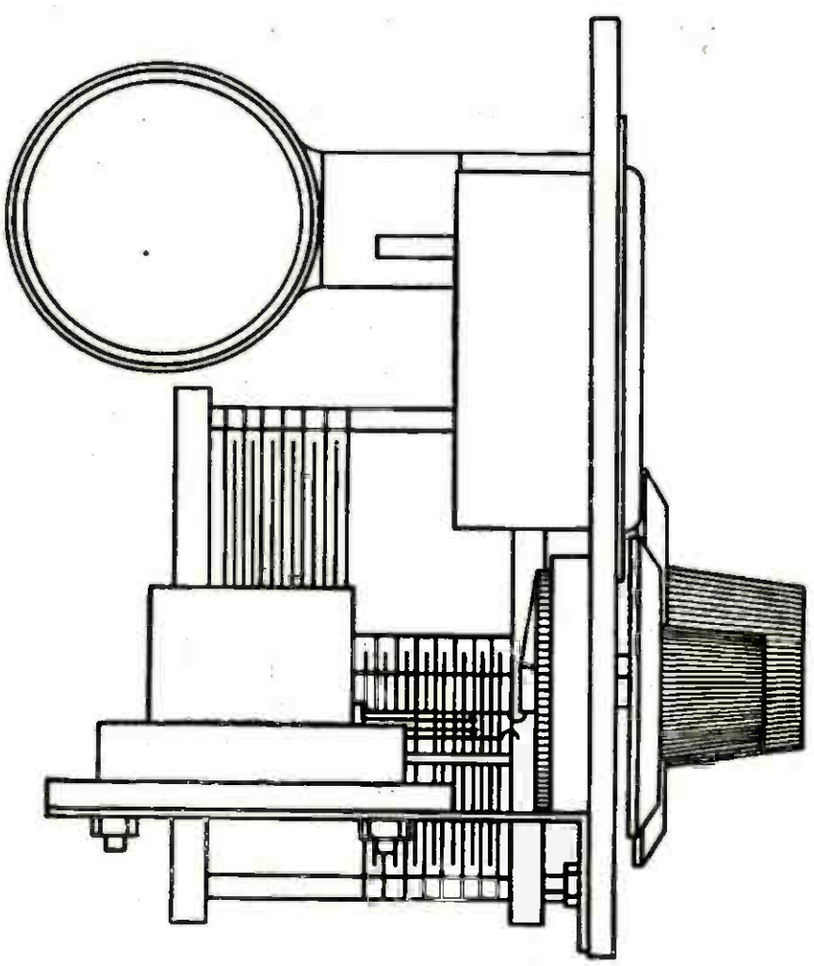
(At this point it might be well to say that it it not good practice to run the oscillator and the receiver tubes from the same "A" battery, as this somewhat destroys the tuning qualities of the receiver.)

At station 2KV the oscillator is calibrated and has a range of 175 to 300 meters with the .0005-mfd. capacity and from 200 to 400 meters with the .001-mfd. capacity. Since the frequency of 200 meter signals is 1,500,000 cycles, the 500-cycle difference in oscillator frequency makes hardly any difference between the wavelength received and the wavelength shown by the oscillator.

The true wavelength may be gotten by obtaining the zero beat. It is noted that as the dial progresses the note heard in the receivers becomes lower and then goes up again. This is due to the fact that at first the oscillator frequency is 500 cycles lower than the received frequency and that it gradually approaches the received frequency, making the frequency difference smaller and the note heard in the telephones lower. When the frequency of the oscillator is the same as that of the received signal there is no frequency difference and no sound in the telephone. Then, as the frequency of the oscillator becomes higher than the signal frequency, the note is heard again, this time rising instead of falling, as the frequency difference is increasing. That point, in between, where no sound is heard in the telephones is the zero beat and the exact frequency of the signal received.

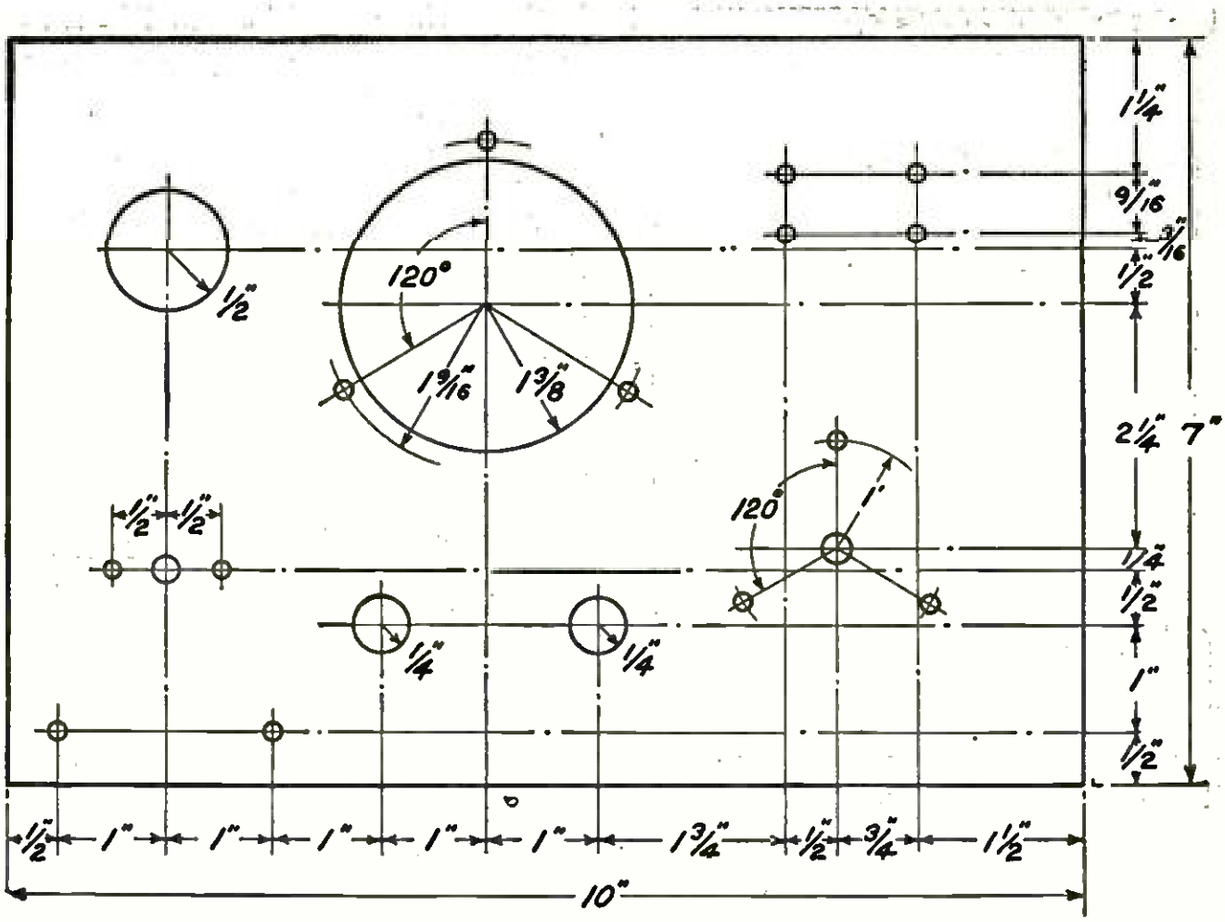
Thus the wavelength of the station received may be determined by noting the oscillator dial reading and glancing at the calibration curve. Station 2KV will gladly give any amateur his exact wavelength.

The oscillator was calibrated by placing a standard wavemeter near it. A pair of phones were plugged into the oscillator telephone jack and the buzzer in the wavemeter was started. The oscillator was put in operation and the condenser dial set at 10-degree intervals, starting from zero. The wavemeter was then tuned until the buzzer signals were loudest in the telephones. The wavelength as shown by the wavemeter was noted and a curve plotted, using wavelength and dial degrees, respectively, as the axes.



SIDE VIEW OF THE UNIT

FIGURE 5: *This diagram shows how the socket is mounted on two brass supports which are screwed to the socket and to the panel in turn.*

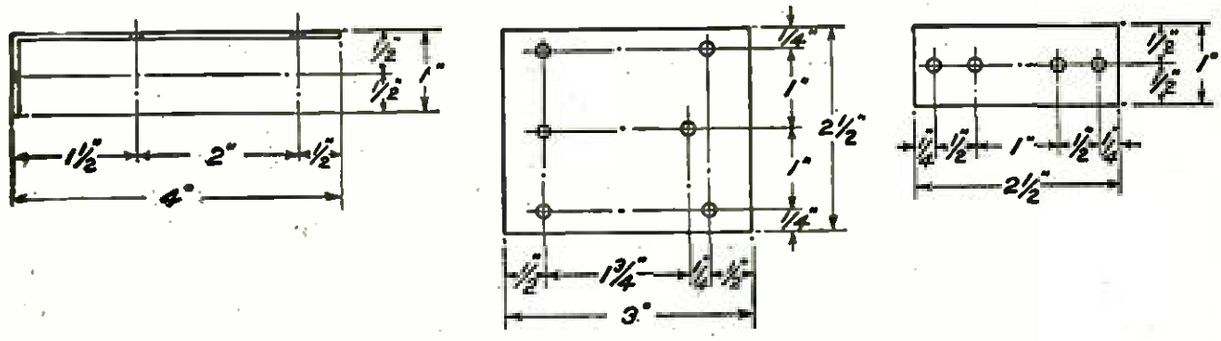


THE DIMENSIONS FOR THE PANEL

FIGURE 6: *The correct spacings for the instruments will be assured if the directions for drilling the holes for mounting them are strictly adhered to.*

When used as a wavemeter, resonance between the oscillator and the circuit of unknown frequency is indicated by an increase in the milliammeter reading or by using telephones in the jack, and obtaining the greatest signal strength in the telephones.

Such an oscillator is an exceedingly useful instrument around the amateur's station, and in conjunction with a reflex receiver it makes an ideal receiver for amateur CW work. Any frequency can be had with the oscillator by using various inductances in the coil mountings. The same number coil should be used in each mounting.



THE DETAILS FOR THE SMALLER PARTS

FIGURE 7: *The sizes for the small panel and connection block are here given, together with the dimensions for the small brass brackets.*

A FOUR-CIRCUIT TUNER BUILT LIKE AN ORGAN

Few readers will recognize in this imposing piece of furniture the Cockaday receiver that every fan knows merely as a small instrument that fits into a bureau drawer. It was designed and built by F. E. Davis of Syracuse, New York, who reports that the set is as efficient in operation as it is dignified in appearance. In this article Mr. Pyle points out how easy it is to give any radio receiver this same elegance of appearance so well illustrated by Mr. Davis' installation.

How to Improve the Appearance of Your Set

Now that the radio fan has got his receiver into good working order, the next step is to arrange the wires, batteries and accessories so that the set will be both convenient to operate and beautiful enough to be an ornament in the home. This article points out some of the ways in which this may be done.

By HOWARD S. PYLE, I. R. E.

WITH the acceptance of radio as a general household convenience, it is high time that we turn our attention to the general overhauling that we have promised our receiving sets for some months past.

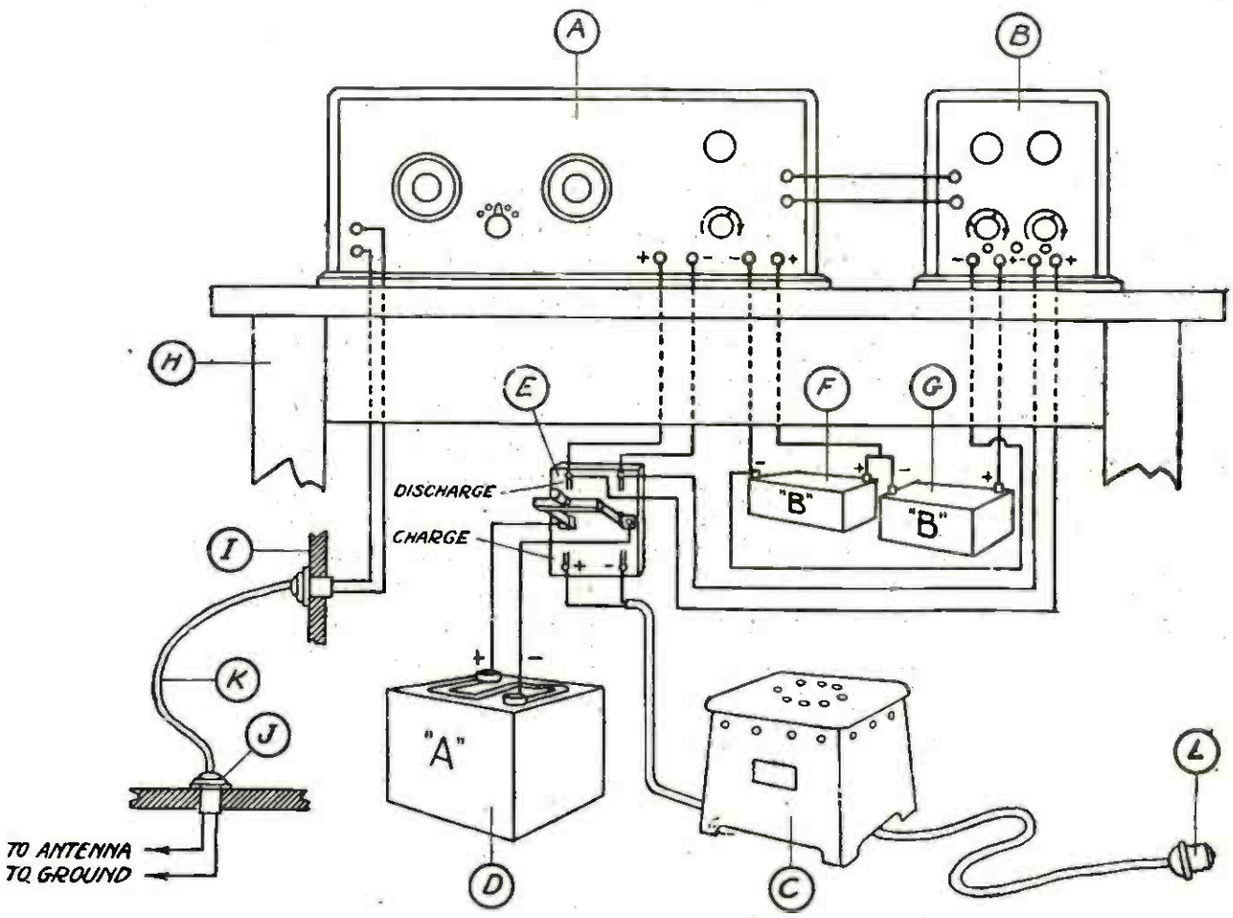
Radio equipment has now taken a permanent place in the home, and as such should be no more intrusive or unsightly than our piano or phonograph. A casual survey of the average broadcast receiving equipment, however, will disclose the fact that about eighty percent of such instruments, while in themselves a triumph of the cabinet makers' art as well as an efficient and sensitive piece of electric equipment, are so installed in the home as to create an impression of untidiness as well as a bit of discouragement to visiting friends who, as yet, have not installed radio as part of their home life. No woman, proud of her housekeeping ability, wishes to have an unsightly storage battery, dry cells or mess of straggling wires in her comfortable living room; we cannot blame her. We know we would not tolerate a similar haphazard installation job were it to be

a piano lamp or wall bracket. Then why need we tolerate careless work in installing radio equipment?

A radio receiving installation offers the handyman of the house an opportunity to demonstrate his ability with the home tool chest, and offers an excellent method for spending some of the spare time that is frequently prone to drag a bit after the holiday season has passed and things have settled back into their regular routine.

Last fall and winter the main object was to get the set in and working; appearances were secondary. Radio broadcasting was completing its second year and we disliked to miss a night's entertainment. But now we have it as an established service. We are used to it, though far from tired of the diversity of entertainment to be gained through this means. Let's see if we can't make an unobtrusive appearing, harmonious piece of furniture of our equipment and then enjoy to the utmost the even higher grade of programs now available without the annoyance of loose wires and messy batteries.

Our first consideration, therefore, should be to set aside a permanent location for our receiving set, with its necessary manual controls. We should take into consideration, in deciding the location, a place which is out of the way yet easily accessible for the operator. A small table should be provided, matching the other furniture of course, and be designated *solely* as a resting place for our radio equipment. It should then be decided whether it is desirable to have the "A" and "B" batteries *with* the set, or remotely placed. If the



HOW TO HOOK UP THE RADIO TABLE

FIGURE 1: *Connections are here shown for the receiver A and the amplifier B, which are placed on top of the table, with the batteries underneath and with a plug connection for the antenna and the ground. The switch E controls the use of the battery charger C. The plug J connects the fixed wires with the flexible connector K.*

former, the table should be provided with an enclosed set of shelves beneath the top, arranged with swinging doors at the front. Such tables are now offered in a variety of styles for radio purposes.

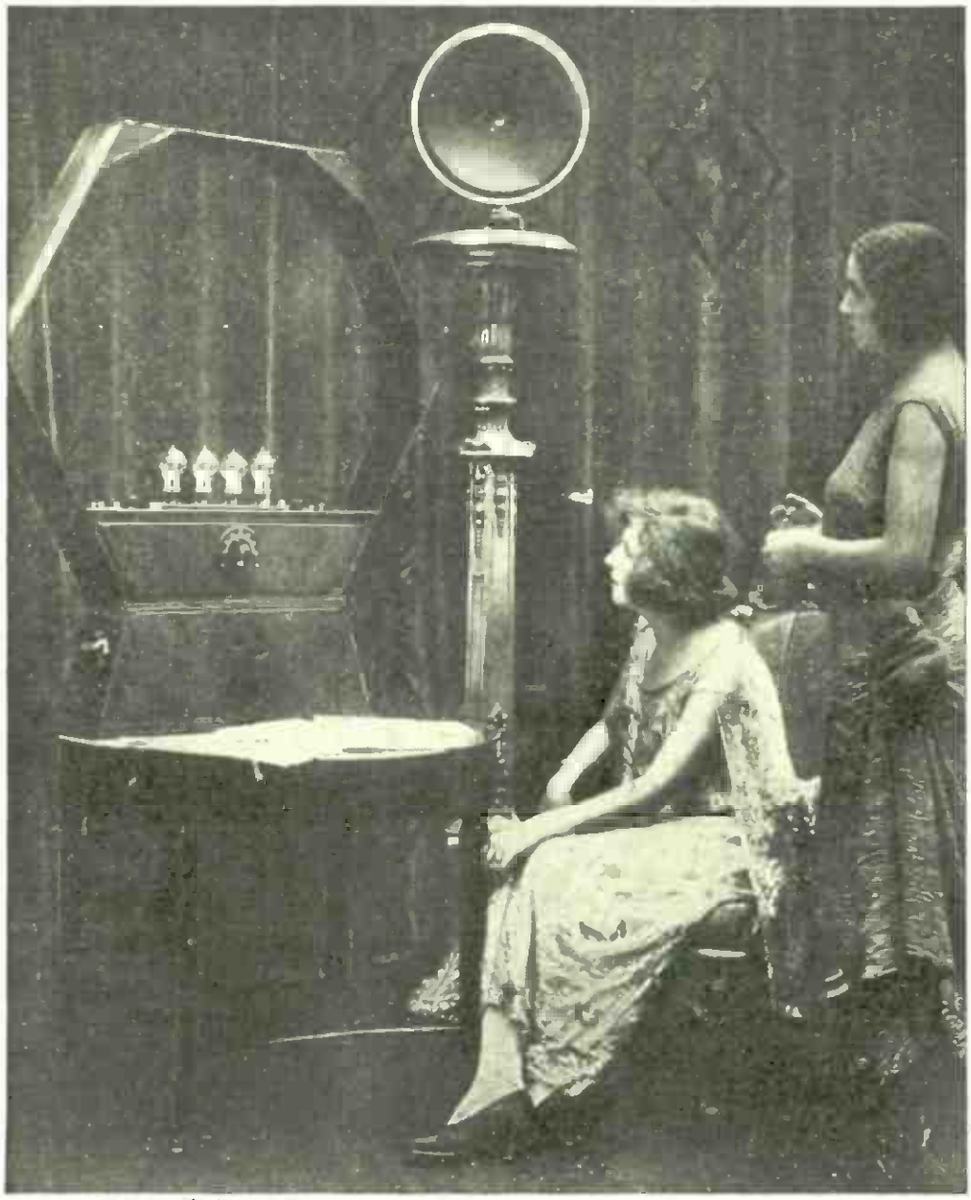
Perhaps such an arrangement is more desirable than a remote arrangement of the batteries. In that event, our batteries will be placed on the shelving beneath the table, with the set directly above. So far, matters are simple.

But we are now faced with the problem of connecting the batteries to the set with suitable conductors. This is where the average home installation is sadly in need of revision. Some of the tables are provided with a large opening at the rear of the lower cabinet, through which to pass the conducting wires up the back of the table to the set. This is a poor makeshift for a really good installation job. A neat wiring scheme cannot be arranged if the wires all straggle up over the back of the table to their respective binding posts. They are only in the way when the lady of the house wishes to dust, and at such times they are subject to damage or misplacement. Much as we may dislike to mar the beautiful surface of the table, it is the only way in which a good job can be made. You bought your table for radio purposes; then don't hesitate to drill holes in it where required. You dislike to think of an electrician cutting a large hole in your baseboard to install a floor plug for your vacuum cleaner, but you would not think of having him tack the wires along the baseboard to the plug. You accept the inevitable and are really surprised at the inconspicuously neat appearance of the finished plug with its plate. The same applies to your radio set.

Secure your receiving set (and amplifier if in a separate cabinet) in a permanent place on the table with good, husky wood screws. Set the instruments well toward the rear of the table and somewhat to the left of center, which will allow room to the right for future loudspeaker installation, if you have not already so equipped your set. Once you have permanently fixed the instruments, make a light pencil mark around the extremities of the base and then remove them, after marking also the approximate place over which the binding posts will be. At these latter marks, make a slight depression with a sharp center-punch (the ice-pick will do) to guide your drill. Then drill holes clear through the top, with a ⅜-inch wood bit. (You had best suggest that the good wife take herself to other parts of the house during the drilling process, for the writer knows from experience, that every twist of the cold steel into the nicely polished table top will wring a moan of agony from her.)

A hole should be made for *each* individual wire that connects the batteries to the receiving set. Ordinarily, this will mean a pair for the "A" battery, two more for the detector "B" battery and one or two, according to the hook-up of the set for the amplifier "B" battery. More will be required in the event that a loudspeaker is to be employed, if it is of the current-operated type. A hole under the antenna binding post and a similar one for the ground connection should also be drilled.

Now, on your way home from town, drop in at your electrical dealer, or even one of the five and ten-cent stores, and purchase for a few cents sufficient ⅜-inch molded-rubber socket-bushings to bush each hole in the table top. These are the little rubber bushings in use on the cap of each of the electric light sockets in your home that are not directly connected to the fixture. This is a good time also to provide yourself with sufficient silk-covered, flexible, stranded lampcord to make the necessary connections between the instruments and the batteries. Such conductor may be obtained in a variety of shades to match the flexible cord on



Courtesy of *Radio-Électricité*, Paris

A UNIQUE SET FOR THE DRAWING ROOM

This is a French fashion hint; it is a receiver designed in Paris. The antenna is a loop, wound on the hexagonal wooden frame. The tubes are on the box below. The disk-shaped device on top of the standard looks like an electric fan but it is really the loudspeaker.

your floor lamp or to please your particular fancy.

After the evening meal, shed the uncomfortable collar, get your feet into a pair of old slippers, and we'll proceed to get down to the business of the evening.

Move the table into a good light to avoid even the slightest mistake. Smear the threaded portion of the hard-rubber bushings with a bit of the kitchen glue, and press each one firmly into its particular hole in the table top. Now the instrument cabinets may be replaced and firmly screwed fast.

Slip over and borrow the neighborhood soldering iron, if you have none of your own, and while it is heating on the kitchen gas range proceed to prepare the leads. Pass a length of the silk cord, which has previously been untwisted, down through one of the holes and cut it to a length to reach from the binding post (above the hole) to the particular terminal to which it is to be attached. It will make a neater

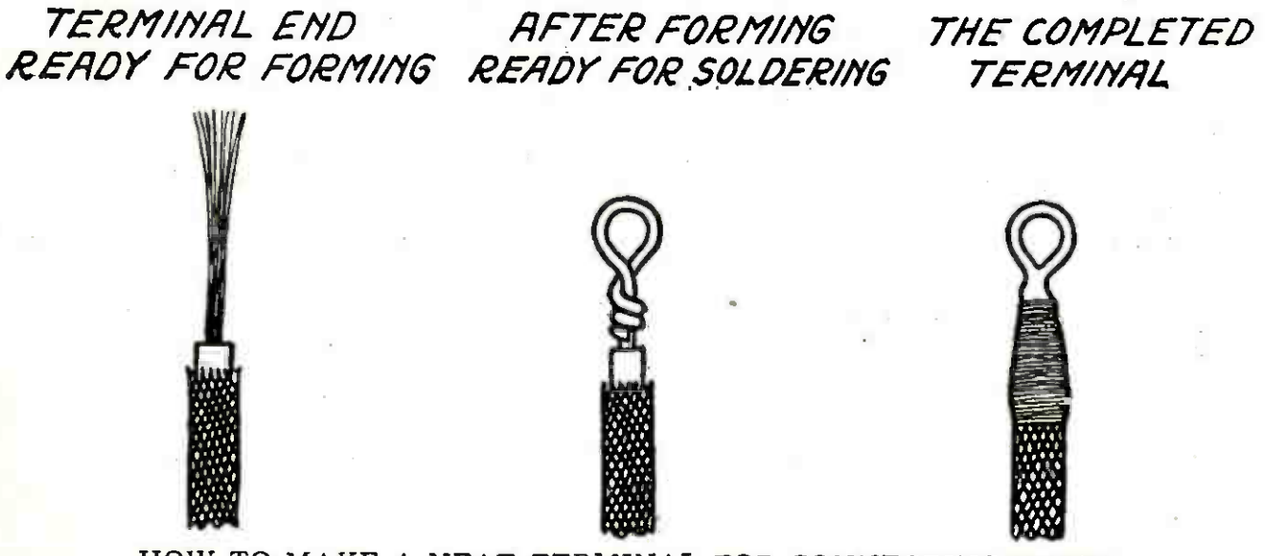
job if you will allow slack enough to enable running each wire through a system of small picture frame screw-eyes, secured at various points on the interior of the cabinet to enable leading each wire in an even, straight course with sharp right-angle bends direct to its final terminal. The insulation is then scraped from both ends of the wire, and a twisted loop made at each extremity.

Our soldering iron should be hot by now, and after applying a small bit of paste to the twisted loop of wire, we will quickly coat it with solder, making a solid closed loop. With both loops well tinned, we can finish the lead by wrapping the end, from the point where the insulation ends to that where the loop begins, with a serving of black or colored silk thread. The result is a neat appearing terminal end to the cord (see figure 2), which is electrically and mechanically perfect. This same procedure is followed with all leads. It will be found necessary to *leave* each wire in the hole while soldering the loops, for it will be found impossible to pass the finished end through the small opening in the bushing. Such an error *may* result in thoughtlessly biting a perfectly good pipe stem in two.

The loops formed as described should be of a sufficient size to enable the hole in the finished loop to fit easily over the binding post screw on the set.

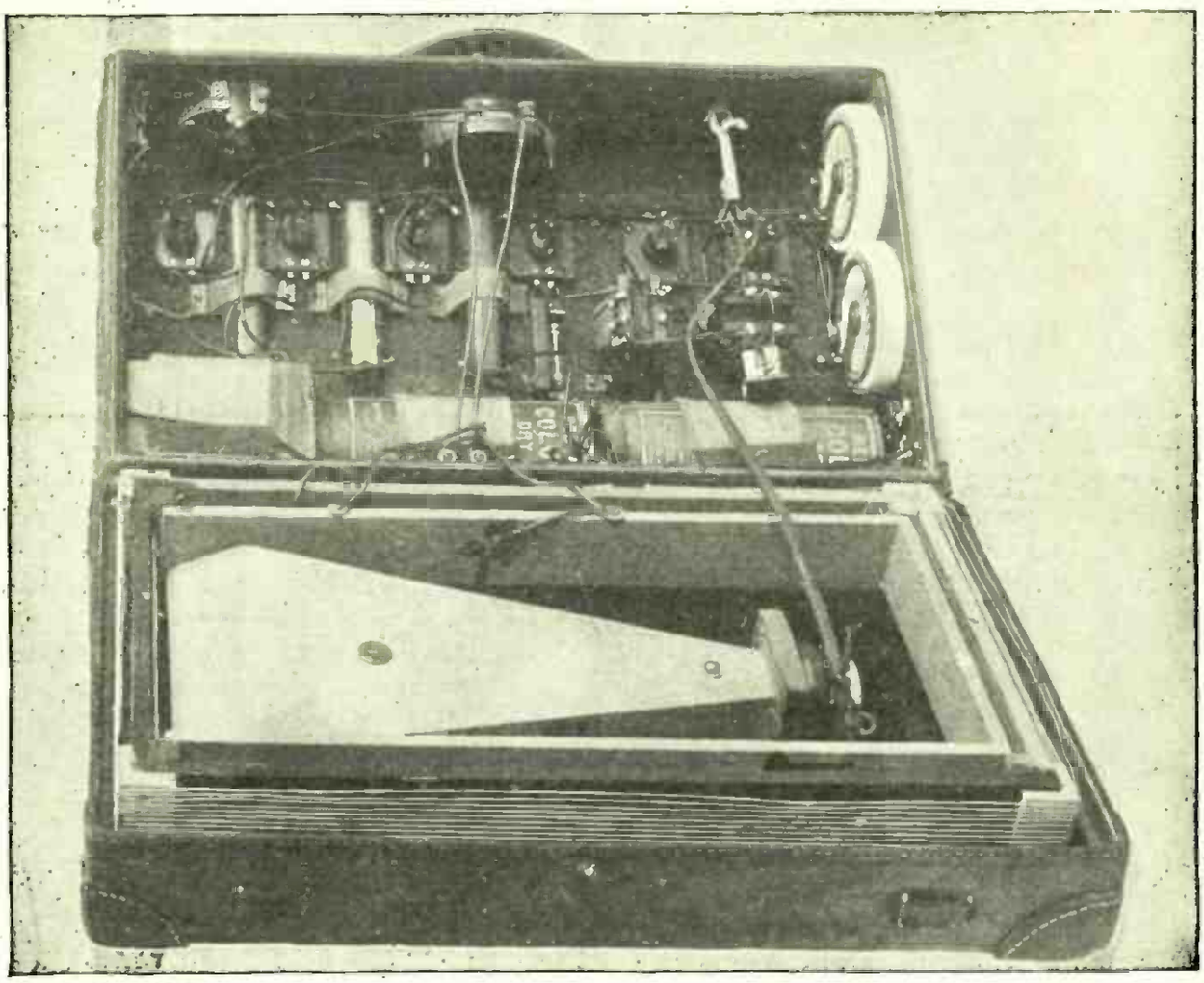
We have already mentioned that the leads were to be cut to a length sufficient to reach from the set to the particular terminals within the cabinet where they were to terminate. To determine such a termination point we must consider what type of battery we contemplate using. A good many listeners still stick to the reliable, lead-plate storage cell for a filament supply source for their home set, and in the opinion of the writer, this is good judgment. Properly installed and cared for, a storage battery is less of a source of annoyance than dry cells, for if we conscientiously charge our battery periodically we are never faced with a dead "A" battery at a critical moment—usually when visitors are eager to hear a radio program. A storage-battery installation, however, is a constant nuisance if a means for charging without moving the battery is *not* provided. Accordingly, we will plan to incorporate such charging arrangement in our cabinet.

Of course, in the event that dry cells are more desirable for some reason,



HOW TO MAKE A NEAT TERMINAL FOR CONNECTING WIRES

FIGURE 2: *By proceeding in the manner illustrated above and described in this article you can make a terminal connector that will provide good electric contact, that will not slip out or come loose and that will maintain always its neat and workman-like appearance.*



Bureau of Standards

AN EXCEPTIONALLY WORKMAN-LIKE DESIGN FOR A PORTABLE SET

This set carries out the idea of neat appearance in a set built into a suitcase. It employs three stages of radio-frequency amplification, detector and two stages of audio-frequency amplification, working on a loop antenna which may be seen on the frame in the lower section of the suitcase. The wooden horn is the loudspeaker.

the "A" battery leads are led directly to their terminals from the set. With a storage-battery installation, however, the two leads from the set should be brought to a small, double-pole, double-throw knife switch of the porcelain-base variety, mounted in a convenient place within the cabinet. The connections are clearly indicated in the diagram in Figure 1. The leads from the charging source are also brought to the opposite jaws of the switch, with the battery terminal connected to the blades. Obviously, by throwing the switch one way, we connect the battery to the set, and in the opposite direction, to the charging source. To charge, then, it is only necessary to throw the switch to the position marked *"charge"* on the diagram, and snap on the current to the charging rectifier. Similarly after completion of a charge, and when we wish to use the set, we merely throw the small switch to the opposite side and the connection to the set is complete.

The same system may be applied to the "B" battery if of the storage type, although in the case of the more commonly used dry "B" batteries the leads from the set are directly connected to their terminals as in the case of the dry-cell "A" battery.

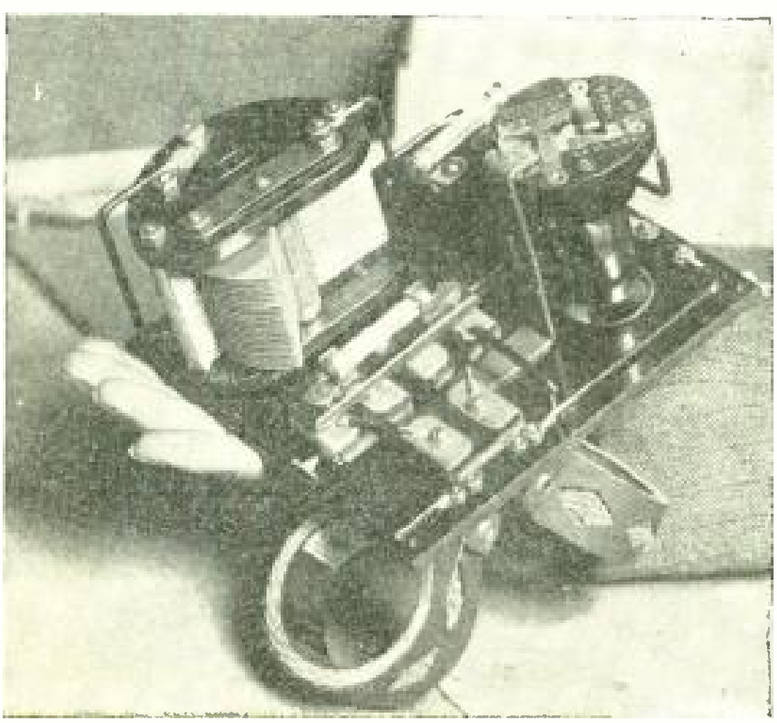
After these connections have been made, there remain only the antenna and

ground leads. The best method for handling these, when circumstances permit, are by means of a simple floor-plug system. The two leads from the set are brought down through the cabinet to the rear of the table, where they are connected to one of the small flush plug receptacles, known as a "telephone receptacle." This has its face plate screwed to the outside rear of the cabinet. A twisted, flexible silk cord of two conductors is connected with the detachable plug of the receptacle, and its opposite end connected with a similar plug. A second base receptacle is inserted in a hole made in the floor or baseboard, and the antenna and ground leads brought down the side of the house, through a partition to this second receptacle. This is by no means as difficult a job as it may at first appear. If the home worker shies at tackling it, however, an electrician will take care of the installation of the receptacle for a few dollars, and the finished job will be well worth the slight expenditure involved.

Do not be misled here by the over-enthusiastic radio fan, who will protest at bringing the antenna and ground to the set by means of a twisted flexible cord. The loss is negligible except in the case of a very long antenna and a long cord connecting the two plugs—thirty feet or more, when the capacity effect between the two wires does have some effect.

In the event that such a method of bringing the antenna and ground leads up to a floor receptacle is impractical for some reason, it will probably be necessary to resort to some makeshift lead-in arrangement through a window casing or like method. This will have to be worked out by the individual, however.

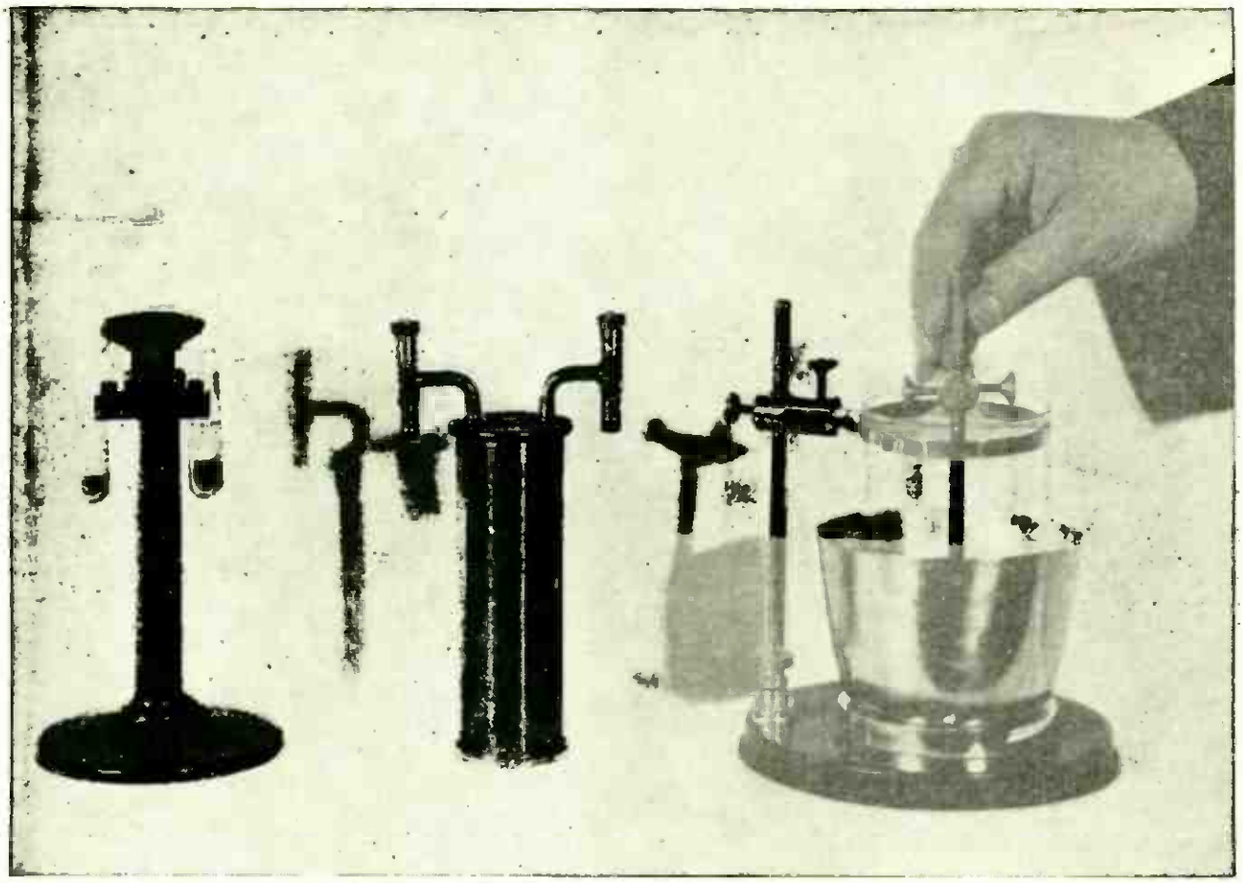
If the foregoing suggestions are carefully followed, the result will be a well installed set, with a maximum of convenience and a minimum of effort in daily operation. In appearance the finished job will take its place rightfully with the other furnishings of the room in which it is installed, and your radio set will no longer be a cause for constant apology.



Kadel & Herbert

A NOVEL ARRANGEMENT FOR A FLIVVER SET

This shows how Alexander Udoff, a 16-year-old experimenter, put together a Flewelling circuit for use as a portable receiver. The set employs one tube and two honeycomb coils and a variable condenser for tuning.



From a photograph made especially for POPULAR RADIO

HOW THE BUREAU OF STANDARDS MEASURES ELECTRICITY

On the left is a standard cadmium cell, the official device for comparing voltages. In the middle is a standard resistance of one ohm. On the right is the form of silver-depositing apparatus, used by the Bureau of Standards for the accurate measurements of amperage.

HOW TO MAKE

Power Calculations

ARTICLE NO. 2 OF A NEW SERIES

Useful facts about units of power and energy—summarized for your notebook

By E. E. FREE, Ph.D.

THE basis of all engineering calculations is the computation of power. Everyone who handles steam or water power or electricity must know how to transform kilowatts into horsepower, or any power unit into any other unit. Here is how to do it.

You must notice, first of all, the difference between units that mean *rate* and units that mean *amount*.

Consider a reservoir full of water. It contains a certain *amount* of water. If you open a pipe from it the water flows out at a certain *rate*. The same distinction applies, for instance, to electricity.

The kilowatt is a unit of *rate;* it means that a certain amount of electricity is flowing or being used per hour or per second. To express *amount* of

electricity we must add to the kilowatt an indication of the time the current flowed; that is, we use the unit of the kilowatt-hour.

Similarly, the horsepower is a rate unit, the corresponding amount unit being the horsepower-hour. All figures below are in amount units.

The basic fact about all power calculations is that every kind of energy or power is convertible into heat. A kilowatt-hour of electricity may be converted into a definite quantity of heat, as is done, in fact, in an electric iron. Similarly, a horsepower-hour of steam power, or so many foot-pounds of gravitational energy, or the energy in a ton of coal or a barrel of oil, each has its definite equivalent in heat. It is as though heat were a sort of international currency into which all other currencies, like the dollar, the pound sterling, the franc or the mark, were always convertible. Only the rates of exchange between the various power units and the units of heat are not variable like the rates of exchange for money, but are always exactly the same. It is these fixed rates of exchange that are given in the accompanying table.

Suppose you have a certain amount of electricity expressed in kilowatt hours and you want to know how much heat this will produce in British thermal units:

Look for "kilowatt-hours" at the left of the table, then look along this horizontal line until you come to the column headed "British thermal units." You see the Figure 3413. This is the number of British thermal units corresponding to one kilowatt-hour. Multiply your kilowatt hours by this number and you have your answer.

Similarly, in the last line of the table you can see that one pound of coal equals 4.13 kilowatt-hours of electrical energy or (as you run your eye along the line) 5.50 horsepower-hours, or 14.000 British thermal units, and so on.

But here is a very important caution. These figures are for *perfect conversion;* for what engineers call an efficiency of 100 percent. You cannot attain this practically. For example, the best steam engines have an efficiency of less than 25 percent; that is, they convert less than a quarter of the energy of coal into energy of motion or into electricity. Accordingly, for the practical calculation of the power that you can actually get out of coal you must take, not 4.13 kilowatt-hours per pound but whatever percentage of this figure the efficiency of your particular steam plant permits you to save and convert.

If, for example, your plant efficiency is 25 percent, the real figure is 1.0325 kilowatt-hours for each pound of coal.

The units in the table and some other units of power and energy are described below:

Ampere. A unit of electric current, not of power. Amperes multiplied by volts gives you watts, which see below.

British Thermal Unit. The amount of heat necessary to warm one pound of water from a temperature of 68 degrees to 69 degrees Fahrenheit. This is the unit of heat generally used by engineers.

Calorie. The unit of heat generally used by scientists. There are several calories which must be carefully distinguished: the one used in the table is the "large calorie" or "kilogram calorie." It is the amount of heat necessary to warm one kilogram of water from 20 degrees to 21 degrees Centigrade. The "small calorie" or "gram calorie" is one-thousandth of this value. The large calorie (used here) is the same as the "mean calorie." This is also the calorie used in measuring the value of foods.

Coulomb. The quantity of electric current corresponding to one ampere flowing for one second. To convert coulombs into other units, first calculate the watts from the coulombs and volts, then use the kilowatt-hour figures in the table.

Dyne. The dyne is a scientific unit of *force,* not of power. One dyne-centimeter equals .000,000,0737 foot-pound, which see below.

Erg. A scientific unit of energy. It is the same as the dyne-centimeter, just defined.

Foot-pound. The usual engineers' unit of energy. It is the energy necessary to lift one pound one foot, or, conversely, the energy produced by a weight of one pound when it falls one foot.

Force de cheval, also called the *French horsepower* or the *metric horsepower* is used by French engineers. It equals .9863 horsepower.

Horsepower-hour. The horsepower was originally intended to represent the power that can be exerted by an average horse, but horses

vary so much in strength that this meaning has been given up. The unit is now defined as equal to 550 foot-pounds per second. The exact value is nearer .7457 kilowatt, but the figure of .746 used in the table is the one commonly employed.

Joule. The scientific unit of work. One kilowatt-hour equals 3,600,000 joules.

Kilogram-meter. The metric unit corresponding to the foot-pound. It means the energy necessary to lift a kilogram one meter. One kilogram-meter equals 7.233 foot-pounds.

Kilowatt-hour. One watt is the power available in an electric current of one ampere flowing between potentials that differ by one volt. The practical rule is that volts multiplied by amperes gives watts. One kilowatt is one thousand watts.

Poncelet. An old French unit equalling 100 kilogram-meters per second. It equals 4/3 force de cheval, which see above.

Pound of Coal. The value of 14,000 British thermal units for the heat set free by the burning of a pound of coal is an average value for good coal. Some kinds of coal will produce as much as 16,000 British thermal units per pound; others fall as low as 11,000 or 12,000. *Wood* will produce from 7,000 to 9,000 British thermal units per pound. *Oil* yields from 18,000 to 20,000 British thermal units per pound. One barrel of oil is 42 gallons, or from 300 to 330 pounds, depending on the kind of oil.

Poundal. An old unit of force, corresponding to the dyne (see above). It equals the weight of .03212 pound.

Ton-mile. The expression is frequently misunderstood. It is *not* a unit of power or work, but of transportation. It indicates the number of tons of commodities transported, for example by railway, for an average distance of one mile. The *power* required to do this depends on many other factors such as railway grades, efficiency of locomotives and the like, and has no determinable relation to the ton-mileage.

Watt. See kilowatt, above.

Power of Men and Animals

A man will exert, on the average, about one-tenth horsepower, or .8 horsepower-hour per working day. This equals about 75 watts, or just about enough power to keep one electric lamp burning. For periods of a few seconds a man of average strength can exert as much as one-half horsepower but he cannot continue to produce energy at this rate without severe fatigue.

The average horse exerts about .6 horsepower during an eight-hour day, but can exert two horsepower or even more for a few minutes at a time. The most powerful animals in proportion to their size are the insects, some of which can exert more than a thousand times as much power, proportionately, as a man can.

Water Power Calculations

The power available in waterfalls may be calculated by multiplying the height of the fall in feet by the amount of water in pounds. This gives the power in foot-pounds. Other units can be calculated from the table. This is total theoretical power. Actual power developed depends on the efficiency of the plant, which may reach 90 percent for large, well-designed power plants. One gallon of water weighs approximately 8.3 pounds.

A TABLE OF CONVERSION FACTORS

	Kilowatt-hours	Horse-power-hours	Foot-pounds	Large calories	British thermal units	Pounds of coal
Kilowatt-hours	1	1.340	2,660,000	860	3413	.244
Horsepower-hours	.746	1	1,980,000	642	2547	.1818
Foot-pounds	.000,000,377	.000,000,505	1	.000324	.001286	.000,000,0918
Large calories	.001162	.00156	3085	1	3.968	.0002832
British thermal units	.000293	.000393	777.5	.252	1	.000,0714
Pounds of coal	4.103	5.50	10,885,000	3528	14,000	1

THE COMING

World Language

Will the international code developed by radio lead to an international method of communication between peoples who speak different tongues? Some scientists think it will. In the light of this possibility, the radio amateur becomes a figure of wide significance.

By EDWIN E. SLOSSON, Ph.D.

THE premature attempt to construct a skyscraper in Babylon some five thousand years ago was stopped by the curse of the confusion of tongues. When the mason at the top of the tower yelled down "More mort!"—meaning by that a bucket of bitumen—the hod carrier was as likely as not to tote up to him a tale of adobe bricks. This caused hard feelings and harsh language.

The curse of the confusion of tongues has rested upon the world ever since. It is getting worse of late. The World War brought to birth a dozen nationalities, which are now struggling to survive the diseases of infancy. These new nations are bursting with patriotism. Their self-respect demands that their vernacular shall be placed on a parity with the leading languages of the world. Every country is ambitious to attain economic and cultural independence and is striving for it by tariff walls, postal impediments, embargoes and boycotts. Nationalism is the order of the day. Secession and separation are in the air. The new map of Europe looks like a patchwork crazy-quilt. The map-maker can hardly muster up enough different colors to keep the countries distinct.

But while statesmen are breaking up the world into smaller portions, scientists are bringing the world together. Paint up the map into as many patches as you please but it is impossible to put up partitions in the ether. Wireless waves know no nationality. They spread in all directions equally and nothing can keep them out. The frontier may be lined with custom house officers, censors and soldiers, but the radio waves will pass right through them. Anybody anywhere may listen in without the consent or knowledge of the sender. Walls and mountains, rivers and seas, do not prevent the passage of the ether messages.

There is only one factor that acts as a barrier. This is difference of language.

The curse of Babel rests upon the radio. What though the telephone of the

From a photograph made for POPULAR RADIO

"THE RADIO FAN IS BECOMING A WORLD POWER"

So states Dr. Slosson, one of the most widely known writers on scientific subjects in America.

Eiffel Tower in Paris can reach all Europe and North Africa if the peoples within hearing talk thirty diverse languages?

As long as most people lived all their lives in one place it did not matter if every valley spoke a divergent tongue. As long as intercommunication was confined to print, mail and telegraph it was possible to get along with the aid of interpreters. But when millions are receiving messages without intermediaries they must have a common language.

A year ago it was an open question whether we ever could or would have a common language. Today it is not a question of could or would. It is a matter of must.

We've got to.

The only question now is what the international language shall be. And how we shall get it?

Already, under the pressure of necessity, various international languages are growing up. The commercial and maritime codes of the world comprise a larger vocabulary than many historic tongues. Music and mathematics have a common symbolism the world over. The names and formulas of the sciences are much the same in all languages. Possibly these separate and spontaneous movements may grow eventually into some sort of a world-language but it would be a haphazard and unsatisfactory affair.

Five hundred years ago Europe had an international language. Latin was spoken and read by the learned classes of all lands. Some professors now propose to revive Latin as the common language of commerce, diplomacy and science.

It would seem sensible to adopt some living language. But which? If we should put it to a popular vote Chinese would win by a large plurality. But who can learn the Chinese alphabet? It hasn't any. Shall the world be asked to accept Russian with its unpronouncable consonants, German with its unspeakable grammar, English with its illogical spelling or French with its elusive idioms? Mutual jealousy will probably prevent the people of the earth from agreeing to adopt any of the existing tongues as a medium of international communication.

Finally, there are several languages invented for the express purpose, nice tidy tongues; no exceptions to the rules, no irregular verbs; pronounced as spelled and spelled as pronounced; said to be easy to learn but not enough people are learning them. Here, too, there is rivalry. Esperanto is now in the lead but Ido claims to be an improvement on it.

In some way or other the world will soon acquire a common medium of communication. The more numerous the languages the more need for another that all peoples shall know. So the forces of nationalism will themselves force internationalism. And it is not inconceivable that the International Code signals, which are coming into more general use as the knowledge and practice of radio spreads, may be a determining factor in deciding what the world-language will some day be.

The radio fan is becoming a world power.

How to Build a Simplified Neutrodyne Receiver

In the coming issue of POPULAR RADIO*—for April—will appear a complete, detailed description of a non-regenerative radio-frequency set that is, in effect, a modified form of the popular neutrodyne receiver, but which is of extraordinary efficiency. This new set has been developed by the technical staff of* POPULAR RADIO*, and constitutes what is perhaps the most valuable contribution of the year to the equipment of the radio fan.*

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Warning Investors by Radio

A NEW use is being found for radio —for the protection of investors and to the confusion of crooks in the financial world. This plan was originated in Cleveland by the Union Trust Company and the Cleveland Better Business Commission, using the Union Trust Company radio station WJAX to broadcast descriptions of typical fake stock schemes and the like which the Commission knew were current in Cleveland and vicinity. Here is a special report of the scheme, made for POPULAR RADIO:

A few weeks ago the Better Business Commission learned that high-pressure salesmen of questionable brokerage houses were trying to sell stocks over the telephone. They would call up one after another of the people on their "sucker list," represent themselves to be investment bankers and give their prospect an "inside tip" on a "hot stock" that was going "to take a rise of from 8 to 10 points any minute." They would talk easy profits and partial payments and, of course, if the prospect seemed at all interested, they would follow up the telephone conversation with an actual sale.

The danger in this lay, of course, in the fact that the "investment houses" which these salesmen represented were not reputable houses and any investor who bought through them stood in imminent danger of losing all his money through failure of the "investment house." In fact, only a few months ago one of these houses did fail and people who had bought stocks on these telephone tips lost everything which they invested.

After obtaining accurate information about this method of stock solicitation from the Better Business Commission, station WJAX broadcast a complete description of this method. Prospective investors-to-be were warned of the high-pressure telephone salesmen. The radio story urged, "before you invest, investigate," and suggested that people get in touch with their bank or the Commission in regard to any proposed investment.

This same method was followed up in order to warn Clevelanders against fake "help wanted" ads. A certain company advertised that men were wanted for bench work—but when they applied for jobs, they were told they would have to buy stock in the company before they would be employed. Some men went ahead and bought stock in order to get jobs. At the end of two weeks, the men were discharged and when they asked the president of the company to buy back their stock as he had agreed to do, he merely laughed at them. Of course, the whole thing was just a "blind" to get money away from unsuspecting workmen. Station WJAX broadcast the full description of this scheme and warned the public against it.

Another "stunt" against which investors were warned by radio was that of the fellow who called upon stockholders in a certain company and told them a long and involved story about New York manipulations which would shortly increase the value of their stock enormously, urging them to buy more stock as soon as possible and suggesting that they give him the money or Liberty bonds with which to make the additional purchase. Of course, the whole thing was faked and the operator was simply after the Liberty bonds or other sound investments of the "suckers" on whom he was calling.

Many letters and inquiries have been received by the Cleveland Better Business Commission as a result of this broadcasting and the success of the plan has been such that its adoption is now being considered by the New York Better Business Commission.

The Union Trust Company and the Cleveland Better Business Commission will continue this plan of warning investors throughout 1924. These warnings will be broadcast every Thursday evening from WJAX, and whenever possible, they will give the public notice of fake investment schemes now being attempted or typical of those being operated currently within Cleveland and vicinity.

—D. S. KNOWLTON

What to Do When Your Set Goes Wrong

WHEN, for no apparent reason, your set quit working the other evening did you hold your temper and test the set out carefully? What you *should* do is told by a reader in Conway, Arkansas:

Look at your antenna carefully and inspect your ground and lead-in. Possibly your antenna has become grounded or your ground or lead-in has either been broken or become loose.

Then look at your "B" battery; sometimes it takes a sudden drop in voltage and, therefore, the tubes do not work right.

Next examine your tubes; once in a while the soldered connections on the prongs become corroded and form a high resistance path for the current; this is equivalent to a bad connection. This may be remedied by rubbing them on a piece of sandpaper until the solder shows up bright.

Next inspect the phone cords. It may be that the tinsel is broken and that you need a new cord. To test them, turn on your tubes, put on your phones and carefully "feel" the cord an inch at a time, bending it back and forth. If there is no sudden increase in the signal strength the cord is O. K.

Then examine all the flexible connections of the set, such as the pigtails of the condensers and the coupler. Blow out all the dust that has collected in between the plates of the condenser. If everything seems all right, carefully inspect the set, looking for crossed leads and corroded connections.

It stands to reason that if the set worked all right just before and that if you did nothing to it, that it is only some minor trouble which usually may be found outside the cabinet.

—Guy Simmons, Jr.

A Vaseline-carbon Grid-leak

THIS Los Angeles fan has devised an improved grid-leak that may be useful to other radio constructors. He passes on his idea as follows:

I have found a fact that may help some of the fans who have trouble with the "pencil type" of grid-leak. I marked heavily on a piece of cardboard with a lead pencil and placed it across the terminals of my grid condenser. I got no result. Then I smeared a little vaseline on the cardboard and fastened it to the condenser by bending it over and clamping it to the two terminals with a paper clip. To my joy it worked.

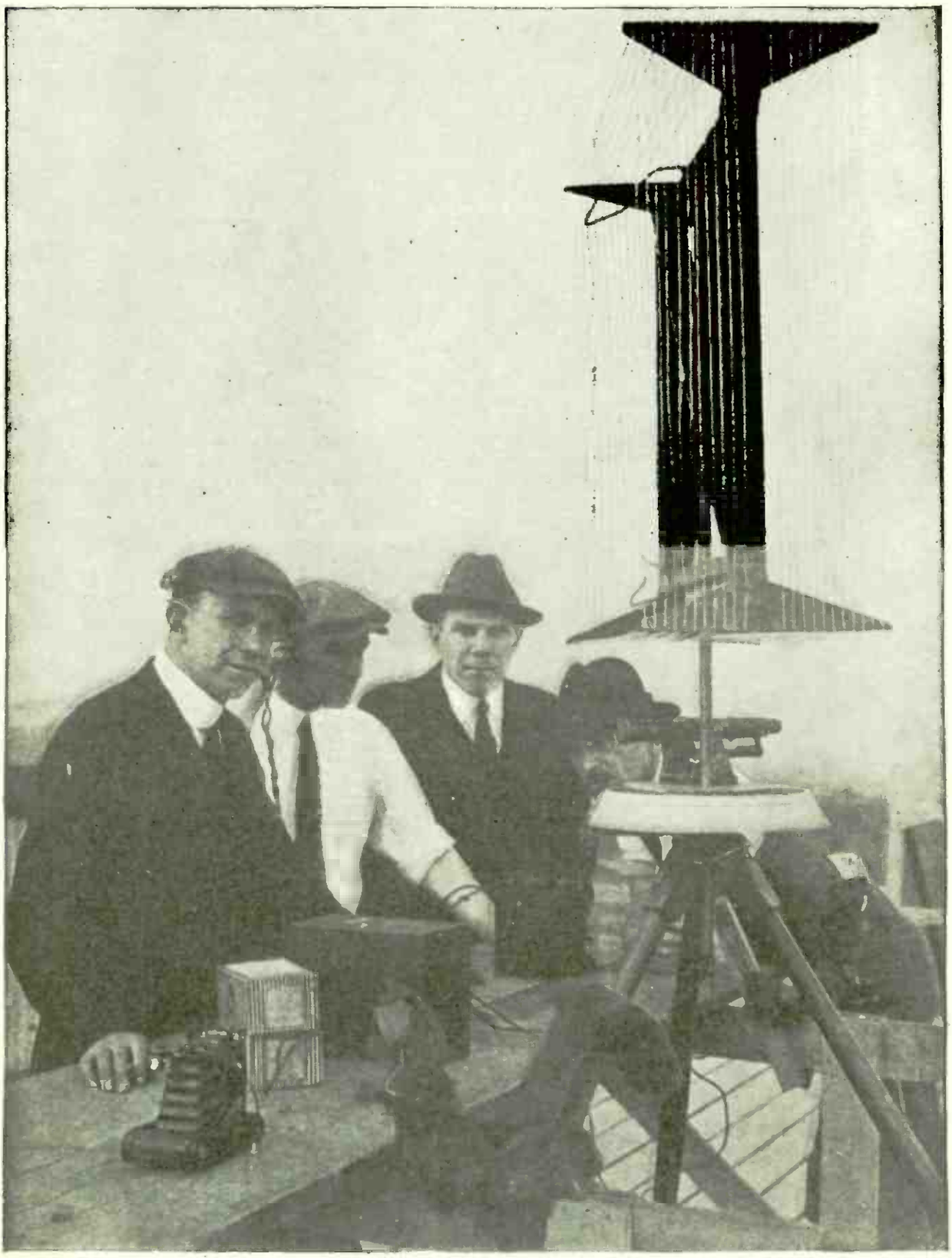
Next, I ground up some carbon from an old dry-cell and mixed a little of it with some more vaseline. I then took the plain vaseline off and smeared some of the vaseline-carbon mixture on the cardboard. It made my set 100 percent louder.

—Hugh J. Hamilton

International

RADIO MAY BE USED TO SCORE RIFLE HITS

Recent tests by the Signal Corps, U. S. A., have indicated that wired wireless and radio systems are more satisfactory and cheaper than ordinary telephones for communicating the number and place of hits from the targets of a rifle range to the officer in charge of the shooting.



S. R. Winters

A DIRECTIONAL LOOP ANTENNA FOR PRECISION MEASUREMENTS

This loop is used as a part of the radio-compass installation at the airship hangar at Lakehurst, New Jersey, where the great dirigible, SHENANDOAH, *is stationed. The telescope permits the comparison of the radio direction with the line of sight.*

Are Deserts a Source of Static?

A RECENT item in POPULAR RADIO about the prevalence of static disturbances in the neighborhood of the mountains of northern Mexico has brought in many letters from radio observers in that neighborhood. Not only the mountains but the deserts in this part of the world seem to be great offenders. Here, for example, is one fan who has found the Imperial Valley, which is in the heart of the great Colorado Desert, to be a point of origin for much disturbance:

I am an ex-operator, who was once stationed at San Diego, California, and have had considerable experience in receiving in Mexico, California and vicinity.

My experiences with static in this region are as follows:

It is directional, or very nearly so, and invariably seems to originate in the Imperial Valley.

It is both blanket and crashing and the crashing is sometimes terrific.

From 7:00 A.M. to perhaps 6:00 P.M., it is at a minimum in intensity, though the signal strength also seems to be at a minimum at this time. Starting about 8:00 P.M. and on until midnight the static gains in volume and is at a maximum from midnight until 4:00 or 5:00 A.M. Then it gradually decreases and is *nil* at 7:00 A.M.

July, August and September are the worst months. The hotter the Imperial Valley temperature the more crashing static there is.

It is generally, though not always, more intense on the long waves, that is, on 4,000 to 20,000 meters.

Reception is often very difficult during the day because of weak signals and at night because of static interference. Reception in southern California is usually better from the east than from the west.

Finally, though static is severe and may cause difficult receiving conditions, it can be minimized and practically eliminated with a barrage system of receiving.

—H. J. WILSON

How the Radio Compass Is Tested for Use on Airship

TESTS have been recently conducted by D. H. Shallcross, radio-compass engineer, to ascertain the amount of deviation (if any) that is caused by the huge hangar upon the interception of radio signals by a direction finder when the dirigible *Shenandoah* is approaching this building. The findings of these preliminary tests justify the conclusion of the radio-compass engineers of the Bureau of Engineering that remarkably satisfactory results may be expected in the operation of a loop antenna in connection with other radio receiving apparatus when in the immediate vicinity of, or located on, a metallic structure of the nature of the Lakehurst hangar.

The radio direction finder employed in these experiments is approximately 36 inches square; together with the tripod upon which it is mounted, it weighs about 35 pounds. This weight, however, is subject to variation, depending upon the auxiliary apparatus that is carried along to make a variety of investigations relative to the influence of metallic objects upon electromagnetic wave fronts. Mounted on the base of the loop, which is distinguished for its sharp directional characteristics, is a telescope which enables the operator to make visual as well as radio observations. These observations with respect to the radio transmitting station enable observers to ascertain the amount of *deviation* which provides necessary data to prepare a chart or deviation curve, thereby computing the distortion produced upon electromagnetic waves by large masses of metal or other energy-absorbing objects.

The equipment used in studying the wave phenomena on the hangar at Lakehurst has heretofore been applied in original investigations of the United States Navy Department in radio-compass stations on shore or on a man-of-war. That is to say, a major portion of the original data relative to electromagnetic wave variations and deviations caused by the different media over which these electric waves have to travel is afforded by the portable direction finder. It is an invaluable instrument in studying the distortion of electric wave fronts as well as in determining the source or station from which these particular waves emanate.

—S. R. WINTERS

QUESTION: I have been experimenting with honeycomb-type inductance for the last six months, changing from one hook-up to the other and trying to find out how many different ways they may be used. I have been trying them with your four-circuit idea and have had some very favorable results. Do you know of any other variations of the four-circuit principle that would be interesting for me to try as an experiment? I get more fun out of the actual experimenting than in the broadcast programs.

Can you give me a hook-up using the idea of an isolated circuit arrangement so that I could use a triple-coil mounting and a double-coil mounting? I want to try something more along these lines as I find that the more circuits the signals have to pass through, the sharper the tuning becomes.

SIDNEY G. CORY

ANSWER: The circuit shown in Figure 1 should interest you. You will need the following parts to try it out:

L1, L2, L3, and L5—honeycomb or duolateral coils, size L-35;
L4—Honeycomb or duolateral coil, size L-50;
VC1—variable condenser, .001 mfd.;
VC2 and VC3—vernier variable condenser, .0005 mfd.;
GL—variable grid-leak;
GC—mica grid-condenser, .00025 mfd.;
R—filament rheostat (to suit tube used);
C—mica fixed condenser, .0005 mfd.;
Tel—telephones;
"A" and "B" batteries.

Coils L1 and L2 may be placed in the double-coil mounting, and coils L3, L4, and L5 may be placed in the triple-coil mounting. The two coil mountings should be placed at right angles to each other.

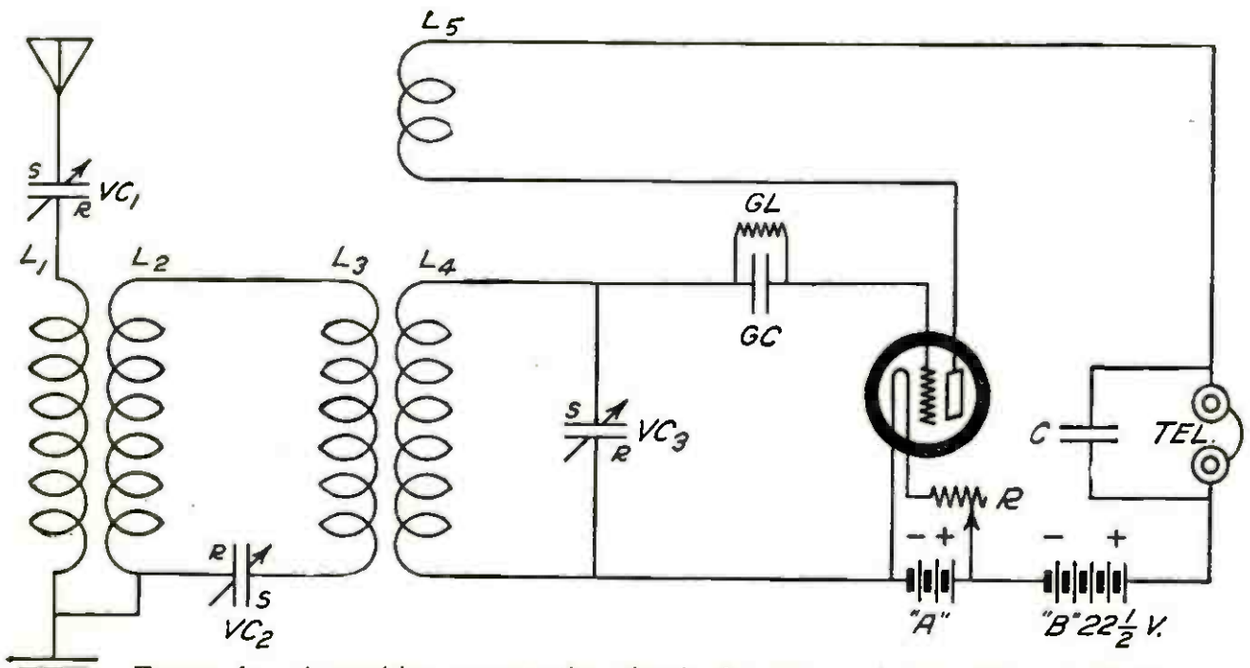


FIGURE 1: *A sensitive regenerative circuit that has an intermediate circuit for a coupling means between the antenna and the grid circuit.*

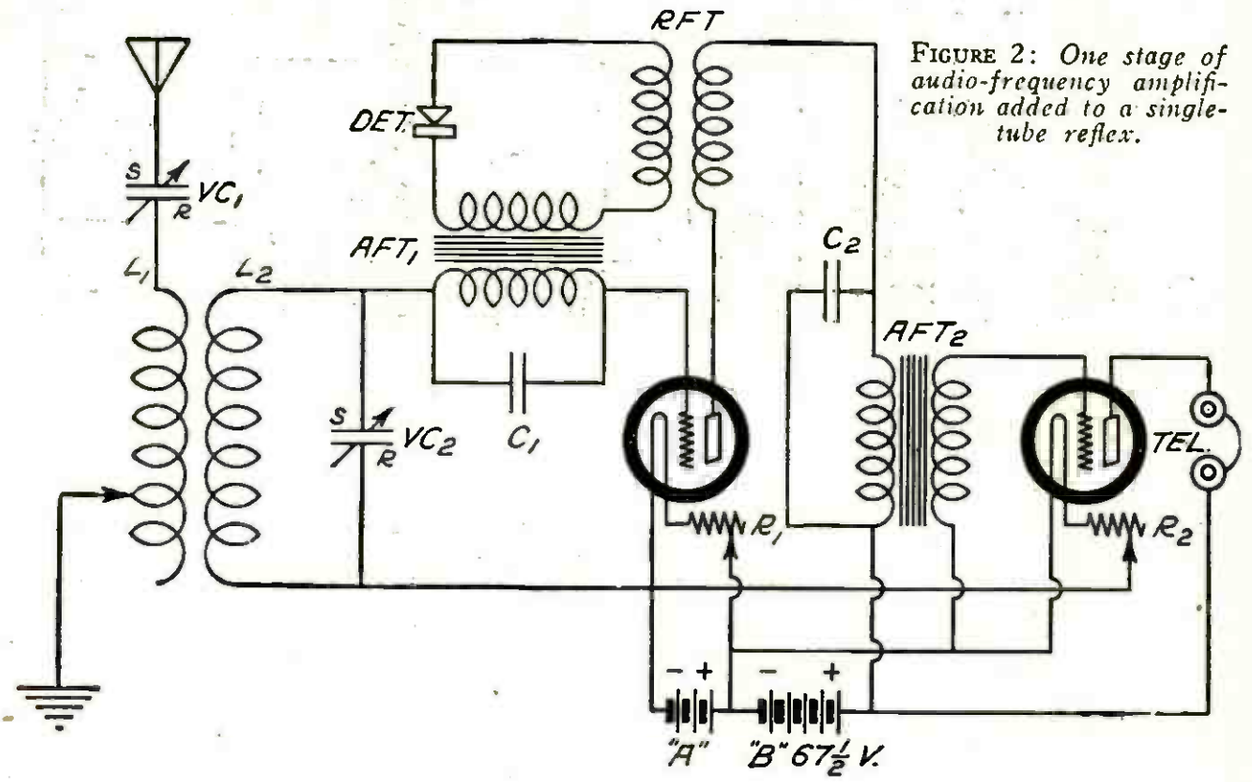


FIGURE 2: *One stage of audio-frequency amplification added to a single-tube reflex.*

QUESTION: I am sending you a diagram of my single-tube reflex set that has a crystal detector. It is giving me perfect results. It brings in the signals with great clarity and I enjoy it very much. I have just obtained a loud-speaker and I find that the signals are not quite loud enough for practical results. The signals can be heard from the horn when everything in the room is quiet but if anyone walks around I miss what is being played or sung. What I would like to do is to add one stage of audio to the reflex if it is possible. Can it be done? If so I would appreciate it if you would let me have it through the magazine. I notice that you say you will help out your readers with their problems.

JOHN HOWARD

ANSWER: The circuit diagram for the additional stage of amplification added to your present set is shown in Figure 2. The parts that you will have to get to do this are the following:

AFT2—audio-frequency amplifying transformer;
R2—filament rheostat;
C2—mica fixed condenser, .001 mfd.

* * *

QUESTION: How far above the roof do I have to string my single-wire antenna? There are now two antennas on my roof, one on each side of the house running parallel with each other. The landlord wants us to put up all our antennas on one side of the roof so that the other side of the roof will be clear for washlines, etc. I do not think that this would be so good and therefore am sending you this question. What would be the best way to run mine and what kind of support would you suggest using?

ANDREW WALLACE

ANSWER: You will have less interference from your neighbors and cause them less interference while tuning, if you run your proposed antenna at right angles to the other two. The easiest and most convenient way to string it up is to use a 16-foot "2x4" pole set up alongside of the clothesline supports and guyed with wire, so that it will remain taut and upright when the antenna strain is put upon it.

* * *

QUESTION: How many volts should be used on the C-300 vacuum-tube detector plate?

K. J. L.

ANSWER: Use a tapped "B" battery of 22½-volts maximum. You will find the best operation when the plate voltage is somewhere between 16 and 18 volts. Try moving the clip on the "B" battery when listening in to a DX station until you get the loudest signals. There will not be much difference on local signals.

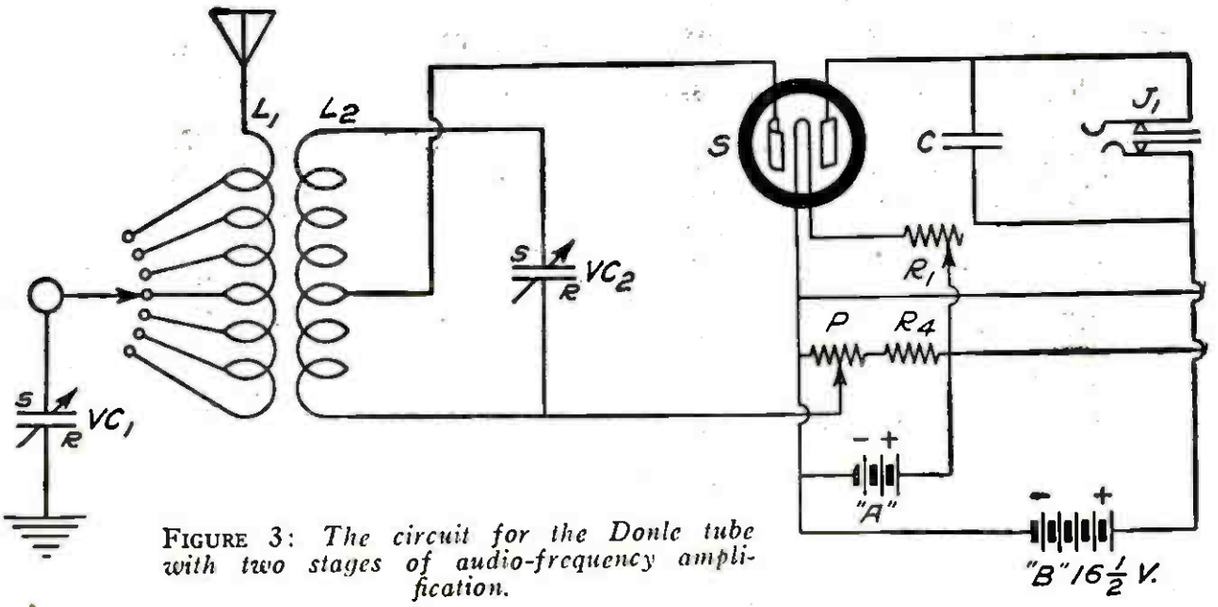


FIGURE 3: *The circuit for the Donle tube with two stages of audio-frequency amplification.*

QUESTION: Is the Donle tube and the sodion tube one and the same thing? I happened to be at the first disclosure of this new tube (the Donle) and I think I remember that he was connected with the same company that has just brought out the sodion. I was astonished at the time at the great sensitivity of this new form of tube and now I want to know if this is the perfected tube and if so, can you give me a circuit to use it with. I would also like to use two UV-199 tubes with it as audio-frequency amplifiers. Will you give me the circuit if my suppositions are correct?

CLEMENT BLANDI

ANSWER: They are the same. In Figure 3 you will find the wiring scheme for this tube together with two stages of audio-frequency amplification. You will need the following parts:

L1 and L2—variocoupler;
VC1—variable condenser, .001 mfd.;
VC2—variable condenser, .0005 mfd.;
P—potentiometer, 100 to 200 ohms;
R4—resistance unit, 100 ohms;
R1, R2 and R3—rheostats, 20 ohms;
C—mica fixed condenser, .0005 mfd.;
AFT1 and AFT2—audio-frequency amplifying transformer;
S—sodion tube;
2 UV-199 tubes;
J1 and J2—double-circuit jacks;
J3—single-circuit jack.

The secondary of the variocoupler should be tapped at about ten turns from the bottom for the collector terminal of the tube.

* * *

QUESTION: Will the small vacuum tubes that operate on dry cells give as good results on an audio-frequency amplifier as the ordinary storage-battery tubes?

AUSTIN KELSEY

ANSWER: These small tubes, dry-cell tubes they are commonly called, will not give as great amplification at an audio frequency as the regular (storage-battery) tubes. They have their own particular advantages, however, for portable sets, or for uses where there are no charging facilities for storage batteries.

For instance, the over-all cost of a single stage of amplification in a receiving set, including batteries, is much less than half for the dry-cell set than for the storage-battery set and the efficiency from a current-amplification standpoint is about seventy-five percent of that of the storage-battery set. If two stages of audio-frequency amplification are used, the efficiency would only be about fifty-five percent. The more stages used, then, the greater the difference in efficiency.

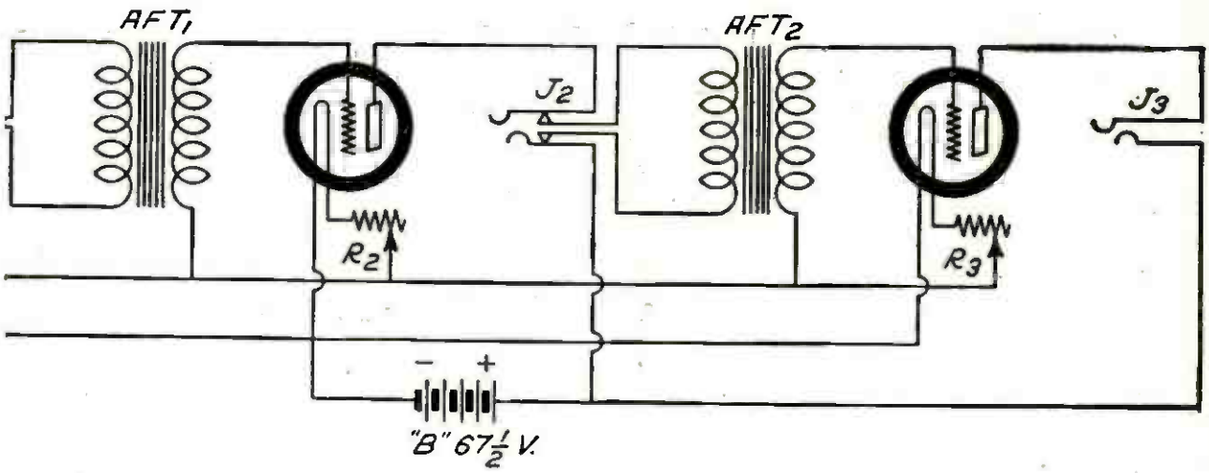
This means, that taken from a standpoint of both efficiency and cost, the dry-cell tube set compares favorably if only one stage of amplification is used, but for more stages it is advisable to use storage-battery equipment.

The dry-cell tubes are about equal in radio-frequency work, as the amounts of energy present in this form of amplification are well within the power limits of such tubes.

* * *

QUESTION: I accidentally allowed the two wires running to my storage battery to touch, and they got almost red-hot before I could get a stick to push them apart with. I also burned my hand on the hot wire, but I do not mind that if the battery is unharmed. How can I tell whether or not the battery is damaged?

T. H. S.



ANSWER: You can tell whether or not the battery was damaged by connecting it up to your set. If the tubes light all right, the battery is still in good condition. If they do not light up bright enough, the battery will need recharging.

If the recharge does not help them to recuperate, you probably left the short circuit on too long and the overload caused the battery itself to heat up and the plates to buckle. In this event you will need new plates; a new battery would be more economical.

In connecting or disconnecting batteries always remember to do it in the following way:

In connecting up: Connect the wires to the instruments *first*, then connect the wires to the batteries.

In disconnecting: Disconnect the wires from the batteries *first*, then disconnect the wires from the instruments.

In this way you *cannot* have any short circuits at the batteries and the batteries *cannot* be damaged.

* * *

QUESTION: Which should I use, the water pipe or the steam radiator for the ground on my receiving set? I can make the ground to the radiator with a lead of only a few feet, but will have to run about 20 feet to the water pipe. Which should I use?

HOWARD CUSHING

ANSWER: Use the water pipe. It will probably be better even if you have to use a longer length of wire to reach it.

* * *

QUESTION: Which is the best, a gas soldering iron or an electric one?

D. S. ADAMS

ANSWER: The electric soldering iron is much more convenient for the experimenter. He can leave it turned on while he tries some experiment, without fear of it overheating and oxidizing. In other words it is always on the job and needs no watching.

QUESTION: What voltage should be used on the filaments of the WD-12 tubes? I have had my set put away while I have been traveling and I have forgotten whether I used one or two dry batteries with it. I am afraid I might burn out the tube if I "monkey" with the batteries and try to find out myself.

J. F. T.

ANSWER: The tube you mention requires a voltage of 1½ volts on the filaments. One dry cell will be correct.

* * *

QUESTION: Can one rheostat be used successfully for controlling the filament current for the two tubes in a push-and-pull audio-frequency amplifier? If so, please let me know the proper rheostat to use with 201-a tubes.

H. M.

ANSWER: One rheostat can be used, provided that the two tubes are identical. (The two tubes should be identical for successful operation.) The proper resistance rheostat to use with the tubes mentioned is one of 20 ohms resistance.

* * *

QUESTION: What is a suitable length for a single-wire antenna for listening in to the broadcasting?

JOS. H. RENWICK

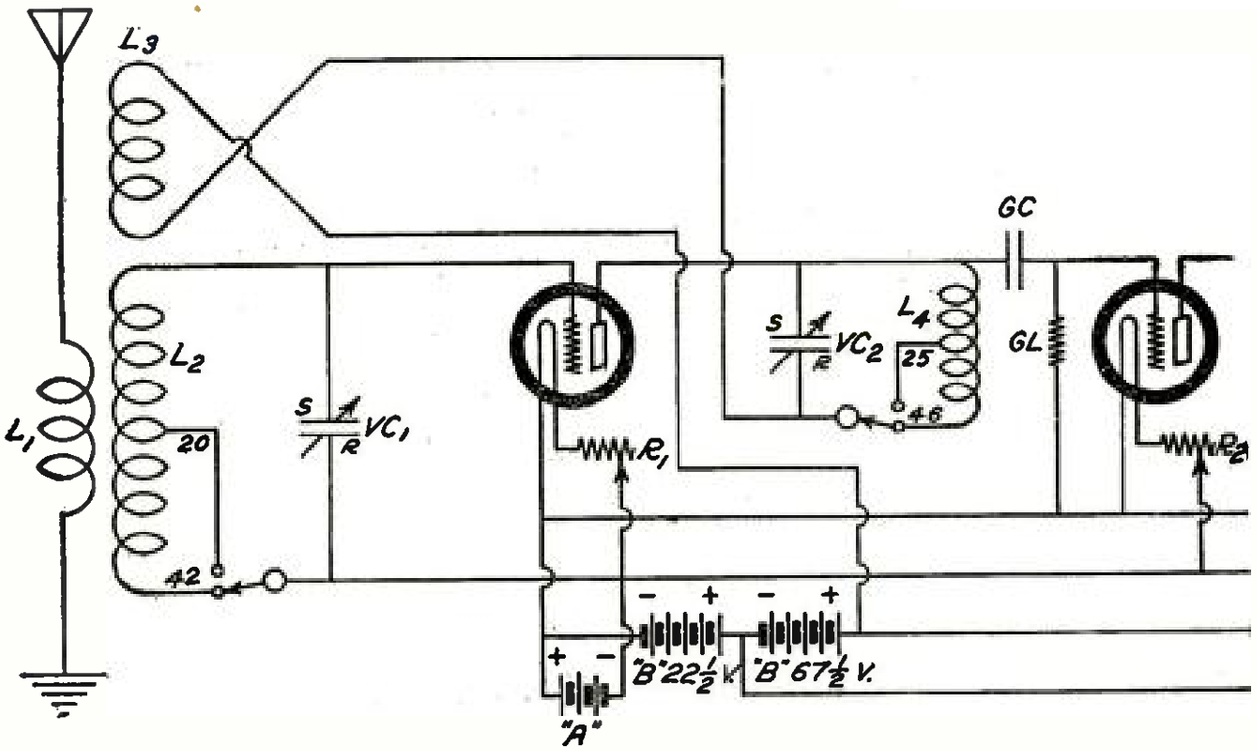
ANSWER: A single wire with a horizontal length of about 100 feet.

* * *

QUESTION: What voltage should be used on the plate of a "soft" detector tube in the single-tube Reinartz?

MILTON ROSS

ANSWER: Use from 16 to 18½ volts.



QUESTION: Will you please give me the circuit for the superdyne as recently brought out by C. D. Tuska? Is this circuit anything like the neutrodyne? I would also like to have the constants for the various instruments and the data for the coils. Do you think that a set containing the features above mentioned would be too difficult for an experimenter to work out and build for his own use?

HENRY F. DRUMMOND

ANSWER: The circuit you require is shown in Figure 4. This circuit accomplishes the same thing as the neutrodyne, but by a different method. In the neutrodyne, feedback is eliminated by means of the neutralization of the tube capacity. This constitutes, in theory, the use of a capacity bridge in which a small condenser is used to balance or neutralize the capacity between the grid and plate electrodes of the tube.

In the superdyne the elimination of feedback is accomplished by a reversed voltage which is also fed back to the grid circuit, but in this case it is done inductively. The system uses a *reversed* tickler coil.

The parts you will need for the set are the following:

L1, L2 and L3—the special coupler;
VC1 and VC2—variable condenser, .0005 mfd.;
L4—plate inductance coil;
GC—mica fixed condenser, .00025 mfd.;
GL—variable grid-leak;
R1, R2, R3 and R4—filament rheostats (to suit tubes used);
AFT1 and AFT2—audio-frequency amplifying transformers;
two switch levers;
four switch points;
J1 and J2—double-circuit jacks;
J3—single-circuit jack.

For coil L2, wind, on a composition tube 4 inches in diameter, 42 turns of No. 22 DSC copper wire, with a tap at the 20th turn. The winding L1 consists of 4 turns of the same kind of wire wound over the secondary winding. Coil winding L3 consists of 36 turns of the same wire wound on a rotor, 3⅝ inches in diameter. The rotor is inserted halfway into one end of the 4-inch tube and arranged with bearings and a knob so that it may be rotated.

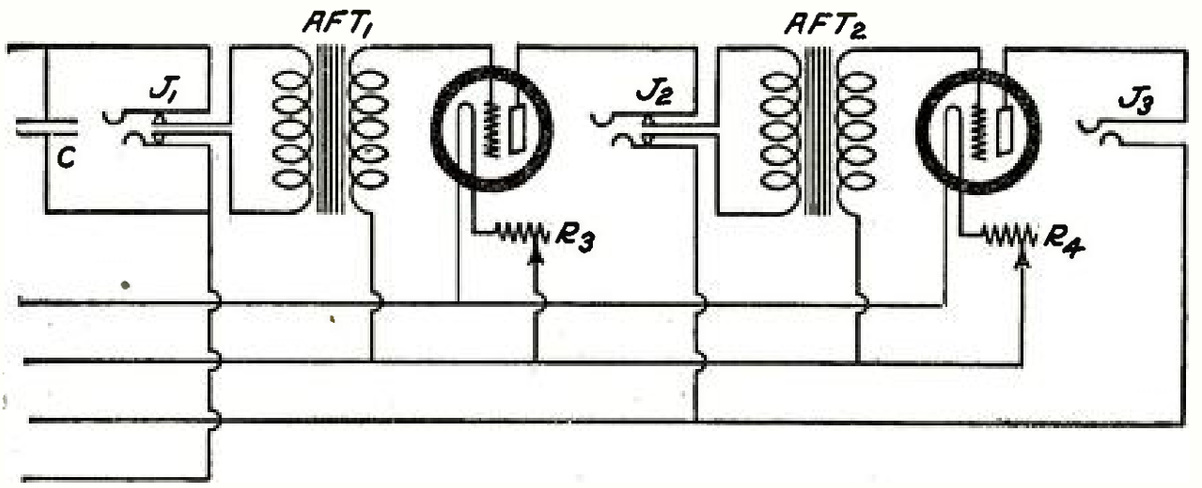
There is nothing extremely difficult in making such a set and any radio fan will experience a lot of pleasure and learn a lot of the theory of radio in building one. The set will function satisfactorily when constructed and operated properly.

* * *

QUESTION: Would it be possible for me to make the "audio" amplifying transformers for my receiver? I want to try to make all the parts for my set if there is no special apparatus or knowledge required to do so. If you think I could do the job satisfactorily please give me a complete description of the way to do it.

WALTER C. HOOP

FIGURE 4: *The superdyne circuit which accomplishes, by electromagnetic means, what the neutrodyne does, by electrostatic means. This circuit tunes sharply and is very sensitive to DX signals.*



ANSWER: There is too much detail and too many obscure but essential points of construction (not to mention the physical qualities of the materials necessary) involved in the manufacture of transformers for audio-frequency amplification for the average amateur or radio fan to be able to make even a fair job in building his own transformers. This is true of most of the parts used in built-up sets. The progressive man who "rolls his own," in the way of radio sets, does not attempt to make the individual parts; he buys instruments and apparatus that he knows are good, and then assembles them into a set employing the particular hook-up that he is interested in, at the time. In this way, if the hook-up is trustworthy and if his wiring is done correctly, he gets good results.

However, if he makes the parts himself he soon finds through experience, that he cannot do as good a job, or as economical a one, as the manufacturer. In the first place, he finds that when he gets a part completed, after spending a lot of time doing it, that it doesn't give the results he expected; and in the second place, he is astonished to find that it *costs more* than the manufactured parts.

Our advice is to stick to reliable, standard manufactured parts which have proven their worth by wide usage. In this way you will avoid the disappointed feeling that comes from a combination of careful planning (seemingly), hard work, but at the same time *poor* results.

* * *

QUESTION: What does the R and S, which is printed on all of your wiring diagrams next to the symbols for the variable condenser, stand for? I am unfamiliar with these markings and wish to make a set that has these markings on all of the variables. E. MARK WAITE

ANSWER: The R stands for the rotary elements of the condenser and the S stands for the stationary plates. When shown in a diagram with these designations, the connections should be made to the stator or rotor terminals as specified. This will assure the builder of a set which, when completed, will not be sensitive to "body capacity."

* * *

QUESTION: Can radio be used to communicate with the spirit world? It seems to me that if radio waves cannot be seen or felt, and have no body and no sound, that they would be of the same stuff as spirits are made of and could be used to communicate, back and forth, with spirits. Has there ever been any experimental work done along these lines?

K. F. ENGLE

ANSWER: We refer you to the article "Ghosts That Talk—by Radio" by Houdini, in the October, 1922, issue and the article "Can We Talk to the Dead by Radio?" by Carrington in the June, 1922, issue of POPULAR RADIO. These will give you two views on the subject that should help you to form your own opinion.

* * *

QUESTION: How many feet of No. 18 DSC copper wire will I need to make the new four-circuit coils?

A. C. HENDRICKS

ANSWER: You will need approximately 120 feet of it.

A Detector Tube Filled with Liquid Silver

In the past few months there have been several announcements of the possibility of radio detection by means of what are called "colloidal solutions" instead of by the ordinary methods. The matter has been put to careful test by Mr. Joseph Roussel, Secretary of the French Society for the Study of Radio.*

Let us see, first, just what a "colloidal" solution is. It was noticed many years ago by the English chemist, Graham, that there exist in nature two different kinds of solution; one of them transparent and perfectly fluid, like a solution of salt or sugar, the other more or less cloudy and viscous, like a solution of glue or of white of egg. These cloudy, glue-like solutions Graham called colloids.

In recent years there has been a great deal of scientific work done with such solutions—so much so that colloid chemistry is now a recognized branch of science. It has been found that the real characteristic of such solutions, the thing that sets them apart from the ordinary transparent solutions like those of sugar or salt, is that the colloidal solutions contain a lot of very tiny, invisible particles that are not dissolved at all. It is possible, for example, to make a colloidal solution of metallic silver, and this solution contains, it is found, many millions of tiny solid particles of the metal floating around in the solution just as dust motes float around in the air.

Of course, these tiny silver particles are far too small for us to see them individually, but they can be detected by many scientific methods, including some electrical ones. It is these electrical properties of the floating colloidal particles that have been made use of in radio detection.

The ordinary vacuum tube operates by means of the loose electrons that escape from the filament and fly around inside the tube. As these electrons are repelled or attracted by the grid, the number of them that reach the plate changes and the plate current fluctuates. Now a colloidal solution (say, for example, a solution of colloidal silver) behaves in many ways like the electron-filled space inside a vacuum tube. The tiny solid particles of silver floating in the solution correspond to the electrons flying about in the tube.

Suppose, then, that we dip into such a solution of colloidal silver the three electrodes of a vacuum tube. The electrode corresponding to the filament need not be heated to emit electrons. We need no electrons. Instead of them we are going to use the floating silver particles. So, the filament electrode is merely one side of the filament-plate circuit. If there is a potential on this circuit, as in the ordinary tube, the particles of silver will be driven across in a stream from filament to plate, just as the electrons are driven in the ordinary vacuum tube. The grid, too, will behave just as it does in the tube. Potential changes on it will decrease or increase the stream of moving silver particles just as such changes on the tube grid affect the stream of electrons. Even with the grid omitted such an arrangement will work as a detector in the same manner as does a two-electrode vacuum tube. Using a solution of colloidal sulphur and two platinum plates for electrodes Mr. Roussel was able to receive the signals from the Eiffel Tower about twice as intensely as with the best galena detectors.

There is no probability, of course, that these new colloidal detectors will threaten in the least the supremacy of the vacuum tube, but there may be special uses for them and they are worth study by experimenters who have the requisite knowledge of colloidal chemistry or are willing to acquire it. Special uses of importance and even of monetary value might be developed for them.

If you want to try them, this is how to do it. You can buy in a drug store two preparations of colloidal silver that are suitable. One is called protargol, the other collargol.

Take a thoroughly clean glass vessel like a drinking tumbler, or better still a chemist's beaker, and fill it about half full of the purest distilled water. To this add about half a teaspoonful of a ten-percent solution of either one of the silver preparations. Dip into the solution so prepared two small platinum plates attached to platinum wires. This gives you a

*"Concerning the Colloids," by Joseph Roussel. *Radio-Électricité*, vol. 4, pages 319-324 (August 15, 1923).

two-electrode detector. If you want to add a grid, a piece of platinum-wire net will serve. You can use silver instead of platinum if the silver is pure. Silver coins will not do.

The silver solution will spoil in a few hours and must be made up afresh, but it is possible to keep it indefinitely if the water and all materials are pure and if the whole is sealed away from the air inside a glass bulb. It is possible that sufficient experimentation with such a sealed-in solution might give us a new type of detector more permanent than a crystal and even more effective. Some radio fan who happens also to be a colloid chemist ought to try to work it out.

Dust in the Earth's Attic

AMONG the most mysterious regions on the earth is one that we look through every time we look up at the stars. It is the upper part of the earth's atmosphere, 100 or 200 miles above the ground, the region famous among radio fans as the location of that mysterious something called the Heaviside Layer.*

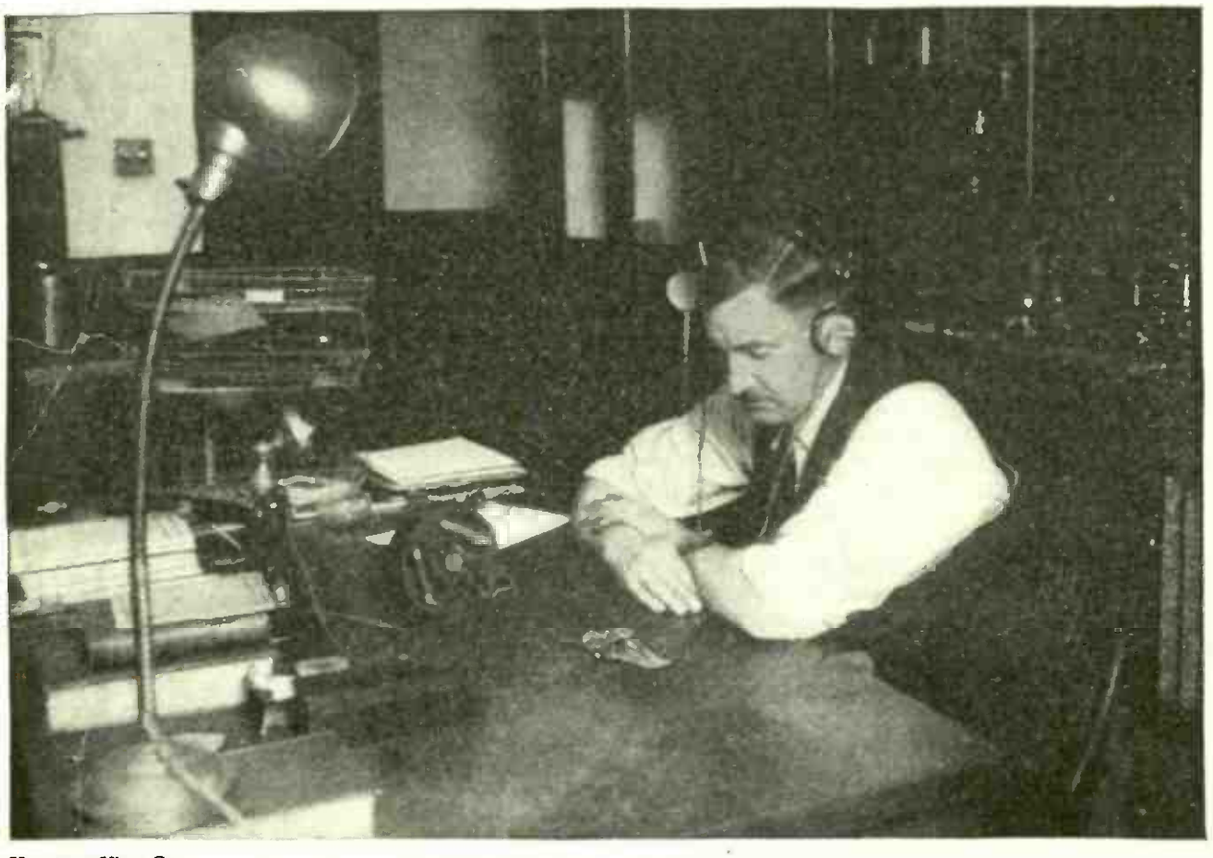
Nobody knows just what the Heaviside Layer really is. It may be ionized gas like the gas inside a Crookes vacuum tube. It may be a vast swarm of electrons. The latest idea is that it consists of dust. The earth's attic is dusty.

But the dust that exists up there is not ordinary dust. It is, the theory says, nitrogen dust. The nitrogen gas of the air is congealed by the intense cold of space into a layer of tiny solid crystals like minute snowflakes. These float in the air, or rather in space, for there is really no air there except as these nitrogen dust particles represent it. This is the theory recently formulated by Professor Vegard of the University of Christiania.*

If we could be sure that this is right it would be of great importance to radio. A full understanding of the principles of radio transmission is unlikely to be attained until we know just what the Heaviside Layer really is and just what are its electrical and magnetic properties. The problems of fading are presumably related to this. So are the many peculiarities of distance radio like the fact that the five-watt transmission of an American amateur has been heard clearly in New Zealand,

*The theory of the Heaviside Layer has been discussed in POPULAR RADIO by Sir Oliver Lodge, Dr. Elihu Thompson, Major General George O. Squier, Dr. R. A. Fessenden and others. See Dr. Fessenden's article in the issue for November, 1923.

*L. Vegard. "The Constitution of the Upper Strata of the Atmosphere." *Philosophical Magazine*, vol. *46*, pages, 577-604 (October, 1923).



Keystone View Co.

LISTENING TO THE "TALK" OF INSECTS WITH RADIO APPARATUS

The Thomas glow-transmitter, described in POPULAR RADIO *for July, 1923, is so sensitive that it picks up sounds even above the usual range of audibility. Some insects make such sounds; sounds that are too shrill to be heard by unaided human ears. Dr. Thomas is shown listening to the sounds made by a moth.*

sion is of a different sort. The waves then travel along the Heaviside Layer as well as along the ground. But they are not so much *reflected* from the Layer as they are *transmitted* along it much as though it were a conducting wire. The new theory is really a double Gliding-wave theory. One wave glides along the ground; the other glides along the under surface of the Heaviside Layer.

During the day the condition of the atmosphere is such, Dr. Dellinger thinks, that waves transmitted from terrestrial stations cannot reach the Heaviside Layer. They are absorbed in the middle portions of the atmosphere. Therefore the only wave that reaches distant stations is the one that goes along the ground. But at night the air is less absorptive for the waves, they reach the Heaviside Layer and follow along it as they do along the ground. The received signal is, therefore, stronger at night since it then includes *both* of the gliding waves, the lower one along the ground and the upper one along the Heaviside Layer.

How Damaged Atoms Operate New Kind of Vacuum Tube

At a recent meeting of the Institute of Radio Engineers Mr. Harold P. Donle* described a new vacuum tube that involves several novelties in tube principles, notably the fact that the tube operates not so much by the aid of electrons as by means of what are called ions. These ions are merely atoms that have been damaged by the loss of one or more electrons.

Readers of recent articles in Popular Radio on the modern investigations of the structure of atoms† will remember that the atoms of every kind of matter are really complex systems built up out of electrons and central

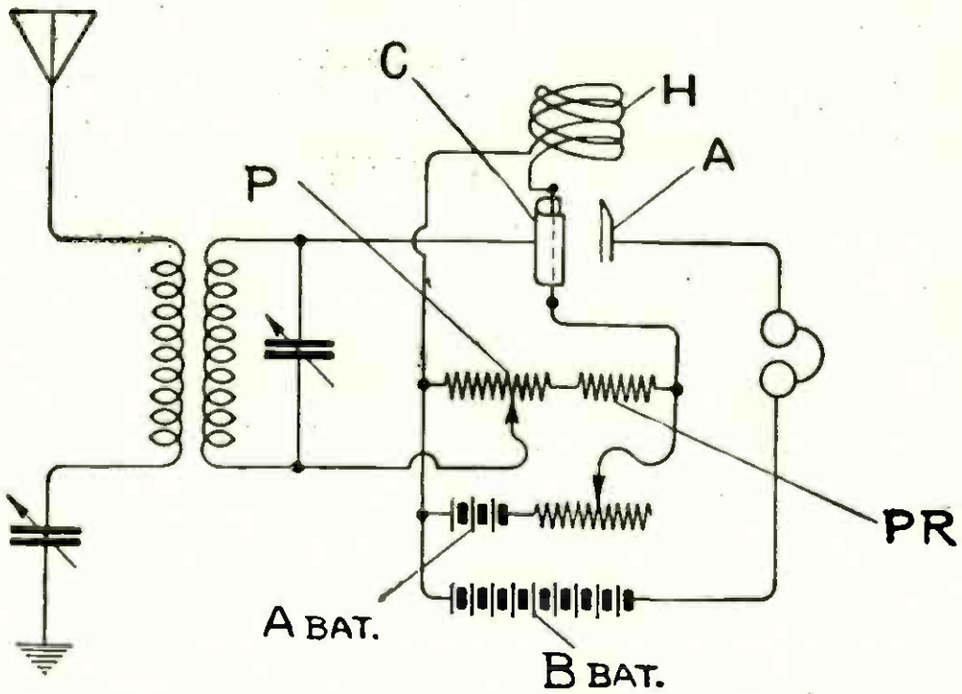
*"New Applications of the Sodion Detector." Meeting of the Institute of Radio Engineers, New York. October 10, 1923. The full paper will appear shortly in the Proceedings of the Institute.

†See, for example, "700,000,000,000,000,000,000,000 Electrons for a Cent," in Popular Radio for January, 1924.

Kadel & Herbert

WILL RADIO HELP THE HARD OF HEARING?

Many persons have reported that they can hear radio concerts better than they hear ordinary spoken sounds. Dr. Paul V. Winslow, a well-known ear specialist of New York City, is testing the truth of this idea and is using radio, also, in the treatment of partial deafness. The theory is that listening to radio will give much-needed practice to imperfect ears. The nerves of hearing are re-educated in perceiving sound combinations. At the same time the mechanical parts of the ear are exercised and improved, just as muscular exercise strengthens the body as a whole.



CONNECTIONS FOR THE TUBE THAT WORKS WITH IONS

A is the plate and C is the collector, which is the device that takes the place of the grid. The filament is indicated by the dotted line inside the curve of the collector. It is in series with the coil H, which serves to heat the tube and produce the ionization of the sodium atoms.

nuclei in a good deal the same way that our solar system is built up out of the planets and the central sun. The electrons in an atom revolve in orbits around the central nucleus and some of these orbits are quite distant, relatively, from the nucleus; even farther away, in proportion, than the outermost planet of our system is from the sun and from the inner planets like the earth. Sometimes these far-out electrons of an atom get loose and fly away or are hit by other electrons and knocked off. Then the atom is shy one electron, just as our solar system would be minus one planet if the outermost one flew off or was hit by some wandering star and driven out into space.

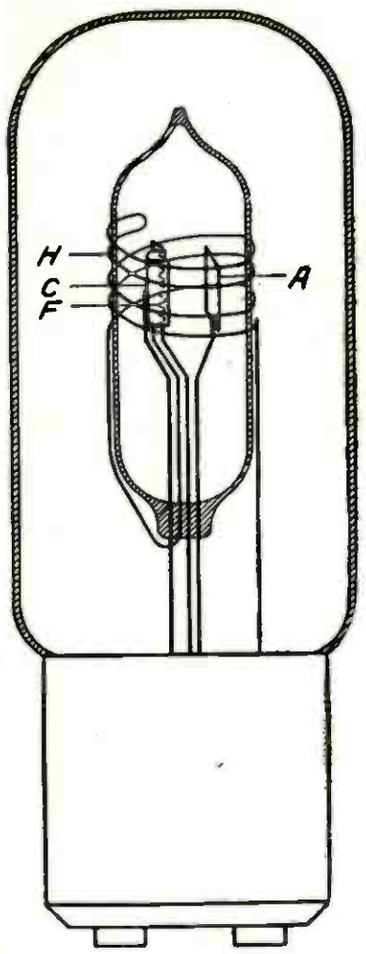
This process of losing electrons from an atom is what is called "ionization." The part left behind is called an ion. There is always a good deal of ionization inside a vacuum tube of any kind. The atoms of gas that are left in it (for the vacuum in the tube is never quite perfect) are being hit all the time by the flying electrons from the filament and many of the atoms have an electron knocked out of them so that they become ions.

Now some kinds of atoms are especially susceptible to ionization. For example, the atoms of the chemical element sodium (a silvery white metal that is so active chemically that it catches fire spontaneously in the air) are very easily ionized. Each of these sodium atoms has a total of eleven electrons that revolve as planets inside it and the eleventh one of these electrons moves in an orbit that reaches a long way out from the center of the atom. It corresponds to the outermost planet of our solar system.

Accordingly this outermost electron escapes very easily from the atom and goes off by itself, leaving the sodium *ion*, that is a sodium atom that has only *ten* electron planets instead of the normal eleven. This ion has, also, a positive electric charge just equal in quantity to the negative charge of the one electron that it has lost.

These sodium ions are used to operate the new Donle tube. The tube has a plate and a filament much as do the ordinary three-electrode tubes. It has no grid, this element of the tube being replaced by a metal half-cylinder placed behind the filament instead of between the filament and the plate. The tube is pumped to the highest possible vacuum and then some atoms of sodium are introduced into it. To keep this sodium in the state of a gas during the operation of the tube, and also to facilitate the ionization of the sodium atoms the tube is heated by a small heating coil, in series with the filament, which coil is wound non-magnetically around the outside of the glass. There is a second glass bulb outside of this in order to protect the heating coil and prevent the cooling of it by the air.

This arrangement gives many billions of sodium atoms in the space inside the inner tube. A large proportion of these atoms lose their eleventh electron and become sodium ions. These ions operate the tube just as electrons operate the ordinary tube, with two exceptions. *First*, the ions are positive, not negative; accordingly they move in the opposite direction to the electrons when placed in the same electric field. *Second*, the ions are far heavier than electrons and accordingly they move much more slowly.



SODION TUBE ASSEMBLY

H is the heating coil; C the collector; A the plate, and F the filament. Note the outer protecting bulb of glass.

The detailed theory of the operation of the tube is quite complicated and persons interested in it must refer to Mr. Donle's paper in the Proceedings of the Institute. The results of its operation are, essentially, as follows:

The tube is a detector only. It will not oscillate nor will it respond at all to a single radio-frequency impulse. The time occupied by a single radio-frequency cycle is too short to affect the tube. But the time of an audio-frequency wave is much longer and this does affect the tube, so that the tube detects it. The tube has, it is claimed, many of the advantages of the crystal detector and the diode tube and avoids some of the outstanding disadvantages of these devices for detection, as well as being the most sensitive detector known. A hook-up for the use of the tube will be found on page 294 of this issue.

One application of the tube may prove to be of considerable value in radio research. This is the fact mentioned by Mr. Donle that the current in the filament-collector circuit (the "collector" is the semi-cylindrical plate that replaces the grid) is exactly proportional to the audibility of a signal at the receiving station. Accordingly a Donle tube connected with a current meter constitutes a direct-reading audibility meter. Mr. Donle has applied such a circuit to the recording of fading curves for the signals from WJZ and WGY. These fading investigations are now so much in the mind of the radio public that this use of the new tube may prove one of its most important services to radio science.

Technical Articles You Ought to Read

THE following brief reviews cover some recent papers of interest to radio amateurs, professional physicists and radio engineers. Translations, abstracts or photostat copies of these papers can be supplied in most cases at prices which will be quoted on application. Address "World's Laboratories Department," POPULAR RADIO.

"The Optimum Wavelength," by Leon Bouthillon, *Radio-Électricité* (Paris), vol. *4*, No. 11, *Bulletin Technique*, pages 41-45 (Aug. 15, 1923); No. 14, pages 52-57 (Oct. 1, 1923); No. 17, pages 68-76 (Nov. 15, 1923); to be further continued. A comprehensive mathematical discussion of the problem of selecting the best wavelength for the transmission of various kinds of signals between different varieties of transmitting and receiving apparatus. In French.

"The Nature of Light and Light Waves," by J. A. Fleming. *Wireless Review* (London), vol. *1*, pages 559-560 (Oct. 13, 1923); pages 587-589 (Oct. 20, 1923). Suggests a new theory of the structure of the universe according to which the ether is conceived as a complicated system of "ether tubes" or lines of force (also called "electrolines"). The theory seems not very different from the original "lines-of-force" conception of Faraday but is of interest in connection with present-day speculations concerning the nature of the ether.

"The Production of Small Alternating Potentials of Known Amplitude," by H. G. Möller and E. Schrader. *Jahrbuch der drahtlosen Telegraphie und Telephonie* (Berlin), vol. *22*, pages 56-72 (Aug., 1923). A full description of apparatus and method for producing electric oscillations of known frequency and amplitude by a loose-coupler method. A useful article for all experimenters with oscillating circuits. In German.

"The Torques and Forces Between Short Cylindrical Coils Carrying Alternating Currents of Radio Frequency," by W. A. Parlin. *The Physical Review*, vol. *22*, pages 193-197 (Aug., 1923). The results of comprehensive experiments show that coils carrying radio-frequency oscillations possess very slight attractions and repulsions, which can be ascribed only to the fact that the emission of a radio

wave produces a repulsion or back-kick against the coil from which it originates. The discovery of this effect may prove to be very important for future investigations of the nature of radio waves and of the ether.

"The Transmission and Reception of Speech and Music in Radio Telephony," by N. W. McLachlan. *Beama* (London), vol. *13*, pages 285-292 (Nov., 1923); pages 366-369 (Dec., 1923). A comprehensive but thoroughly scientific discussion of the modulation, transformation and amplification problems involved in modern radio telephony. Will be especially valuable to the beginning radio engineer.

"Distortion in Radio Telephony," by H. A. Thomas. *The Wireless World* (London), vol. *13*, pages 225-229 (Nov. 14, 1923); pages 257-260 (Nov. 21, 1923). A paper before the Radio Society of Great Britain, similar in character to that of McLachlan referred to above.

"Forced Oscillations in Self-maintained Oscillating Circuits," by W. A. Leyshon. *The Philosophical Magazine* (London), vol. *46*, pages 686-698 (Oct., 1923). A scientific report of some of the investigations being carried out by Prof. W. H. Eccles of Finsbury Technical College, London, on the subject of forced oscillations. A "forced oscillation" means that an oscillating electromotive force of different phase or even of slightly different frequency, applied to a circuit that is already oscillating, will sometimes pull this circuit into tune with the applied electromotive force. The matter is of importance in the theory of the heterodyne and in many other radio problems. The present paper contains, also, an account of experiments with the method of Lissajous for indicating phase differences between two oscillations by means of a steel needle vibrating in the joint magnetic field of the two circuits.

"Multiple Earthing Systems," by G. W. O. Howe. *The Electrician* (London), vol *91*, pages 266-267 (Sept. 14, 1923). A brief account of the methods of avoiding earth-current losses in antenna systems, especially of the multiple earth plates recently installed at Nauen and St. Assise.

"A Study of Net-work Antennas," by R. Villem. *Radio-Électricité* (Paris), vol. *4*, No. 11, *"Bulletin Technique,"* pages 33-40 (Aug. 15, 1923). A mathematical and theoretical discussion of the design of antennas of this type. There is a correction to the original paper in No. 14 of the same journal. *"Bulletin Technique,"* page 57 (Oct. 1, 1923). In French.

"Contribution to the Study of Amplifiers of Very Low Frequency," by P. Lejay. *L'Onde Électrique* (Paris), vol. *2*, pages 521-534 (Sept., 1923). Experiments and theoretical discussion of the design of audio-frequency amplifiers and transformers. In French.

"The Design of Inductances for High-frequency Circuits," by C. L. Fortescue. *Journal of the Institution of Electrical Engineers* (London), vol. *61*, pages 933-939; discussion, pages 939-943 (Aug., 1923). Complete theoretical and practical discussion of this important problem, including the limitations due to the space factor, the design for minimum R/L, and other points. Valuable to the radio engineer.

"Curves for the Design of Variable Air Condensers," by F. Bedeau. *L'Onde Électrique* (Paris), vol. *2*, pages 508-520 (Sept., 1923). A discussion of condenser theory that will be useful to experts. In French.

"Description of a Series of Single-layer Inductance Coils Suitable for Radio-frequency Standards," by J. L. Preston and M. S. Strock. Letter Circular No. 103 of the U. S. Bureau of Standards. Issued October, 1923. How to make coils such as are used with the Bureau of Standards wavemeters. Copies of the Circular are procurable from the Bureau, Washington, D. C.

"The Measurement of Power Losses in Dielectrics," by L. Hartshorn. *Beama* (London), vol. *13*, pages 89-99 (Aug., 1923). An account of the experiments carried out at the National Physical Laboratory, England. Important to all engineers who work with insulating materials, especially the solid insulating materials used in radio apparatus.

"Electrical Loudspeakers," by A. Nyman. *Journal of the American Institute of Electrical Engineers*, vol. *42*, pages 921-927 (Sept., 1923). An analysis of the electrical and magnetic factors involved in the design of loudspeakers. Testing methods are described also. This will be an invaluable article for all engineers engaged in problems of loudspeaker improvement.

"Theoretical and Experimental Study of the Telephone Receiver," by A. E. Kennelly. *The Post Office Electrical Engineers' Journal* (London), Vol. *16*, pages 144-171 (July, 1923). This is a translation of the lectures delivered by Prof. Kennelly, of the Massachusetts Institute of Technology, at the French School of Posts and Telegraphs early in 1923. It is a useful summary of present information for all persons interested in the design of telephone receivers.

"Electrostatic Voltmeters," by R. R. Ramsey. *QST*, vol. *7*, No. 3, pages 18-20 (Oct., 1923). A simple voltmeter based on the principal of the gold-leaf electroscope or of the familiar pith-ball experiment. It can be constructed by anyone and has been applied to the measurement of voltages between 75 and 3,000 volts.

"Vacuum Tubes as Power Oscillators," by D. C. Prince. *Proceedings of the Institute of Radio Engineers*, vol. *11*, pages 275-313 (June, 1923); pages 405-435 (Aug., 1923); pages 527-550 (Oct., 1923). An excellent treatise on the theory and operation of power tubes used either for radio transmission or for other engineering purposes. It is complete, practical and authoritative.

"The Axially-controlled Magnetron," by Albert W. Hull. *Journal of the American Institute of Electrical Engineers*, vol. *42*, pages 1013-1018 (Oct., 1923). A description, by the discoverer, of the theory and operation of the type of vacuum tube in which the movement of the electrons is controlled by the magnetic field set up by the alternations of current in the filament, no grid being necessary. A photograph of this tube was published in POPULAR RADIO for January, 1923.

"The Mobilities of Electrons in Air," by Leonard B. Loeb. *Proceedings of the National Academy of Sciences* (Washington), vol. *9*, pages 335-340 (Oct., 1923). A report on one of the many investigations now going on in American laboratories (this paper is from the University of Chicago) on the behavior of electrons in gases. The theory of this behavior, when we know it completely, will be invaluable to the operation and design of vacuum tubes, especially those that contain some gas and are therefore "soft."

"Some Experiments Illustrating the Electrical Properties of Neon Lamps," by Philip R. Coursey. *The Wireless World* (London), vol. *12*, pages 700-704 (Aug. 22, 1923); discussion, pages 778-779 (Sept. 5, 1923). The neon lamp is filled with the rare gas, neon, a tiny fraction of which is contained in the atmosphere. This gas glows when a current is passed through it between two electrodes, the necessary potential being some 200 volts or less depending on the pressure and temperature of the gas. Such lamps are available commercially in England and can be used in various radio experiments; for example, as detectors in wavemeter circuits, as indicators that the current is flowing in oscillators, and the like. Small neon-filled tubes are used in America as ignition gauges for automobiles and can be employed similarly in radio circuits.

"Experimental Valve Making," by H. P. Warren. *Popular Wireless* (London), vol. *4*, page 31 (Sept. 8, 1923). Hints to the amateur who intends trying to make his own vacuum tubes. ("Valve" in England, means vacuum tube.)

"The Helicoidal Molecular Pump," by F. Holweck. *L'Onde Électrique* (Paris), vol. *2*, pages 497-503 (Sept., 1923). A description, by the inventor, of the special vacuum pump designed for use with the demountable power tube now under test in the Eiffel Tower station at Paris. This tube was described in POPULAR RADIO for December, 1923, page 525. The article cited is in French.

"Physical Measurements of Audition and Their Bearing on the Theory of Hearing," by Harvey Fletcher. *Journal of the Franklin Institute* (Philadelphia), vol. *196*, pages 290-326 (Sept., 1923). A summary of the important investigations made in the laboratories of the Western Electric Company on the relations between sound waves in the air (as measured and produced by *physical* methods) and the *sensations* of hearing which these waves produce in the human ear. This fundamental information is the basis of all theories for the design of loudspeakers, telephone receivers and all similar instruments, as well as of the telephonic amplifiers for the use of the deaf.

"Wireless Direction Finding in Steel Ships," by C. E. Horton. *Journal of the Institution of Electrical Engineers* (London), vol. *61*, pages 1049-1056; discussion, pages 1056-1060 (Sept., 1923). A comprehensive discussion of the effects of metals in the ship on the readings of direction finders. Includes the use of multiple antenna systems. There is also a discussion of laboratory methods for investigating the effects of metals on the propagation of radio waves.

"Recent Developments in the Application of Wireless Telegraphy to Shipping," by John A. Slee. A paper before the meeting of the British Association for the Advancement of Science, Liverpool, September 14, 1923. Reported in *The Electrical Review* (London), vol. *93*, pages 443-444 (Sept. 21, 1923). A general account of recently developed high-speed devices for ship-to-shore telegraphy, of filters for reducing interference in this traffic, of duplex telephony for ship use, of the revolving-beam radio lighthouse at Inchkeith, and of experiments on apparatus for direction finding on shipboard by the use of long waves.

"The Control and Navigation of a Model Ship by Wireless," anonymous. *The Model Engineer and Electrician* (London), vol. *49*, pages 269-271 (Sept. 6, 1923). Detailed description of a small boat that can be controlled from shore by radio signals. It can be built by any amateur of a mechanical turn of mind.

"Report of the Special Broadcasting Committee Appointed to Advise the British Postmaster General on the Broadcasting Situation." Issued by H. M. Stationery Office, London, Oct., 1923. Price, postfree, 10 pence. An important document to persons interested in the future of broadcasting and the possible necessity of its further legal control in the United States.

"The Amateur's Part in Wireless Development," by W. H. Eccles. Presidential address to the Radio Society of Great Britain. Printed in *The Wireless World* (London), vol. *13*, pages 50-54 (Oct. 10, 1923). An article recounting some of the important services of the amateur to radio, services which do not seem to be as clearly recognized by British officialdom as they have come to be by the authorities in the United States.

"Radio Signals of Standard Frequency and Their Utilization." Circular No. 92 of the U. S. Bureau of Standards. Describes the standard frequency signals sent out at intervals by the Bureau of Standards, and how these may be used to calibrate wavemeters or transmitters. A limited number of copies are available at the Bureau for those having real use for them.

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

Most of the Broadcasters Are in North America

THE tremendous advance of broadcasting in the United States and Canada, as compared with the rest of the world, is indicated by the fact that this continent possesses over 600 licensed broadcasting stations while all other countries combined have less than 50.

* * *

Another Record for Amateur Radio

AMATEUR communication between America and Asia has been attained. According to an announcement of the American Radio Relay League, Mr. Charles York of Tacoma, Washington, has been in momentary communication with a Japanese amateur. This leaves Africa as the only continent (so far as we know) which has not been reached by the American amateurs. Our signals were first heard in England on December 8, 1921, which was the initial instance of amateur communication across the ocean. Australia and South America have been reached since then. A notable instance of communication with the European mainland was described by Captain Deloy, French 8AB, in POPULAR RADIO for February, 1924.

* * *

The Most Powerful Radio Station in the World

THE Poulsen arcs of the great radio station in the Malabar Mountains of Java draw 2,400 kilowatts, which is probably the largest power used by any single transmitter in the world. This is enough power to light nearly fifty thousand ordinary electric lamps. The aerial of this station is fastened to the side of a mountain and rises nearly 2,000 feet above the station.

* * *

Newest Demountable Tube Produces 15,000 Watts

THE Holweck demountable vacuum tube, described in POPULAR RADIO for December, 1923, has been constructed in a new and enlarged model having a power of 15 kilowatts. The new super-power tube is under test in the Eiffel Tower station where the former tubes were tested. Its construction has not been described publicly, but it is believed to differ very little from the former model.

Two Vacuum Tubes in One

A NEW French invention, the Junot vacuum tube, contributes to radio science the idea of a tube containing two filaments. Only one is used at a time, but when the first filament has burned out or broken a simple adjustment inserts the second filament in the circuit in place of the damaged one, thus giving the tube a life just twice as long as the life of the usual one-filament tube.

* * *

Line Radio Replaces the Direct-current Telegraph

THE methods and apparatus developed for use in radio are replacing, one by one, the older methods of nearly all branches of electrical engineering. One of the most notable to feel this revolution is wire telegraphy. The older method of sending dots and dashes by direct current permitted only one message for each pair of wires. Line radio multiplies this many times, for a separate message can be sent simultaneously for each separable band of frequencies. Carrier-current (line radio) methods are now in use in Europe employing alternating currents as low as 400 cycles a second, and from this on up into radio frequencies, thus giving scores of separate message channels over the same wire.

* * *

Radio Closes in on the Secrets of the Magnetic Pole

THE northernmost magnetic observatory ever erected in the world has been set up near the ship of the MacMillan expedition. According to a news note by Science Service the magnetic observations are in charge of R. H. Goddard of the Carnegie Institution, who accompanied the expedition for this especial purpose. It is proposed to study the phenomena of earth magnetism in the neighborhood of the magnetic pole itself. Some of the elusive secrets of this important but little-known subject may be solved. One of the great advantages of this new observatory over previous magnetic stations in the far north is that the radio apparatus of the MacMillan expedition permits the magnetic observer to keep in touch with other magnetic laboratories all over the world.

England Hears American Broadcasting on Crystal Sets

THIS is neither the newest radio lie nor a freak record. It is the result of the latest development of relay broadcasting. Concerts from American stations, notably from KDKA, have been picked up in England, amplified and relayed from the stations of the British Broadcasting Company. Thus we come one step nearer to something that POPULAR RADIO has been predicting for months—international broadcasting.

* * *

Does Rain Cause Static?

READERS of POPULAR RADIO for February, 1924, will remember the interesting relation found by Mr. Watson-Watt between the fall of rain at a given locality and the apparent origin of static, simultaneously, at the same locality. *Popular Wireless* (London) has been collecting some observations made by British listeners concerning the occurrence of visible sparks about their radio sets, especially between the plates of the condensers. An interesting feature of the reports to *Popular Wireless* is that most of the instances reported occurred during a rainstorm or some meteorological equivalent. Rain drops are known to be electrified. Perhaps some valuable facts can be uncovered by studying the nature of radio transmission during rain. Have any American readers noticed static sparks in their condensers and was it raining at the time?

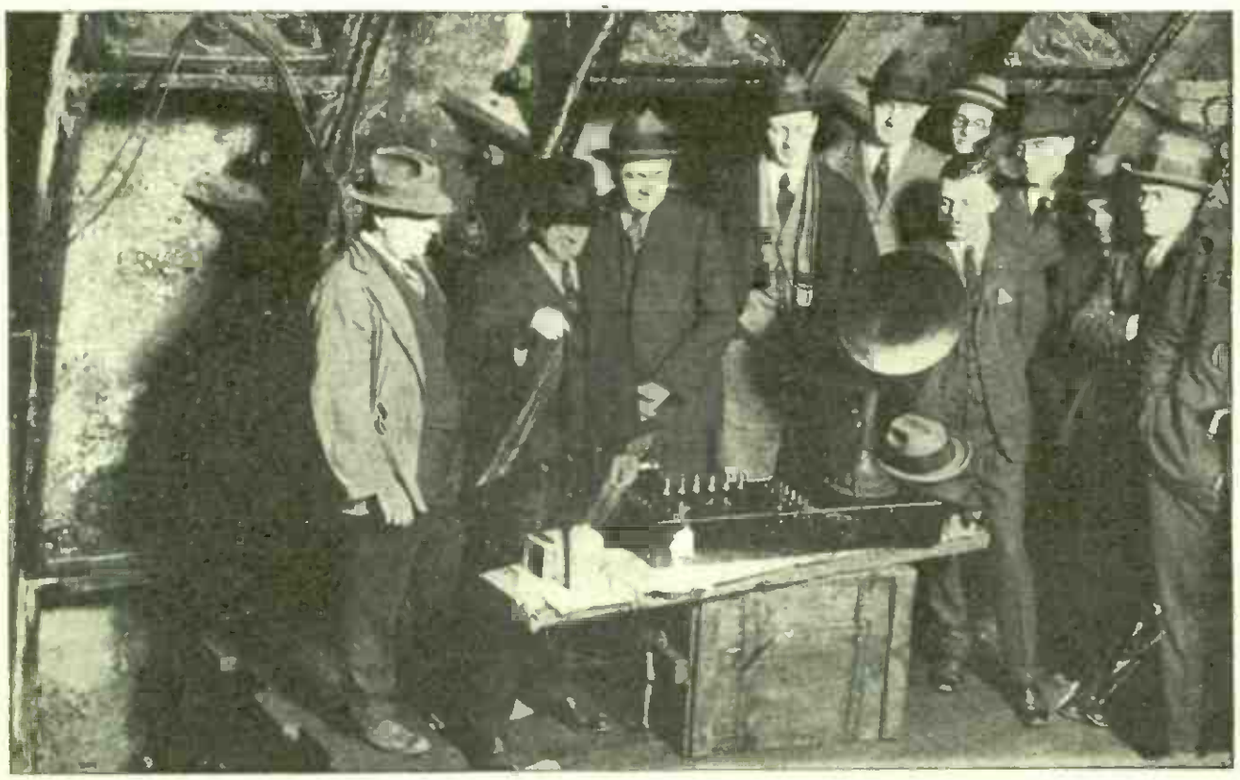
New European Broadcasting Stations

Two new short-wave stations are now on the ether in Europe. One at Brussels, Belgium, transmits each evening from 8:30 to 9:30 (3:30 to 4:30 P.M., New York time) on 410 meters. The second, at Rome, is on 450 meters. The government of Italy has not yet approved regular broadcasting, so the Rome transmission is still experimental. It occurs, usually, from about 10:30 to about 11:30 A.M., New York time. There is also an occasional experimental transmission from PTT at Madrid, Spain, on wavelengths between 400 and 700 meters. If you hear any of these stations let us know.

* * *

Radio and the World State

IN A recent thoughtful article in the New York *Evening Post,* Professor Preserved Smith of Cornell University points out that the world possesses already at least one element of that international world community which all historians and most statesmen agree in believing to be desirable if not inevitable. This is the existence already of a large measure of international co-operation among professional scientists. Quite true, but Professor Smith omits to mention that one group of scientists, the radio amateurs, not only possess such co-operation by means of publications and letters, but have the inestimable advantage of continual acquaintance through the ether. Amateur radio may prove a potent force for peace.



Underwood & Underwood

RADIO RECEPTION BENEATH A RIVER

In a recent test in the vehicular tunnel now being constructed to connect New York and New Jersey broadcast programs were received when the apparatus was ninety feet below the surface of the river. Together with the earlier experiments by the United States Bureau of Mines and in England, this test shows that radio may be of value in communicating with men entombed underground by disasters.

Marconi Co., London

BAND CONCERTS IN A LONDON PARK—BY RADIO

The approach of the summer season suggests the possibilities of using radio receiving sets and loudspeakers for giving evening concerts simultaneously in the parks of American cities. Successful experiments have been made in London and Paris.

Do Sunspots Effect Radio Reception?

RECENTLY Dr. L. A. Bauer of the Carnegie Institution told the American Association for the Advancement of Science that he had discovered a close connection between the occurrence and character of spots on the sun and the phenomena of atmospheric electricity. The details remain to be worked out, but that there is a close linkage of some sort seems to be beyond question. Since the phenomena of static are associated, beyond doubt, with some feature of the electrical changes in our atmosphere, this new observation by Dr. Bauer is of great interest to radio engineers. It may be that we will be looking for sunspots soon in order to decide whether or not it will be worth while to try for DX records that night.

* * *

New Wavelengths of British Stations

THE wavelengths of the eight broadcasting stations operated by the British Broadcasting Company have been rearranged. At last advices the following are the wavelengths in use:

350 meters, 2LO, London.
370 meters, 5NO, Newcastle.
385 meters, 6BM, Bournemouth.
400 meters, 2ZY, Manchester.
420 meters, 5SC, Glasgow, Scotland.
435 meters, 5WA, Cardiff, Wales.
475 meters, 5IT, Birmingham.
495 meters, 2BD, Aberdeen, Scotland.

New Words that Radio Fans Already Know

IN an address before the recent meeting of the American Association for the Advancement of Science, the distinguished physicist, Mr. John Mills, criticised the makers of engineering text-books for using still the outworn terms of older electrical and physical theory. The engineering terms of the future will be, he said, such things as electrons, ions, protons, atomic nuclei and quanta of energy. Undoubtedly, and in this new engineering the radio man will have the great advantage of familiarity with exactly these terms that Mr. Mills says the engineers must learn to use. For it is these ideas, little used in the older branches of engineering, that the radio engineer must learn about first of all.

* * *

Apartment Superintendent Becomes Radio Policeman

THE annoyance of re-radiation from regenerative receivers has become so serious in many parts of New York City that Mr. Louis Doty, superintendent of a large apartment house, has insisted, says the New York *Sun and Globe*, upon inspecting every radio set in the apartment house before the installation of an antenna is permitted. If the receiver is of a type from which re-radiation is possible Mr. Doty, who is a competent radio engineer, offers his assistance in modifying it so that annoyance to the neighbors will be impossible.

The Loudspeaker Is Not a Legal Nuisance

SEVERAL suits have been brought recently in various parts of the United States to determine just what are the rights of the radio listener as compared with the rights of his neighbors. Loudspeakers, it must be admitted, are too often louder than they are intelligible. Many persons object to being annoyed by them, especially when the horn is outside or the windows are open. Do such objectors have the legal right to stop the performance and compel the discontinuance of noise audible outside the broadcast listener's own house? In at least one case, in Ridgefield Park, New Jersey, the local courts have said no. The radio fan has the same right to operate a loudspeaker inside or outside his premises as he has to operate any other sound-producing instrument, for example a phonograph or a cornet. However, it behooves the radio public to be generous and considerate in the exercise of its legal rights. The good-will of your neighbor is an important asset. Some day you may want to string an antenna across his lot.

Underwood & Underwood

A RADIO ANGELUS

The noon time-signals relayed by station WGY are put to practical use by C. J. Waldron, an ardent radio fan of Medusa, N. Y., who rings the church bell immediately upon receipt of the official U. S. announcement of the arrival of 12:00 o'clock.

Uses for Rare Chemical Elements in Radio

MANY new uses for rare metals have developed in the radio field. Some of them were demonstrated, says *Science*, at the recent Chemical Exposition in New York. Thorium is used in the special coated filaments for vacuum tubes. Tellurium, an element that has previously had no use at all, is finding its place in detector crystals. Selenium, a chemical twin of tellurium, has many uses in the electric light-detecting devices, including the various systems for sending pictures by radio or for recording radio messages on photographic films. Tantalum, long entirely useless, is the basis of a new rectifier for battery-charging purposes. Molybdenum, a chemical curiosity until the French used some of it for cannon linings in the recent war, is now a necessary element in the high-power vacuum tubes. Many of these metals, once known only to research chemists, are now regular commercial articles—thanks to radio.

* * *

Who Will Invent a Sterling Silver Radio Set?

THERE is an over-production of silver in the United States and the Bureau of Mines is looking for new uses for the metal in industry. It is suggested that some parts of radio sets might, with advantage, be made of silver. Silver has about seven percent more conductivity (for direct currents) than has copper. It is also somewhat more malleable and is much less easily corroded in the air. If you can suggest some new use for it the Bureau of Mines will be glad to hear from you.

* * *

Vacuum Tube Proves the Radioactivity of the Earth

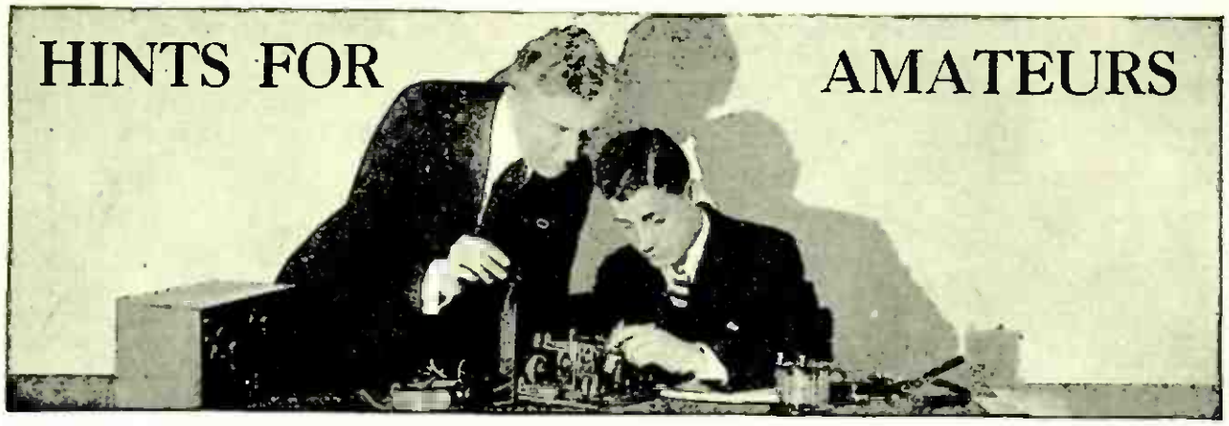
THE fact that the substance of the earth itself, including all ordinary rocks and soils, is radioactive in the same way that radium is, though more faintly, has been proved recently by Professor Compton, of Princeton, and by Mr. T. E. Foulke using an electric-discharge tube built on the same principles as a vacuum tube. It is found that the rays coming from the ground produce enough ionization of the minute quantity of gas left in the tube so that a high-tension discharge through the tube is possible at any time, even without a hot filament to provide a source of electrons and ions. This continual ionization can be prevented by encasing the tube in lead which cuts off the rays coming from the ground.

* * *

England Discovers the Radio Worm

To the writing beetle, the book-worm and the bug that eats lead sheathing off the telephone cables we now must add the radio-set earwig. Mr. H. E. Adshead in the *Wireless World* (London) reports that so many of these humble insects have delighted to crawl into the hole of his telephone jack that it has been necessary to insert a small plug in order to keep them out. Some of the insects have been found even inside the cases of earphones.

HINTS FOR AMATEURS



SELECTIVITY is the main consideration in a set that is to be used for pleasure or amusement. You want to be able to "pick" any program that is within the range of your instrument whether or not you can receive only the local or both the local and distant stations.

A set that is sensitive and enables you to receive distance, but that has not sufficient selectivity to tune out the local stations is worse than useless. You don't want to listen to opera from one station with a background or accompaniment of jazz leaking through from some other station.

You want a *selective* receiver whether it is a simple crystal set or a complicated multi-tube receiver, and remember this: the more sensitive a set is, the more selective it must be! Get a set that is selective, by all means.

* * *

IN a two-stage audio-frequency amplifier that is noisy it will sometimes help a lot, in eliminating howling and squeaks, to ground the negative filament connection at the "A" battery. This will place the filament circuits at ground potential and cut out the capacity troubles that cause the howls.

* * *

A RADIO set, like a chain, is no better than the poorest link used in it. Make all the links strong by using good parts. Cheap makeshift instruments make weak links.

* * *

GROUND your set on the water pipe. It is usually better than other grounds.

MANY uses can be found for a temporary connector made by detaching two Fahnestock connection clips from a worn-out dry battery and soldering the severed ends together. The connector joins cord tips conveniently when two or more headsets are used in series.

* * *

Do not let the acid from the storage battery spill on your clothes or on the carpets. It will eat a hole in the cloth. If you *should* spill any of this electrolyte on the carpet or your clothes make a solution of ordinary baking soda in water and wash the spot thoroughly with this solution, being sure to use plenty of the soda solution. Then finish with a good wash with plain water.

A solution of household ammonia in water will neutralize the acid just as well but the ammonia itself sometimes damages fine fabrics and a solution of baking soda, though slightly less convenient than the ammonia, is safer.

* * *

Do not let your single-circuit regenerative set *whistle* when you are trying to pick up a station. If you do, it will cause a similar *whistle* in your neighbor's receiver that will interfere with his reception. If everybody would observe this golden rule of silence the reception in our large cities would be much improved.

* * *

Do not run your antenna close to, or parallel with, the fifteen others now on the same roof.

A HANDY indoor antenna system can be made from the ordinary desk telephone stand and a small tin pie-plate. Connect the radio set up in the ordinary way except that the antenna binding post on the set is connected directly to the pie-plate. Then take the desk telephone stand and set it on the pie-plate, and tune in the signals in the regular manner.

The theory of operation is this: The telephone line is grounded on the metallic frame of the telephone and the base of the telephone desk set acts as one plate of a condenser while the pie-plate acts as the other plate. The felt covering on the desk set acts as the insulation or dielectric. What you really will have is the telephone line acting as an antenna with the telephone-pie-plate condenser in series with it. The telephone company can have no objection to this use, as you will not be making any metallic connection to their lines. The way to hook up the outfit is shown below.

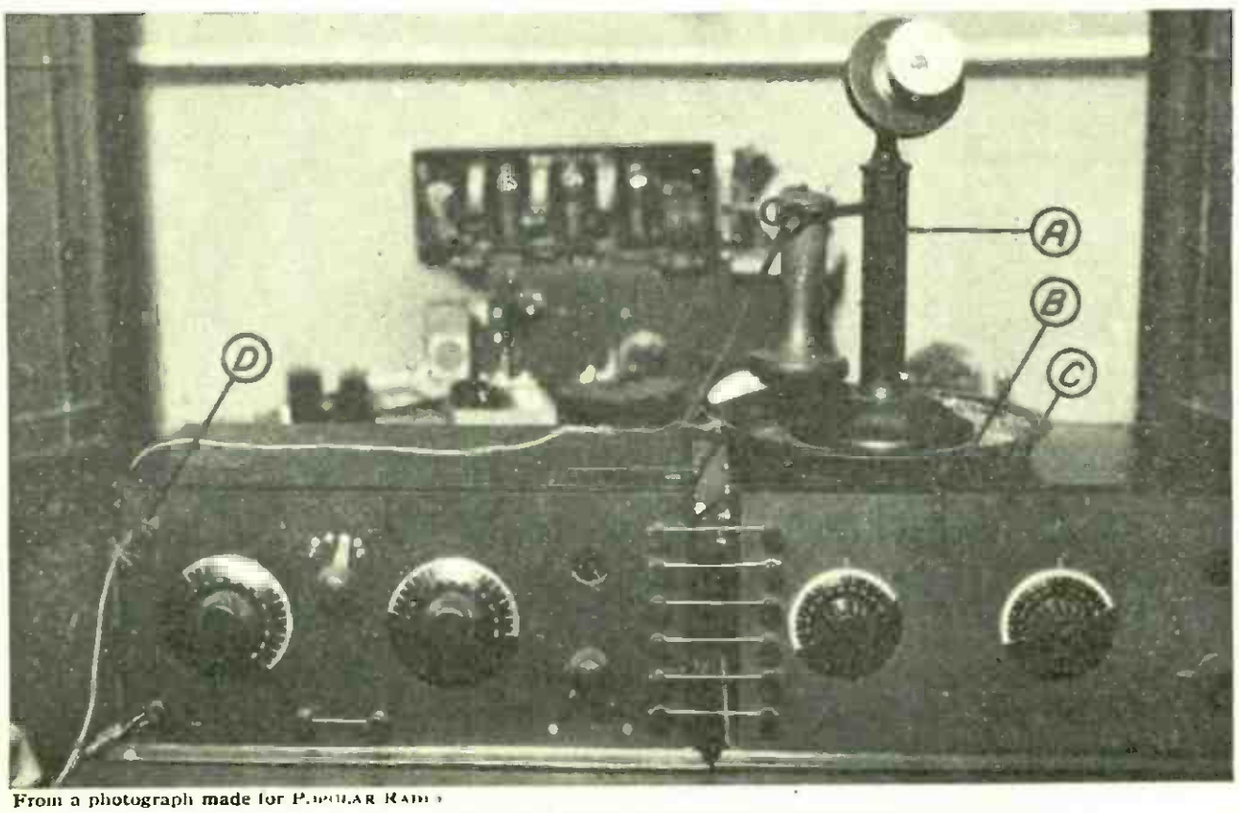
* * *

Do not use a variable condenser which has iron end-plates or an iron shaft, unless the iron is not placed near or in the magnetic field of the tuning coils. In other words keep any iron parts away from the tuning coils by a distance of at least two inches.

The iron, if it is within the magnetic field of the coils will materially reduce the strength of signals. This is the cause of relative failure in many sets where the builders have taken all the other precautions that they know about or have checked up the connections until they were sure they were right.

* * *

A RADIO set that is wired up poorly is like an apple with a worm-eaten core. It may look pretty from the outside, but it is worthless. *Moral:* do a good wiring job.



From a photograph made for POPULAR RADIO

THE PIE-PLATE-TELEPHONE ANTENNA

Take an ordinary pie-plate C, and attach a wire to it running to the antenna binding post D, of the receiving set. Then stand the telephone A, on the pie-plate as shown. The metallic parts of the telephone and pie-plate form the plates of a condenser of which the felt covering B of the telephone is the insulator or dielectric. This in no way interferes with the working of the telephone.

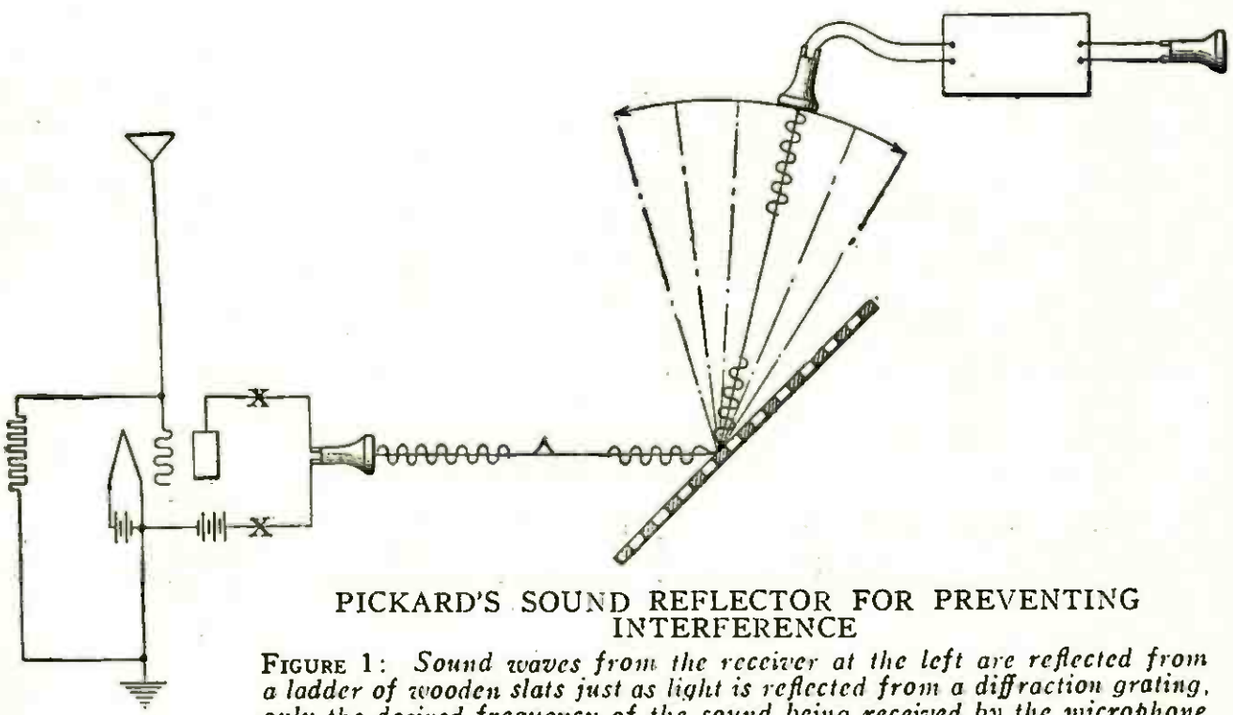
THIS *department will keep you in touch with the latest inventions of interest on which patent rights have been granted, and which are significant contributions to radio art.*

FIGURE 1: No. 1,460,439. INTERFERENCE PREVENTER. Invented by *G. W. Pickard* and assigned to the Wireless Specialty Apparatus Co. of Boston.

This device removes interference by dealing with sound waves rather than with the electric waves or impulses. The received signal (together with any interference that is present) is first converted into sound by a telephone. The sound waves thus produced are directed against a frame of wooden slats like the pickets of a fence. Sound waves of different frequency are reflected at different angles, as shown in the figure. A microphone placed at the proper point picks up the sound wave corresponding to the signal frequency. The waves of other frequencies (corresponding to the interference) fall on either side of the microphone and are not picked up. The purified wave received by the microphone may then be amplified or detected in any manner. The sound waves used for the purifying reflection may be of frequencies above the range of hearing. Students of physics will recognize in this device a principle analogous to that of the diffraction grating commonly used to separate light rays into their component wavelengths.

FIGURE 2: No. 1,460,734. WIRELESS DETECTOR. Invented by *W. H. Ruf* of Roselle Park, N. J.

This is a freak crystal detector made in the shape and size of a finger ring. By bending the finger slightly the two prongs of the mounting can be spread apart or brought together, thus moving the catwhisker over the surface



PICKARD'S SOUND REFLECTOR FOR PREVENTING INTERFERENCE

FIGURE 1: *Sound waves from the receiver at the left are reflected from a ladder of wooden slats just as light is reflected from a diffraction grating, only the desired frequency of the sound being received by the microphone above.*

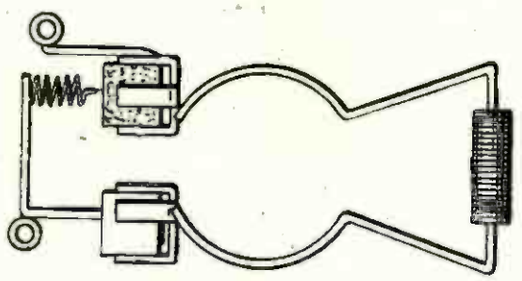
of the crystal in order to find the best point for reception. A similar device can be attached to a scarf pin.

No. 1,460,801; (no figure). DIRECTIONAL RECEIVING SYSTEM. Invented by *Robert H. Marriott* of Bremerton, Washington.

Ordinary periodic loop receivers are two-directional, that is, they will receive equally well in either of two opposite directions. This invention makes a periodic loop receiver *one-directional*. This is accomplished by a connection from the loop to ground through a vacuum-tube amplifier and an arrangement of circuits so that the signals from one direction are neutralized in the loop circuit by the loop-to-ground circuit while those in the reverse direction are not neutralized.

FIGURE 3: No. 1,462,057. SWITCH FOR VACUUM TUBES. Invented by *Peter I. Wold* and assigned to the Western Electric Company of New York.

This automatic switch for use with two vacuum tubes is devised for the purpose of instantly substituting a new tube in the circuit in case the tube originally in the circuit should fail. The cessation of current in the tube on the right of the drawing stops the pull of the solenoid on the magnet in front of it. The spring draws back the magnet and this instantly reverses the switch points and throws the left-hand tube into the circuit.



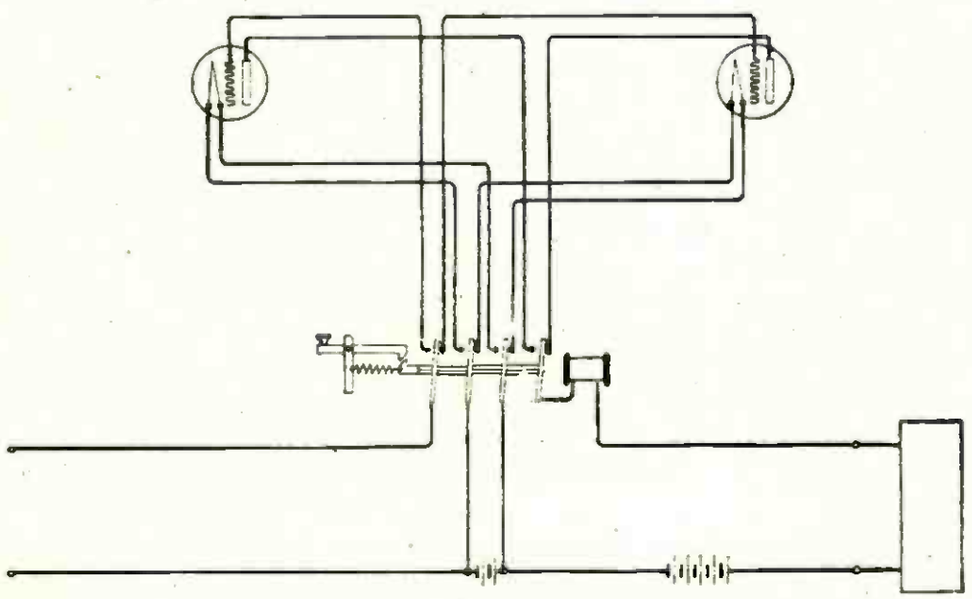
A RADIO FINGER RING

FIGURE 2: *This crystal mounting may be worn on the finger like a ring, the catwhisker being adjusted by bending the finger.*

Nos. 1,463,386 and 1,463,391; (no figure). RADIO-TELEGRAPH SYSTEM USING MAGNETIC RECORDS ON IRON WIRE. Invented by *W. L. Carlson* and *E. C. Hanson* of Washington, D. C.

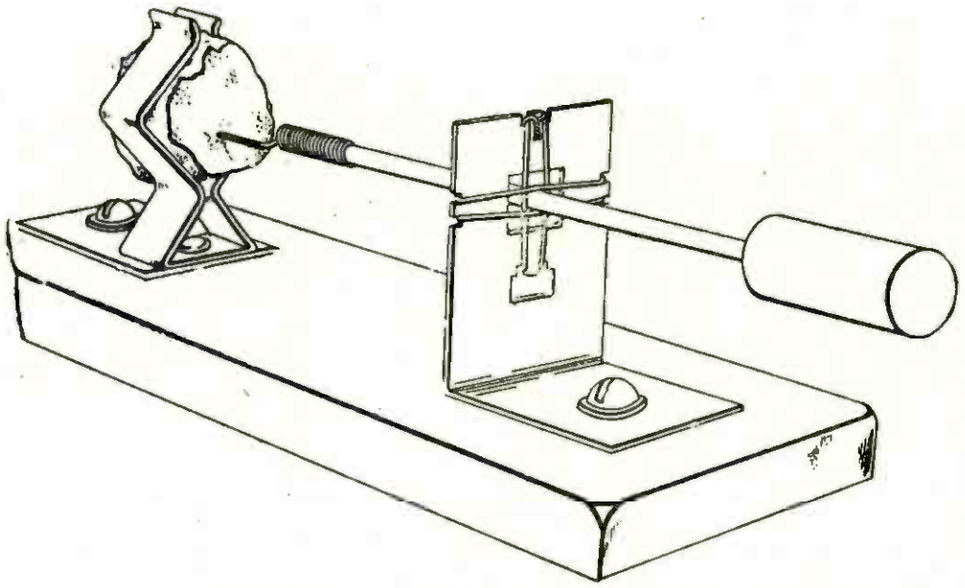
These patents describe some of the details of a new process for recording and receiving radio signals by means of the well-known iron-wire telegraphone, the basic patents on which have now expired. The telegraphone, it will be remembered, is based upon the fact that an iron wire will retain a part of any magnetism impressed on it. If a wire, running between spools, passes near the pole pieces of an electromagnet, alternately magnetized and demagnetized, as, for example, the magnet of a telephone, a record of these magnetic alternations will be left in the wire and can be read from it by appropriate apparatus. It is now proposed to use such records in radio telegraphy.

FIGURE 4: No. 1,463,554. MOUNTING FOR CRYSTAL DETECTOR. Invented



SAFETY SWITCH FOR TUBE CIRCUITS

FIGURE 3: *If one tube burns out, this automatic magnetic switch operates instantly to disconnect the tube that has failed and replace it in the circuit with the other tube, previously unused.*



A CRYSTAL MOUNTING THAT IS EASY TO MAKE

FIGURE 4: *The loops of wire hold the supporting rod of the catwhisker tightly enough so that it will remain in position and yet loosely enough to permit moving it for readjustment.*

by *A. N. Pierman* of Newark, N. J.

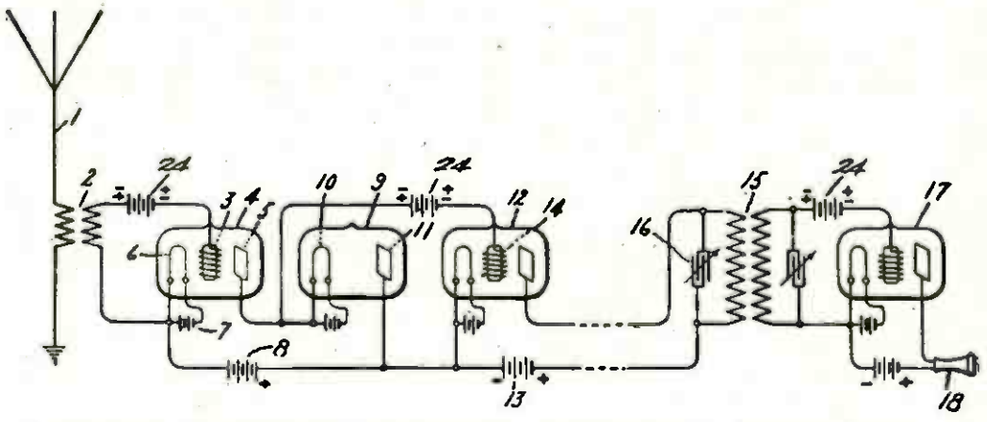
The nature of this simple mounting, easily made at home, is clear from the drawing. The rod that carries the catwhisker is held by friction between the two double loops of wire, these loops being held in place by the notches in the upright metal plate. The crystal itself is held between two simple metal clips.

No. 1,468,049; (no figure). RECEIVING SYSTEM. Invented by *A. H. Taylor* of Grand Forks, North Dakota, and assigned to the Radio Corporation of America.

This is a method of making a partial separation between signal impulses and static or other strays by using two or more antennas, one of which is more receptive to the signals while the others are more receptive to strays. The antennas are then opposed electrically so that the effect of the strays in the signal-receiving antenna is more or less neutralized. Detailed arrangements of circuits and antennas for this purpose are described and covered by the patent.

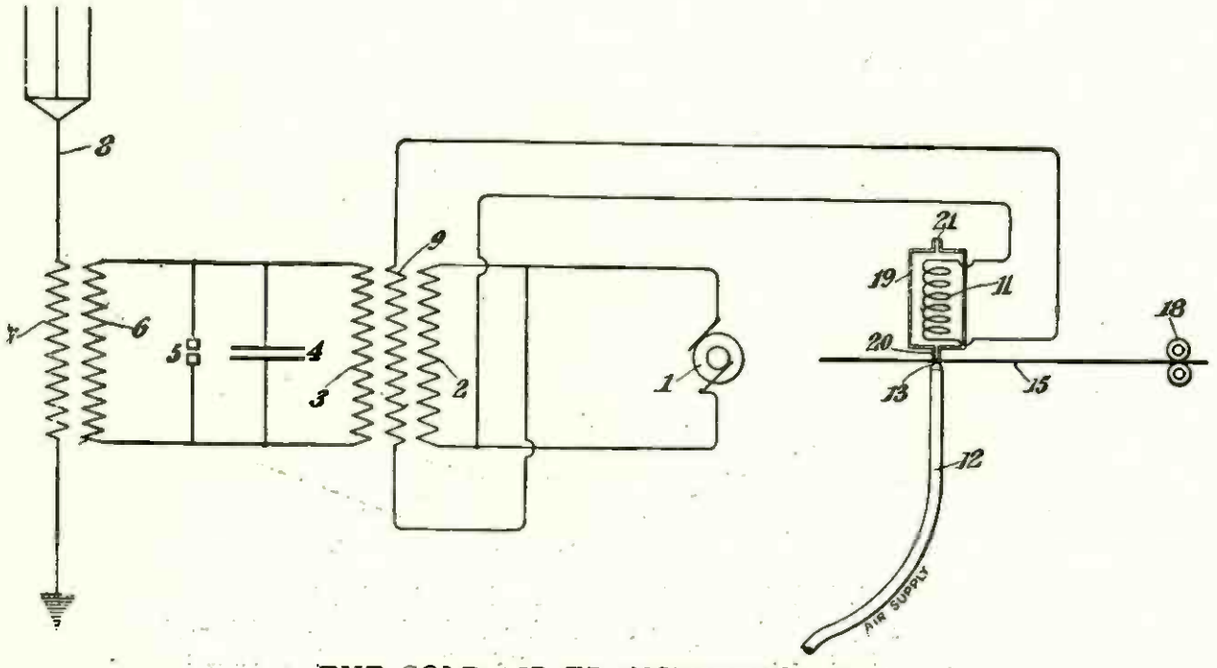
Nos. 1,468,059 and 1,468,061; (no figure). METHOD AND APPARATUS FOR RADIO SIGNALING. Invented by *R. A. Weagant* of Douglas Manor, New York, and assigned to the Radio Corporation of America.

These patents are applications of a theory



HOOK-UP FOR LANGMUIR'S POTENTIAL AMPLIFIER

FIGURE 5: *The second tube from the left is a diode and acts to limit the current possible in the first tube. This amplifies the potential variations in the first tube and these are then impressed on the grid of the third tube. The current variations in this third tube are translated into audible signals in the usual manner, through the transformer and the fourth tube.*



THE COLD-AIR TRANSMITTING KEY

FIGURE 6: *The coil inside the box at the right is of fine platinum wire. When the current flows this wire gets hot. Then when a blast of air is admitted to the box, through the flexible tube shown, the platinum coil is suddenly cooled. This lowers its electrical resistance. More current flows in the circuit and a signal is sent out through the transformer and antenna circuit at the left.*

formulated by the patentee to the effect that the impulses of static are mainly vertical while the signal impulses that one wishes to receive are mainly propagated horizontally. Circuits are arranged to receive selectively the up-and-down waves of static and to oppose these to the impulses in ordinary antennas, thus balancing out the effects of static in the latter.

FIGURE 5: No. 1,468,116. METHOD OF AMPLIFYING POTENTIAL VARIATIONS. Invented by *Irving Langmuir* of Schenectady, New York, and assigned to the General Electric Company.

This patent describes certain applications of the fact that the vacuum tube may be employed as a device to limit the amperage of an electric current. The emission of electrons from the filament forms an upper limit to the current that can pass through a tube, no matter what the potential of the grid. In the figure is shown Langmuir's application of this fact to the amplification of the *voltage* of radio signals, instead of the more usual method of amplifying their current strength. The second tube from the left (which has no grid) acts as the current-limiting device. The plate current of the first tube being thus limited, the difference of potential between the filament and the plate of this tube is variable and reflects, with considerable amplification, the potential variations on the grid of this tube. In this way the changes of voltage in the antenna circuit are greatly amplified before being impressed on the grid of the third tube. The same principles can be applied to the elimination of high antenna voltages due to static.

No. 1,469,349 (no figure). RADIO CONTROL SYSTEM. Invented by *A. L. Wilson* of Edgewood, Pennsylvania, and assigned to the Westinghouse Electric and Manufacturing Company.

A ratchet wheel at the receiving station is moved one notch by the radio signal whenever the corresponding wheel at the transmitting station moves one notch. This device is already a familiar one in many systems for distant control. The novelties of the patent lie in the means for controlling the ratchet movement by separate sets of modulated waves so that the accidental operation of the control by stray waves is unlikely. For these details the patent itself must be consulted.

FIGURE 6: No. 1,469,905. CIRCUIT-CONTROLLING DEVICE. Invented by *R. E. Hall* of Chicago, Illinois.

The patent describes a novel and interesting device which can be used either as a transmitting key or for many other purposes. It involves the idea of varying the current strength in a circuit by cooling a wire through which the current is flowing. It is well known that the electrical resistance of many kinds of wire changes with the temperature. By blowing a blast of cold air over a current-carrying coil, as shown in the drawing, the resistance of the coil can be varied and a signal thus produced.

Radio instruments deserve the best panel you can buy. The appearance of your complete set depends on the panel material—its workability and its finish.

The right front door

YOUR radio set without a good panel would be like a house with its front door hanging on one hinge. Your radio instruments need a first-class panel just as much as that house needs a good strong front door. Mounting expensive instruments on a cheap panel is as big a mistake as trying to get distance with weak batteries in your circuit.

Use a Celoron panel

Celoron Standard Radio Panels satisfy the requirements of the most exacting set-builder. Celoron, a bakelite product, is one of the best insulating materials known. The U. S. Navy and U. S. Signal Corps testify to its high dielectric strength. Leading radio manufacturers mount their parts on it. Radio fans in all parts of the country use Celoron panel front doors in their sets.

Celoron panels were the first panels to be cut in standard sizes and sold in separately wrapped packages. They come ready for working and wrapped in dust-proof glassine envelopes. Size and full instructions for working are on every envelope.

Highly polished, finished in lustrous black, mahogany, or oak, Celoron panels make a set that you will be mighty proud to show anybody. Drilling and engraving can not chip or feather the dense, hard surface.

Ask your dealer for a Celoron panel. You can identify it by the Celoron label that is on every panel.

Celoron Radio Panels come cut in the following standard sizes:

1— 6 x 7 x 1/8
2— 7 x 9 x 1/8
3— 7 x 12 x 1/8
4— 7 x 14 x 3/16
5— 7 x 18 x 3/16
6— 7 x 21 x 3/16
7— 7 x 24 x 3/16
8—12 x 18 x 3/16
9— 7 x 26 x 3/16

Special sizes can be cut to order from sheet stock. See your dealer.

Write for our free booklet, "Getting the Right Hook-Up," which contains diagrams and valuable radio information for the set-builder.

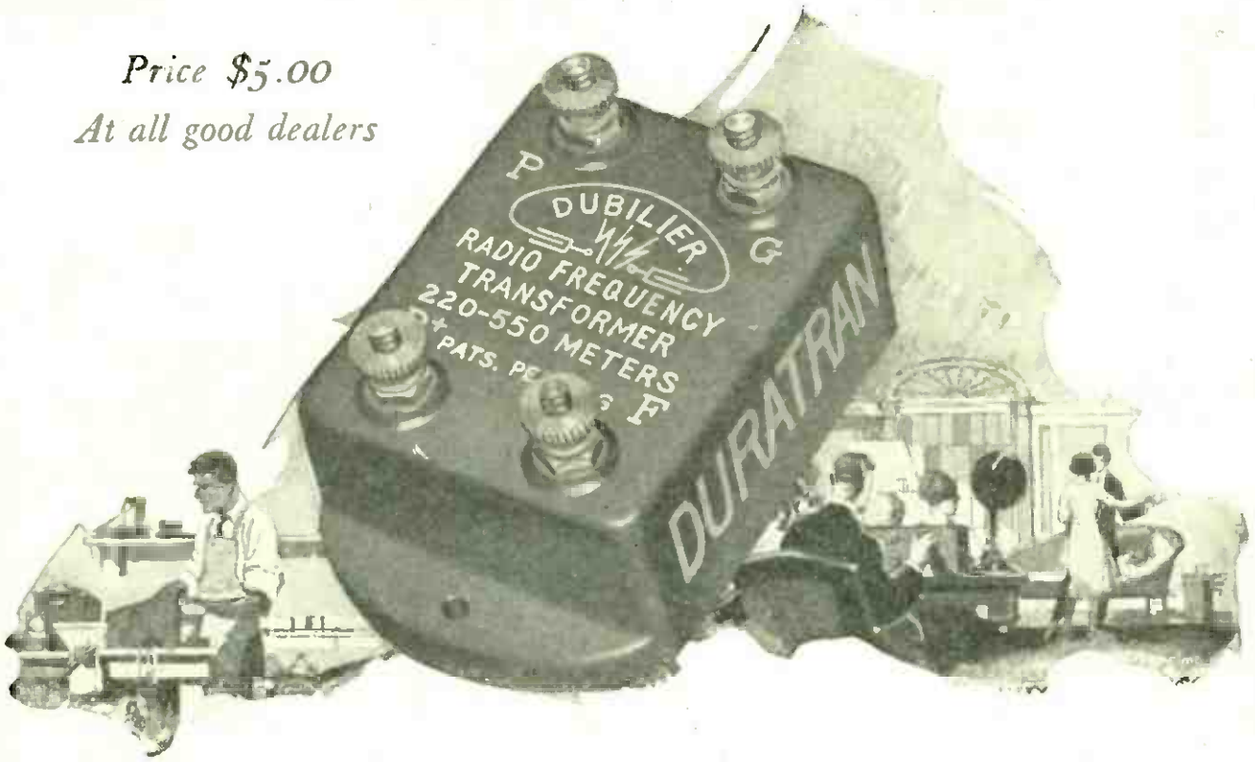
To radio dealers: Send for special dealer price list showing standard assortments.

DIAMOND STATE FIBRE COMPANY
Bridgeport, Pennsylvania
(near Philadelphia)
Branches in Principal Cities
Toronto, Canada London, England

CONDENSITE CELORON STANDARD RADIO PANEL

DUBILIER

Price $5.00
At all good dealers



The DUBILIER Duratran —
Amplification on all wavelengths

DUBILIER
DUCON
(Standard
Socket-Plug)

DUBILIER
VARIADON
(Variable Mica
Condenser)

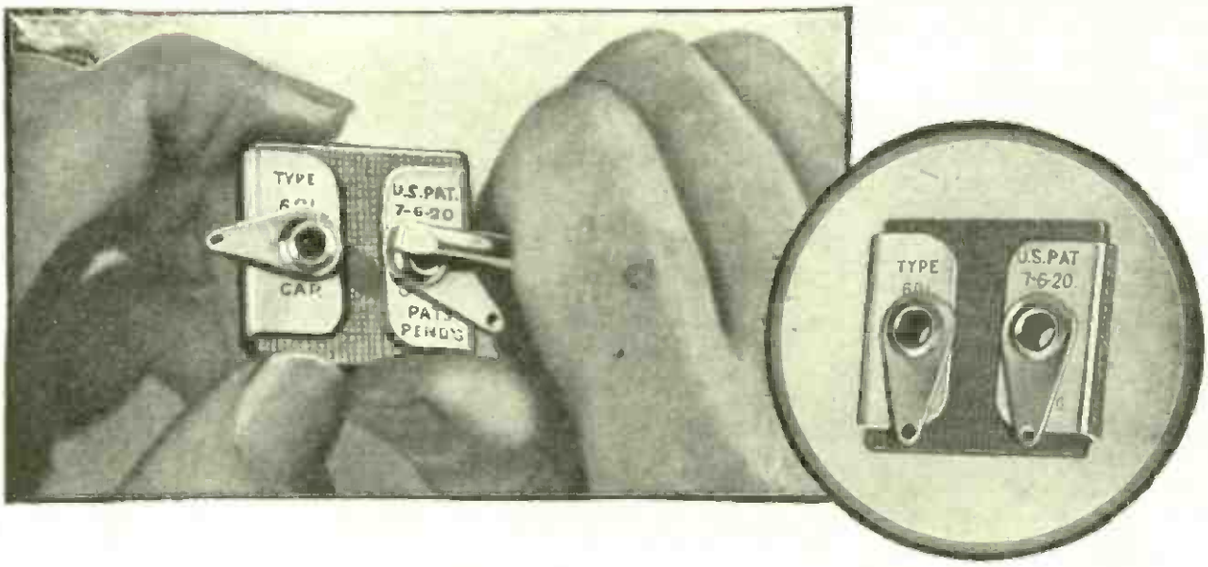
THE Dubilier Duratran is the supreme radio-frequency transformer. It amplifies powerfully and uniformly *over all the wavelengths* now used by broadcasting stations.

Write for free booklet of Duratran hook-ups.

DUBILIER CONDENSER AND RADIO CORP.

40-50 West Fourth Street, New York

DEVICES



Dubilier Micadons for Any Circuit

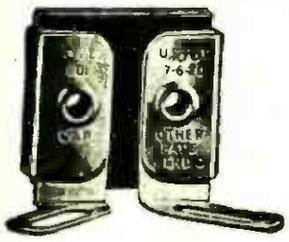
Dubilier Micadon, type 601, is now made with extension soldering tabs. These facilitate mounting. The hot soldering iron need not touch the Micadon directly. Hence the capacity cannot be affected by the heat.

If Dubilier Micadons are to be mounted with screws simply push the soldering tabs aside or clip them and use the eyelets.

Thus the Dubilier Micadon; the standard of radio because of its permanent capacity, becomes even more convenient.

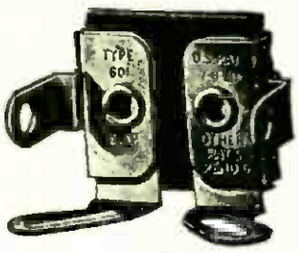
Dubilier Micadons are retailed at 35 cents up depending on style and capacity.

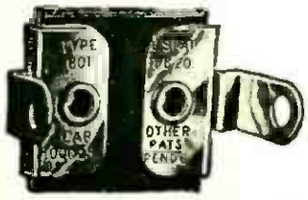
There is a Dubilier Micadon for every circuit requirement. If your dealer cannot supply Micadons, write to us.



Micadon type 601T has adjustable clips which slip over transformer and other binding posts.

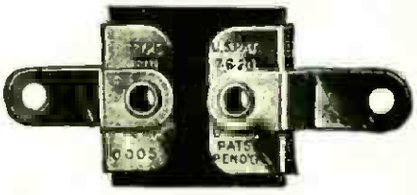
Micadon type 601G-T has clips to hold a fixed grid-leak and adjustable clips that slip over binding posts.





Micadon type 601G has clips to hold fixed grid-leaks (Grid-leaks not supplied with Micadons).

Micadon type 601L has eyeletted tabs that slip over the terminals of a variable grid-leak.



Write for free folder, showing ways of using Micadons in any circuit.

DUBILIER CONDENSER AND RADIO CORP.

40-50 West Fourth Street, New York

The AFRICAN "Drum talk" of TODAY

BOOM! BOOM! BOOM! BOOM!

Thus the drum talk of the natives of Africa broadcasts to a radius of fifty or sixty miles the departure of white men leaving one village for another. To the weird Boom! Boom! of the huge drum, the travelers with their porters commence the perilous journey, knowing that their arrival is expected at the next village.

What a far cry this crude method of sending messages is from our modern, useful, pleasure-giving radio. And how very backward it seems when we consider the rapid strides made in the radio industry in just a few years time as exemplified by the Crosley story.

Three years ago Crosley Radio Receivers were unknown. To-day, The Crosley Radio Corporation is the largest manufacturer of radio receivers in the world. In every part of the United States, happy users are enjoying the beautiful concerts, useful lectures and valuable news that Crosley instruments unfailingly bring in from the distant points desired.

Real merit at moderate prices has brought about this Crosley popularity. Crosley engineers have continually kept abreast and perhaps a little ahead of the rapid advancement that radio has made.

We firmly believe that Crosley Radio Receivers are the best that have ever been offered to the public.

Insist upon Crosley Radio Apparatus
For Sale By Good Dealers Everywhere

The Crosley Radio Corporation owns and operates Broadcasting Station WLW

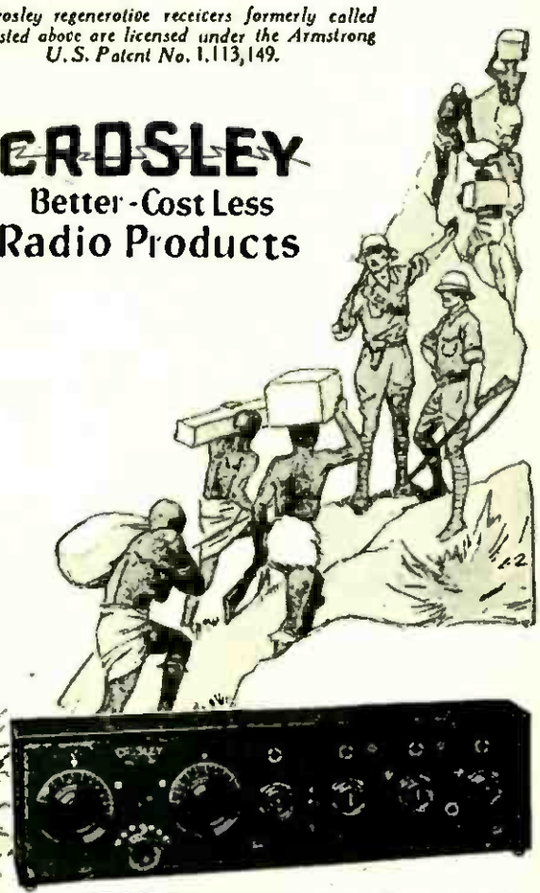
THE CROSLEY RADIO CORPORATION
POWEL CROSLEY, Jr., President
FORMERLY
The Precision Equipment Company and Crosley Manufacturing Company
316 Alfred Street Cincinnati, Ohio

Following is a List of the Most Popular Crosley Receiving Sets With Their Prices

Crosley Type V (formerly Ace) one tube regenerative	$20.00
Crosley Type 3 B (formerly Ace) three tube regenerative	50.00
Crosley Type 3 C (formerly Ace) consolette model	125.00
Crosley Model VI, two tube incorporating radio frequency	30.00
Crosley Model X-J, four tube, incorporating radio frequency	65.00
Crosley Model X-L, four tube consolette	140.00

The Crosley regenerative receivers formerly called Ace, listed above are licensed under the Armstrong U. S. Patent No. 1,113,149.

CROSLEY
Better-Cost Less
Radio Products



CROSLEY MODEL X-J—Price $65.00

A 4 tube radio frequency set combining one stage of Tuned Radio Frequency Amplification, a Detector, and two stages of Audio Frequency Amplification. A jack to plug in on three tubes for head phones, the four tubes being otherwise connected to the loud speaker, new Crosley multistat, universal rheostats for all makes of tubes for dry cells or storage batteries, new condenser with molded plates, filament switch and other refinements add to its performance and beauty.

We believe that for bringing in distant stations it cannot be equalled.

Cost of necessary accessories from $40.00 up.

MAIL THIS COUPON TODAY

The Crosley Radio Corporation,
316 Alfred Street, Cincinnati, Ohio.

Gentlemen: Please mail me free of charge your complete catalog of Crosley instruments and parts.

Name .....

Address .....

Here Is the Man—Here Is the Receiver

The amazing story of continued communication with the MacMillan Expedition, on the Steamer Bowdoin—frozen in somewhere near the North Pole—and with other distant points is here told by Mr. Len Weeks, Radio 9DKB, Minot, N. D.

December 30, 1923.

"I submit the following account of the use of the Ace Type 3B and the Ace Type V radio receivers for DX work, especially with WNP.

"Using the Ace Type 3B or Type V, I have heard the schooner Bowdoin radio WNP a total of seventeen times during November and December. On thirteen of these occasions communication was established. Thirty-four messages totaling several thousand words were received from the Bowdoin, including a 1500 word press dispatch, taken in 3 hours and 30 minutes. Twenty-two messages were sent to MacMillan and members of the crew. The greatest length of time between communications was nine days, of which four were spent away from the station. Signals were unusually readable and often uncomfortably loud on two steps.

"During the month of December Canadian 9BP, Jack Barnsley, has been on a vacation. During this time my station has been the main, but not the only, link between the North Greenland expedition and the United States. Most of the credit for this is due to the fine control of regeneration and ease of adjustment on the Ace sets. Having a wave length range that completely covers the amateur band, it was easy to quickly shift wave length in order to avoid interference.

"In addition to the above reception, 7AHB in Alaska and 6CEU in Hawaii have been copied several times. Of course stations on both the east and west coast are heard every night. It is nothing unusual to copy stations from every district in a night's work. I have discarded a higher priced three circuit set for I honestly believe that the ACE sets give greater receiving range both in miles and kilocycles."

January 5, 1924.

"Last night my second operator, Homer Stenerson, a man comparatively inexperienced in amateur work, successfully established communication with WNP, giving him a message and getting an acknowledgment. Many people seem to think that the results are due to expert manipulation. This is not the case, for on several occasions I have had other amateurs listening for WNP while I took a much needed sleep. Nearly always they were able to pick him up and hold him till I got on the job."

The above communications are merely samples of the continued proofs, voluntarily sent us, of the superiority of Crosley Instruments.

We believe that for bringing in distant stations they cannot be equaled.

And the Prices are Remarkably Low.

The ACE TYPE V—$20.00 The ACE TYPE 3B—$50.00

Write for Complete Catalog

THE CROSLEY RADIO CORPORATION

POWEL CROSLEY, Jr., President

FORMERLY

The Precision Equipment Company and Crosley Manufacturing Company

316 Alfred Street **Cincinnati, Ohio**

The Ace Receivers mentioned above are now known as Crosley Receivers

"My Manhattan Loud Speaker reproduces musical programs with a rich tone and magnificent feeling that is truly remarkable"

Vincent Lopez

A twist of the Concert Modulator and the room was flooded with beautiful music.

Of course you know Vincent Lopez. He clicks his baton—his famous Hotel Pennsylvania Orchestra starts—and the whole world dances. Or at least, that part of the world that live near enough to New York to tune-in on his wonderful programs.

No wonder Vincent Lopez is one of the most popular radio artists today. For he is a radio fan himself.

"I must confess" he writes, "that I was never entirely satisfied with musical reception until I heard the Manhattan Loud Speaker. Its rich tone and magnificent feeling are truly remarkable. It reproduces musical programs with a quality and feeling that is not only rare but extraordinary. Moreover, I consider the Manhattan Concert Modulator an important step forward. A slight turn of this Modulator floods the room with beautiful music that is entirely free from distortion or chattering. This really is an achievement that every Radio Fan will appreciate."

Surely you will want the Loud Speaker that Vincent Lopez selected above all others for his own Radio set. Go to your nearest dealer and insist upon a Manhattan, "the Loud Speaker with the Concert Modulator."

Manhattan Electrical Supply Co., Inc.
17 Park Place, New York
Makers of the famous Red Seal Dry Battery
New York Chicago St. Louis San Francisco

MANHATTAN
"The Loud Speaker with the Concert Modulator"

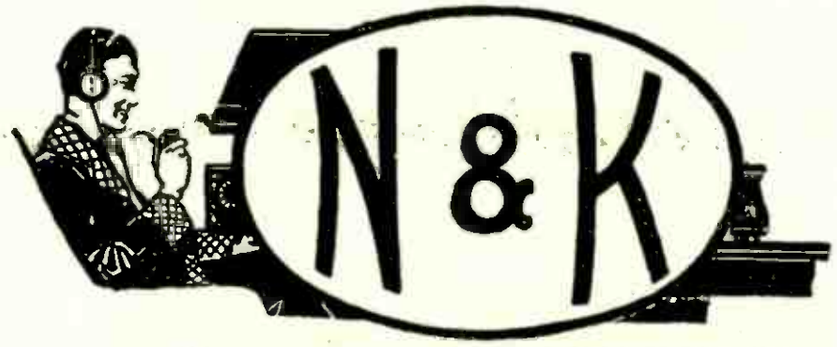
The CLEAR Loud Speaker!

HOW near the music sounds when it comes through the clear Herald! Just as if you were dining in a famous restaurant, and its orchestra were playing beside you.

That's the effect the Herald always gives. *Absolute clearness.* Because it is free from all blast and blurr. Whether the number be music, lecture or news, the clear Herald is faithful to the performer.

THE Herald, like other good musical instruments, improves with age because of its laminated core, mica diaphragm and permanent magnet. It stands up under power without rattling. The adjustable diaphragm makes it possible to get the most out of a weak set. Height 30 inches. 6-foot cord. Price $30. Slightly more on Pacific Coast and in Canada. Write for folder and enclose your dealer's name.

Herald Electric Co., Inc., 113 Fourth Avenue, New York



Imported PHONES

give you a *new* radio set!

A PAIR of N & K Phones on your old radio set work a complete transformation. They make it sound new and different. Never before have high or low tones, loud or soft tones, come in so *clear*, so mellow, so natural, so free from distortion.

Get The World With N&K

N & K was designed by one of the world's foremost makers of telephone and other scientific apparatus. It was designed especially for *telephone* reception, whereas most radio phones in use today were originally designed to receive *telegraphic spark signals*. The diaphragm is larger and more sensitive, and is placed at a carefully measured distance from the poles. Even the sound chamber is different.

Last year this head set was submitted to hundreds of American amateur radio stations. 90% of these declared it the best head set they ever used.

Famous for comfort

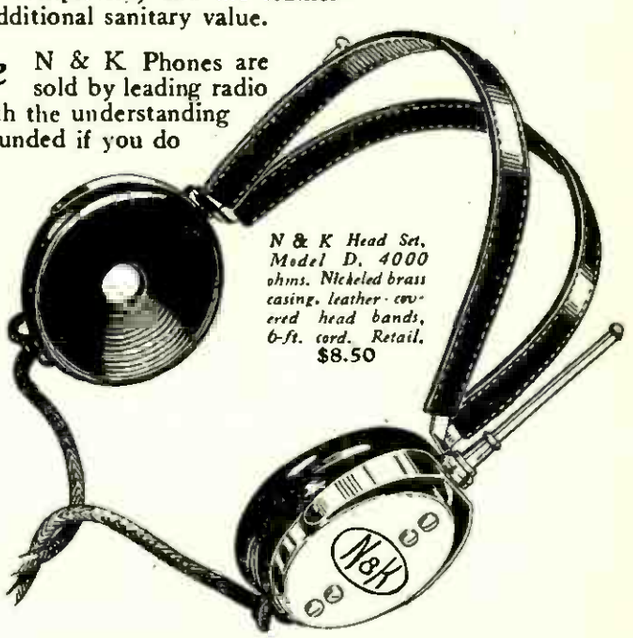
Every user of N & K Phones comments immediately on their comfort and the way they exclude outside sounds. This is due to two things—the extra size of the phones, covering the ear completely, and the leather-covered head bands—which have an additional sanitary value.

You shall be the sole judge

N & K Phones are sold by leading radio dealers everywhere. They are sold with the understanding that your money will be cheerfully refunded if you do not find that N & K Phones reproduce more naturally, give clearer, mellower tone, and fit more comfortably than any other head set.

Dealers, read this!

We authorize you to refund the money on any N & K Phones returned after the above test. We will exchange or replace any that come back to you. Pending the announcement of jobber distributors, we will fill orders direct so that dealers may be prepared for the increasing demand for N & K Phones. N & K comes packed ten to the carton, each carton containing a supply of display matter and literature. Wire or write your order today to department P3.



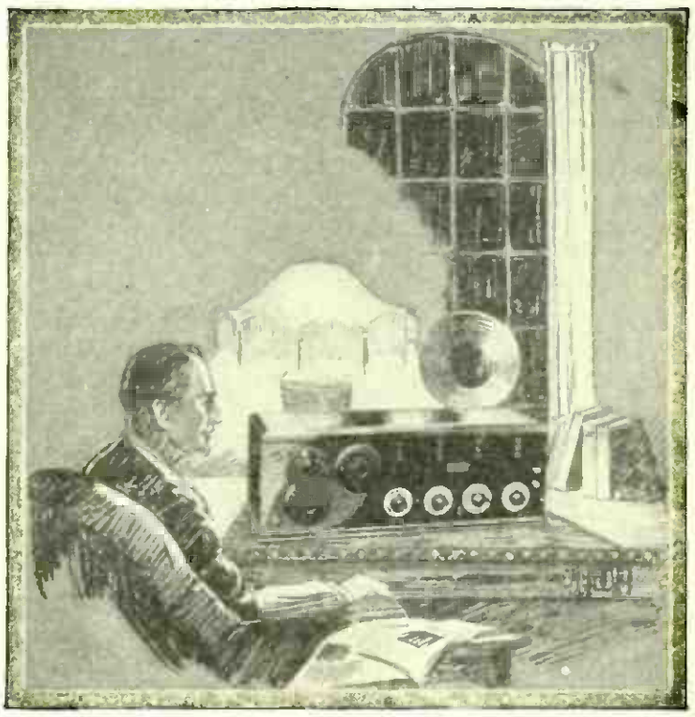
N & K Head Set, Model D, 4000 ohms. Nickeled brass casing, leather-covered head bands, 6-ft. cord. Retail, $8.50

TH. GOLDSCHMIDT CORPORATION, Distributors, 15 WILLIAM STREET, NEW YORK CITY

E·D·Elliott of Milford, N.Y. establishes a record

Think of getting London, England, Fairbanks, Alaska, and La Palma, Panama, when you live in New York! Yet this is the experience of Mr. Elliott, one of the hundreds of enthusiastic users of MIRACO sets. With the inexpensive outfit shown here, priced at **only $29.50**, he received the following list of stations—*results that would do credit to a set costing three or four times as much.*

	London, England
WLAY	Fairbanks, Alaska
NNW	La Palma, Panama
PWY	Havana, Cuba
CFAC	Calgary, Can.
CJCY	Calgary, Can.
KFBC	San Diego, Cal.
KSL	San Francisco, Cal.
KHQ	Seattle, Wash.
WJAR	Providence, R. I.
KFBU	Lorine, Wyo.
WEV	Houston, Tex.
WMAT	Duluth, Minn.
WPM	Washington
WRAA	Houston, Tex.
WHB	Kansas, Neb.
KFHB	Hood River, Ore.
CFCA	Toronto, Can.
CKCE	Toronto, Can.
CJCI	St. John, Can.
WRP	Dallas, Tex.
NGE	Miami, Fla.
KGA	Oakland, Cal.
KFEL	Denver, Colo.
WIAZ	Miami, Fla.
WKY	Oklahoma City
WDAE	Tampa, Fla.
WEB	St. Louis
WRK	Hamilton
WHAB	Galveston, Tex.
6ZV	Salt Lake City
NAA	Arlington Va.
WJAX	Cleveland, O.
WBZ	Springfield
WOO	Philadelphia, Pa.
WOS	Jefferson City, Mo.
WOK	Pine Bluff, Ark.
WLAG	Minneapolis
WFAZ	Charleston
WJAB	Lincoln, Neb.
WCT	Chicago
WMC	Memphis
WBAK	Harrisburg
WLAK	Bellow Falls, Vt.
WBAN	Paterson, N. J.
WOC	Davenport
WPAP	Winchester, Ky.
WMAM	Beaumont, Tex.
WWZ	New York
WHAY	New York
WGL	Philadelphia, Pa.
WMAF	Dartmouth, Mass.
WBAG	Bridgeport
WCAP	Decatur
WHN	Ridgewood
WIAR	Paducah
WRP	Camden, N. Y.
WGAR	Fort Smith, Ark.
WDAK	Hartford, Mass.
WCAG	New Orleans
WWAJ	Columbus, O.
WHAY	Wilmington
WRAY	Scranton, Pa.
WQAY	Birmingham
WSB	Atlanta, Ga.
WMU	Washington
WCAT	Rapid City
WRC	Washington
KYW	Chicago
KFCB	Phoenix
WWT	Buffalo, N. Y.
WHAS	Louisville, Ky.
WCAY	Milwaukee, Wis.
WLW	Cincinnati, O.
WDAW	Omaha, Neb.
WOQ	Kansas City
WPAW	Wilmington
WCE	Minneapolis
WCX	Detroit, Mich.
WLAZ	Warren, O.
WAAS	Decatur, Ga.
WTAM	Cleveland, O.
WWJ	Detroit, Mich.
WJAZ	Chicago, Ill.
WDAP	Chicago, Ill.
WGY	Schenectady, N. Y.
WJZ	New York City
WEAF	New York City
WOR	Newark, N. J.
WHAS	Louisville, Ky.
WEAB	Dodge, La.
WKD	Gainville, Ga.
WUQ	Washington, D. C.
KMO	Tacoma, Wash.
KOB	New Mexico
WDAR	Philadelphia, Pa.
WFI	Philadelphia, Pa.
WIP	Philadelphia, Pa.
KDKA	Pittsburg, Pa.
WCAE	Pittsburg, Pa.
KMN	Butte, Mont.
KQP	Hood River, Ore.
WHAZ	Troy, N. Y.
WGR	Buffalo, N. Y.
WMAV	Auburn, Ala.
KFDD	Boise, Ida.
WNAL	Omaha, Neb.
WCAP	Washington, D. C.
WQAB	Springfield, Mo.
WFB	St. Louis, Mo.
WDR	Detroit, Mich.
WNAC	Boston, Mass.
WBAZ	Columbus, O.
CFZC	Montreal, Que.
WMAK	Lockport, N. Y.
WGF	Des Moines, Ia.
WHAM	Rochester, N. Y.
WCAM	Villa Nova, Pa.
WGAY	Madison, Wis.
WWI	Dearborn, Mich
WGAM	Orangeburg, S. C.



Radio's finest low-priced receivers

Here, in the improved MIRACOS, you'll find the same thrill of getting long distances, generally obtainable with only the most expensive and elaborate sets. To the whole family it will furnish entertainment, **unfailingly**, the whole year round—and at an initial price most every family can afford.

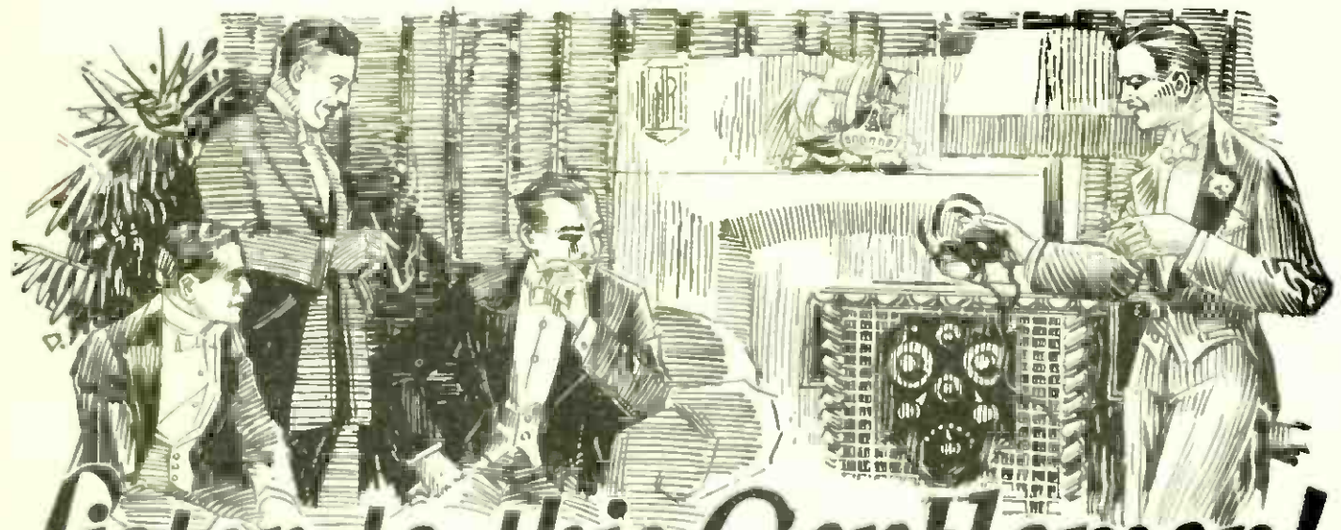
It isn't necessary, either, to be an expert at tuning in with the MIRACO. The operation is extremely simple. Scores of users everywhere tell us of the long-distance records they're making—Cincinnati hears 'Frisco, Denver hears Schenectady, New York hears Havana!

Such range as this is made possible through MIRACO'S many new refinements. Improved rheostats with multiple resistance windings enable you to use any type of tube, and a new aluminum shield prevents annoying body capacity effects. Shock absorbing pads prevent tube noises. Fully GUARANTEED against defects in material or workmanship. Price for 4-tube outfit shown above only **$54.50.**

Other details of MIRACO receivers are explained more fully in our new bulletin. Write today for a copy.

THE MIDWEST RADIO COMPANY
812 Main Street, Cincinnati, Ohio

The Improved MIRACO



Listen to this, Gentlemen!

You wouldn't think it was the same set since I've added "All American" Power Amplification

For an astounding roundness, richness, depth and clarity of tone —*plus maximum* volume wholly without distortion!—just hook up a pair of All-American Power Amplifying Transformers in a "push pull" circuit and add it to your present audio frequency amplifiers.

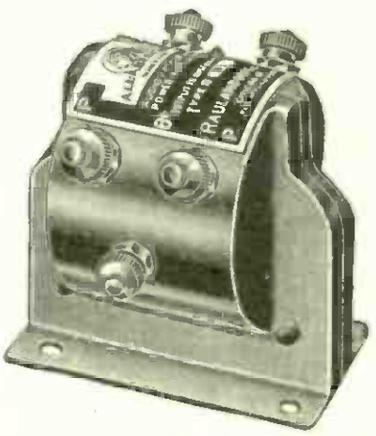
Use any good loud speaker—you'll be delighted beyond words.

"Absolutely the most efficient, most satisfactory 'push-pull' transformers ever put on the market"—this is the verdict of radio enthusiasts everywhere.

All-American Power Amplifiers are as popular as All-American Audio and Radio Frequency Transformers—which is the highest compliment that could be paid them because the latter are the best-liked, most widely used transformers in the world.

SPECIAL OFFER

Send for the new "All-American" diagram and circular describing Power Amplification; also Book of 22 Tested Hook-ups for getting new thrills out of your radio equipment. Send 4c in stamps.



For "Push-Pull" Circuits: The All-American Power Amplifying Transformers Input and Output types $6.00 each.

Rauland Mfg. Co., 200 N. Jefferson St., Chicago

(Pioneers in the Industry)

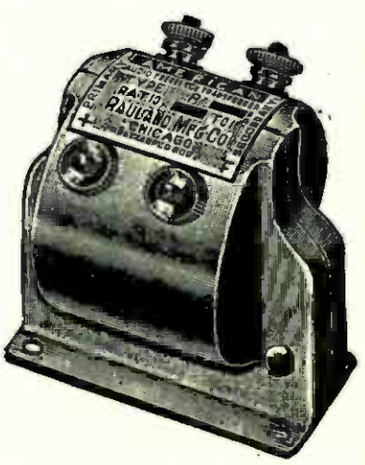
Audio and Radio Frequency; Power Amplifying (input and output)

ALL-AMERICAN

AMPLIFYING TRANSFORMERS

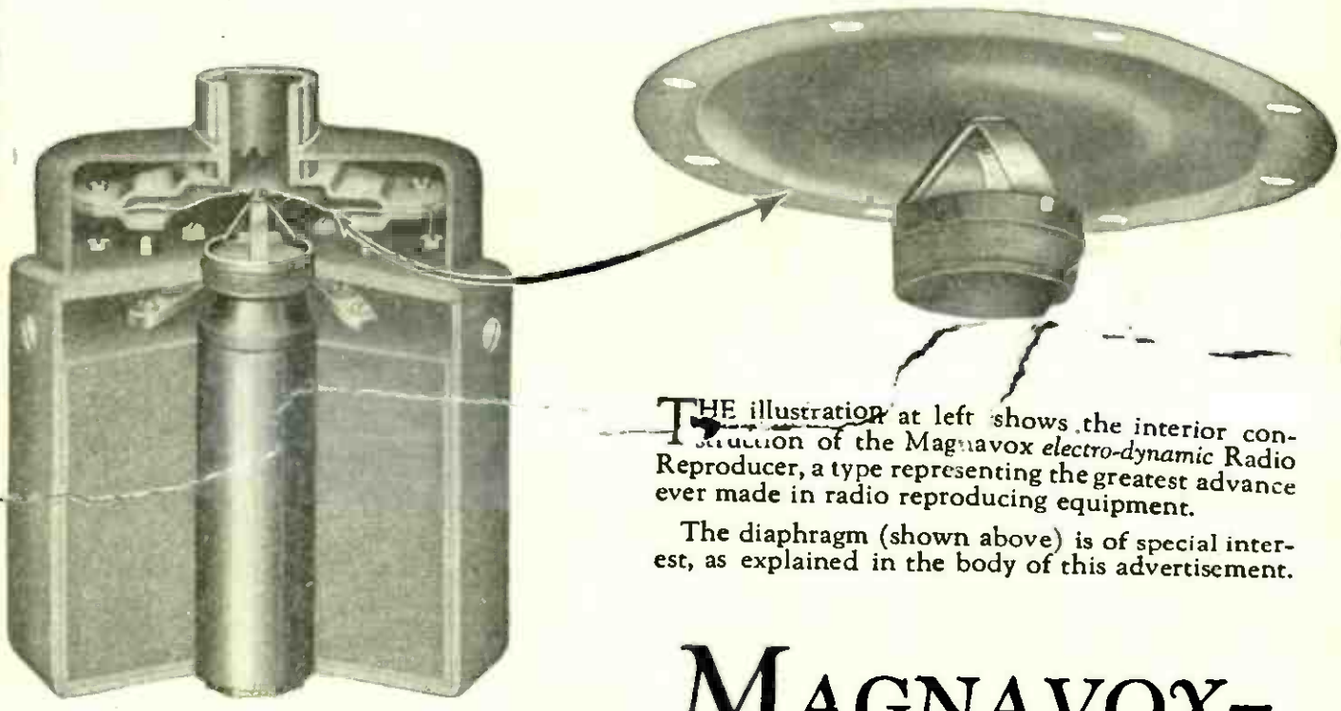
Largest Selling Transformers in the World

OVER 500,000 IN USE! ALL THE BETTER DEALERS SELL ALL-AMERICAN



All-American Audio Frequency Transformers lead in sales: 3:1, 5:1, 10:1, $4.50 to $4.75. The best—no need to pay more.

Watch for the new All-American Long Wave Radio Frequency Transformer suitable for Super-Heterodyne Circuits.



THE illustration at left shows the interior construction of the Magnavox *electro-dynamic* Radio Reproducer, a type representing the greatest advance ever made in radio reproducing equipment.

The diaphragm (shown above) is of special interest, as explained in the body of this advertisement.

MAGNAVOX-

The true Radio Reproducer

THE basis of the operation of a Magnavox Reproducer is its diaphragm, the importance of which can be seen from the fact that it is required to render an almost human service in recreating every tone and quality of instrumental music as well as speech.

This diaphragm (as illustrated above) has been designed and constructed in accordance with entirely new principles. Its shape, size and special character make it capable of responding to the widest range of tones.

But even this highly efficient diaphragm might be handicapped by operating restrictions—every diaphragm must have a vibrating force applied to it, and the inherent ability of any diaphragm will be injured if it is affected by mechanical operation or other foreign influences.

The use of the electro-dynamic principle of operation (found only in Magnavox Reproducers) removes all objectionable influences. This principle, utilizing the famous "movable coil" permits the Magnavox diaphragm to respond in perfect unison to the original tone.

There is a Magnavox for every receiving set: Type R for storage battery sets, and M1 for dry battery sets.

A1-R—$59.00

This instrument (Magnavox Combination Set) consists of Magnavox electro-dynamic Reproducer combined with a Magnavox Power Amplifier in one unit.

THE MAGNAVOX COMPANY

Oakland, California

***New York Office:* 370 SEVENTH AVENUE**

PERKINS ELECTRIC LIMITED, Canadian Distributors
Toronto, Montreal, Winnipeg

GR

Eagle Neutrodyne

Balanced!

RADIO RECEIVER

Limitations removed—new possibilities, new pleasures made available for a larger circle of radio enthusiasts—by this marvelous radio receiver.

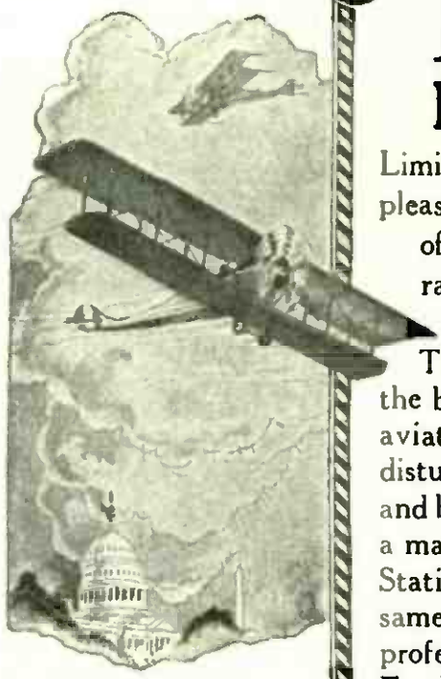
***

Tube capacities, in balance as perfect as the balance of the gyroscope upon which the aviators' life depends. Clears reception of disturbances from regeneration, reradiation and body capacity effects. Tuning, no longer a matter of guessing, but positively precise. Stations once located, always found at the same point on the dial. Operation of this professional's circuit made as simple in the **Eagle Neutrodyne Receiver** as the use of a phonograph. Each **Eagle receiver** balanced—(tube capacities neutralized) **individually,** by foremost radio experts. Sponsored by a well reputed manufacturer. Guaranteed without reservations.

***

Licensed by Independent Radio Manufacturers, Inc., under Hazeltine Patent No. 1,450,080. Dated March 27th, 1923, and other patents pending.

Write for Illustrated Leaflet



BALANCED AS PERFECTLY AS THE GYROSCOPE BALANCES THE AEROPLANE

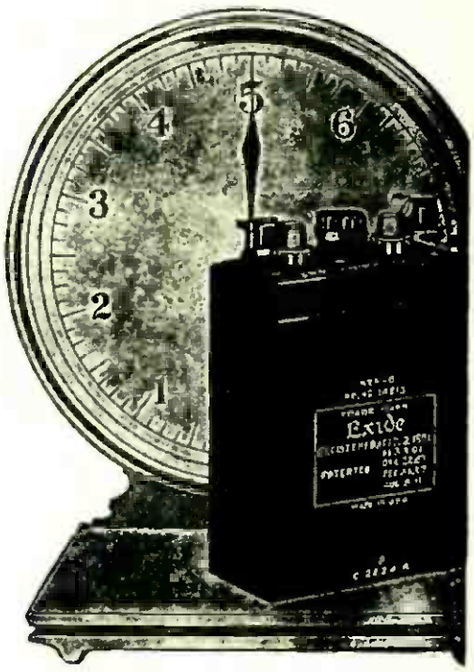
WE SOAR ABOVE

EAGLE RADIO COMPANY

NEWARK NEW JERSEY

18 Boyden Place

To get best results with low-voltage tubes



This 2-volt A Exide Storage Battery weighs only five pounds

FOR perfect clearness you must use a storage battery with uniform current. This is particularly true if you are a fan for long distance. When signals are weak the steadiness of a dependable A storage battery is indispensable to good receiving.

There are two tiny but sturdy Exide A Batteries designed specially for WD-11 and UV-199 vacuum tubes, and they give fine service with any low-voltage tubes.

You can carry one of these little batteries in the palm of your hand, yet they are powerful enough for long-distance receiving and have the true Exide ruggedness built into them.

A battery for 6-volt tubes

Three sizes of A batteries

The 2-volt battery has a single cell and weighs five pounds. It will heat the filament of a WD11 or other quarter-ampere tube for approximately 96 hours. The 4-volt battery has two cells, weighs six pounds and will light the filament of a UV-199 tube for 200 hours.

A battery with a pedigree

The Exide A Battery for 6-volt tubes is made in four sizes, of 25, 50, 100 and 150 ampere-hour capacities. These batteries have extra-heavy plates, assuring constant voltage and uniform current over a long period of discharge.

A good storage battery does not just happen. It is the result of long experience. The skill acquired and the resources developed in making batteries for every purpose since the beginning of the storage battery industry thirty-five years ago are built into the Exide Batteries made specially for your radio.

Wherever batteries *must* be reliable—such as on submarines, in the telephone system, in firing the guns of our battleships, in the central power stations of our great cities—there you will find Exides doing their unfailing duty. A majority of all government and commercial radio plants are equipped with Exide Batteries.

Exide Radio Batteries are sold by radio dealers and Exide Service Stations everywhere. Ask the dealer, or write direct to us, for booklets describing the complete line of Exide Radio Batteries.

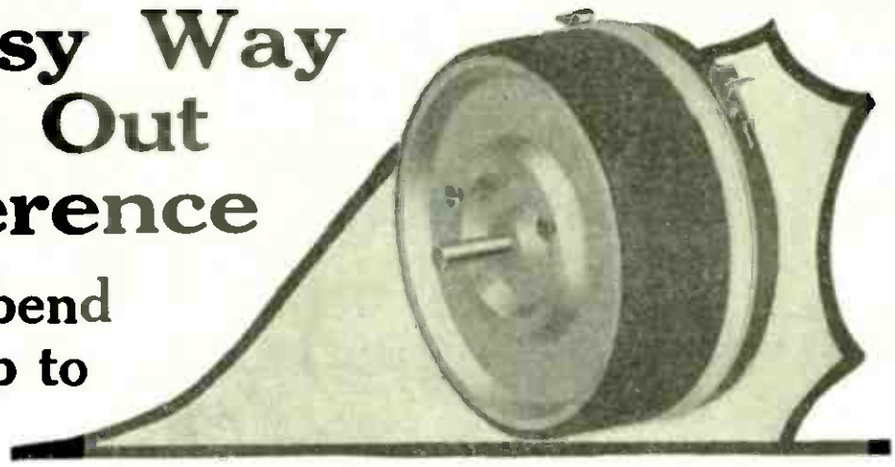
Exide
RADIO BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA

Manufactured in Canada by Exide Batteries of Canada, Limited, 133-157 Dufferin Street, Toronto

An Easy Way to Cut Out Interference

Add a Ferbend Wave Trap to Your Set



Enjoy your radio set. Get the station you want, *quickly*. Listen in on one thing at a time without annoying squawk-k-k-s or irritating whistles.

The Ferbend Wave Trap Makes Every Night Silent Night

New radio broadcasting stations are making receiving constantly more difficult. Many owners of long-distance sets are discovering powerful amplification is of little value so long as local stations are "all over the dial." Hundreds of users have solved the difficulty with the Ferbend Wave Trap—the missing link in Radio. A St. Louis user reports: "Heard Havana clearly with three St. Louis stations broadcasting. My receiver works like a new set. The 'Ferbend' is certainly a wonder!"

YOU Can Obtain These Remarkable Results

You can obtain results as satisfactory as this St. Louis user. If you don't, it doesn't cost you a penny for the "Wave Trap" is sold with a positive guarantee that it will tune out your powerful local stations. Don't wait. Order now at our risk.

SEND NO MONEY

You need not send a penny. Pay Postman $6.00 (plus postage). If you prefer, send $6.00 with order and Wave Trap is mailed *postpaid* ready for panel mounting. Money back guarantee either way. You see you take no risk, so order TODAY.

FERBEND ELECTRIC CO.
21 E. South Water St. Chicago

Ferbend Electric Co.
21 E. South Water St., Chicago

Send me a Ferbend Wave Trap. I will pay Postman Special low price plus postage. I understand you guarantee Wave Trap to tune out interfering stations or refund money.

☐ Check here for Ferbend Wave Trap unmounted at $6.00. ☐ Check here for Ferbend Wave Trap mounted at $8.50

Either way, the Ferbend comes to you completely guaranteed.

Name .....

Address .....

City ..... State .....

FERBEND
TRADE MARK
Wave Trap
PATENT APPLIED FOR

The Original Wave Filter

The Ferbend Wave Trap can also be supplied completely mounted ready for instant use on formica panel in mahogany finished cabinet. 6 x 5 x 6, $8.50. Get full benefit of all the distance your set will give you. Order your Ferbend **TODAY.**

The Whole Family "Listens In"

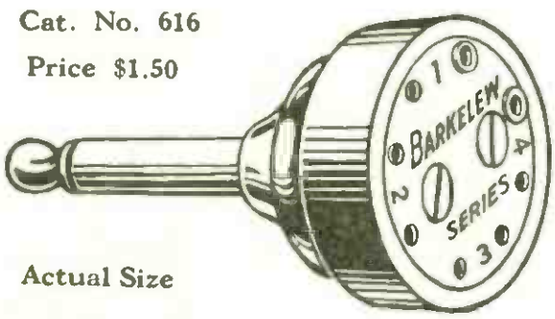
It makes a happy family group, when Dad, Mother and the children can "listen in."

The Barkelew Four Phone Plug makes this possible.

With this plug, 4 persons can enjoy the Radio Program from your set, as clearly and distinctly as one. There is ample room for all the phone tips, and they can be adjusted without removing the plug.

Barkelew Four Phone Plug

Cat. No. 616
Price $1.50



Actual Size

Connects one to four head sets all *in series* to any radio set employing standard telephone jacks. Improvements in the 1924 model make it the most reliable buy on the radio market.

CHICAGO, ILL.
15 S. CLINTON ST.

NEW YORK
50 CHURCH ST.

BARKELEW
ELECTRIC MANUFACTURING CO.
MIDDLETOWN, —— OHIO.

SAN FRANCISCO.
75 FREMONT ST.

LOS ANGELES
411 S. MAIN ST.

THE SIEGE OF TROY

AT the dawn of civilization the signal fire was the principal means of conveying information over distances.

During the ten-year siege of ancient Troy, the Greeks under Agamemnon by this means maintained constant communication throughout their encircling camps.

Today there has been developed a series of instruments that enable us to communicate and even protect our actual personalities over vast distances.

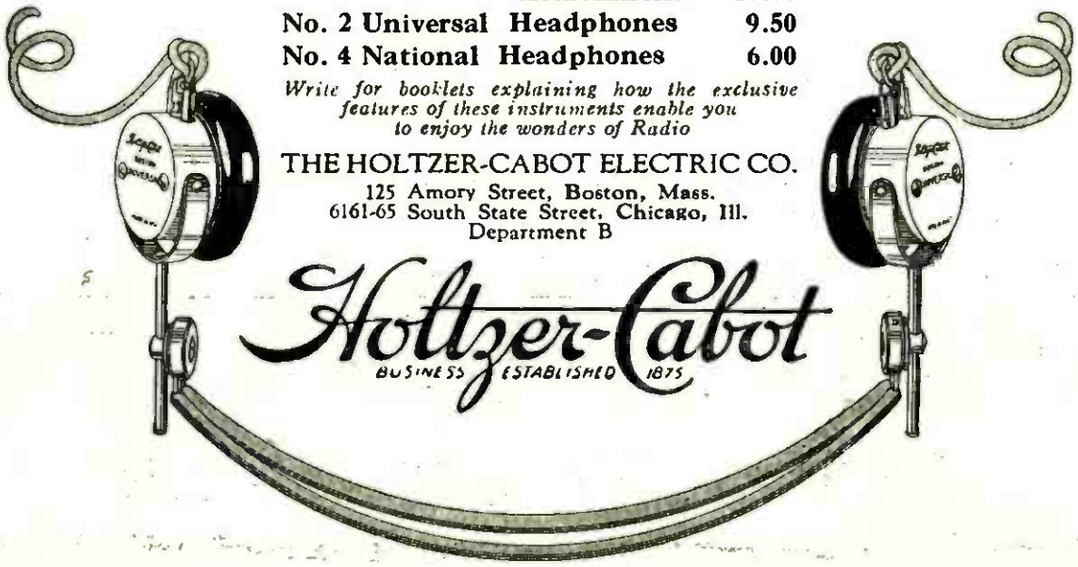
Of all the instruments that make Radio possible none is more important than the Headphones or Loud Speakers. These transform into sound the delicate electric currents produced in your receiving set. If they are imperfect the results are unsatisfactory.

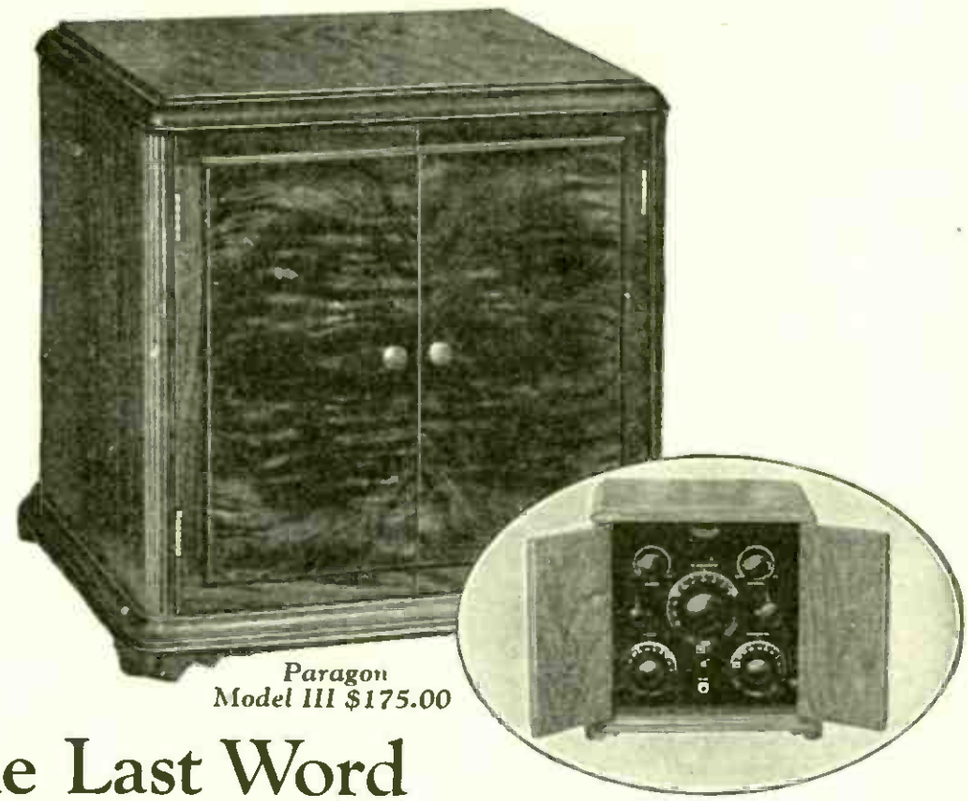
HOLTZER-CABOT Headphones and Loud Speakers embody the latest developments in the art and will greatly increase your enjoyment of Radio.

Holtzer-Cabot Loud Speaker	**$25.00**
Loud Speaker Phonograph Attachment	**10.00**
No. 2 Universal Headphones	**9.50**
No. 4 National Headphones	**6.00**

Write for booklets explaining how the exclusive features of these instruments enable you to enjoy the wonders of Radio

THE HOLTZER-CABOT ELECTRIC CO.
125 Amory Street, Boston, Mass.
6161-65 South State Street, Chicago, Ill.
Department B





Paragon
Model III $175.00

The Last Word In a Paragon Receiver for the Home

At last—a radio set that not only harmonizes with your furniture but adds to the attractiveness of any room in which it is placed. And not an ordinary radio set but a PARAGON.

Paragon Receivers are famous for the long distance records they hold which include the reception of the first trans-continental amateur message and the first trans-Atlantic message. It is a Paragon that keeps the world in touch with the MacMillan Expedition, frozen in north of Greenland.

Paragon Receivers, because of their superior selectivity and sensitivity, are equally famous for the ease with which they can be operated and the clear results obtainable.

The Model III, pictured above, has all the advantages of the other models but is housed in a mahogany or burled walnut cabinet which is a work of art.

In appearance, the Paragon Model III Receiver now matches up in every way to the perfection of the instrument itself.

Write for illustrated catalog of Paragon Radio Parts

Dealers: We believe in the proper distribution of Paragon Radio Products. Our Exclusive Distributors are particularly interested in territorially protected dealers, who will concentrate, solicit and serve the consumer in the sale of Paragon Radio Receivers. If interested, write us for details.

ADAMS-MORGAN CO., 20 Alvin Avenue, Upper Montclair, N. J.

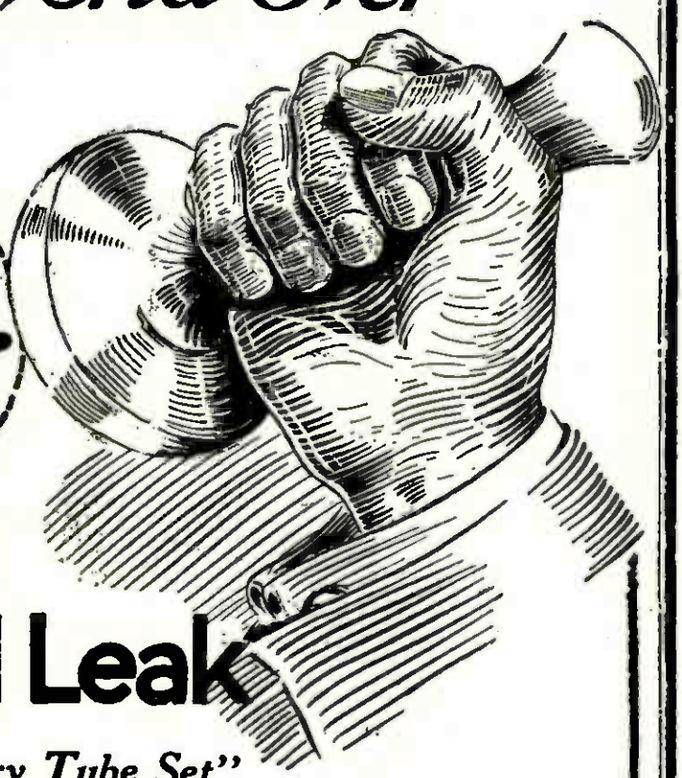
PARAGON

Reg. U. S. Pat. Off.

3-CIRCUIT RECEIVER

The Stamp of Approval the World Over

VARIABLE *Standard* GRID LEAK



FRESHMAN Variable Grid Leak

"The Standard Unit for Every Tube Set"

EVERY tube and every circuit require a different grid leak resistance. The method employed in the Freshman Variable Grid Leak permits you to adjust your circuit to any resistance you wish, from 0 to 10 megohms in an unbroken range of 180 degrees.

The Freshman Variable Grid Leak and Condenser combined, takes the place of a grid condenser, leak mounting and grid leak—and, in addition, permits an adjustment to the correct amount of resistance.

The Freshman Variable Grid Leak is the most compact, the most perfect, the most efficient, the most readily adapted to all grid circuits,—and the only one which is entirely sealed and always remains unaffected by any climatic conditions. It is the

ORIGINAL
VARIABLE GRID LEAK

Ask your dealer or write for our free diagrams of Neutrodyne, Tri-Flex, Kaufman and other good circuits.

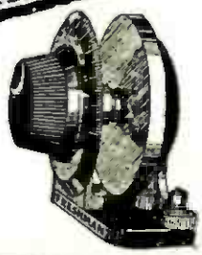
Either Base or Panel Type Complete with .00025 or .0005 MF. Freshman Condenser... $1

Either type without Condenser..75c

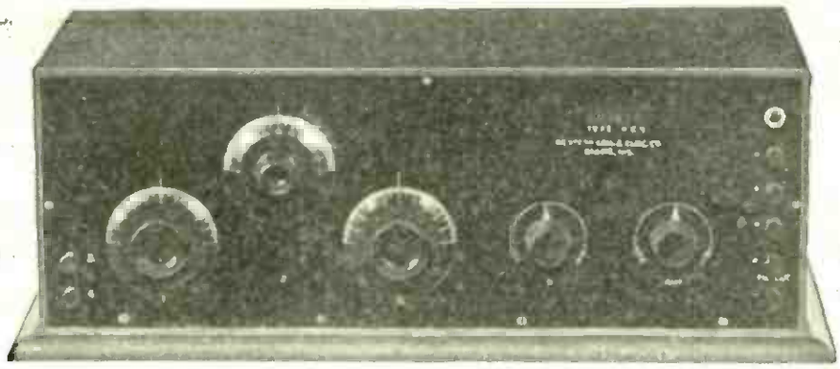
At your dealers, otherwise send purchase price and you will be supplied without further charge.

PANEL TYPE
VARIABLE GRID LEAK

Chas. Freshman Co. Inc.
Radio Condenser Products
106 SEVENTH AVENUE
NEW YORK CITY



"FRESHMAN SELECTIVE" MERCURY VARIABLE CONDENSER
$5.00



A Special Low Wave Receiving Set

Wave Lengths from 90 to 380 Meters

Are you having trouble getting short wave signals? The WC-5-SW shown above is the most practical set for low wave specialists. Built by short wave experts the WC-5-SW eliminates the trouble which transmitting amateurs are having with ordinary receiving sets. If you are interested in getting better low wave results it will be to your advantage to investigate the WC-5-SW. Enthusiastic operators from all parts of the country write us praising its efficiency.

WC-5-SW

Built Especially for Transmitting Amateurs

The WC-5-SW is a 4-tube set. One stage of tuned Radio-Frequency amplification is employed ahead of the detector to make it super-sensitive. Two stages of audio-frequency are used to bring up the signal strength. Uses any type of tubes. Gives perfect control of audibility. Detector rectifies only. Uses antenna compensating condenser. Only two control adjustments. Pure negative biasing on all tubes, thus marked saving on "B" Battery current. Tuned Radio-Frequency sharpest known and most selective principle ever adopted. Plate potential non-critical. Mono-block tube socket. No grid plate leads on audio amplifiers. Audio amplification absolutely necessary when using low efficiency receiving antenna, i.e., underground or indoor. Mahogany cabinet, piano rub finish. Rabbited-in panel. Split lid cover. The price is only $85.00.

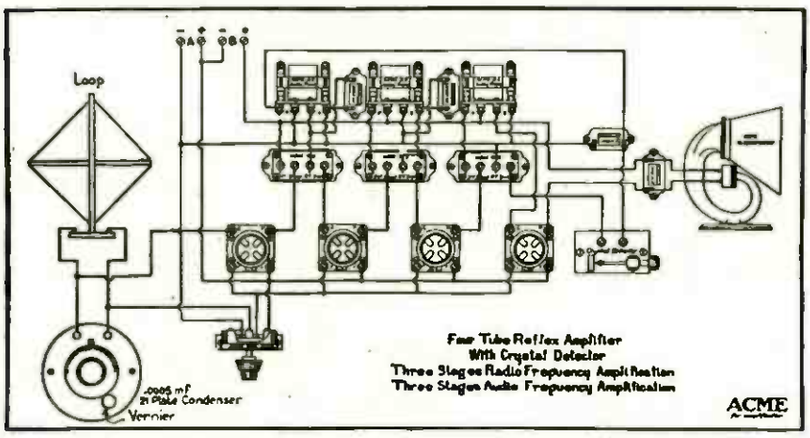
Write for complete description and illustrated folder on this practical set for low wave specialists. All transmitting amateurs will be interested in this literature.

OTT RADIO, Inc.

222 Main Street **La Crosse, Wis.**

TOT

Make your Set "REFLEX" with ACME



The Acme Pot Rheo

. . . "Having tried almost every circuit on the market, I find that there is nothing that will compare with this hook up in any way."

"MY LIST of call letters is too long to mention in this letter. . . . This circuit delivers such volume from points thousands of miles away . . . in fact, it brings in the distant stations just as loud as it does the local and without any distortions" . . . Writes an enthusiastic builder of an Acme Reflex.

This Reflex circuit was perfected by our engineers after eighteen months of testing and experimenting. It gives the best consistent results for the least expenditure, the least construction and tuning effort and the least trouble. It brings in the distant stations loud and clear and it won't annoy your neighbor.

For best results—Follow the diagram closely and use only the best apparatus. One Acme booster writes us: "Acme is so far ahead in every way that we would be foolish to attempt this hook up with any other make of transformer." Write to us for "Amplification without Distortion"—a booklet containing wiring diagrams and helpful points on construction and operation. Use the coupon.

Acme Kleerspeaker

The Acme Radio Frequency Amplifying Transformer R-1, 2, 3, 4 for distance

The Acme Audio Frequency Amplifying Transformer Type A-2

ACME APPARATUS COMPANY
Dept. 41, Cambridge, Mass.

ACME
~ for amplification

ACME APPARATUS COMPANY,
Dept. 41, Cambridge, Mass.

I enclose 10 cents (U. S. stamps or coin) for copy of new edition of "Amplification without Distortion" containing complete instructions and wiring diagrams for making my set "Reflex."

Name .....

Street .....

City ..... State .....

ONE CONTROL ONLY

Makes It Most Simple to Operate

BRISTOL SINGLE CONTROL RADIO RECEIVER

(Non Regenerative)

Using Grimes Inverse Duplex System

SIMPLICITY OF OPERATION is the outstanding feature of this Receiving Set. One Control Dial includes every adjustment. To tune in, turn this Dial. A station once located can always be brought in again at the same setting.

NOT CONFINED TO LOCAL BROADCASTING—this four-tube set has power equal to six. Because the Grimes Inverse Duplex System utilizes the first two tubes for both Radio and Audio Amplification.

ANTENNA OR LOOP—either may be used to suit conditions.

SOLID MAHOGANY CASE with walnut finish encloses the complete Receiving Set. It is a beautiful piece of furniture fully in keeping with the most luxurious room.

The price—Bristol Single Control Radio Receiver, $190.00.

Ask for copy of Bulletin 3013-L describing this set.

THE BRISTOL COMPANY
Waterbury, Conn.

This Radio Catalogue FREE

Save 1/3 on Guaranteed Radio Equipment

Write us a post card—
Address Dept. 38-R

and we will send you free this 52 page catalogue of radio sets and parts. It also contains explanation of radio terms, map and list of broadcasting stations and much radio information, including an explanation of successful hook-ups and circuits.

You will be amazed at the low prices Ward's quote. A complete tube set having a range of 500 miles and more, including tube, head set, batteries, and antenna equipment, as low as $23.50.

This catalogue contains everything for the expert and amateur. Complete sets and every improved part for building sets, all the most up-to-date devices—at the lowest possible prices.

Headquarters for Radio

Montgomery Ward & Co. is headquarters for Radio, selling everything direct by mail without the usual "Radio-profits." Why pay higher prices? Ward quality is the best and the prices will often save you one-third. Everything sold under our Fifty Year Old Guarantee—Your Money Back if You Are Not Satisfied. Write today for your copy of this complete 52-page Radio Book.

Write to our house nearest you
Address Dept. 38-R

Chicago **Kansas City** **Ft. Worth** **St. Paul** **Oakland, Cal.** **Portland, Ore.**

Established 1872

Montgomery Ward & Co.

The Oldest Mail Order House is Today the Most Progressive

POWER-FORMERS

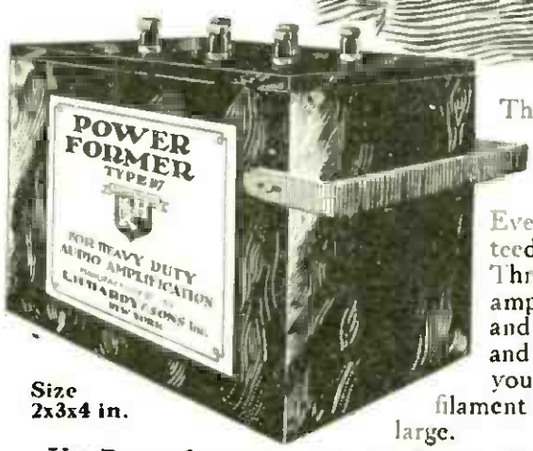
for Undistorted Amplification

Use one or more **Powerformers**— one for each stage

TREMENDOUS energy lies latent in your vacuum tube receiver if you will but put the tubes to work. Instead of mere whispers and muffled orchestrations you will be electrified with the pure, full tone of distant stations when using **Powerformers.**

The **Powerformer** absolutely refuses to distort and at the same time amplifies beyond your weirdest expectations.

Every **Powerformer** is guaranteed to give successful results. Three stages of **Powerformer** amplification will astound you and your friends with their clarity and volume. On local programs you will be forced to reduce your filament unless the room is unusually large.



Size 2x3x4 in.

THE Hardy Powerformer is an impedance balancing device which forces the vacuum tube to amplify to the extreme limit of its *constant*. It is therefore 100% efficient as a coupler. Furthermore, it does not cause or permit distortion.

Hitherto, the great difficulty in audio frequency amplification has been due to the inherent inefficiency of magnetic, iron-core transformers. Such couplers have high losses, do not afford a properly balanced load on either of the tubes between which energy is being transferred and they introduce serious distortion no matter how cleverly designed.

The Hardy Powerformer performs efficiently regardless of the tuning circuit. Powerformers are adaptable to all standard vacuum tubes.

Prices

Powerformer, Type D-7	$5.50
Toro-Tran, Type R-7 (200-600 meters)	5.00
Toro-Tran, Type R-8 (3,300 meters)	9.50
Inductometer, Type R-9	3.50
Inductometer, Type 5-K	8.50
Inductometer, Type X-4	35.00
Ultimate Receiver	500.00

Use **Powerformers** with the Hardy Circuit **Inductometer** for long distance results and precision tuning. For Tuned and Nullified Radio Frequency, as well as for Super-Heterodynes, specify Hardy **Toro-Trans,** using **Powerformers** for audio amplification.

THE HARDY ULTIMATE RECEIVER

THE Hardy **Ultimate Receiver** is a console type receiving set which is sold complete with all accessories. It is built into a period table cabinet of unusual taste and ornamental value. Each instrument is custom built, for specific service and is fully guaranteed under written specifications.

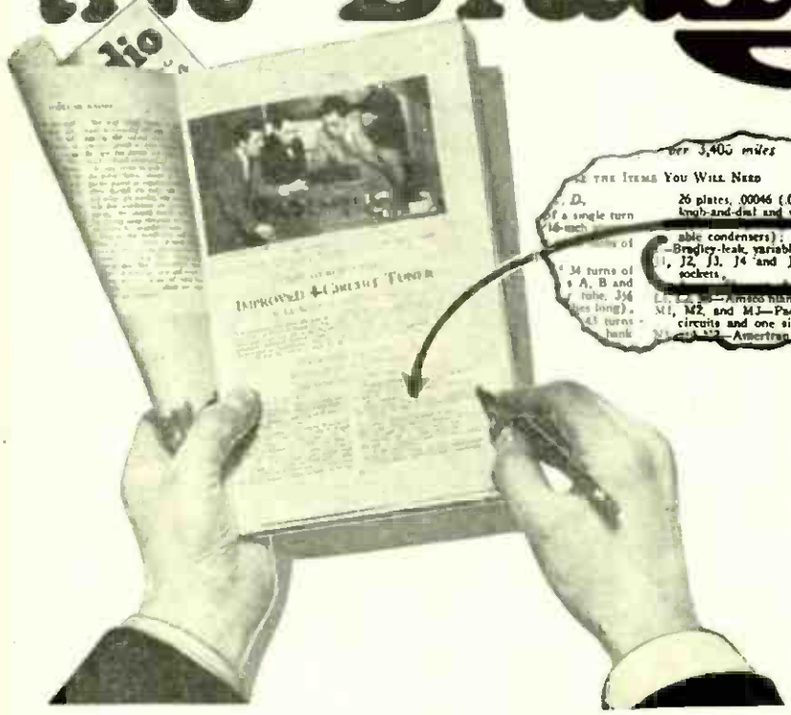
Write for Brochure: "HARDY RADIO DEVICES."

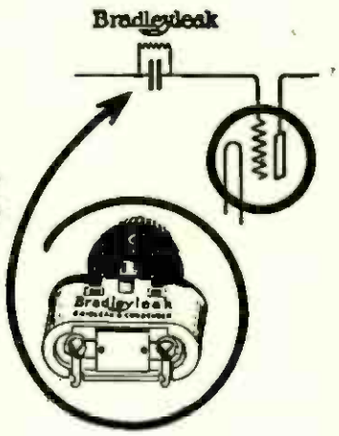
A Good Name

HARDY MANUFACTURING CO.

130 EAST 55th ST. NEW YORK CITY

Cockaday specifies the Bradleyleak





At All Dealers
$1.85
Condenser 35c

In Canada
$2.50
Condenser 50c

Improved 4-Circuit Tuner Needs Bradleyleak
for perfect operation of detector tube

ANOTHER Prominent Radio Engineer has recognized the unusual performance of the Bradleyleak! In a recent article in Popular Radio, Mr. Laurence M. Cockaday, inventor of the Cockaday circuit, specifies the Bradleyleak as an essential part of his tuner which produces such wonderful results. Many other radio experts such as Kennedy, Crosley, Amrad and Flewelling endorse the Bradleyleak as a distinct achievement in grid leak construction. Amrad has just adopted the Bradleyleak for the expensive Console and table sets.

THERE are very definite reasons for the success of the Bradleyleak. It is unaffected by moisture or atmospheric conditions and has a guaranteed range of stepless control from ¼ to 10 megohms. The grid circuit is extremely sensitive and a poor grid leak can cripple the action of the finest tube.

Try a Bradleyleak tonight and be assured that your grid circuit will remain permanently adjusted for long range reception.

Is Your Grid Leak Correct?

The following table gives the approximate values of grid leak resistance recommended by vaccum tube manufacturers:

Audion (De Forest) DV-6,	2 Megohms
C-200	2 Megohms
C-299	2 to 5 Megohms
C-301-A	2 Megohms
UV-199	2 to 5 Megohms
UV-200	2 Megohms
UV-201-A	2 Megohms
WD-11	3 Megohms, or more
WD-12	3 Megohms, or more

Allen-Bradley Co.
Electric Controlling Apparatus

276 Greenfield Ave. — A-B — Milwaukee, Wisconsin

Manufacturers of graphite compression rheostats for over 20 years.

Mail This Coupon—Today!

ALLEN-BRADLEY CO.
276 Greenfield Ave., Milwaukee, Wis.

Please send me your folder describing the Bradleyleak and its construction.

Name.....

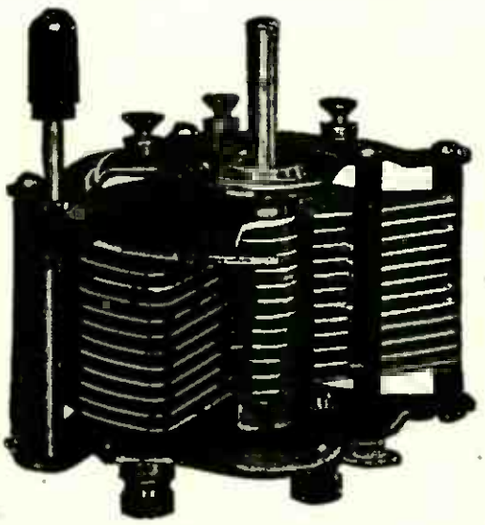
Address.....

.....

A Standard of Condenser Excellence
—note the points of proven Superiority!!

5 POINTS

1. Stator plates pressed into slots, assuring perfect electrical contact.
2. Proper capacities, and no over-rating of same.
3. Rigid construction, so original adjustment is maintained.
4. Rotor and stator plates of logarithmic curve type.
5. Formica insulation throughout.



5 MORE!

1. Patented vernier arrangement, eliminating body capacity.
2. Special spring aluminum plates.
3. Lowest dielectric losses, proven by laboratory tests.
4. Special friction bearing on rotor shaft.
5. Independent vernier control. Vernier does not rotate with main rotor plates.

A radio receiving set is no better than its variable condensers!

STRAITLINE
TRADE MARK

V A R I A B L E
VERNIER CONDENSER

Upon the condensers used depends the efficiency of your set. Buy only the best! You can pay a higher price—but cannot get a better condenser than STRAITLINE

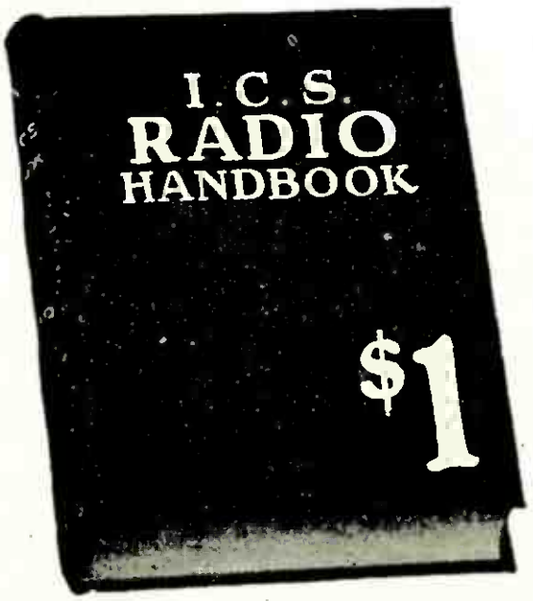
Type G 13 Pl. .0002 mfd. 3.00 Type H. 23 Pl. .0005 mfd. 3.50 Type J. 43 Pl. .001 mfd. 4.00

A Product of **HAIG & HAIG** Manufacturing Co.
ROCHESTER, NEW YORK

If your dealer has none send his name with your remittance direct to

RADIO STORES CORPORATION
Sole International Distributors
NEW YORK—CHICAGO—MINNEAPOLIS—LOS ANGELES—CLEVELAND — ST. LOUIS — OMAHA — SAN FRANCISCO.
HOME OFFICE, 220 West 34th Street, NEW YORK, N. Y.

—*insist on* STRAITLINE



At last! A practical authoritative book on RADIO

562 pages. Price only $1

Compiled by HARRY F. DART, B.S., E.E.
Formerly with the Western Electric Co., and
U. S. Army Instructor of Radio
Technically edited by F. H. DOANE

THE most complete book of its kind ever published. Written, compiled and edited by practical radio experts of national reputation. Packed with concise, sound information useful to every radio fan—from beginner to veteran hard-boiled owl. Hundreds of illustrations and diagrams to make every point clear. Note this *partial* list of contents:

Different types of receiving and sending hook-ups, electrical terms, condensers, oscillating circuits, coupled circuits, induction coils, antenna systems, electric batteries, generators and motors, protective devices, crystal detectors, arc generators, transmitters, filters, wavemeters, radio experiments, International and Morse codes, commercial receiving sets, tables and data, radio transmitting and broadcasting stations (with call letters), Radio License Regulations, etc.

Send $1 to-day and get this 514-page I. C. S. Radio Handbook before you spend another cent on parts. Money back if not satisfied.

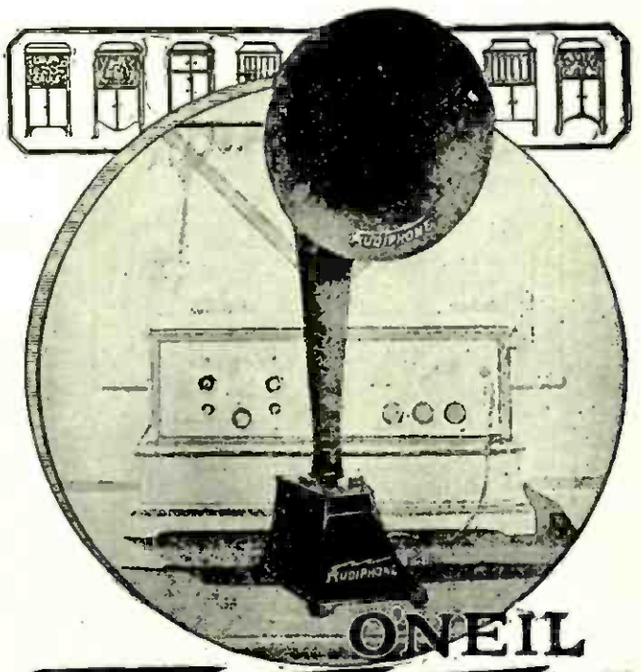
TEAR OUT HERE

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 8251-B, Scranton, Penna.

I enclose One Dollar. Please send me—postpaid—the 514-page I. C. S. Radio Handbook. It is understood that if I am not entirely satisfied I may return this book within five days and you will refund my money.

Name.....

Address.....



O'NEIL AUDIPHONE

THE absolutely natural tones of the phonograph now attained in radio reproduction through the O'NEIL AUDIPHONE. Phonograph craftsmen have made a perfect musical instrument and radio acoustic engineers have made it a flawless radio reproducer. Volume without blast. Exterior diaphragm adjustment. The "laminated voice core" makes the AUDIPHONE marvelously versatile.

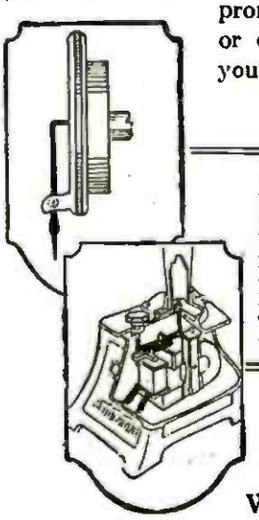
Absolute satisfaction or your money promptly refunded. At your dealers or direct, C. O. D., if you mention your dealer's name.

Write for Literature

No extra batteries needed. Complete, with connecting cord.

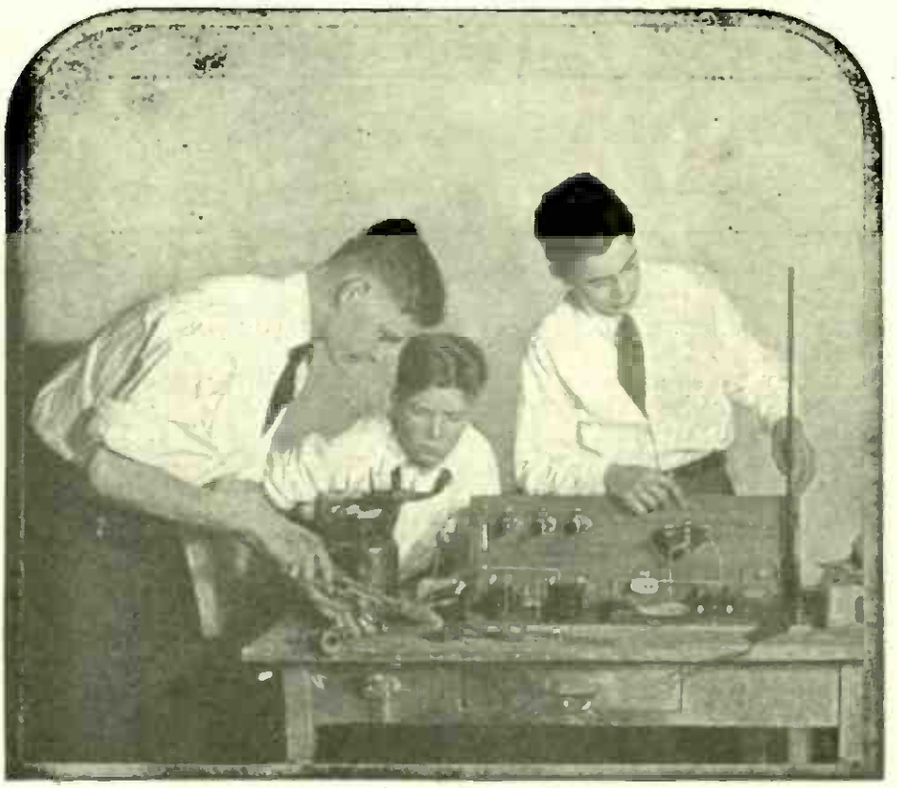
Art Model
Beautiful Antique Bronze Finish
$30

14 Inch Horn $5 additional



Note the similarity of construction between the phonograph reproducer (illustrated in the upper panel) and the reproducer of the O'Neil *AUDIPHONE* (below): both have a mica diaphragm set in a sound-box chamber actuated by an elbow stylus bar.

O'Neil Mfg. Co.
714 Palisade Avenue
West New York, New Jersey



Youth is the creative age in radio

Boys are the builders of radio. In them flames a creative urge that impels them to constant experiment—constant improvement. The fine, high-powered set that satisfies a man is to the boy but the starting point for further testing and searching.

While older men marveled at the first primitive sets, youths still in their teens, like Armstrong, Cockaday, Reinartz and Tuska, were developing the inventions that have made possible such unbelievable advances in this new science. To-day millions of boys, actuated by the same irrepressible urge, are building their own sets, designing new hook-ups, changing, revising, improving. And that's why the bulk of radio sales are made to boys, or to parents buying for boys.

THE AMERICAN BOY

"The Biggest, Brightest, Best Magazine for Boys in All the World"

is the radio guide of 500,000 up-to-the-minute boys, averaging 15½ to 16 years old. Radio takes a big part in its stories. Its articles deal with the latest developments in radio—written by radio authorities. And this great section of boydom naturally turns to its advertising columns for information on all that's newest and best in radio equipment.

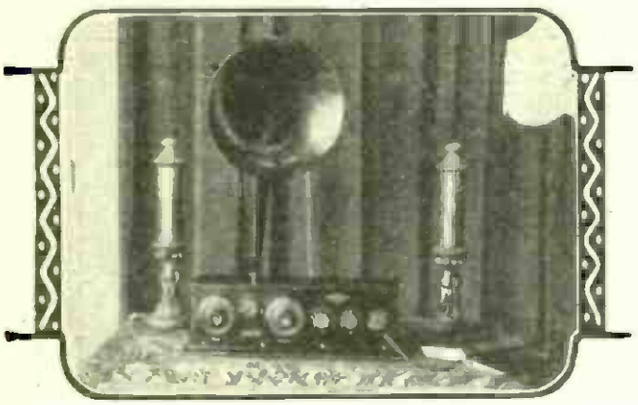
Tell these boys about your product. They're the very cream of your market. Win their confidence in your goods, and their preference for them, by advertising in THE AMERICAN BOY.

Copy reaching us by March 15th will appear in May.

THE SPRAGUE PUBLISHING COMPANY

(Member A.B.C.)

548 Lafayette Boulevard **Detroit, Michigan**



Radiodyne

"The Voice of the Nation"

NO LOOPS - - - NO ANTENNA

The RADIODYNE is ready for operation by simply grounding to a water pipe or radiator, and throwing a few feet of wire on the floor. Uses any standard tubes—dry cell or storage battery. Extremely selective. Simple to operate—***only two controls.***

Stations within a radius of 2,000 miles can be picked up on the loud speaker; any wavelength from 200 to 700 meters. You can select the best programs with the Radiodyne.

PRICE $150.00

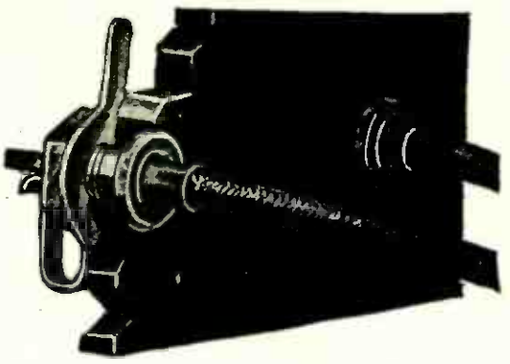
For use in apartments, boats, automobiles, railroad trains, etc., the RADIODYNE is enjoyable where other receiving sets would not be practical.

When interference, strays, static, etc., make other types of reception utterly useless the RADIODYNE picks up broadcast programs clear and distinct.

Write for illustrated folder which describes the RADIODYNE in detail. Every radio fan will be interested in this new type (antennaless) receiving set.

WESTERN COIL & ELECTRICAL CO.
308 5th St. :: Racine, Wisconsin

For Better Connections



Union Radio Tip Jacks

(Patent Pending)

Price 25c a Pair

The greatest little part in all Radio. Just what you need when building sets, or when trying new hook-ups. They replace binding posts and give quick, positive, electrical connections. Heavily nickeled, they add to the attractiveness of your set. Are now adopted by leading set manufacturers because of superior merit over binding posts.

Two sizes for all mountings. STANDARD TYPE A for panels up to ¼" thickness. SPECIAL TYPE B for panels, cabinet walls and partitions from $\frac{5}{16}$ to ½" thick. Will firmly grip all wires from No. 11 to No. 24 B & S Gauge. Can easily be reamed to hold antenna wire, loading coil, etc.

Price 25c—in Canada 35c a Pair.

Other Guaranteed Union Radio Parts

TUBE SOCKETS of highly polished moulded condensite. Phosphor bronze contact springs. Reinforced bayonet slot. For all standard tubes. **Price 70c.**

DIAL ADJUSTERS for minute adjustment of dials, necessary for close tuning. **Price 60c.**

Retailers—Wholesalers

Write for free samples of our guaranteed reasonably priced Quality Radio Products. Get details of our dealer proposition, also write for your copy of the Union Radio Catalog "A."

UNION RADIO CORPORATION
200 MT. PLEASANT AVENUE, NEWARK, N.J.
NEW YORK OFFICE — 116 WEST 32nd STREET

The Golden Rule Tube

The Sodion brings a benefit to Radio infinitely bigger and better than any superiority of range, strength or quality of tone.

It opens the way to emancipation from the greatest fault in broadcast reception today—reradiated interference.

Based on an entirely new principle;

Differing materially both in the design and in the arrangement of its elements;

Making an absolutely original use of the peculiar properties of the sodium ion;

The Sodion not only produces stronger signals than any other detector on the market, but it does this without resort to oscillation, regeneration or other expedients.

Just what this means to you—to every other broadcast receiver—and to the art of radio in general, will best be understood when you realize that the whistles, squeals, and howls that interfere so seriously with your reception are due to nothing other than the oscillations in ordinary detectors.

We will send descriptive circular upon request.

Under date of January 21st a Boston user, among other things writes: *"May I add that it is a source of satisfaction for me to know that in operating my Sodion I am in no way interfering with the pleasure of my neighbors."*

CONNECTICUT TELEPHONE & ELECTRIC COMPANY
MERIDEN Radio Division CONNECTICUT

D-E-P-E-N-D-A-B-L-E

RADIO PLATE "B BATTERIES"

When you use DIAMOND RADIO PLATE BATTERIES, there's one place less you need to look for trouble. You KNOW they're good for endurance and power beyond other batteries you've had. Don't play tricks with your tubes. Give you more of your money's worth in uninterrupted radio entertainment. Get this better "B" battery NOW. Look for the DIAMOND trade mark.

If your dealer cannot supply you, order direct, C. O. D., naming your dealer

LIST PRICES

No. B-1, 22½ volts, $3.00, 5 binding posts in steps of 1½ volts.
No. B-2, 45 volts, $5.50, 5 positive taps.
No. B-16, 45 volts, $4.50, 5 taps from 16½ to 22½ volts.
No. B-4, 22½ volts, $1.75, for portable sets. 5 taps.
No. 3, Type C, 4½ volts, 70c, 3 taps.

DIAMOND ELECTRIC SPECIALTIES CORP.

102 SO. ORANGE AVE., NEWARK, N. J.

Dealers—Jobbers, Write for Proposition

★"EVERYTONE" *guaranteed* RADIO HEADSET

—two pairs of phones for what you would ordinarily pay for one—and you're not sacrificing quality.

The "Everytone" is an improved type of headset, combining clear reception, comfort and long satisfactory service.

Pacent Universal Plug No. 40

Improved

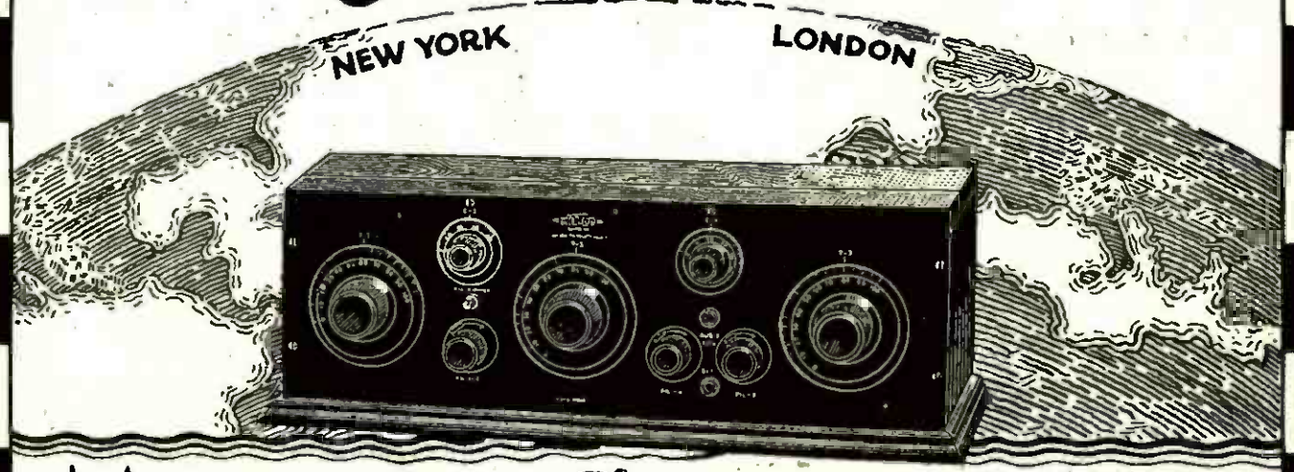
Connection of cord tips has been simplified—you just insert the tips and clamp the shells together to obtain a sure gripping contact. Polarity is marked on connectors and all metal parts are satin nickel finished. **50c.**

Write for Catalog P-3

PACENT ELECTRIC CO., INC.
22 PARK PLACE NEW YORK

Pacent
RADIO ESSENTIALS

Now Links Two Continents!

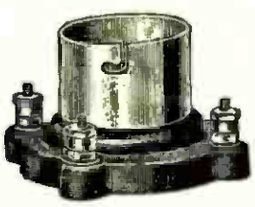


MELCO-SUPREME

Tuned Radio-Frequency RECEIVER

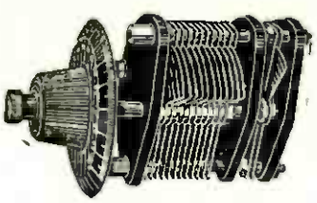
Satisfies Every Radio Wish

AMSCO



Tube Socket

Rheostats and Potentiometers



Variable and Vernier Condensers

SURPASSING even the most critical standards of LONG DISTANCE reception, the Melco Inductively-Tuned and Neutralized Receiver leads in trans-oceanic and trans-continental reception. Results are certain whether you are an expert or a novice. The Melco-Supreme adds to its distance supremacy

Extreme Selectivity — **Exceptional Clarity**
Simplicity of Operation — **Perfect Control**

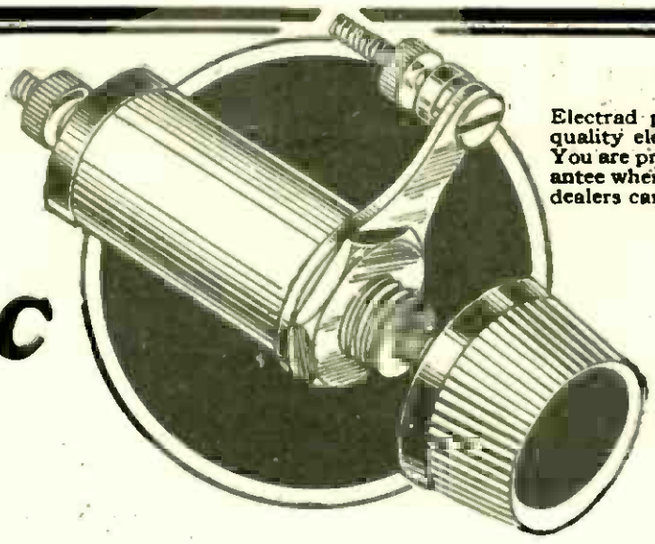
Each instrument is fully guaranteed

Write for complete descriptive literature

AMSCO PRODUCTS, Inc.

FAIRBANKS BUILDING
BROOME & LAFAYETTE STS. NEW YORK CITY

MELCO



Electrad products are of the highest quality electrically and mechanically. You are protected by an absolute guarantee when you buy them. Most good dealers carry them.

75c

Double your distance with this Variohm

THE latest invention in grid leaks enables you to get exactly the correct resistance for your individual set as it receives in your home. With the Variohm you can secure and maintain any resistance from ½ to 30 megohms. Once adjusted to your individual set, the setting is permanent.

With it you get maximum distance and sensitivity. Without it your set is working at a disadvantage. It eliminates circuit noises, is moisture-proof and non-microphonic. Suitable for panel or base-mounting. Unmounted 75c, mounted $1.00. Equipped for use with standard fixed condensers.

Displayed, sold and recommended by most good dealers. If your dealer cannot supply you, send us his name and purchase price and we will send it to you post-paid. Satisfaction guaranteed or money back.

Dealers Electrad Radio Products of guaranteed superior quality offer you wonderful opportunities for quick turnover and good profits. Write for details on our greatly increased advertising campaign, dealer helps and package of fast moving items.

Other Electrad Products of Superior Quality & Dependability

FIXED GRID LEAKS

Absolutely uniform, unvarying fixed resistance. A superior product of dependability in all resistances from ¼ to 10 megohms. Price 30c.

LEAD-INS

No longer do you need to ruin your window frames. Electrad Lead-Ins fit under closed windows, can be bent to any shape. Covered with fireproof insulation of 1000 volts resistance which prevents grounding on wet sills. Fitted with Fahnestock Clips 40c.

INDORARIALS

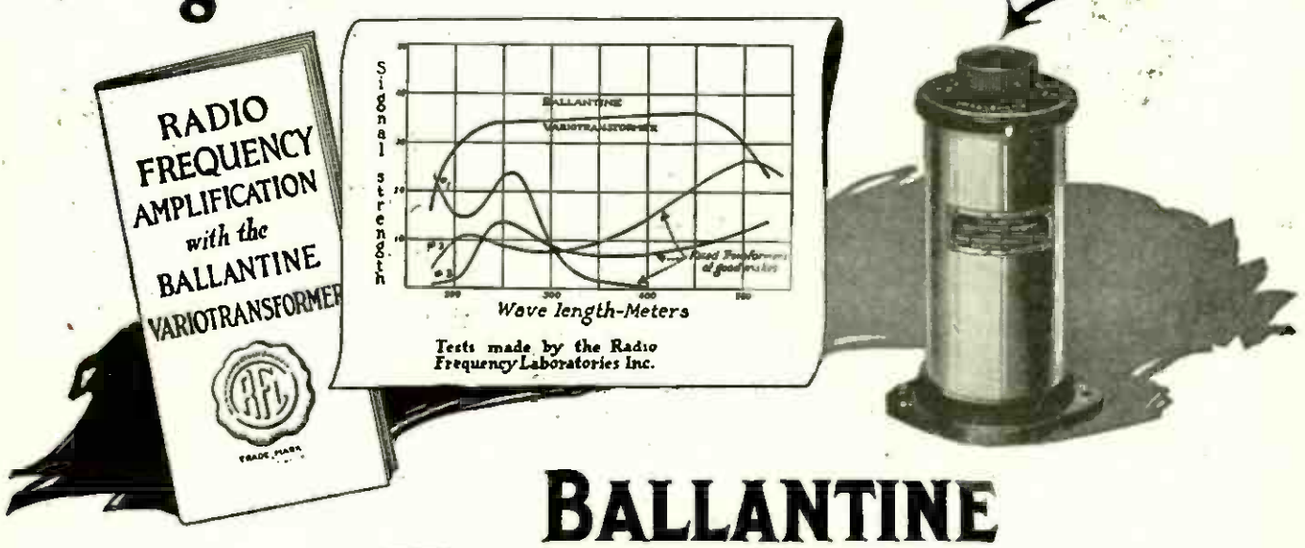
Ideal for sharp tuning. Wonderful directional effects. Reduces static. Can be used anywhere. Hang on door or wall behind draperies or laid under rug. Can also be used as ground. Price $1.50.

Electrad, Inc., Dept. C, 428 Broadway, New York, N. Y.

ELECTRAD

a name stamped only on Superior Radio Products

How turning this knob gets more stations



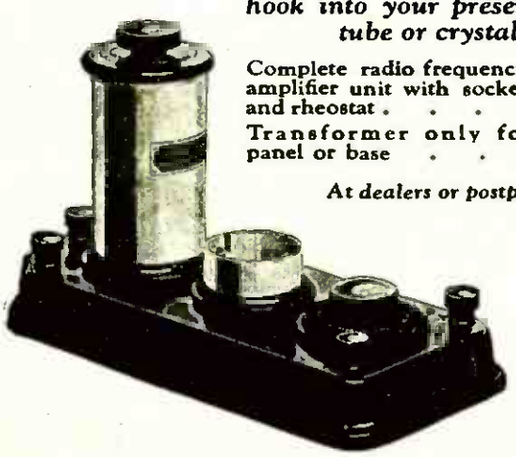
BALLANTINE VARIOTRANSFORMER

HERE'S evidence that the tuning dial of a Ballantine Variable R. F. Transformer gives superior results. The light line curves (plotted from careful experiment) show you that fixed transformers do not give satisfactory amplification for many of the important stations. Why? Because the *fixed* windings are out of tune.

With Ballantine instruments you can accurately tune everything from 200 to 600 meters—by merely turning the knob. This adjusts the windings to the wave length of the station wanted.

Get Stations You've Never Had

Perfect shielding and pig-tail connections assure clear tones. Then, by keeping amplification uniformly high throughout the broadcast range, you get all there is within reach of your set.



Here's an assembly ready to hook into your present set—tube or crystal.

Complete radio frequency amplifier unit with socket and rheostat $15.00

Transformer only for panel or base $9.60

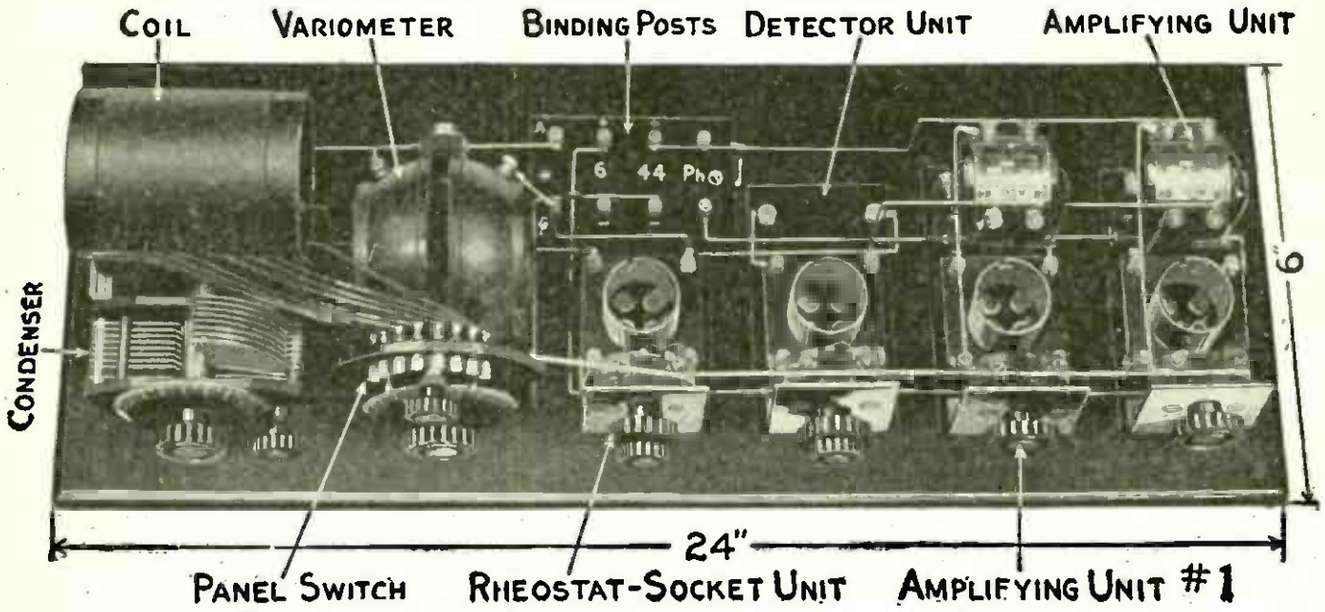
At dealers or postpaid

Send for This Booklet

"Radio Frequency Amplification with the Ballantine Variotransformer," 25 pages of practical interest. Mailed to Radio experimenters upon request.

BOONTON RUBBER MFG. CO.
Pioneers in Bakelite Moulding

224 Fanny Road, Boonton, N. J.



Tuned Wave Trap Radio Frequency Receiver

BUILT ON FAMOUS COPP CIRCUIT No. 4

1 Stage Radio-frequency—2 Stages Audio-frequency
Efficient for all wave-lengths from 200 to 700 meters
Range up to 2000 miles

Any person can build the above set with A-C DAYTON Complete Units

$43.35

Units packed complete in one carton with wiring diagrams, photographs, instructions, etc., for complete installation.

SEE YOUR DEALER OR WRITE US DIRECT

We manufacture a complete line of Radio Parts and Units—Catalog on request

THE A-C ELECTRICAL MFG. CO., Dayton, Ohio

Makers of Electrical Devices for over 20 Years.

We Offer Cash for Your Spare Time

MAIL the little coupon today. It will mean money to you.

For every subscription to POPULAR RADIO that you send us, we will reward you liberally in cash commissions.

Many of your friends and acquaintances will be glad to subscribe to POPULAR RADIO when they see what a helpful and interesting magazine it is. You can do your friends a good turn and at the same time make money for yourself by taking their subscriptions for POPULAR RADIO.

Mail the coupon today for full particulars and a free sample copy

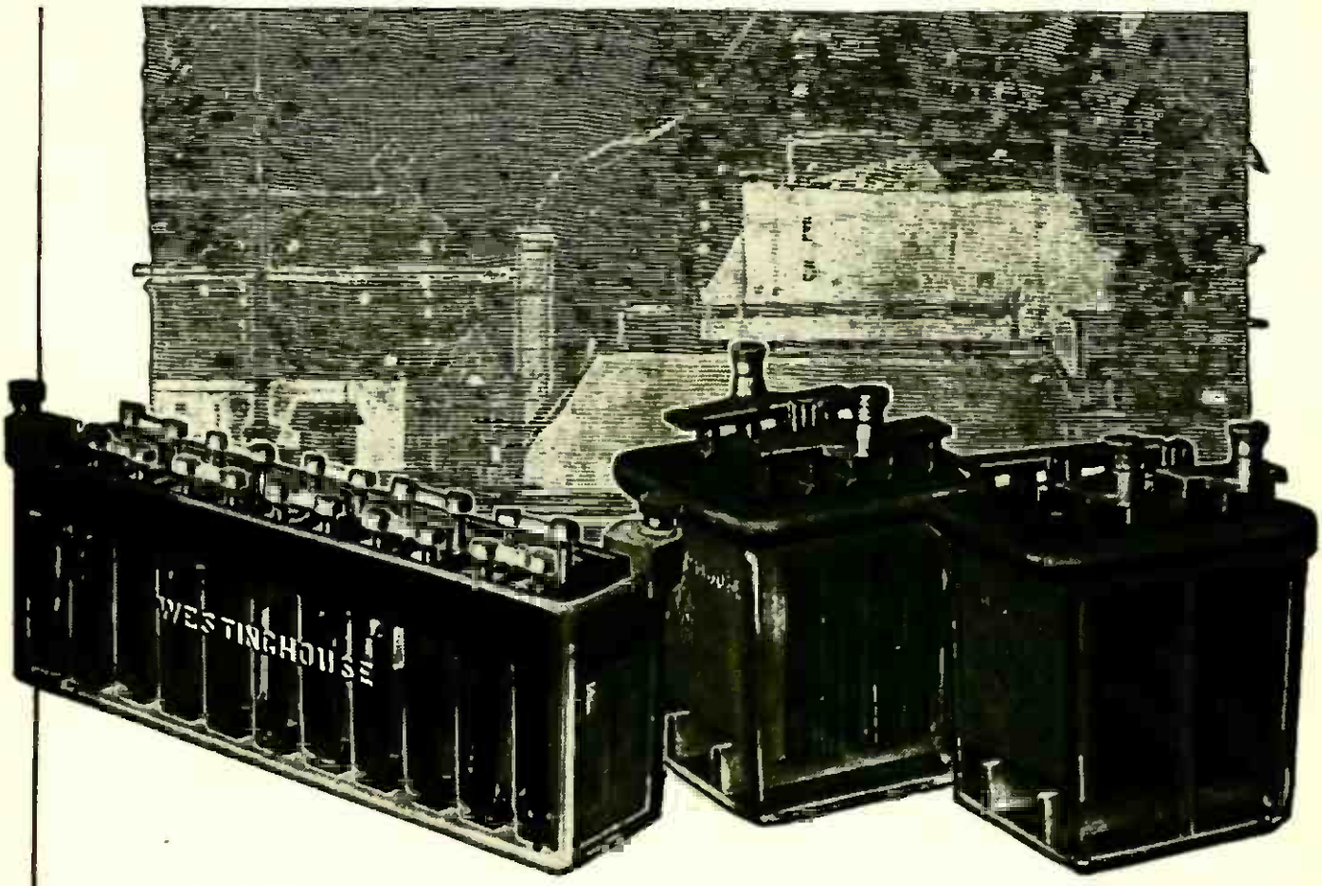
POPULAR RADIO, Dept. 36,
9 East 40th Street, New York City

Please tell me how I can make money in my spare time taking subscriptions to POPULAR RADIO. Send along a sample copy for me to work with; also other necessary supplies.

NAME .....

ADDRESS .....

.....



NOTHING about a radio set is so absolutely essential to satisfactory receiving as *good batteries.* Sustained voltage, slow, even discharge, ample capacity, utmost quiet, long life—these are important. Don't be satisfied with anything less than Westinghouse Radio Storage Batteries. They are built to meet the most exacting requirements of radio broadcast transmission and reception. And they last! Thoroughly insulated against current leakage. Easily recharged. A size and type for every radio need.

MAIL COUPON for interesting facts about batteries.

Westinghouse CRYSTAL CASE Radio Batteries have one-piece clear glass cases, with glass cell partitions and high glass plate rests (deep sediment spaces). "A" Batteries in 2, 4 and 6 volt sizes. 6-volt size made in rubber-case types too. "B" Batteries in 22-volt units—regular and quadruple capacities. "C" Batteries in 6-volt units.

WESTINGHOUSE UNION BATTERY COMPANY, Swissvale, Pa.

WESTINGHOUSE

RADIO

"A," "B" and "C" BATTERIES

Westinghouse Union Battery Co.
Swissvale, Pa.

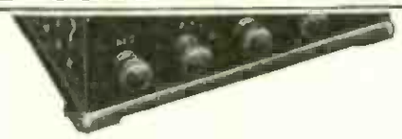
Send me Westinghouse Radio Battery Folder A-3-B.

.....

.....

.....

For All Batteries



Longer distance and clear signals are the pleasing results which you can be sure of when both the A and B batteries of your radio set are storage batteries. No other source of power for radio equals the storage battery.

The Valley ABC Battery Charger is so simple and so easily operated that it makes storage batteries the most convenient and inexpensive source of power for radio. Enjoy radio at its best. Use storage batteries and charge them with The Valley ABC Battery Charger.

Charges 2-volt peanut tube batteries, 6-volt A Batteries, 6 and 12-volt automobile batteries, and 1 to 4 B batteries. Bakelite panel, glass top. Harmonizes with any receiving set. At good radio shops.

VALLEY ELECTRIC CO.
3157 S. Kingshighway · St. Louis, Mo.

Valley Battery Charger

1500 MILE RANGE
VACUUM TUBE RADIO SET READY BUILT

1,500-mile range attained in favorable weather with **Atlas Wizard** Single Tube Radio Set. Wonderful selectivity—clear tone reproduction—brings you melodies, music and market reports. Dials log with accuracy of a Neutrodyne.

One ATLAS WIZARD Radio Set completely built, to one person in each community, only **$19.95.** Don't fail to take advantage of this amazing offer. Name and address brings set complete by express C. O. D. You take no risk so order this Radio wonder today.

$19.95 REG. VALUE $57.50

WHAT YOU GET
Atlas Wizard Receiver, mahogany finish; Head Phones; Vacuum Tube; A & B Batteries; Aerial; Ground Wire; Instructions.
READY BUILT

ATLAS CUT RATE RADIO STORES
Div. 21, 345 S. Clark St., Chicago
Send 35c in stamps for Atlas Wizard Blue-print. Big Radio Catalog FREE.

SUPERTRAN
Registered U. S. Patent Office

VOLUME

The Supertran TALKS while other transformers whisper! The reason for its enormous sound amplification lies in the skillful engineering design,—the result of years of intensive research and study.

***Price* $6.00**

These transformers are specially designed for the Neutrodyne Set.

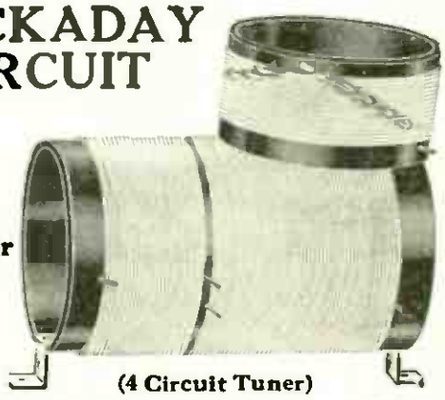
Can be used with any amplifying tube on the market with excellent results

At your dealer—or direct by mail on receipt of purchase price

FORD MICA CO., Inc.
33 East 8th St. New York

EASTERN COIL SETS
for the COCKADAY CIRCUIT

are the Standard, and in Universal Use due to their Proved Efficiency in this wonder circuit



(4 Circuit Tuner)

Made as per specifications of Mr. Cockaday, "D" Coil bank-wound.

Complete assembled Set of B. C and D Coils on GENUINE BAKELITE TUBING, wound with #18 double silk covered wire $4.25

Original and new improved hook-ups with material lists FREE with each set of coils.

Genuine Lavite Resistances, 48000 ohm, each **$1.50**
These resistances *control* the *tone* of the Cockaday Circuit and eliminate all transformer distortion; modulating the tone after the fashion of the best of phonographs.

Mail Orders Filled. Dealers Communicate.

EASTERN RADIO MFG. CO.
22 Warren Street, Dept. P. R. NEW YORK, N.Y.

Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City

A. J. HAYNES
Assoc. Institute of Radio Engineers

NEW AND IMPROVED RADIO APPARATUS

Designed by A. J. Haynes

Mr. Haynes has made many valuable contributions to Radio. Featured in this advertisement are four pieces of apparatus designed and perfected by Mr. Haynes after extended research. Each of these items represents an invaluable contribution to the art of Radio.

The Haynes Condenser

$3.50

Meets every requirement — extreme low minimum capacity and maximum capacity of exactly .00023 mfds. No other condenser is exactly like it—no other achieves exactly the right balance between perfect selectivity and over-critical adjustment.

The Haynes Bank Wound Vario-Coupler

$4.35

Furnished with only the taps you actually use and just the right number of turns on the secondary. Bank winding provides 100% efficiency on higher broadcasting wave lengths.

Haynes-Griffin Transformer

$4.25

An efficient intermediate wave radio frequency transformer giving a minimum of audio frequency amplification. Uniformly tuned to a limited wave length range, and providing a degree of quietness and stability heretofore unknown in transformers of this type. Haynes-Griffin Input Transformer also, $4.25.

Special Oscillator Coupler

$3.50

An indispensable adjunct for those who want the best results from the most advanced circuits.

Supplied with necessary leads already attached.

OTHER NEW APPARATUS

.5 Mfd. By-pass Condenser	$ .90
Haynes-Griffin Precision Grid Leak (Every one tested for exact resistance)	.60
Como Push-Pull Transformers (pair)	12.50
Bradley leak ¼ to 10 meg	1.85
Amplex grid-densers	1.25
Haynes-Griffin Head Phones—2400 Ohms	4.75

FOR RADIO EXPERIMENTERS

F. and K. .0005 Microtune Vernier Condenser	$5.80
¾ meg grid leak	.50
.005 fixed condenser with transformer mounting	.60
Fada Socket (Standard)	1.00

SEND FOR COMPLETE PRICE LIST

Located in New York City, the headquarters of the radio industry, Haynes-Griffin is always first in marketing new and improved apparatus.

Our new price list—just off the press—brings you up-to-date in radio. Everything that's new in radio included. Mailed anywhere upon receipt of 4c in stamps. Use the handy coupon.

Parcel Post Prepaid in U. S. anywhere east of the Mississippi River.

New York's Largest Radio Store

Haynes-Griffin
145 W. 45th St.,
New York City

Send me at once complete price list of new and improved radio apparatus. I enclose 4c in stamps for same.

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HAYNES-GRIFFIN RADIO SERVICE, Inc.
Mail Order Dept.—145 W. 45th ST., N. Y. City
Retail Store—41 W. 43rd ST., N. Y. City

Just like being there yourself

JUST like being in the same room—when your favorite violinist plays. You miss none of the wizardry of his art, if you listen-in with Murdock Radio Phones. You get it all—the rich resonance of the high and low notes and the subtle shading of the softer tones. Everything is reproduced clearly and with wonderful volume.

Perfect construction and diaphragm adjustment the reasons

The powerful magnets in the Murdock build up volume signals—and the sensitive, perfectly adjusted diaphragms turn these into clear, natural tones.

The seating and clamping of the diaphragms is an outstanding feature of the Murdock. This adjustment prevents distortion due to vibration.

May be worn for hours without discomfort

The Murdock may be worn through a whole evening without fatigue. Ear caps are moulded to fit the ears and exclude outside noises. The improved flat headband is feather-weight and does not bind the head; and there are no screws to entangle the hair.

For 20 years Murdock has been making radio phones of high efficiency. Over 1,000,000 users have accepted the Murdock standard of quality and price as the best measure of radio phone value. Buy a Murdock today and test it out—if you want to get the best results from your receiving set. They are fully guaranteed.

SEND FOR FREE BOOKLET. Mail coupon to us and we will send you our helpful booklet, "The Ears Of Radio." It explains in detail the importance of radio phones to efficient radio reception.

MURDOCK MULTIPLE PLUG JACK. This effective plug jack permits the use of one to four 'phones at the same time. Get one.

Announcing the Murdock five tube Neutrodyne Set. (Illustrated above). See this new type at your dealer's. Wm. J. Murdock Company, 371 Washington Ave., Chelsea Mass., Branch Offices: Chicago and San Francisco.

Built, not assembled

Murdocks are made in a single unit, of superior moulded insulation. Each part is fitted by one process into its proper place. They are moulded together—assuring firmness, strength and durability. And they can't get out of adjustment.

MURDOCK RADIO PHONES

Standard since 1904

WM. J. MURDOCK CO.
371 Washington Avenue,
Chelsea, Mass.

Gentlemen: Please send me, without obligation, your free booklet, "The Ears Of Radio."

Name.....

City.....

State.....

Spin *All* Nuts on—

IT'S SO EASY now—assemble any radio hook-up in half the time—make connections leakproof as soldering with **Stevens Spintite Wrenches.**

Fit all radio nuts. Hollow stem goes over projecting screws—hex socket gets full grip and protects nut—ebonized handle for comfortable leverage—cinch to reach difficult places. All sizes from 3/16 to 1/2 inch.

STEVENS & CO., 377 Broadway NEW YORK

Toolsmiths since 1899

SEND $1.00
For set No. 71 illustrated

Sizes 1/8 and 1/2 in. for phone jacks, 65c each.

Stevens SPEED UP TRADE MARK *Tools*

Sterling

PORTABLE RECTIFIER

"The Battery Charger Without a Weakness"

AN old stand-by made according to latest radio improvements. A 5 amp. maximum charging rate. Number of contacts reduced to one. Freezing and sticking eliminated. Quiet in operation. Almost total absence of sparking. Connect to any 110 volt A.C. lighting circuit. Cannot be used incorrectly nor harm plates.

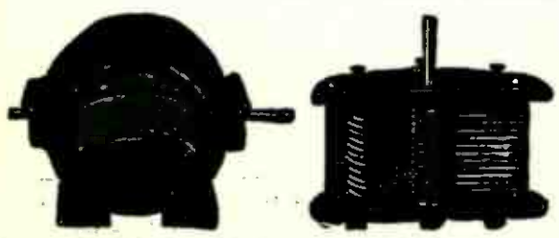
THE STERLING MFG. COMPANY
2843 Prospect Ave., Cleveland, O.

$16.00
West of Rocky Mountains $17.00

Save $2

—probably more, by using R.P.C. famous

NON-MICROPHONIC
You Cannot Hear Them During Tuning



MOULDED BAKELITE VARIOMETER, $5.00

Scientifically accurate for long distance tuning. Moulded of Mahoganite Bakelite.

Non-Microphonic!

23-PLATE CONDENSER $1.50

Affords precise calibration at all wave lengths. Mechanically rugged. Electrically correct.

Non-Microphonic!

"Guaranteed to Satisfy"

RADIO PRODUCTS CO.

Westport, Conn. U. S. A.

Distance & Volume

are found in

RayCoils

RayCoils "A" for Reinartz, Ray Coils "B" for RCS and Ultra Audion Circuits, RayCoils "C" for RCS, Ultra Audion and Tuned Radio Frequency for All Circuits. RayCoils "D" for Neutralizing Circuits 4 & 5 Tubes.

A = $2.50
B = 2.00
C = 2.00
D = 2.00

Use the RCS Circuit with or without Radio Frequency for Simplicity in operation and results. Not equalled by any set for volume and distance.

Coils in Separate Box With Wiring Diagram

Working **Blue Prints** of four sheets 12 x 18 of all standard circuits, such as The Variometer, Reinartz, RCS one and three tube sets and five tube Neutralizing Circuit 50 cents a set.

We also carry a complete line of Carter, Howard, Kellogg, All American and Trimm parts.

If your dealer cannot supply you, we will mail direct.

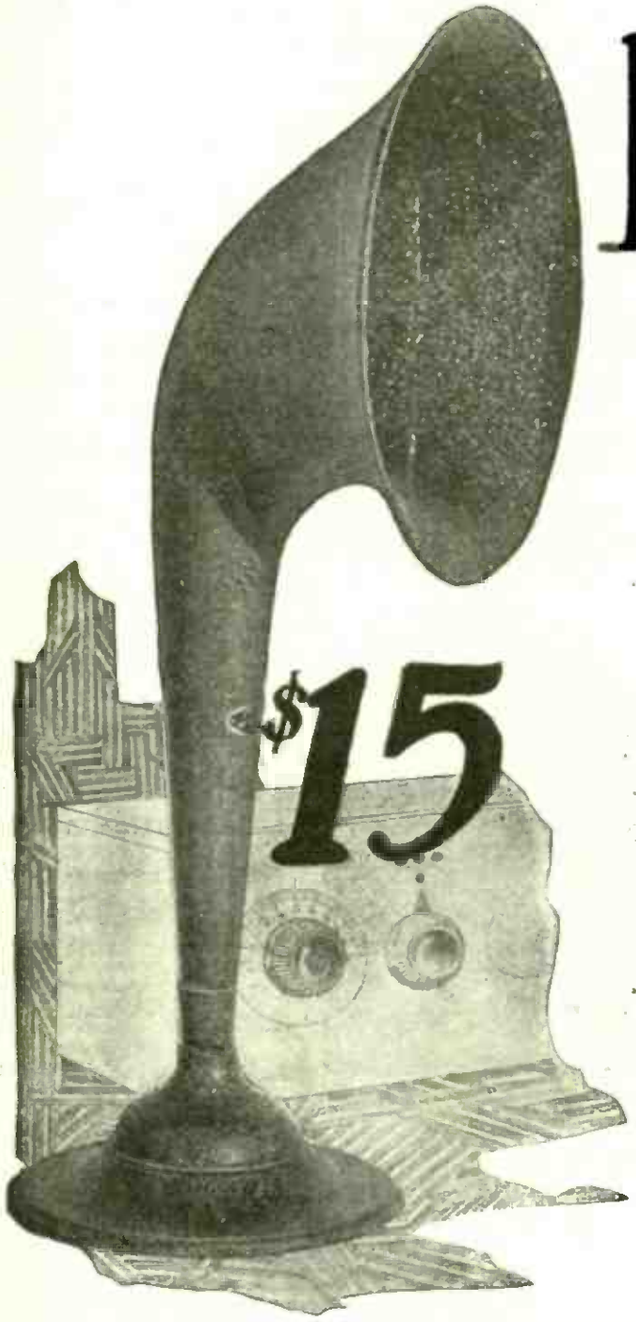
R. C. SCHOONHOVEN
Major Q. M. R. C.
ELGIN, ILL.

Perfectone

TRADE MARK

RadioReproducer

Listen in—home folks



Enjoy radio broadcast music and voice as faithfully reproduced with a Perfectone, the connecting link between radio broadcasting and its satisfactory interpretation in the home.

As the name implies, its perfect tone enables the radio audience to visualize the performers and to feel their presence.

The Perfectone has volume beyond the merrymaking of your guests, yet its tone may be softened by an adjustable volume-control feature.

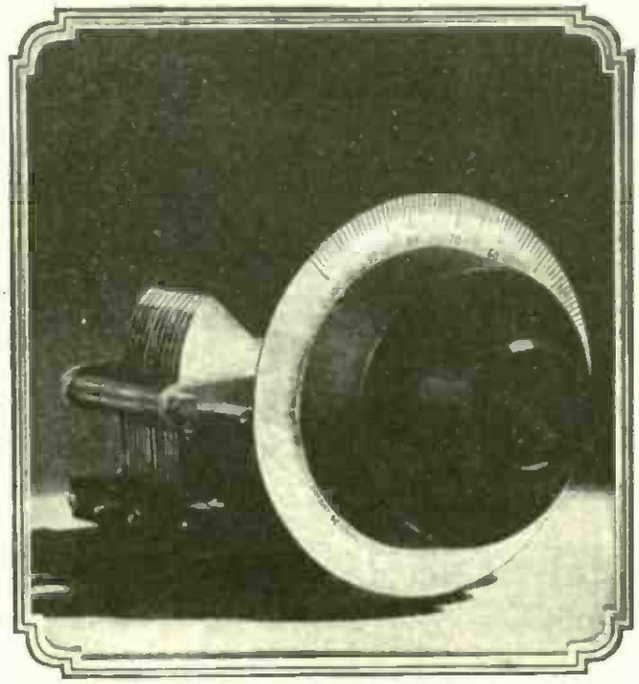
The Perfectone is pleasing in appearance, and when used with a Neutrodyne, Regenerative, or in fact any tube set of sufficient energy, gives remarkable reproduction.

Before you purchase a loud speaker at any price, listen to the Perfectone.

PERFECTONE
RADIO CORPORATION
490-C Broome Street
New York

BROADCASTING IS THE UNIVERSAL STAGE—YOUR ARM CHAIR A BOX SEAT

Controlled Reception



Tune out Local Interference

The Accuratune is not a mere dial, but an actual micrometer tuning control ten times more efficient than various tuning devices. With any good condenser, the Accuratune action is so precise that local stations can be tuned out completely, and station after station brought in that you never received before.

Even a person with little knowledge of radio can easily tune a receiver with the precision and accuracy of a radio amateur.

The Accuratune is designed for both coarse and fine tuning without the use of vernier attachments. Fits standard condenser shafts.

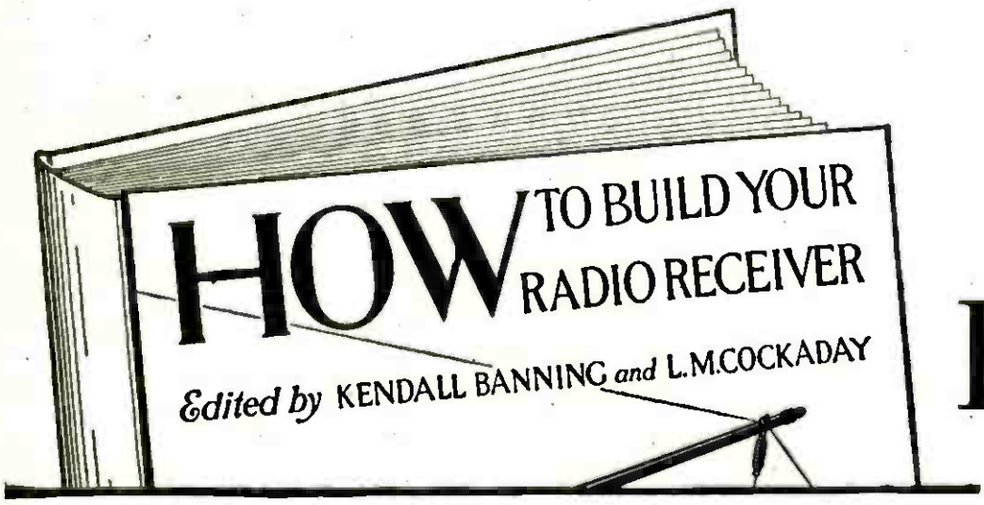
This unusual tuning efficiency amply repays you for the slight addition in cost over ordinary dials. Price $3.50.

THE MYDAR RADIO COMPANY

9-B Campbell Street, Newark, N. J.

ACCURATUNE

MICROMETER CONTROL



This Big 100-Page Handbook

FREE

They're Going Fast!

Popular Radio's New Book "How to Build Your Radio Receiver"

The most complete and authoritative collection of material yet published in book form on how to build and operate various types of radio receiving sets

THE first edition of POPULAR RADIO's new 100-page handbook, edited by Kendall Banning and Laurence M. Cockaday, is fast becoming exhausted. It can be *given away free*, for only a limited time longer.

So great has been the demand for this new handbook, "How to Build Your Radio Receiver," since its publication was first announced, that now after only 60 days it is necessary to plan for a second printing.

Therefore it is very doubtful how long this most liberal introductory offer can be held open.

This book is the most comprehensive and valuable contribution of its kind ever published for the radio enthusiast who, *with or without previous technical knowledge or training*, wishes to construct a radio receiving set of his own that will meet his every requirement.

"How to Build Your Radio Receiver" gives complete specifications for the construction of *seven* separate and distinct receiving sets—covering the most amazing range and variety of circuits, from the most modern simple crystal set to the famous Super-heterodyne (see opposite page).

All working details are given—the list of parts required and their approximate cost; complete hook-ups and circuit diagrams and *how to read them;* illustrations making all points clear, and simple instructions on how to assemble, mount, wire and operate each set.

Nor have any helpful pointers been omitted. In this new book edited by Mr. Banning and Mr. Cockaday, you will also find scores of valuable hints and suggestions about aerials, how to select your parts, how to install your set, tips on tuning, and how to learn the code.

In all, a book you will not want to be without—one that will be worth many dollars to you. Yet, if you act at once, it will not cost you a penny. We will send you a copy of this valuable handbook absolutely free with a year's subscription to POPULAR RADIO at $3.00. If you are already a subscriber, you may renew or extend your subscription for an additional year and still secure one of the first copies of this valuable book *absolutely free.*

The Coupon printed at the bottom of the opposite page provides a convenient means for you to secure this big cloth-bound handbook free. But you must act quickly!

Seven Remarkable Receiving Sets

Illustrated *Diagramed* *Described*

EACH of the sets described in POPULAR RADIO'S new book has been selected as the most *ideal* of its kind—for distance, selectivity, tone, volume, simplicity of construction, ease in tuning, reliability and general all-around satisfaction.

You will find sets employing both crystal and vacuum tube detection, with regenerative amplification, audio-frequency amplification, "push and pull" power amplification, radio-frequency, *compensated* radio-frequency and *intermediate wave* radio-frequency amplification.

You have your choice of crystal, one-tube, three-tube, five-tube, six-tube or eight-tube sets—the broadest selection anyone could ask for, all clearly illustrated, charted and explained in the simplest possible terms.

Here are the actual receiving sets described in this new book, "How to Build Your Radio Receiver":

A $5 Crystal Set

The simplest up-to-date set for local broadcast reception. Approximate range, 15 miles, though distances up to 400 miles are not extraordinary. Gives clear signals on headset without distortion. No operating cost whatever.

The Haynes Single Tube Receiver

An efficient set that may be made by a novice at an approximate cost of only $15 for parts. Simple to tune, selective, good audibility. Long distance range up to 1,000 miles on earphones. Six-volt storage battery and 22½ volt "B" battery required, or may be adapted for dry cells and dry cell tubes.

A Two-Stage Audio-Frequency Amplifier

This instrument may be added to *any* set, crystal or tube, to strengthen the received signals so that they will operate a loud speaker. It is easy to construct, efficient, and costs only about $15 for parts. Operates on the same "A" battery that is used on the vacuum-tube detector unit.

The Cockaday 4-Circuit Tuner

A 3-tube set, famous for its high selectivity and beautiful tone. So neat and compact that it may be kept in a bureau drawer. Cost of parts about $40. Receiving range approximately 1,500 miles on a loud speaker. Operates on 6 volt storage battery and two 45-volt "B" batteries, or may be adapted to dry cells and dry cell tubes.

A 5-Tube Tuned Radio Frequency Receiver

Two stages of tuned radio-frequency amplification, detector, and two stages of audio-frequency amplification are here employed so that the possibility of "oscillation and re-radiation" is eliminated. The set can be operated on a loop antenna and may be built at a cost of only $80 for parts. Six-volt storage battery and two 45-volt "B" batteries required. Range about 1,000 miles on loop or indoor antenna, and 2,500 to 3,000 miles on an outdoor antenna.

The "Improved" Cockaday 4-Circuit Tuner

Probably the most important contribution yet made to the equipment of the radio fan. A compact 5-tube set with a receiving range of over 3,000 miles. Cost of parts about $70. Wavelength range from 150 to 675 meters. Automatic tuning and power amplification. Maximum volume of sound, excellent reproduction and no interference. Requires a 6-volt "A" battery, three 45-volt "B" batteries, one 22½-volt "B" battery and a 9-volt "C" battery.

The Regenerative Super-heterodyne Receiver

More sensitive, more selective and more simple to tune than any other 6-tube receiver yet developed. A three-section, 6-tube set employing the Haynes Single Tube Receiver as tuner. May be further extended to a four-section, 8-tube set by the addition of the two-stage audio-frequency amplifier. The cost of parts approximate $65. Range of 3,000 to 4,000 miles on a loud speaker. Has been called the "Rolls-Royce" of radio receivers.

¶ As a special introductory offer, for a limited time only, this book will be given FREE with a year's subscription to POPULAR RADIO at $3. Simply mail your remittance with the handy coupon below, and a FREE copy of "How to Build Your Radio Receiver" will be sent you, postage prepaid. Your subscription will be entered at once.

This Coupon Entitles You to a Free Copy

POPULAR RADIO, Dept. 35,
9 East 40th Street, New York City.

Please send me, postage prepaid, a FREE copy of POPULAR RADIO'S new handbook, "How to Build Your Radio Receiver," edited by Kendall Banning and L. M. Cockaday. I enclose $3 for a year's subscription to POPULAR RADIO which entitles me to this big cloth-bound book (size 7⅝ by 11¼ inches) absolutely free of charge.

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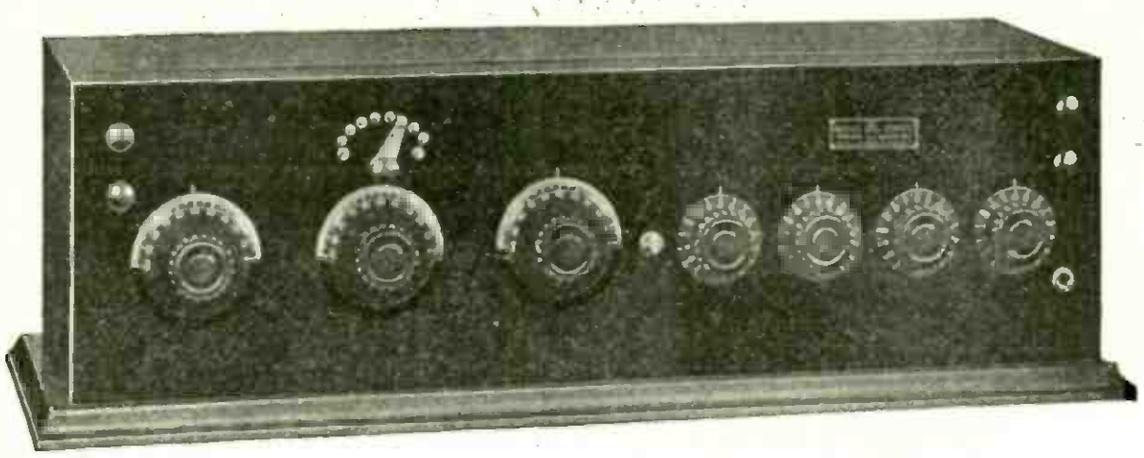


Broadcast Receiver — Type R-12

Employing special Copp VARIO-SELECTOR constructed on Copp Circuit No. 5.

This Receiver combines Tuned Radio Frequency with a special selector device which gives to this set the requirements necessary for perfect radio reception:

Selectivity Volume Clearness Distance Ease of Tuning

Wave Length Range — 200 to 600 meters
Distance — up to 2500 miles

Type R-12 is a 4 tube Set designed for satisfactory use at a reasonable price, both for cities where the nearness of Broadcasting Stations requires fine selectivity; as well as for suburban districts where selectivity is not as essential as clearness, volume, distance and ease of tuning.

The VARIO-SELECTOR makes this set efficient for either Sharp or Broad tuning as conditions warrant.

Broadcast Receiver Type R-12 is built of the highest grade materials using Bakelite insulation throughout, all contained in a beautiful Brown Mahogany finished Cabinet.

Copp Circuit No. 5 is the fifth proven circuit developed and perfected by our Engineering Department under the direction of Mr. R. S. Copp, who built and perfected the first single circuit regenerative Receiving Set, known as Copp Circuit No. 1.

Full information, with descriptive literature, etc., will be mailed on request.

The Price of Type R-12 . . . . . $98.00
(Without Tubes)

The A-C Electrical Mfg. Co. - - Dayton, Ohio

Makers of Electrical Devices for over 20 Years

RECEPTRAD HAS REDISCOVERED THE SUPERHETERODYNE

THREE years have elapsed since the famous Superheterodyne circuit was first developed. Since then many have regarded the Superheterodyne as the most desirable circuit to use—but only to be attempted by the expert!

RECEPTRAD, after elaborate development and laboratory work has *rediscovered* the Superheterodyne for the layman—by its specially designed Heterodyne parts and easily followed construction helps.

You can now build a Superheterodyne without difficulty of any kind—regardless of your knowledge of radio or engineering. Thousands of miles on a loop! Volume so great you never use beadsets to tune in. Distance vanishes before the Receptrad Superheterodyne.

The heart of the Superheterodyne is in its transformers. Receptrad has designed special intermediate frequency amplifying transformers which surpass in efficiency anything on the market—because they are built solely for the Superheterodyne. These transformers (Type 1716) have steel cores to assure power and stability. They cover a band of frequencies from 5,000 to 25,000 meters.

Type 1716 Transformers.....$8.50

Special Receptrad 8-Tube Superheterodyne Package:

1 Oscillo-Coupler, Type S W-21
1 Tuned Filter Coupler, Type H-34
3 R F-1716 Transformers—Range 5,000 to 25,000 meters.
1 Audio Transformer, Type ATX
1 Audio Transformer, Type AT3
2 1MF By-Pass Condensers Type G-1000
1 SUPERHETERODYNE MANUAL

$55

JUST PUBLISHED! "The Superheterodyne Manual." This comprehensive book by Victor Greitt, A.I.E.E., I.R.E., is the only complete treatise on the subject of the Superheterodyne. 64 pages. Copious illustrations. Authoritative. Gives full instructions on HOW TO BUILD THE SUPERHETERODYNE SUCCESSFULLY with full size panel layouts, circuit details, etc. Price 1.50.

RADIO RECEPTOR CO., Inc.

57 BANK STREET **NEW YORK, N. Y.**

THE CALLOPHONE LOUD SPEAKER

A Handsome Addition to Your Home

that will faithfully reproduce the broadcasting, program. Its soft, mellow tones of pleasing volume will bring the artist *home* to you as no other loud speaker can do.

Each Callophone is made with exacting care—tested under actual operating conditions—and *sealed* before shipment.

The Callophone is absolutely GUARANTEED—and will be kept in repair and adjustment free of charge—*as long as the seal remains intact.*

A dial adjustment of the diaphragm regulates the volume and enables you to adjust it to your particular type of receiver. No extra batteries are required.

The Callophone is $35.00. And here is the test we want you to make: compare it with any loud speaker you have ever heard—*if you are not satisfied* with its superiority—return it and the full purchase will be refunded to you.

"Made by the makers of Callophone Commercial Loud Talking Apparatus—recognized for years as the best."

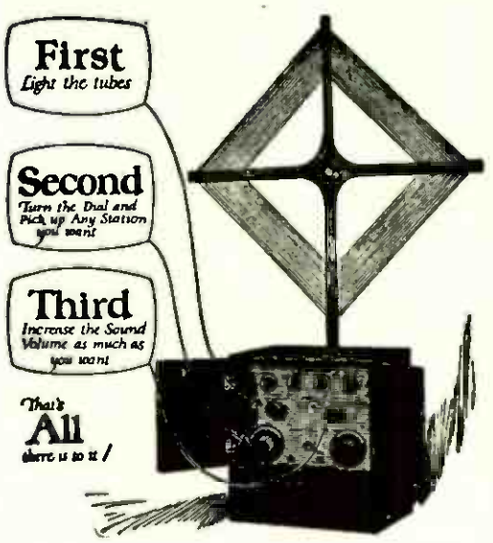
If unable to secure Callophone from your dealer send direct to

THE CALLOPHONE COMPANY OF NEW YORK, Inc.
216-222 Mercer Street
New York, N. Y.

See How Easy It Is

to Get the Radio Broadcast from all over the Continent

If you Have a DE FOREST RADIOPHONE!



NO OUTDOOR ANTENNA—The Loop as shown is all you need, though the De Forest Reflex can be used with outdoor aerial if desired.

NO OUTSIDE BATTERIES—All Dry Cells go inside the box, although the set can be used with the storage batteries if desired.

NO GROUND—No outside wires or connections of any sort. The set gets cross-continent broadcast just as you see it with great clearness.

The world-famous De Forest Reflex Radiophone, type D-10, is a 4-tube set with a range on indoor loop of 3,000 miles (record range 5,000 miles). It has a reputation for the clearest reception of broadcast in existence. Uses either head phones or loud speaker. The simplest long-distance set made; low in first cost; economical to operate. Price for set and loop, $150.00, plus 6% for territories west of the Rockies.

FREE RADIO CATALOGS Send us your name and address and we will send you the new De Forest Catalog with full details and prices on sets, audions, and parts.

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Dept. P. R. 7 Jersey City, N. J.

De Forest Radiophones

"Made by the Man who Invented Broadcasting"

Charge Your Radio or Auto Battery at Home Overnight for a Nickel with the

GOLD SEAL HOMCHARGER

—the world's best as well as its most popular rectifier. Simple, dependable, practically silent and absolutely safe. Beautifully finished in mahogany and gold—an ornament for the finest living room.

Why Pay More—Or Get Less?

Why buy a 2 or 3-ampere rectifier without ammeter requiring from 40 to 50 hours to charge your battery and costing twice as much to operate when, for the same price, you can secure the genuine 5-ampere GOLD SEAL HOMCHARGER which does a better job in one-third the time and at half the cost? Fitted with high grade ammeter (eliminating guesswork) charging cable and battery clips—no extras to buy. For sale by all good dealers. $18.50. ($25.00 in Canada.)

Insist on the Gold Seal

It's your guarantee against substitution and appears on nameplate and package. No other charger is just as good.

GENUINE GOLD SEAL HOMCHARGER MFG. UNQUALIFIEDLY GUARANTEED

Radio Fans, Attention!

FREE Ask your dealer or send direct for free HOMCHARGER list of broadcasting stations and GOLD SEAL bulletin.

The Automatic Electrical Devices Company
132 West Third St., Cincinnati, Ohio
Largest Manufacturers of Vibrating Rectifiers in the World

Regal

"Pays For Itself In Longer Service"

Broadcast Tested, High Quality Audio Transformer

For clearness of tone, amplification of voice and music from nearby and distant broadcasting stations, is unequaled by any Transformer on the market.
3½ to 1 Ratio...$4.25
5 to 1 Ratio... 4.50

Fifteen Taps—But Only One Drill Hole Required!

A 15 Point Switch complete in one unit. No more messy soldering. No more drilling of holes. No more chipped panels. Complete with hard rubber Knob and Dial.
Type No. 162.....$1.50

Perfect Contact Vernier Rheostat

For fine filament control of tubes and superfine tuning, the Regal Vernier stands alone. Nothing just like it on the market.
Complete with Knob
6-Ohms.....$1.25
30-Ohms..... 1.25

At all good dealers—otherwise write direct for complete descriptive folder No. 24, sending dealer's name.

AMERICAN SPECIALTY CO.
Bridgeport, Connecticut, U.S.A.

LAVITE RESISTANCES

1,000 OHMS
12,000 "
48,000 "
50,000 "
80,000 "
100,000 "

$1.00 Each

Money Orders and Checks Only
NO STAMPS

HAROLD HERBERT Inc.
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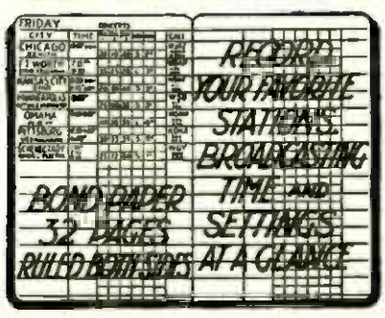
TRADE MARK REGISTERED

GET YOUR STATION

WHEN YOU WANT IT WITHOUT FISHING



Stop wasting time on silent stations. Send a quarter for this handy radio reference and list all stations you hear.

CONTAINS A LIST OF ALL BROADCASTING STATIONS

SECURITY SALES CO.
3051 MARCUS AVE. ST. LOUIS, MO.

CARTER
JACK SWITCH

$1

Compact—durable—mounts like jack; heavy phosphor-bronze springs—silver contacts. Westinghouse "Micarta" insulation.
Furnished complete with "On and Off" Name Plate, Knob and Pointer. Made in four styles.
Write for catalog complete line Carter quality Radio Products, including special hook-up for Jack-Switches.

Carter Radio Co.
1807 REPUBLIC BUILDING
CHICAGO

NA-ALD
De Luxe Dials

The artistic qualities of Na-ald De Luxe dials distinguish these dials as truly beautiful. They add to the appearance of any set in which they are used.
Na-ald Dials have a high gloss finish. They are moulded of genuine Bakelite and have patented construction. Dials are matched and made in 2", 3", and 3¼" sizes.

Alden Manufacturing Company
Largest makers of Radio sockets and dials in the world
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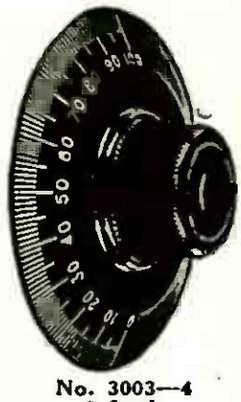

No. 3003—4
3 Inch
35c, 3 for $1.00

RADIO "B" BATTERIES
AT FACTORY PRICES

Greatest radio "B" battery on market. Full number voltage taps; QUALITY GUARANTEED; LOWEST PRICES; brings in concerts LOUDER AND STRONGER; will work on any tube or loud speaker. Order by number TODAY with check, money order or pay postman C. O. D.

No. 122B 22½ volt variable, regularly $2.25... **$1.52**
No. 122A 22½ volt variable, regularly 3.00... **1.85**
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AYRES BATTERY CORPORATION, Cincinnati, Ohio

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EVERYTHING IN RADIO

One of the largest complete stocks in the world. 40 diagrams of latest Hookups.

DEALERS ALL OVER THE U.S.

Making big profits handling our supplies. 24-hour service. Goods shipped same day order received.

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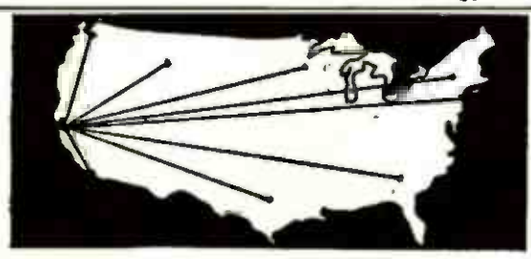
NEW PYRALIN
SHELTONE LOUD SPEAKER
$3

Made by Du Pont expressly for us. WORKS with any Phones.
Beautiful, transparent, exceptional value. Satisfaction guaranteed.

THE SHELTONE CO.
185-189 Clinton Ave.
Newark, N. J.



ON ONE TUBE

Broadcasting from Atlantic Coast, Canada, Mexico, Cuba & Hawaii heard in Calif. by users of the CROSS-COUNTRY CIRCUIT. Range due to simplicity. One tuning control. ANY NOVICE can build easily and cheaply. Dry cell tubes used. No soldering. Complete instructions, Blue print panel layout, Assembly Photo, etc., postpaid 25 cents. Stamps accepted.

VESCO RADIO SHOP, Box PR-117, OAKLAND, CALIF.

Vacuum Tubes
Repaired

WD-11, WD-12, UV-201A, UV-199
and others for

$3.00

Quick service. All tubes repaired by us guaranteed to work as good as new.
Send your dead tubes. We prepay parcel post to you. All you pay is $3.00 to postman.

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A complete set at a special price.
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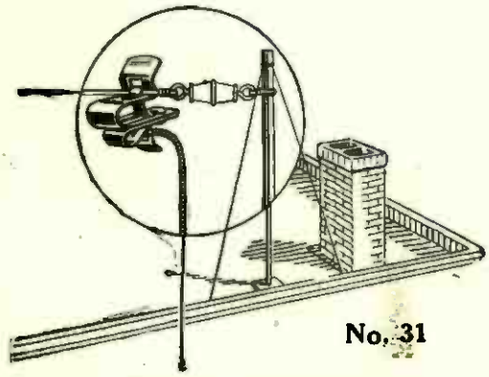

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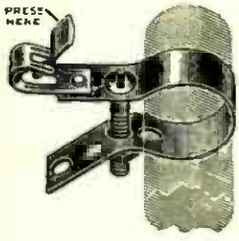
Snap larger connector over Antenna Wire: Insert Lead-in Wire into smaller clip and a perfect connection is the result.



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For use in all standard Reflex and Radio-Frequency Circuits.

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PERHAPS you haven't realized what a tremendous amount of information is available in the back issues of POPULAR RADIO. Since the first number was published, May, 1922, literally hundreds of requests have come to us for these valuable back issues of POPULAR RADIO which contain so many practical hints and worth-while suggestions.

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Glance over this partial list of contents of each issue. Then tell us which ones you want, enclosing stamps, check or money order to cover your requirements. Our stock is getting very low, so don't delay taking advantage of this offer!

May, 1922

—Harnessing waves to wire.
—How to tune a Regenerating Receiver.
—Symbols that help in reading diagrams.
—How to make soldered connections.
—How Radio waves are sent and received.

June, 1922

—Wireless that we can see.
—Can we talk to the dead by Radio?
—How electricity is generated.
—Tones that do and don't broadcast.
—How to make a simple tube Receiving Set.

July, 1922

—Steinmetz on ether waves.
—How to learn the code.
—How to make a two-circuit Receiving Set.
—How high frequency currents are generated.
—Pointers for preventing interference.
—How to make a loose-coupler coil.

August, 1922

—How machines are controlled by Radio.
—How Radio circuits are coupled and tuned.
—What "call letters" mean.
—How to make a variable condenser.

September, 1922

—How to build the Armstrong Circuit Receiver.
—A resonance wave coil for reducing static.
—How to make a rotary plate condenser.
—The simplest receiving antenna.

October, 1922

—How to make a spider-web tuner.
—How to make your own grid condenser.
—Don'ts for Radio fans.
—How to use a Regenerative Set as a transmitter.
—How to restore worn-out crystals.

November, 1922

—Sir Oliver Lodge on ether waves.
—How to add a Vacuum Tube to your crystal set.
—The most popular transmitting aerial.
—How to make a novel variocoupler.

December, 1922

—How to select the best coil for your set.
—How to make and use a loading coil.
—A Receiving Set that takes notes.
—How to make a series-antenna condenser.

January, 1923

(Out of stock. A Reprint of Mr. Cockaday's article describing the DX Regenerative Receiver may be had for 22 cents.)

February, 1923 (Out of Stock)

March, 1923 (Out of stock.)

April, 1923

—Regeneration without Radiation.
—How to make a simple single tube Receiving Set.
—Circuit diagram of the Cockaday DX-3 Circuit Tuner, with instructions on how to add three stages of radio frequency.

May, 1923

(Out of stock. A Reprint of Mr. Cockaday's article describing the original 4-Circuit Tuner may be had for 22 cents.)

June, 1923

—How the microphone transmitter works.
—How to build a good single tube receiver.
—How to make a crystal detector stand.

July, 1923

—The ratio in size between your antenna and your coil.
—Useful facts about ear-phones.
—How to make a dry-cell tube Regenerative Set.
—How to keep up your storage battery.

August, 1923

—How to build a Tuned Radio Frequency Receiver.
—Measurement chart for determining the constants for a loop antenna.
—How to calibrate your wave meter.
—Circuit diagram of the original Cockaday 4-Circuit Tuner adapted for use with dry-cell tubes.

September, 1923

—How to get a radio license.
—How weak signals are regenerated.
—How to make a battery charging rectifier.
—How to build the Haynes DX receiver.

October, 1923

—Practical hints for Coil Calculations.
—How to make a Two-stage Audio frequency Amplifier.
—Ten good rules for Broadcast Listeners.
—How to make a simple Honeycomb Receiver.

November, 1923

—The 100 Best Hook-ups (Part 1)
—Receiving without Antennas.
—How to build the New Regenerative Super-heterodyne Receiver (Part 1.)
—How to build a combination Short and Long-wave Receiver.

December, 1923

—How to Select your Radio Parts.
—The 100 Best Hook-Ups (Part 2).
—How to Read a Diagram (Part 1).
—How to Build an efficient Crystal Receiver.
—How to Build the Super-heterodyne Receiver (Part 2).

January, 1924

—How to build the "Improved" Cockaday 4-Circuit Tuner.
—The 100 Best Hook-ups (Part 3.)
—How to Read a Diagram (Part 2.)
—List of U. S. Broadcasting Stations.
—How to build the coupler, oscillator coupler and r. f. transformers for the Super-heterodyne.

February, 1924

—How to add "Push and Pull" amplification to the original 3 tube Cockaday 4-circuit tuner.
—The original 4-Circuit Tuner as a Portable Set with Loop.
—The 100 Best Hook-ups (Part 4.)
—How to build a 3-tube Reflex. Receiver (Part 1.)

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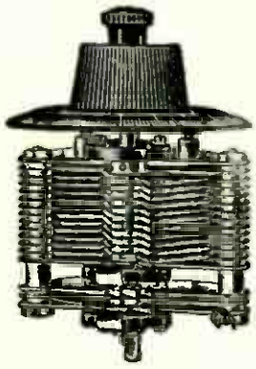

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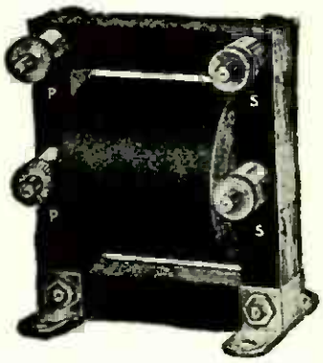

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Of tested and permanent capacity, ranging from .0001 to .006, 35 cents to 75 cents, of **superior** quality.

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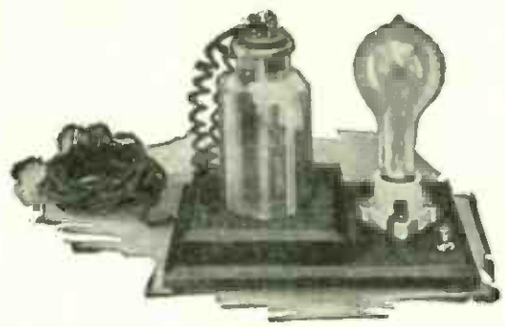
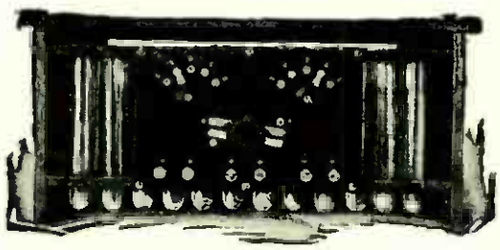


Mounted Charger



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A prominent New York engineer said the above. KIC-O batteries made good with professionals and novices. Alkaline type; won't sulphate or buckle. Life unlimited. Not harmed by short-circuiting, over-charging, idleness. Panel switches give single cell variations. Recharge from any 110-volt A.C. line with small home rectifier. Charge lasts 3 to 6 months in detector plate circuit.

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36	48	9.50	14.00
50	68	12.50	17.00
78	100	17.50	22.50
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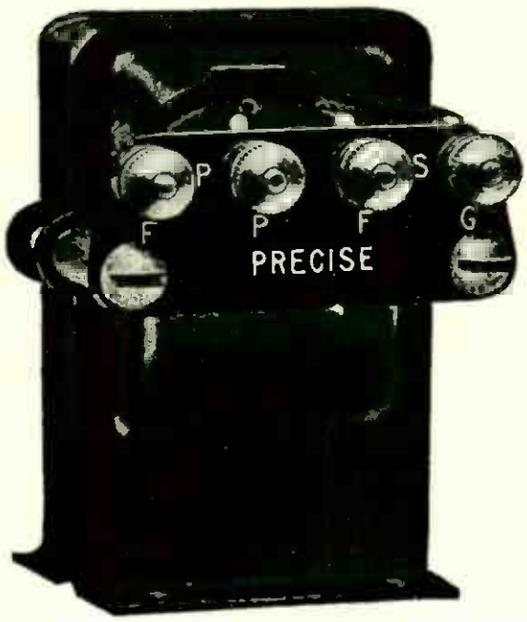

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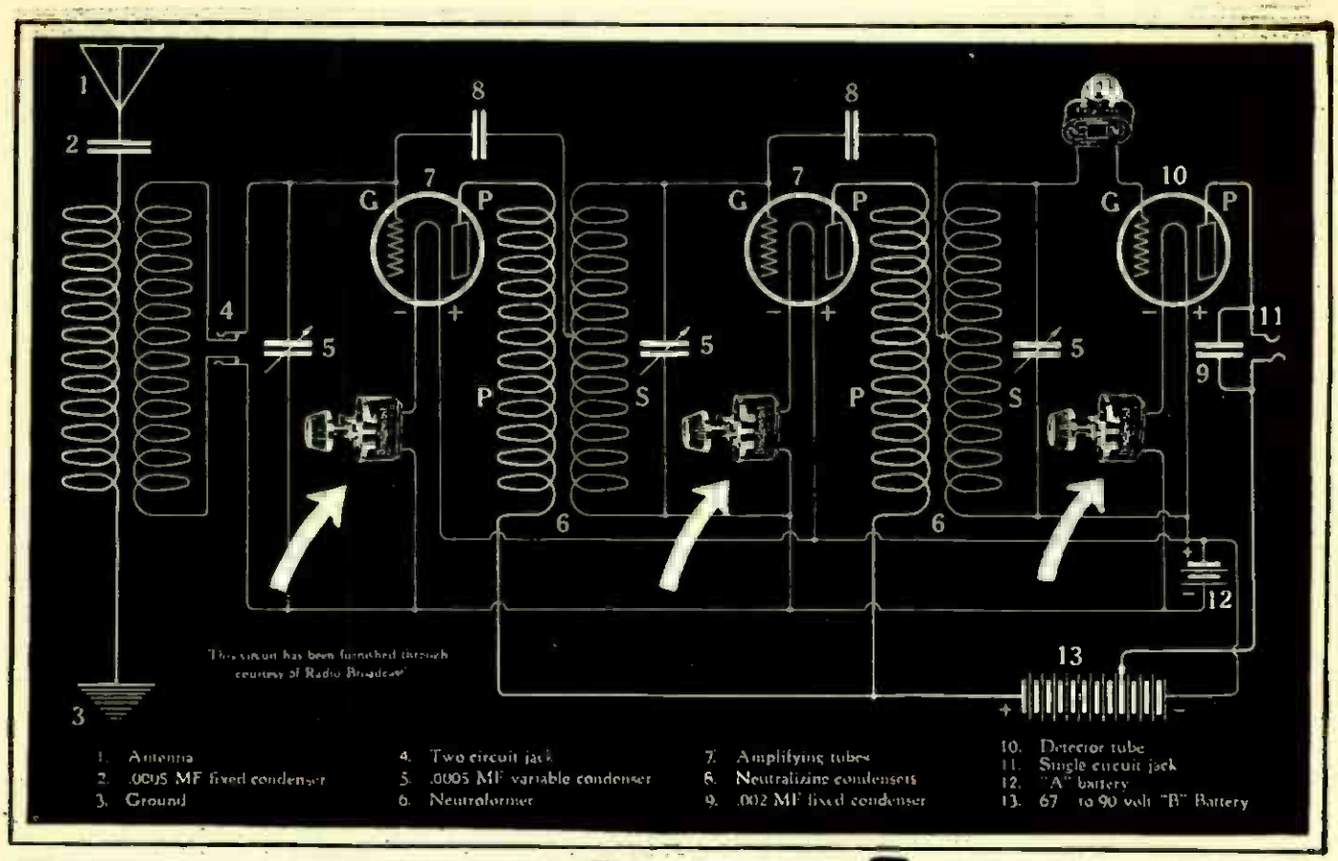

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