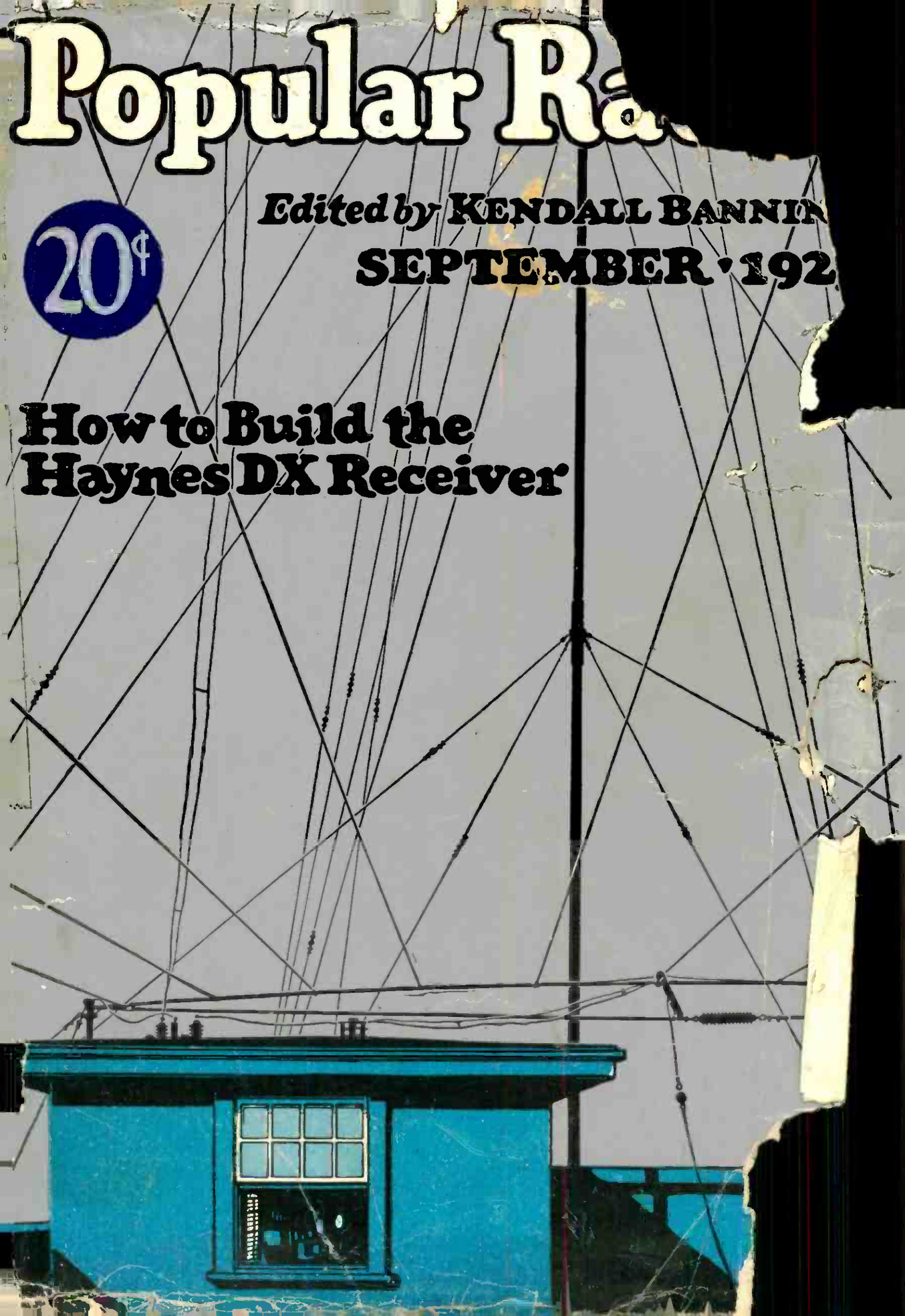
Popular Ra

Edited by KENDALL BANNIN

20¢

SEPTEMBER • 192

How to Build the Haynes DX Receiver



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The super-amplifier tube, $6.50

Radiotron UV-199
The little tube of big performance
$6.50

Radiotron UV-200
The long distance detector, $5.00

Radiotron WD-11
The ideal dry battery detector
$6.50

Radiotron WD-12
The standard base dry cell tube $6.50

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For quality of reception and length of service, every man wants a RADIOTRON. Experienced amateurs and broadcast listeners know the sensitivity and dependable performance of these tubes. UV-199 for portable sets because it operates on flashlight batteries—WD-11 and WD-12, the dry cell tubes, for use everywhere—especially on farms and at the summer bungalow—UV-200 and UV-201-A for use with a storage battery. There is a Radiotron for every need.

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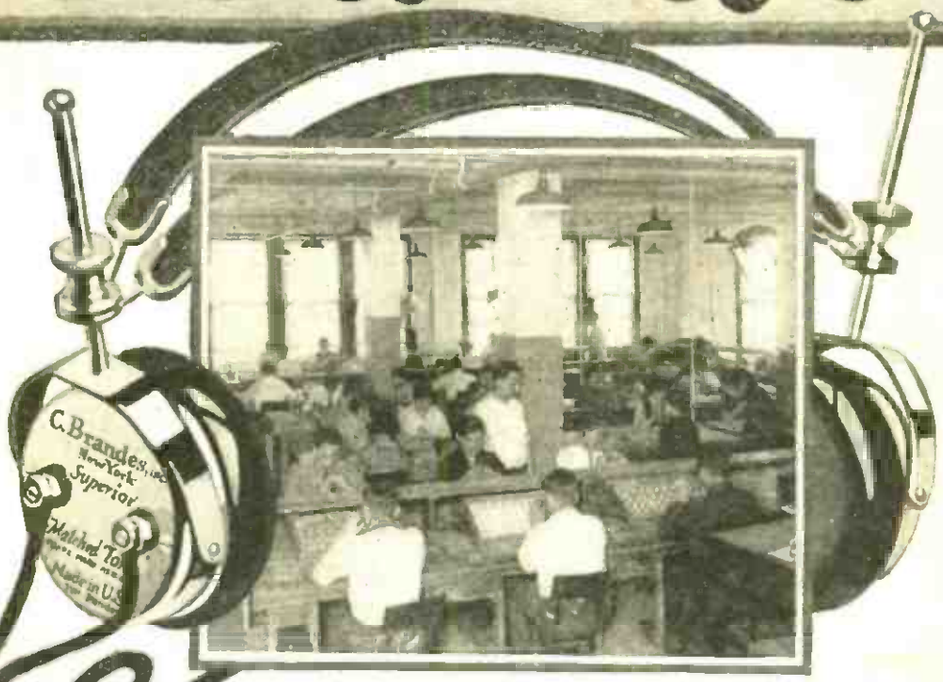

One every ten seconds

Production is the principal governing factor in determining costs.

The Popular demand for Brandes *Matched Tone* Headsets has caused the installation of so many special machine tools and other labor saving devices that a substantial reduction of cost has resulted.

This we pass on to the consumer in lowered prices. The standard of Brandes quality will ever be maintained or raised if possible—checked by twenty-two rigid tests and inspections of each headset.

NEW PRICES

Superior
$6.00

Navy Type
$8.00

Made in Canada and England by
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Matched Tone

TRADE MARK REG. U.S. PAT. OFF.

Radio Headsets

POPULAR RADIO

EDITED *by* KENDALL BANNING

CONTENTS *for* SEPTEMBER, 1923

(Cover design by Frank B. Masters)

VOLUME IV NUMBER 3

VOLUME IV SEPTEMBER, 1923 NUMBER 3

Published monthly by Popular Radio, Inc., 9 East 40th Street, New York, N. Y., telephone number Vanderbilt 9985; H. B. Emerson, President; E. R. Crowe, Vice-President; F. C. Hemberger, Treasurer. Price, 20 cents a copy; subscription $2.00 a year in the U. S., Canada and all countries within the domestic postal zone; elsewhere $2.25 a year, payable in advance. The International News Company, Ltd., No. 5 Bream's Bldg., London, E. C. 4, sole distributors in England. Entered as second-class matter April 7, 1922, at the Post Office at New York, N. Y., under the act of March 3, 1879.

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

PAGES WITH THE EDITOR

THE Editor takes pleasure in here announcing a long-contemplated and carefully-planned move that will not only vastly benefit our readers but that will establish POPULAR RADIO in a class by itself among the radio magazines:

Beginning with the November number, POPULAR RADIO *will be enlarged by 56 pages.*

* * *

THIS substantial increase—(which is almost equivalent to the size of the entire magazine eighteen months ago)—has been inevitable for several months, owing to the increasing obligations of publishing the very latest and best information concerning the radio art and electrical science while that information is new and while our readers can get the fullest benefit from it.

* * *

THIS enlargement (equivalent to about 40 percent) will enable the Editor to include many valuable articles which have been deferred from time to time only because of the lack of space; also (and more particularly) it will enable him to broaden the editorial scope of the magazine so that it will hereafter include many notable features, including new developments, that will add immeasurably to the interest and importance of POPULAR RADIO.

* * *

THIS forward step will be accompanied by an increase in price from 20 cents to 25 cents a copy on the newsstands—and the yearly subscription price will advance to $3.00.

* * *

AND it will be further accompanied by a circulation guarantee—for the protection of our advertisers—that establishes POPULAR RADIO as having "the largest *guaranteed* circulation of any radio magazine."

* * *

EVERY once in a while the Editor gets a letter that makes him realize even more keenly the astonishingly far-reaching effects of the material that is published in our pages; even an obscure little item tucked away in one of the departments may lead to important consequences that could not possibly be anticipated.

* * *

THE Editor has only recently learned, for example, that one of the largest industrial concerns in the country abandoned plans for a long and costly series of experiments with certain electrical apparatus, as the direct result of an article that appeared in POPULAR RADIO some months ago—an article that was written by one of the foremost scientists of the world, whose investigations indicated that the proposed experiments would be directed along obsolete and consequently futile lines.

* * *

STILL more recently comes this significant letter from Dr. O. I. Hess of Scottsdale, Pa., to whom a short item on page 83 of our July number gave his first understanding of reradiation:

"The first item in the July number that greeted me," he reports, "was the protest of a radio fan suffering from psycho-asthenia and calling upon the U. S. Government to suppress the single circuit receiver. I have often wondered what might be the cause of the buzzing, whistling and squawking and other interference. Now I know—and the information is worth several years' subscription to your magazine."

* * *

BOTH of these incidents of widely divergent natures emphasize not only the wisdom of insuring the absolute accuracy of every item that appears in this magazine, but the compelling necessity of it—as a foremost obligation to our readers.

* * *

"IF *you see it in* POPULAR RADIO, *it's so!*

* * *

"A BUSINESS friend who has POPULAR RADIO come to his office," writes a friend in Chicago. "told me that the only way by which he could be sure to preserve his copy to take home in the evening, was to lock it in the office safe during working hours; otherwise some one was sure to walk off with it."

Well, after all, is not the office safe the proper place to keep valuables?

* * *

MORE and more apparent is it becoming that Laurence M. Cockaday's article in our May number, "How to Build the New Four-Circuit Tuner," is noteworthy not only because of the remarkable efficiency of the receiving set which it describes, but also because of its remarkably clear and concise presentation. And when praise comes from the editor of an Esteemed Contemporary, it can hardly be construed exactly as mere flattery.

* * *

"IT is the best prepared and best presented technical article of its kind that I have ever seen," generously admitted the amiable Major J. Andrew White (who is known by radio fans through the country) during a visit to the Editor.

"Praise from Sir Hubert is praise indeed."

* * *

"YOUR Four-Circuit Tuner described in May POPULAR RADIO is certainly a fine one. I built one according to your specifications; it has the world beaten for ease of tuning, minimum amount of static and other outside noises. I cut KPO completely (he's across the bay in Frisco from me) and tune in KFI without hearing KPO. And that's more than a lot of hams are doing around the bay. I get stations 750 miles away like local stuff, and no distortion whatsoever."

—A. S. NIELSEN, (6NA)

* * *

AN inkling of our plans for enlarging POPULAR RADIO was published in our August

(Continued on page 8)

The DUBILIER Duratran—

Amplification on all wavelengths

THE Dubilier Duratran is the supreme radio-frequency transformer. It amplifies powerfully and uniformly *over all the wavelengths* now used by broadcasting stations.

Price $5.00

At all good dealers

DUBILIER CONDENSER AND RADIO CORP.

48-50 West Fourth Street, New York

DUBILIER DEVICES

PAGES WITH THE EDITOR

(Continued from page 6)

issue, which had no sooner reached the newsstands than the Editor began to receive letters from enthusiastic readers who wrote, in effect, "Go to it!" The very first letter, indeed, came from Waterville, Maine; it reads as follows:

"I notice in the August issue that mention is made of the fact that the size of the magazine is liable to be increased. Go ahead! It will be the best thing that could be done. As long as this dandy radio magazine keeps up the way it has been going in the past, it will always be the leader in the radio magazine field. Keep us amateurs filled with the dope we need, and you'll always have plenty of friends!"

—D. GILBERT LIBBEY

* * *

JUST as this number of POPULAR RADIO is going to press our Advertising Manager was offered a contract for $1,800 worth of advertising—with the proviso that we publish in our editorial pages a press agent "write-up" that accompanied it. The contract was not accepted.

* * *

THIS incident (which is merely one of many of the same nature) gives the Editor the opportunity of defining one of the fundamental editorial policies which is perhaps the most significant of all, and to which the quite remarkable growth in circulation of POPULAR RADIO may be attributed.

The editorial columns of POPULAR RADIO *are not for sale!*

* * *

EVERY article, every paragraph, every picture—every bit of information that appears in our editorial pages—is selected carefully with a definite purpose; to give our readers sound, authoritative, practical and interesting information that is entirely without bias and which is independent of any commercial consideration.

* * *

THE Editor believes that his first obligation is to his readers. He believes that any editorial item that is prejudiced either for or against any product or any manufacturer or any dealer or any special interest, *particularly if that bias is determined by money considerations*, is a form of editorial prostitution to which POPULAR RADIO has not and cannot lend itself.

* * *

IN pursuance of this policy POPULAR RADIO has established itself as a publication entirely apart from the trade journals, dealer magazines and similar periodicals whose editorial content is frankly determined in greater or less degree by the advertisers. Such magazines have a perfectly proper and legitimate field with which the Editor has no quarrel. But their circulation and influence are necessarily limited.

In contrast to that policy POPULAR RADIO has established itself as an eminently authoritative, high grade publication that is receiving not merely the indorsement, but the active support of many of the foremost scientists in the world, whose writings seldom appear in print except in the published proceedings of learned societies and of the technical institutes. These scientists appreciate the fact that the editorial contents of POPULAR RADIO are selected solely because of the intrinsic merits of the articles themselves, and not because advertising may or may not be dependent upon them.

* * *

THE Editor will not knowingly publish any article that exploits a patented product that is on the market, or "boost" any manufacturing concern, or otherwise lend himself to the purposes of the press agent who (naturally enough) has a very special ax to grind. The Editor won't do it because he would not be playing fair with his readers nor would he in the long run be serving the interests of the advertiser.

* * *

THE wisdom of this editorial policy is significantly illustrated in POPULAR RADIO's large and constantly growing circulation, not only among the very best class of radio amateurs and novices, but among scientists and laymen and even among the manufacturers and dealers as well. And the advertiser in POPULAR RADIO is getting the benefits of this reaction and is profiting accordingly.

* * *

The editorial pages of POPULAR RADIO *are not for sale!*

* * *

THE format of POPULAR RADIO—meaning its physical appearance, its illustrations, diagrams and typographical arrangement—is attracting attention in the Old World as well as in this country. From the editor of one of the most conservative and distinguished electrical journals of England, *Beama*, known to scientists throughout the world, comes this pertinent comment.

"We have just received the latest number of POPULAR RADIO, and should like to congratulate you on the style of its production and layout."

* * *

IN the next number—for October—will appear an important article by the foremost radio expert of France, General Gustave Ferrié, of the French Army.

Kendall Banning

Editor, POPULAR RADIO

STRIKING BEAUTY
in this new Kennedy Set

THIS NEW ADDITION to the Kennedy line has a three-fold appeal for you. First, its artistic beauty—simple, refined lines. Second, the faithfulness and unusual tonal purity of its reproduction. Third, it is a self-contained unit, all batteries and loud speaker unit enclosed in the cabinet. Ample volume is assured for dancing or entertainment.

In this set extreme simplicity of operation has been obtained, at the same time retaining the selectivity of tuning and long distance reception that has distinguished all Kennedy receiving sets. Only two dials are used—one to bring in the desired station, the other to regulate volume. Truly a set of which the Kennedy laboratories can justly be proud.

You can arrange with the nearest Kennedy dealer for a demonstration, or write us direct for descriptive literature.

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS SAN FRANCISCO

THE KENNEDY MODEL X

This beautifully inlaid mahogany cabinet encases a complete, self contained radio receiver (wave length range 150 to 600 meters.) Two stages of audio amplification, built-in loud speaker. Formica panel. Dials and metal trimmings gold plated. All dry batteries—three dry battery tubes—phones for weaker signals or individual reception—complete, $285.00

All Kennedy radio receiving sets are regenerative—licensed under Armstrong U. S. patent No. 1,113,149

KENNEDY

The Royalty of Radio

From a photograph made for POPULAR RADIO

"THE HEAVISIDE LAYER IS REAL"

So says Dr. Reginald A. Fessenden, the distinguished pioneer in radio, who contributes an important article on the much-discussed "sliding wave" theory in a coming issue of POPULAR RADIO.

Western Electric

ENGLAND'S FOREMOST AUTHORITY ON THE ELECTRON

SIR JOSEPH J. THOMSON, *the discoverer of the electron and a foremost investigator of the structure of matter, whose observations on the elements of the electrons as expressed in the following pages are of value to both the scientist and the layman.*

Popular Radio

VOLUME IV SEPTEMBER, 1923 NUMBER 3

NEW THEORIES OF

How the Atom Is Put Together

How atoms make up all kinds of matter—
even the bodies of living men

THE idea of the electron has revolutionized modern physical science. All electricity is composed of electrons. When electrons accumulate at one particular place they cause what we call an electric charge; when they are in motion they constitute an electric current. The electric impulses which produce the waves of radio are merely surges of electrons, millions of billions of them, back and forth in the antenna wires. Electrons are also the building stones of matter itself. Atoms are composed of electrons arranged in space around a central nucleus which is positive in charge, the electrons being negative.

Sir Joseph J. Thomson, who discovered the electron back in 1897, has been studying recently the probable arrangement of these electrons inside the atoms of matter and the effects of this arrangement in determining the chemical properties of the different elements. The following article is based upon recent lectures on "The Electron in Chemistry" delivered by Sir Joseph before the Franklin Institute in Philadelphia, and is published by permission of the Institute.

—EDITOR

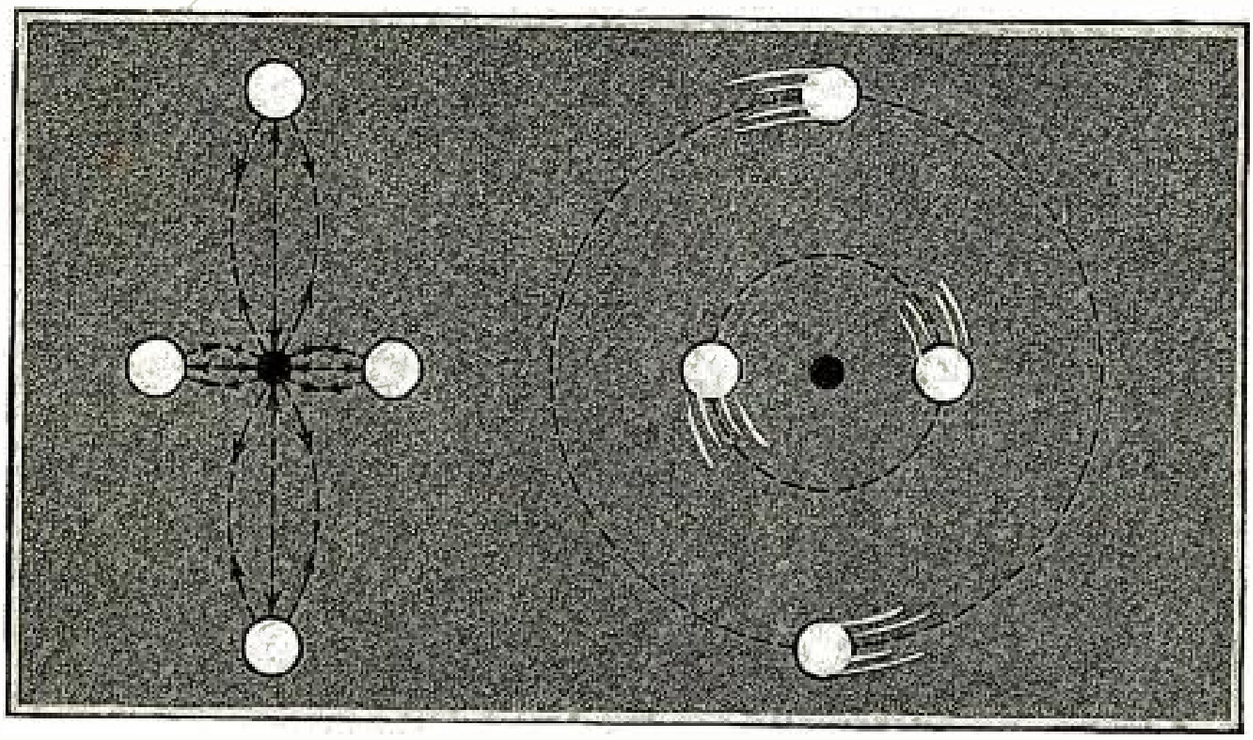
By SIR JOSEPH JOHN THOMSON, O.M., F.R.S., LL.D., Ph.D., D.Sc.

I BELIEVE that the introduction of the idea of the electron will break down, and indeed has already done so to some extent, the barrier of ignorance which has divided the study of the properties of matter into two distinct sciences, physics and chemistry.

The properties of matter which are of primary importance to the chemist are those which relate to the power of atoms to unite together to form new combinations, new compounds. Until recently the conception of the atom, formed by the physicist, afforded no clue to the variation in the chemical properties of the atom and gave therefore but little guidance to the chemist in what he rightly regarded as the most important part of his work.

The chemist wants to know much more about the difference between an atom of hydrogen, and one of oxygen than that "the atom of hydrogen is a small particle of one kind of matter" and that "the atom of oxygen is a heavier particle of another kind of matter."

The chemist wants to know the rea-



THE TWO PREVAILING THEORIES OF THE STRUCTURE OF ATOMS—

Illustrated by one of the simplest atoms, that of the element Beryllium. The figure on the left shows the theory of Sir Joseph J. Thomson, as embodied in this article. The four electrons, represented by white spheres, are held by a balance of attractive and repulsive forces at definite distances from the central nucleus of the atom, represented by the black dot. The other figure (at the right) shows the alternative planetary theory, according to which the electrons are supposed to be revolving around the nucleus much as the earth and the other planets revolve around the sun.

son why the behavior of an atom of hydrogen is so different from that of an atom of oxygen. This must depend upon the difference in the constitution of the two atoms themselves. Thus to explain the difference between the chemical properties as different atoms we have to go a step further than that considered by the atomic theory. Just as some of the physical properties of matter in bulk had required for their explanation the conception that matter is not continuous but has a structure of finite and measurable fineness, so no progress could be made towards the explanation of their chemical properties until we gave up the idea that the atom was indivisible, continuous and uniform, and assigned to atoms, as well as to solids and liquids, a structure of their own.

The discovery of the electron in 1897 was the first direct evidence of such a structure. It was shown that these electrons came from all types of atoms, and that whatever the source there was only one kind of electron, which has a mass of only about 1/1700th that of an atom of hydrogen and carries a charge of negative electricity numerically equal to the positive charge associated with an atom of hydrogen in the electrolysis of solutions.

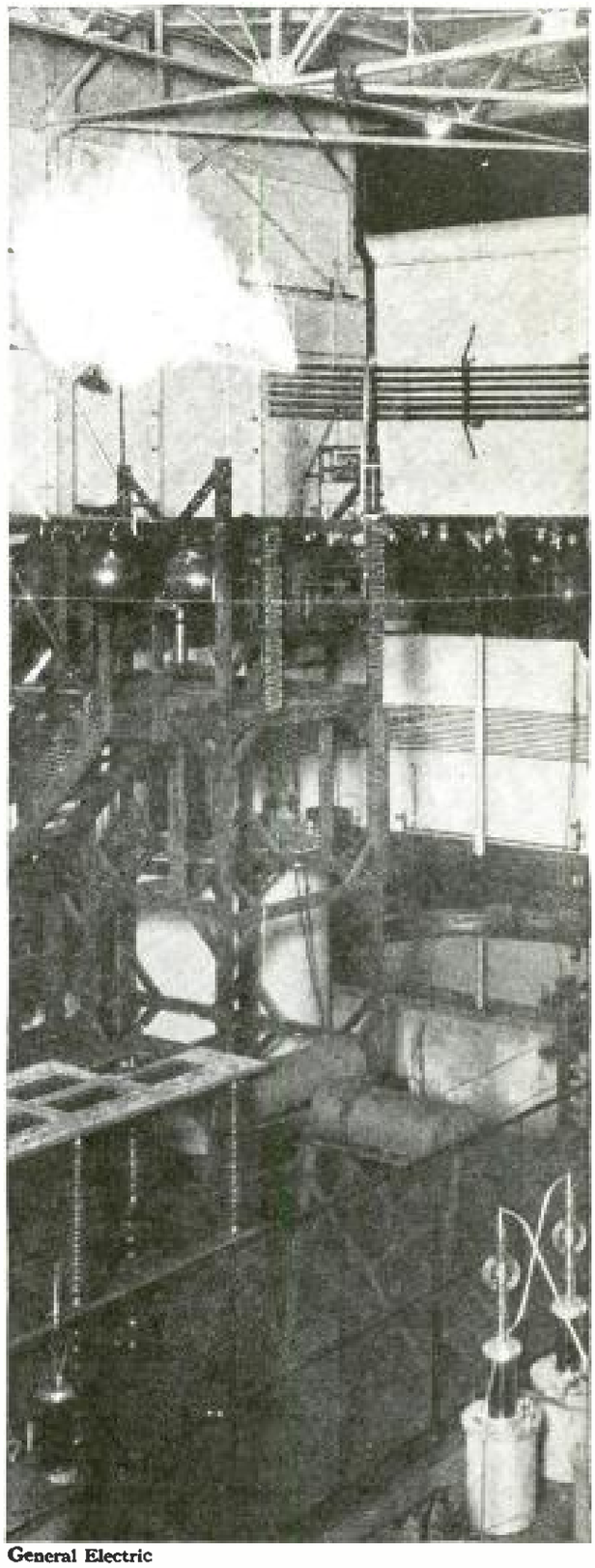
Thus an invariable electron was proved to be a constituent of all atoms. Means were then devised to measure the number of electrons in the atoms of the different chemical elements. It was found that this number was finite and varied from element to element, and that the number of electrons in the atom of an element was equal to the atomic number of the element—the atomic number of an element being its place in the list when the elements are correctly arranged

in the order of their atomic weights.

The electrons, however, only account for about 1/3400th of the whole mass of atoms, and for most purposes this is a negligible fraction. The greater part of the mass is accounted for by the positively electrified part of the atom. The electrons are all uniform and are negatively electrified, and as the normal atom is electrically neutral, there must be within it a positive charge to balance the negative one on the electrons. This positive charge, as experiments on positive rays show, is attached to a mass equal to the mass of the atom. Thus the carrier of the positive charge, unlike that of the negative, does vary from element to element. As the mass of the positive charge is always an integral multiple of a unit, it is natural to suppose that this mass is made up of a number of units bound together.

Thus, in addition to the structure conferred by the electrons, the positively electrified parts of the atom have themselves a structure. It is the structure conferred by the electrons which is responsible for the chemical properties of the atom, and the structure of the positive core or nucleus is concerned with radioactive transformations.

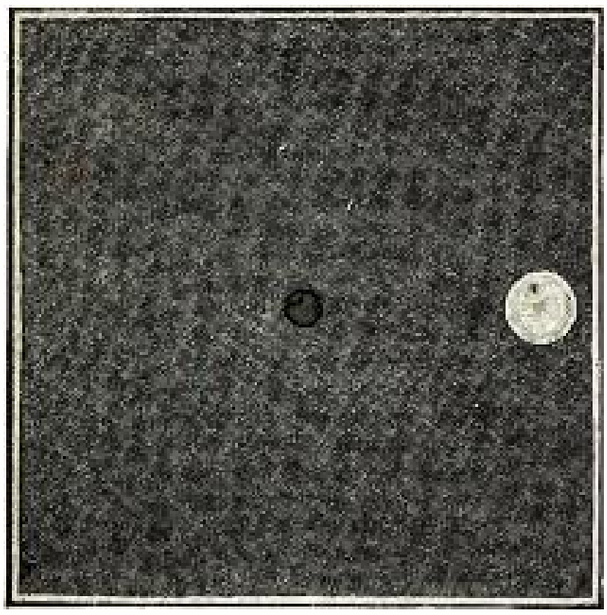
Up to the present time nothing has been discovered that cannot be resolved into electrons and positively electrified particles, and so it is natural to frame a theory of the structure of the atom on the supposition that it is built up of these two ingredients. It should be borne in mind, however, that our means for detecting the existence of electrically charged bodies far surpass those for detecting uncharged bodies, and if there were any uncharged constituents of the atoms, they would in any case probably have escaped detection. We know, however, even supposing that such constituents do exist, that their mass must be negligible compared with that of the positively charged parts, for these parts account



General Electric

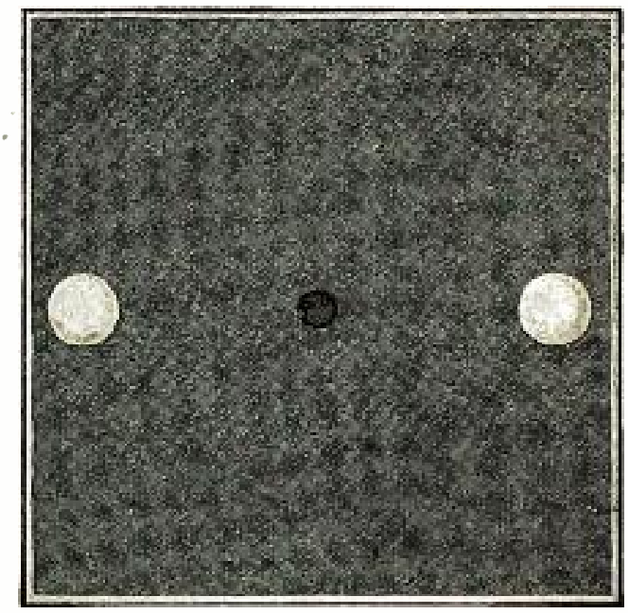
A VIOLENT ELECTRON DISCHARGE

This "artificial lightning" is merely a rushing mass of electrons flying with incredible swiftness from one electrode of the spark gap to the other, knocking off electrons from the gas atoms which go to make up air and manifesting itself in a crashing bolt, which is second in destructive power only to nature's own lightning.



THE ATOM OF LITHIUM

3 **Model of the atom of lithium according to the Thomson theory. The two electrons closest to the nucleus, as shown on page 180, are omitted in this and following models for the sake of clearness. This lithium atom contains only the one electron shown in the shell outside these two inner electrons.*



THE ATOM OF BERYLLIUM

4 *Model of the atom of beryllium, the same atom shown on page 180. The two inner electrons that are there shown are omitted in this model just as they are omitted in the adjoining model of atom Number 3. The two external electrons are balanced one on each side of the nucleus.*

for well within a fraction of a per-cent of the whole mass of the atom.

Confining themselves, then, to the consideration of things the existence of which has been demonstrated, we regard the atom as made up of a massive positively electrified center surrounded by electrons; the number of electrons varying from one, in the atom of hydrogen, to a hundred or more in the heavier elements. The positive charge of the center and the negative charges on the electrons produce a field of electrical force which is determinable when the position of the electrons are specified.

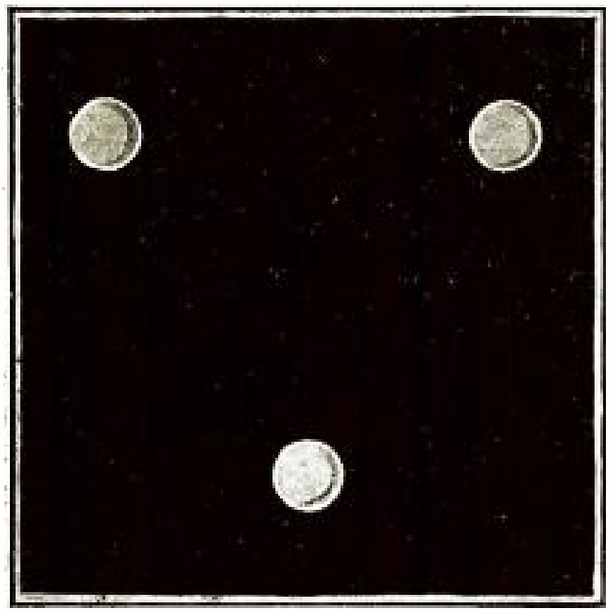
Thus the force exerted by the atom, and therefore its chemical properties, depend upon the configuration of the electrons and to determine this is one of the most important problems in the electron theory of chemistry.

This problem is that of determining the way the electrons arrange themselves under the action of their mutual repulsions and under the effect of forces exerted by the positive charge.

I have adopted the plan of supposing that the law of force between the positive part and the electrons is, at the distances with which we have to deal in the atom, not strictly that of variation with the inverse square of the distance, but a more complex one which changes from attraction to repulsion as the distance between the positive charge and the electron diminishes. This hypothesis leads to a simple mental picture of the structure of the atom and its consequences.

In this connection it may be observed that the introduction of some new physical law is necessary for any theory of the structure of atoms. We could not form a theory at all if all we knew about the action of electric charges was that they repelled or attracted inversely as the square of the distance, for this would put at our disposal only two quantities—the mass of an electron and its charge, and so we could not furnish

*These numerals refer to the atoms in order of atomic number.



THE ATOM OF BORON

5 *Like atoms number 3 and 4 the electrons of this atom (the atom of boron) are arranged in the same plane about the atomic nucleus at equal distances from it and from each other.*

the three units of *space, mass* and *time* required for any physical theory.

The discovery of the induction of currents or (what is equivalent) the magnetic effect due to electric charges, introduced another fundamental unit, the *velocity of light;* the unit of length to which this system leads is the radius of the electron, about 10^{-13} cm., a quantity of quite different order from 10^{-8} cm., which corresponds to atomic dimensions. The size of atoms being what it is furnishes proof that there is some law of physics that is not recognized in the older science.

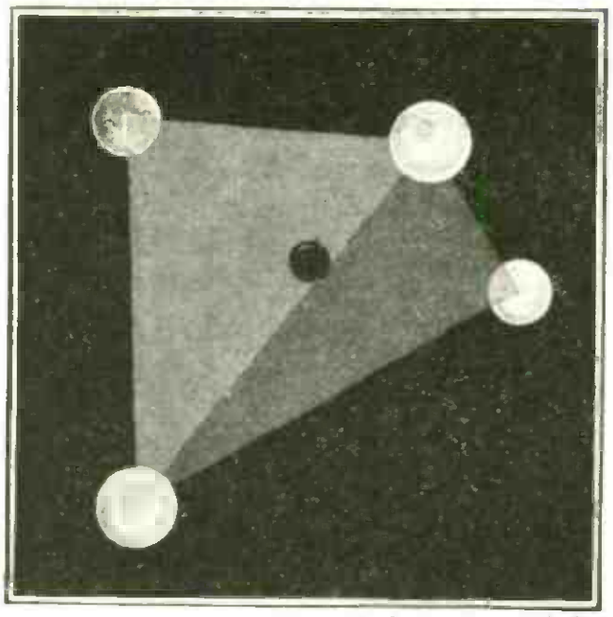
If the law of force is that just given, then a number of electrons can be in stable equilibrium around a positive charge without necessarily describing orbits around it.

Thus, for example, if there is one electron in the second shell of the atom (ignoring the two inner electrons that are shown on page 180), this electron will be in stable equilibrium at a certain distance from the positive charge. If there are two electrons they will be in equilibrium with the positive charge midway between them. When there are three electrons, they will be in equilibrium at the corner of an equilateral triangle with the positive charge at the center. The most symmetrical arrangement of four electrons is when they are at the corners of a regular tetrahedron. Six electrons are in equilibrium when at the corners of a regular octahedron. Eight electrons arrange themselves at the corners of a twisted cube, a figure obtained by making two squares, placing them parallel to each other and at right angles to the line joining their centers, and twisting them relatively to each other so that the projection of their corners on a parallel plane forms a regular octagon.

There must come, however, a stage when it will no longer be possible to have all the electrons at the corners of a regular polyhedron.

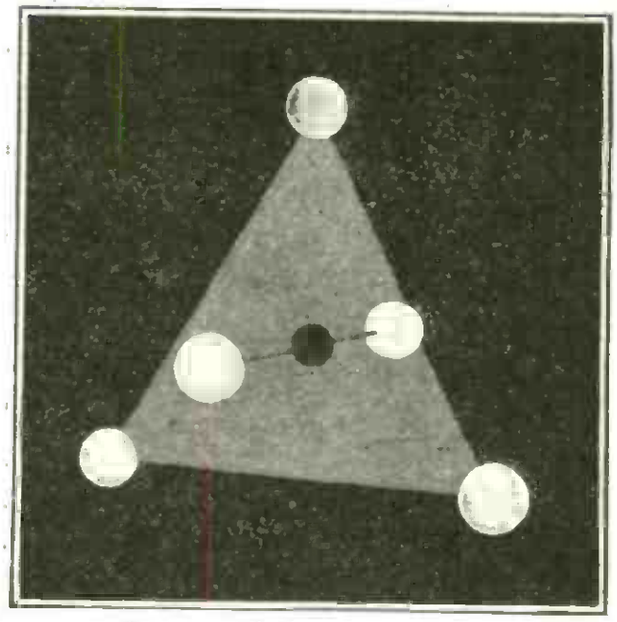
To keep the electrons in stable equilibrium in spite of their mutual repulsion requires a finite positive charge and the greater the number of electrons (and, therefore, the smaller the angular distance between an electron and its nearest neighbor) the greater the positive charge must be. When the number of electrons is not greater than eight, the electrons can be kept in equilibrium by a positive charge equal to the sum of the negative charges on the electrons, which is the greatest positive charge which can occur in a neutral atom. So that when the number of electrons is not greater than eight, a neutral atom can have these electrons arranged symmetrically at the same distance from the center at the corners of a regular polyhedron.

When, however, the number exceeds eight this is no longer possible. To keep, say, nine electrons in stable equilibrium would require a positive charge of more than $9e$, where e is the charge of an electron, but in a neutral molecule $9e$ is the maximum positive charge available when there are nine electrons in the atom. Thus the regular pro-



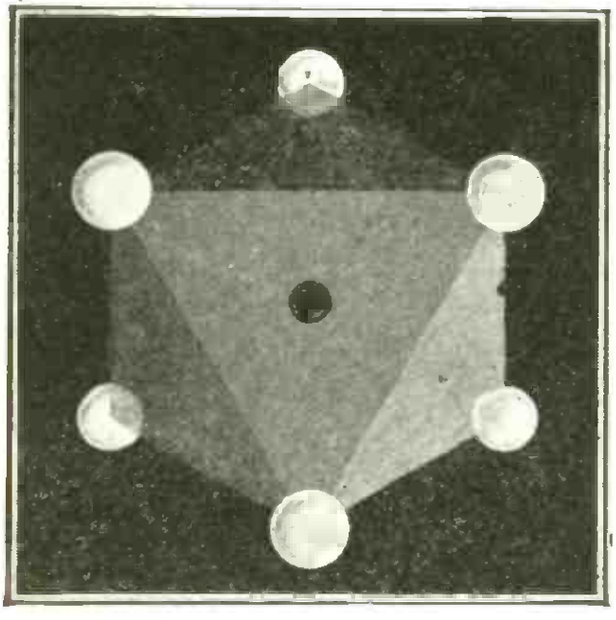
THE ATOM OF CARBON

6 *This is the atom of the very common element carbon, the element of coal and of diamonds. Its four external electrons are arranged about the nucleus at the corners of an imaginary tetrahedron. As before, the two internal electrons are not shown.*



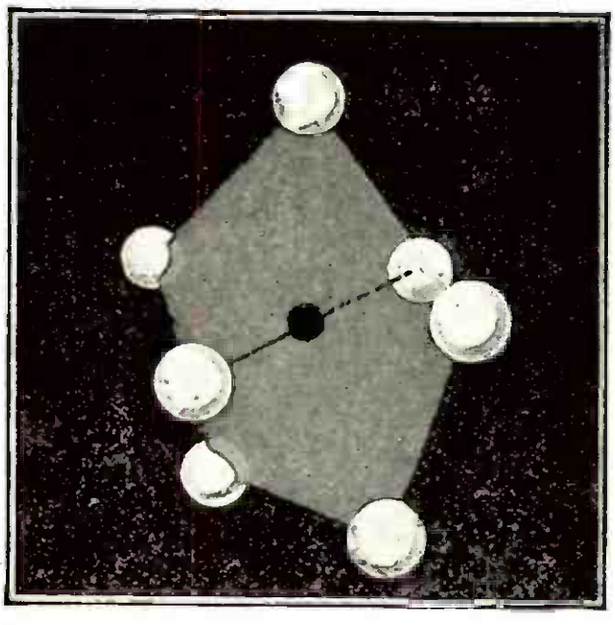
THE ATOM OF NITROGEN

7 *The atom of nitrogen—the gas that composes four-fifths of the air. In this there are five external electrons, three of them arranged at the corners of an imaginary triangle, the other two at the ends of a perpendicular line through the center of this triangle.*



THE ATOM OF OXYGEN

8 *One of the most important of all atoms, the atom of oxygen. This element is the commonest element in the earth's crust and is the element we breathe in air. Its six external electrons are arranged at the corners of an imaginary eight-sided solid or octahedron.*



THE ATOM OF FLUORINE

9 *The atom of fluorine, containing seven external electrons. Five of these electrons are arranged in one plane through the nucleus, as though at the corners of a regular pentagon; the other two electrons are at the ends of a perpendicular line, as in the case of atom number 7, shown above.*

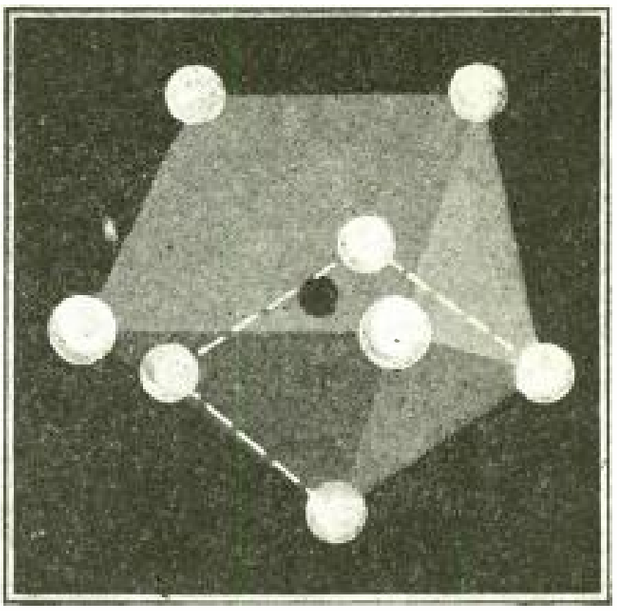
gression in the arrangement breaks down when the electrons amount to eight and a new arrangement must come into force.

Let us suppose that there are nine electrons; then these nine cannot all be arranged at the same distance from the center, for this arrangement would be unstable since a positive charge of nine is insufficient to keep nine electrons in stable equilibrium. The charge $9e$ could, however, keep eight electrons in stable equilibrium at the same distance from the center, leaving one to go outside, relatively a long way out from the center of the atom.

If there are ten electrons, these can be arranged so that eight form a layer round the center and two go outside. Eleven electrons can be arranged with an inner layer of eight and an outer one of three, and so on. Sixteen electrons can be arranged with an inner layer of eight and an outer layer of eight.

We have now got eight electrons on the outer layer and there is not accommodation for any more; as the atom is neutral, the excess of positive over negative electricity in the system consisting of the central charge and the inner layer is equal to the charge on the electrons in the outer layer. We can, however, get a system which will be in stable equilibrium if the electrons proceed to form a third shell; thus, if there are seventeen electrons, we could have an inner shell of eight, then another shell of eight and then an electron a long way outside. If we had eighteen electrons we should get two shells of eight and two electrons outside, and so on, until with twenty-four electrons we shall have filled up the third shell and have to begin again.

Thus, if we arrange the elements in the order of the number of electrons in the atom, which is the same as the order of the atomic weights, there will be a periodicity in the number of electrons in the outer layer. It will increase from one to eight, then drop again to one; increase again to eight, drop to one, and so on. Thus, as far as properties depending upon the outer layer are concerned, the elements will show a periodicity in their properties similar to that expressed by Mendeleef's periodic law in chemistry.



THE ATOM OF NEON

10 *The atom of the rare gas neon. This contains eight external electrons, which is the greatest number of electrons, Sir Joseph Thomson believes, that can be held in a single shell all at the same distance from the nucleus.**

The valency of an element is a property depending on the number of electrons in the outer layer, the electropositive valency being proportional to that number, so that this type of atom would explain the periodic law.

There are some other interesting results which follow at once from the view we have taken of the constitution of the atom. One is the change in the chemical properties produced by electrifying the atom. Let us take the oxygen atom as an example, it has six electrons in the outer layer, and its

*With the preceding seven models this completes the list of the first ten elements. Element number one (hydrogen) and number two (helium) are not shown in this series as they contain only the two internal electrons shown on page 180; hydrogen having one electron only, helium having both of them.

valency is determined by the number of electrons in this layer.

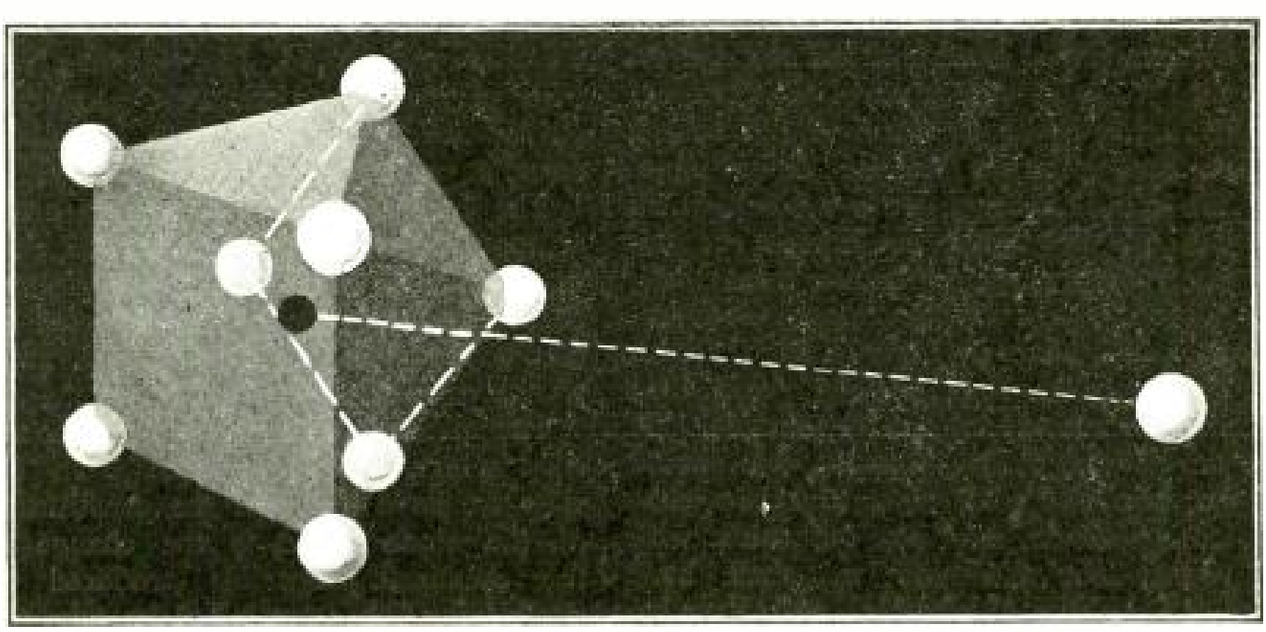
When the oxygen atom is positively electrified it has lost one or more electrons. If it is electrified so that it has lost one electron, the atom will only have five electrons in the outer layer, the same number as there are in a neutral atom of nitrogen. Thus, if the valency depends on the number of electrons in the outer layer, the valency of oxygen carrying a unit charge of electricity ought to be the same as that of a neutral atom of nitrogen, i. e., it ought to form the compound OH_3, a compound having the molecular weight 19.

This is confirmed by observation with the rays of positive electricity; when hydrogen and oxygen are present in the tube, a line corresponding to this molecular weight is frequently observed.

If we turn to negatively electrified atoms, a negative electrified chlorine atom would have eight electrons in the outer layer, it would resemble the neutral atom of an inert gas and so would not be able to enter into chemical combination. It might be expected to resemble argon not merely in its chemical properties, but also in the nature of its spectrum. Again, a positively electrified potassium atom has lost an electron and so would contain the same number of electrons as a negatively electrified chlorine atom or a neutral argon one. Thus we should expect the spectrum of positively electrified potassium atoms to show similarities with that of negatively electrified chlorine atoms and with neutral argon atoms.

Professor Zeeman and Mr. Dik have compared the red spectrum of argon, with the spectrum due to the positively electrified potassium atom and have found some exceedingly interesting points of resemblance.

Similarly, positively electrified oxygen atoms might be expected to give spectra resembling those of neutral nitrogen atoms and positively electrified nitrogen atoms might show similarities with neutral carbon atoms.



WHAT HAPPENS WHEN MORE THAN TEN ELECTRONS TRY TO CROWD INTO A SINGLE ATOM

11 *The eleventh electron goes into a second shell at a distance from the nucleus 6.7 times as great as the distance of the first shell of eight electrons shown in the preceding models. This eleven-electron atom is that of sodium, one of the elements in common salt. The remainder of the eighty-seven different chemical elements are formed by adding more electrons to this outer shell and then, in succession, to still other shells at still greater distances from the nucleus.*

Underwood & Underwood

A CLASS OF APPLICANTS STUDYING THE CODE

You must be able to receive ten words a minute in order to qualify for the amateur first-grade license. This requirement is not difficult to obtain.

HOW TO GET A RADIO LICENSE

There are now about 19,000 amateur stations in the United States that are licensed to transmit. This article tells how to enter this Inner Circle

By H. M. DAVIS

GENERAL radio communication is carried on in what to most of us is a foreign language—a peculiar language, composed of dots and dashes. Study and practice is necessary before one can talk through the ether with it, although it is easy enough to listen in.

Because of the difficulty of mastering this code language and the necessity of keeping the ether free of inexperienced novices, a license is required before one is permitted to operate a transmitting apparatus. As thousands of radio fans have learned in the last few months, no license of any sort is required by the government for a receiving set in the United States.

Just as the immigrant who comes to this country reads the preamble to the Constitution to prove that he can command the English language sufficiently to make his way about, so there is a

minimum speed requirement in the use of the Continental Morse code for passing the amateur's test. The operator must be able to send and receive ten words a minute, and has to understand the international abbreviations, two of which are "SOS," the signal of "distress" and "QRM" meaning "Interference."

But why is a license necessary for operating a radio telephone transmitter? The reason is sufficient.

Sending stations are apt to interfere with one another. The number of wavelength bands is so relatively small for the great amount of traffic that is already being sent over them—that considerable regulation is necessary in order to give an equal chance to all. Of course the control must be centralized in one place, or disputes would arise which would end in the hopeless deadlock of two small boys, one saying, "My mother says I can play in your yard," and the other, "My mother says you can't." In fact, it would be worse, for there would be no strong right arm to settle the matter. So Congress has provided the arm to start with, and power to regulate radio communication has been vested in the Secretary of Commerce, who administers it through the Commissioner of Navigation. The present law makes no difference between radio telegraph and radio telephone.

If you are an American citizen, it is not difficult to get a sending operator's license, provided, of course, that you know the Continental Morse code. The first step is to find out who the district Radio Inspector is and get in touch with him.

The United States is divided into nine radio districts; the area of each is based upon its population and need for radio supervision.

The First District comprises the New England States, and its Inspector is at the Customs House at Boston. The Second District has its headquarters at the Customs House at New York City and takes in the counties of New York State along the Hudson River, Long Island, and the northern part of New Jersey. The rest of New Jersey, southeastern Pennsylvania, Delaware, Maryland, the District of Columbia, and Virginia are included in the Third District. This Inspector's office is at the Customs House at Baltimore, and he has jurisdiction also, at present, over the Fourth District, which is composed of the southern Atlantic Coast States: North and South Carolina, Georgia and Florida; and the island of Porto Rico. In the near future, the Fourth District will have its own inspector, with headquarters at the Customs House at Savannah.

District Number Five takes in the southern states west of District Four, and extends as far north as the northern boundaries of Tennessee, Arkansas, Oklahoma, and New Mexico. Its Inspector is at the Customs House at New Orleans. The Sixth District takes in the southwestern corner of the United States: Utah, Arizona, Nevada, and California, and also extends itself to take in Hawaii. Its headquarters is at the Customs House at San Francisco. Seattle, Washington, is headquarters for the Seventh District, and its Inspector is to be addressed at 2301 L. C. Smith Building. This district comprises Wyoming, Montana, Idaho, Oregon, Washington, and Alaska. The Eighth District takes in the rest of New York not included in District Two, the rest of Pennsylvania not included in District Three, West Virginia, Ohio, and the lower peninsula of Michigan; its Inspector is at the Federal Building in Detroit. The Ninth District takes in all that is left; its northern boundary follows the Canadian border east from North Dakota through the middle of Lake Superior, then curls down through Lake Michigan to the northern boundary of Illinois. Its Inspector has his headquarters at the Federal Building in Chicago.

Having written to the Radio Inspector of the proper district, the prospective operator receives application blanks for his

Form 783

PROVISIONAL
ORIGINAL

Official call 2 X A *Number* 575

LICENSE FOR GENERAL (General or restricted) AMATEUR RADIO STATION

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
RADIO SERVICE

Pursuant to the act to regulate radio communication, approved August 13, 1912, Donald J. Pieri, age 20, a citizen of the State of New York, county of Bronx, city or town New York, street East 175th Street, No. 154, having applied therefor, is hereby granted by the Secretary of Commerce, for a period of two year s, on and subject to the restrictions and conditions hereinafter stated and revocable for cause by him, this License to use or operate the apparatus for radio communication (identified in the Schedule hereinafter) for the purpose of transmitting private radiograms or signals, notwithstanding the effect thereof extends beyond the jurisdiction of the State or Territory in which the said station is located: *Provided*, That no interference other than may result under the restrictions contained in this License shall be caused with the radio communication of stations of the Government of the United States or licensed stations.

2. The use or operation of apparatus for radio communication pursuant to this License shall be subject also to the articles and regulations established by the International Radiotelegraphic Convention, ratified by the Senate of the United States and caused to be made public by the President, and shall be subject also to such regulations as may be established from time to time by authority of subsequent acts and treaties of the United States.

3. The apparatus shall at all times while in use and operation be in charge of a person or persons licensed for that purpose by the Secretary of Commerce, and the operator of the apparatus shall not wilfully or maliciously interfere with any other radio communication.

4. The station shall give absolute priority to signals or radiograms relating to ships in distress; shall cease all sending on hearing a distress signal; and shall refrain from sending until all the signals and radiograms relating thereto are completed.

5. The station shall use the minimum amount of energy necessary to carry out any communication desired, and the transformer input shall not exceed one kilowatt.[1]

6. The station shall not use a transmitting wave length exceeding 200 meters.

7. The station shall not use a transmitter during the first 15 minutes of each hour, local standard time, whenever the Secretary of Commerce by notice in writing shall require it to observe a division of the time, pursuant to the Twelfth Regulation of the act of August 13, 1912.

8. The President of the United States in time of war or public peril or disaster is authorized by law to close the station and cause the removal therefrom of all radio apparatus, or may authorize the use or control of the station or apparatus by any department of the Government upon just compensation to the owners.

9. The Secretary of Commerce and Collectors of Customs or other officers of the Government authorized by him may at all reasonable times enter upon the station for the purpose of inspecting and may inspect any apparatus for radio communication of such station and the operation and operators of such apparatus.

10. The apparatus shall not be altered or modified in respect of any of the particulars mentioned in the following Schedule except with the approval of a radio inspector, or other duly authorized officer of the Government.

Name of naval or military station, if within 5 nautical miles, None

Power: ~~Transformer~~ Plate input, 80 W.[2] Antenna: Type (T, ┐, etc.) Inverted L

Height, 60 (Above ground.); horizontal length, 80.

Wired: Number in vertical part, λ; in horizontal part; λ

The normal sending and receiving wave length shall be 200 (Not exceeding 200.) meters and the station is authorized to use the following additional wave lengths, not exceeding 200 meters: - - - - - - - - - - - - meters, - - - - - - - - - - meters.

This License expires on December 25th 1924.

Edwin F. Sweet
Assistant Secretary of Commerce.

~~By Direction of the~~
Commissioner of Navigation.

Delivered by Henry L. Reinhardy (Radio Inspector)

Place New York, N. Y. Date December 26th 1922.

[1] Strike out "one" if the station be within 5 nautical miles of a naval or military station; otherwise strike out "one-half."
[2] Not to exceed 1,000, or if the station be within 5 nautical miles of a naval or military station, not to exceed 200.

THE STATION LICENSE

This is the document that permits you to use your amateur transmitting station. It is issued to any American amateur who has already installed his transmitting antenna and planned his set and who can pass the tests that qualify him for the operator's license shown on page 193. This license is good for two years—providing you conform to the rules.

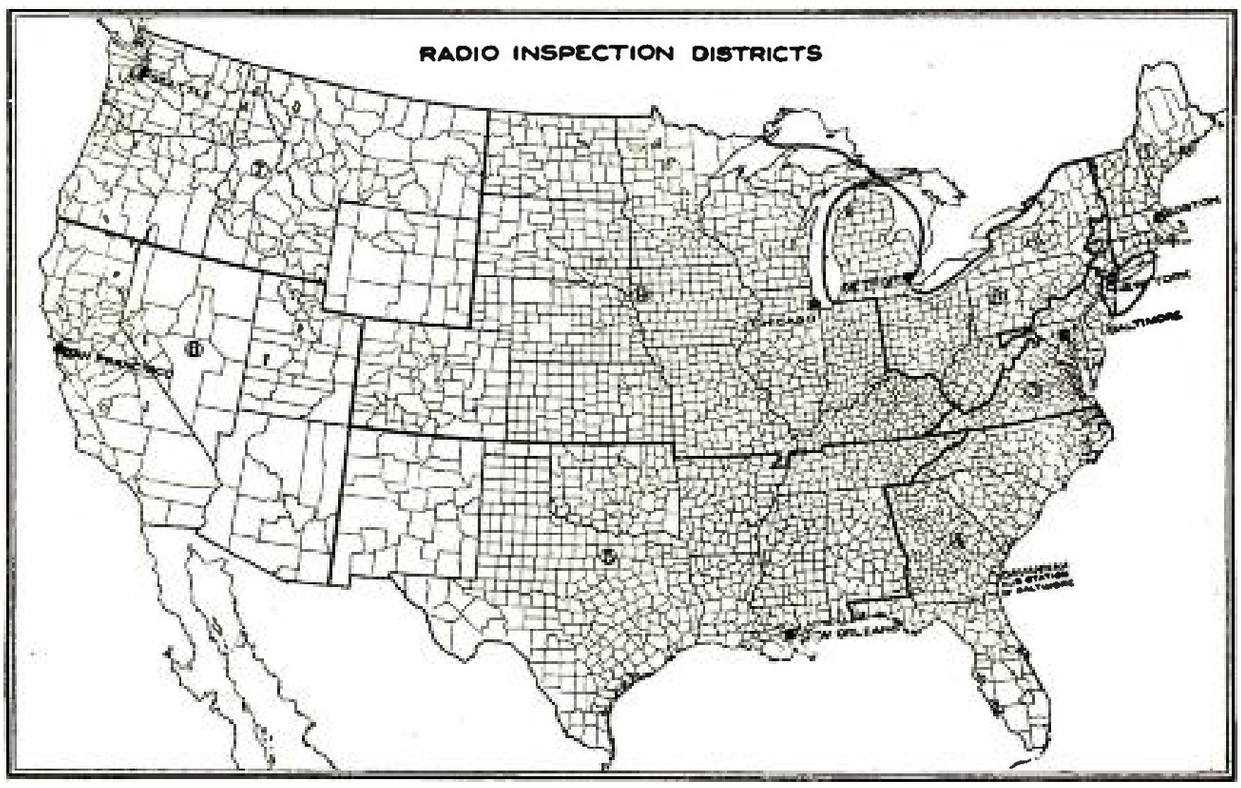
examination. Examinations are usually held at the offices of the district Radio Inspectors, but Inspectors may arrange examinations at other places in their districts when they deem it necessary.

The examination consists of two parts: A practical test on sending and receiving in the Morse Continental code, at which a speed of ten words a minute must be attained; and a written examination on the adjustment and operation of the prospective operator's apparatus and the regulations of the International Convention and Acts of Congress "in so far as they relate to interference with other radio communication and impose certain duties on all grades of operators."

The Radio Laws and Regulations of the United States, Part II, Section 121, states:

> Amateurs, before applying for their operator's licenses, should read and understand the essential parts of the International Radiotelegraphic Convention in force and sections 3, 4, 5, and 7 of the Act of August 13, 1912. The Department recognizes that radio communication offers a wholesome form of instructive recreation for amateurs. At the same time its use for this purpose must observe strictly the rights of others to the uninterrupted use of apparatus for important public and commercial purposes. The Department will not knowingly issue a license to an amateur who does not recognize and will not obey this principle. To this end the intelligent reading of the International Convention and the Act of Congress is prescribed as the first step to be taken by amateurs. A copy of the radio laws and regulations may be procured for this purpose from the radio inspector or from the Commissioner of Navigation, Department of Commerce, Washington, D. C., but they are not for public distribution. Additional copies may be purchased from the Superintendent of Public Documents, Government Printing Office, Washington, D. C., at a nominal price.

If the applicant is so far away from the district headquarters that the expense of going there for examination would be too great, he may obtain a second-grade amateur operator's license without examination upon submitting evidence that he is qualified to hold a license. To do this, he gets an operator who holds a license to examine him on sending and receiving in code and upon the other



THE NINE "RADIO DISTRICTS" OF THIS COUNTRY

Each district has a Radio Inspector who is in charge of the radio experts who control the operation of all stations, issue licenses to operators and stations and who check up the wavelength of all transmitting stations within their districts.

From a photograph made for POPULAR RADIO

HOW APPLICANTS FOR A TRANSMITTING LICENSE ARE EXAMINED BY THE RADIO INSPECTOR

A typical scene in the inspector's office. In this case assistant radio inspector Bogardus is sending "code" to applicants who are located in the next room with phones on their heads, copying down as much of the test messages as they can. The test papers are then corrected by the inspector and rated for speed in reception.

requirements, or he may go before a local radio club for such an examination. He sends in the statements of those who have examined him, and, if these are satisfactory, a second-grade license is granted him, subject to later inspection and examination by the Radio Inspector of his district. An amateur second-grade operator's license is usually granted for eight months. It may be revoked if the holder refuses to offer himself for examination when given opportunity to do so.

After receiving his operator's license, the applicant's sending apparatus is inspected and tested, and he is assigned his call and wavelengths. The call consists of a number followed by two, or more, letters. If the Inspector cannot go over his set at once, the amateur receives a temporary station license for use until his apparatus can be inspected.

Most amateur sending stations are classed as "general amateur stations," and their transformer input of power is 1 kilowatt or less. There are, however, "restricted amateur stations" whose input must not exceed one-half kilowatt. This restriction is placed upon stations located within five nautical miles of a naval or military station.

It is interesting to note that in all laws relating to radio supervision, distance is measured in nautical miles. The nautical mile is 6076.1 feet, or about 1⅛ land miles.

Each operator must have two licenses, the operator's license and the station license. These licenses are renewable at their time of expiration. Radio Laws and Regulations, Part III, Section 153 (b) says:

> Operators holding licenses for grades other than commercial, who submit satisfactory evidence to the examining officer showing actual

operation of radio apparatus for three months during the last six months of the license term, may be issued new licenses without examination. Otherwise, applicants for renewals will be examined in the usual manner.

No charge is made for any license or examination.

Having received his licenses, it is incumbent upon the operator to keep the rules and regulations which apply to his section of the ether. The first of these, which in these days of broadcasting seems a little bizarre, is secrecy. This is required, in fact, even of those who only listen.

No person or persons engaged in or having knowledge of the operation of any station or stations shall divulge or publish the contents of any messages transmitted or received by such station, except to the person or persons to whom the same may be directed, or their authorized agent, or to another station employed to forward such message to its destination, unless legally required to do so by the court of competent jurisdiction or other competent authority. Any person guilty of divulging or publishing any message, except as herein provided, shall, on conviction thereof, be punished by a fine of not more than two hundred and fifty dollars or imprisonment for a period of not exceeding three months, or both fine and imprisonment, in the discretion of the court.

But, of course, the rules and regulations were made originally for commercial operators.

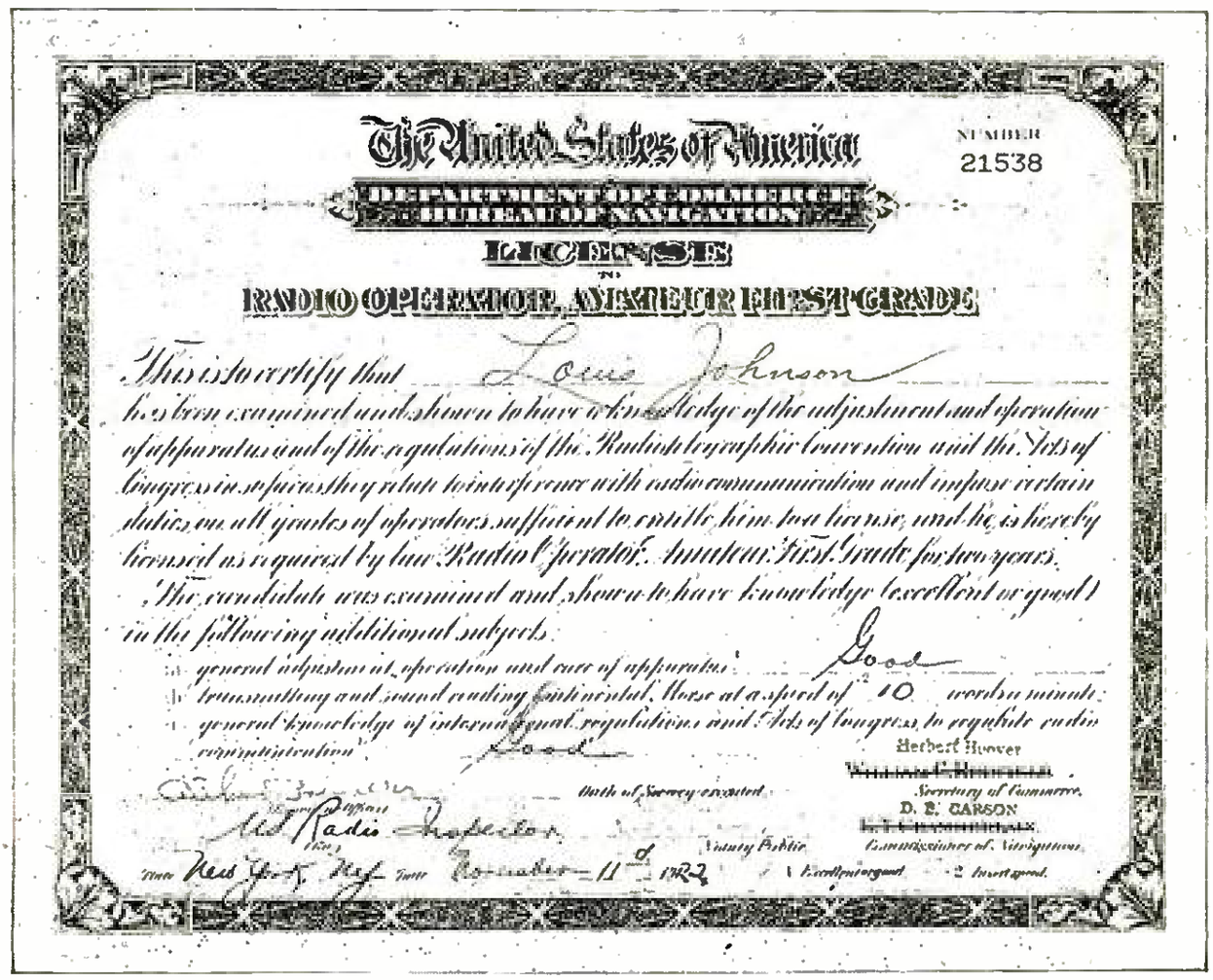
Another rule strictly prohibits ship or coast stations from sending unnecessary signals. This applies to amateur as well as commercial operators. Trials and practice are allowed only at times and under conditions that make interference with other stations negligible, and even then the experimenters are cautioned to listen in frequently for distress signals, which have right of way over everything else. Commercial operators not infrequently have their licenses withdrawn for sending unnecessary signals.

Transmission of profane language is forbidden by another rule.

Every licensed operator is assigned a wavelength upon which he must send, and he must be careful not to overstep his limits and interfere with other communication. Wilful or malicious interference constitutes a misdemeanor under the law, and is punishable by a fine of not to exceed five hundred dollars or imprisonment not to exceed one year, or both. It is often difficult for amateur operators to be sure that they are sending within their proper wavelengths, and the Bureau of Navigation has recently issued the following warning to them: "The Bureau has received a number of complaints recently of amateur stations using wavelengths in excess of those authorized in their licenses, which has resulted in much unnecessary interference. Amateurs should, if possible, have their wavelengths measured (*with a wavemeter*) to avoid violating the law."

In sending messages, the operator must give his call letter. This gives other operators a chance to take it up with him if his messages are interfering with those of other operators. Little trouble is experienced with operators sending without a license. There is a strong sentiment against such a practice among licensed amateur operators, who are very proud of their licenses, and they are quick to object when messages are sent out under irregular call letters. If such a rebuke does not silence the unofficial sender, and he becomes a pest, complaint may be made to the radio inspector of the district. If a reprimand from the district Inspector is not sufficient, the might of the law may be invoked against him, and the case turned over to the District Attorney. But trouble of this kind is rare. The American boy is a law-abiding citizen.

The inspecting force of the Bureau of Navigation for regulation of amateur operators is fast becoming inadequate. The district inspectors' offices being at the seaboard leaves the great interior of the country almost without supervision. The work of inspecting outgoing vessels to see that their radio outfits are in perfect working order is by far the most important duty of the Bureau of Navigation. Vessels upon the high seas are dependent upon their radio sets for all their com-



The United States of America

NUMBER 21538

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION

LICENSE
TO
RADIO OPERATOR, AMATEUR FIRST GRADE

This is to certify that Louis Johnson has been examined and shown to have a knowledge of the adjustment and operation of apparatus and of the regulations of the Radiotelegraphic Convention and the Acts of Congress in so far as they relate to interference with radio communication and impose certain duties on all grades of operators sufficient to entitle him to a license, and he is hereby licensed as required by law Radio Operator, Amateur First Grade for two years.

The candidate was examined and shown to have knowledge (excellent or good) in the following additional subjects:

a. general adjustment, operation and care of apparatus: Good
b. transmitting and sound reading (continental Morse at a speed of 10 words a minute: Good
c. general knowledge of international regulations and Acts of Congress to regulate radio communications: Good

Herbert Hoover
Secretary of Commerce.
D. B. CARSON
Commissioner of Navigation.

Oath of Secrecy executed

Radio Inspector

Notary Public

New York, N.Y. November 11 1922

THE AMATEUR OPERATOR'S LICENSE

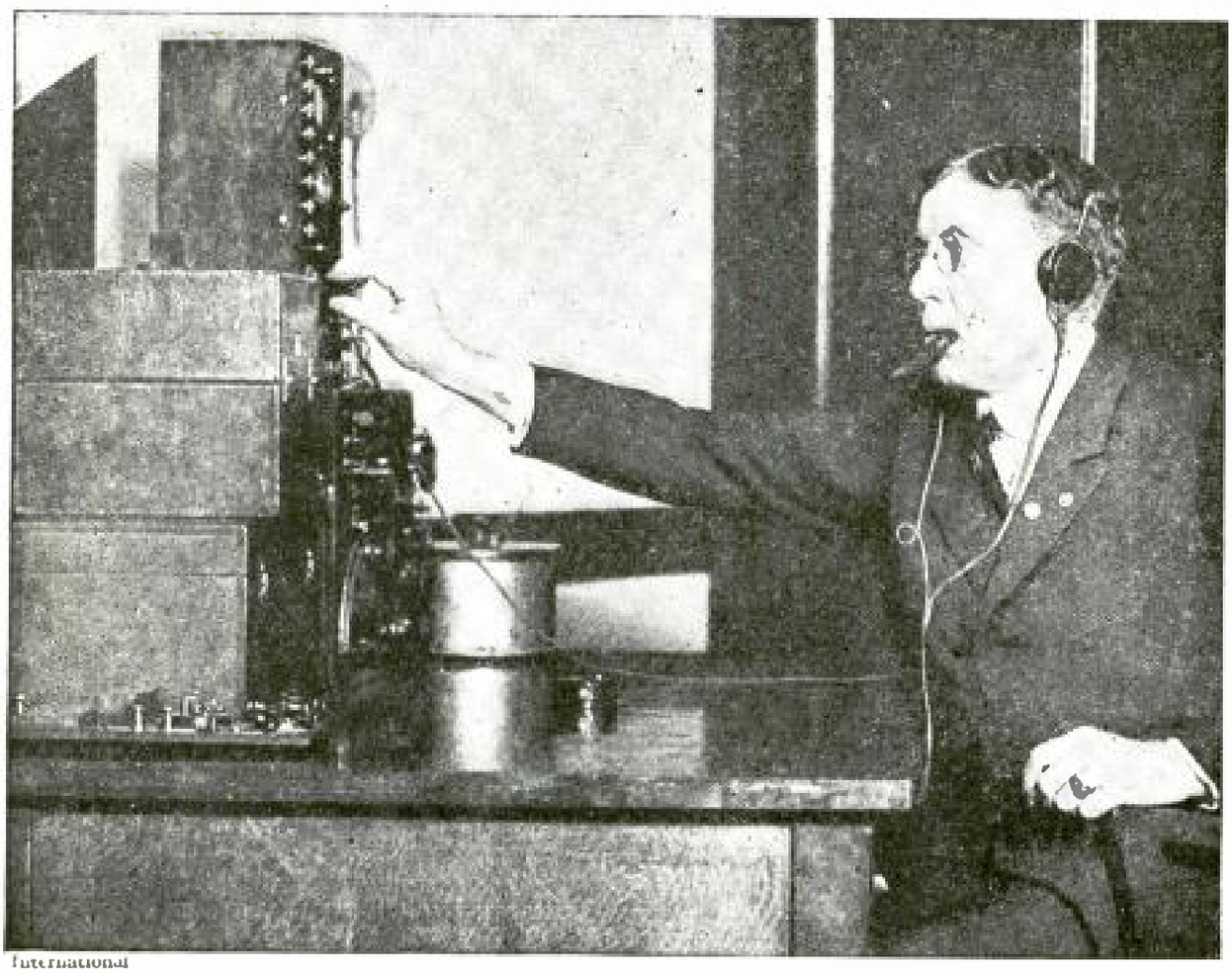
This is the coveted document that is issued to you after you have passed the required examination. It is good for two years and is issued without fee other than the trifling cost of the notary's seal.

munication with the rest of the world, and in time of danger it is vital that radio messages can be sent. It is for this reason that inspectors' headquarters must be at the principal harbors of this country.

But since July 1, 1922, when a slightly larger appropriation was made available to the Bureau of Navigation for radio inspection, extension of the service of the district radio inspectors has been increased, and provision has been made to cover fully every large city in the United States. It is, of course, impossible for the Government to place inspectors in every county and every town at the present time.

For purposes of local regulation, the Amateur Committee of the Washington Radio Conference recommended that the office of Amateur Deputy Radio Inspector be created and conferred upon an amateur elected by the other amateurs of each locality. The person so chosen would serve without compensation, but would be clothed with whatever authority might be necessary to enforce the observation of such local co-operative measures as are agreed to in each community for the minimization of interference between the various groups of the public interested in radio. In case it were found that such officers could not legally serve without compensation, a nominal sum would be paid them. They would probably be "dollar-a-year" boys.

This plan is well thought of by the Bureau of Navigation, but whether it will be put into effect or not has not been de-



International

HOW THE RADIO INSPECTOR CHECKS UP THE TRANSMISSION WORK OF THE AMATEUR

The "traffic cop of the ether" sits and listens in with his receiving apparatus, carefully checking up the wavelength of the transmitting stations in his district and keeping strict watch on the amateur so that messages may be handled with dispatch and without undue interference.

cided. It will not be necessary for the present, as the funds now available provide for an adequate inspection staff. Some plan of policing will ultimately have to be adopted, as there are close to a million receiving sets in the country, and the number of sending operators is increasing all the time.

Eight grades of licenses are issued by the Bureau of Navigation: (1) Commercial extra first grade; (2) commercial first grade; (3) commercial second grade; (4) commercial cargo grade; (5) commercial temporary permit; (6) experiment and instruction grade; (7) amateur first grade; (8) amateur second grade.

The commercial extra first grade is the highest license granted radio operators by the Government. It is issued to operators whose trustworthiness and efficient service entitle them to extra confidence and recognition. It may be earned by commercial first-grade operators who have put in eighteen months' satisfactory service on sea or land during the two preceding years and have not been penalized for violation of the radio laws and regulations, upon passing a special examination. In the examination a speed of at least 30 words a minute, Continental Morse, and 25 words a minute, American Morse, must be attained. The technical questions and the questions on the radio laws and regulations will be considerably wider in scope than those for commercial first grade, and a higher percentage is required, 80 or better on

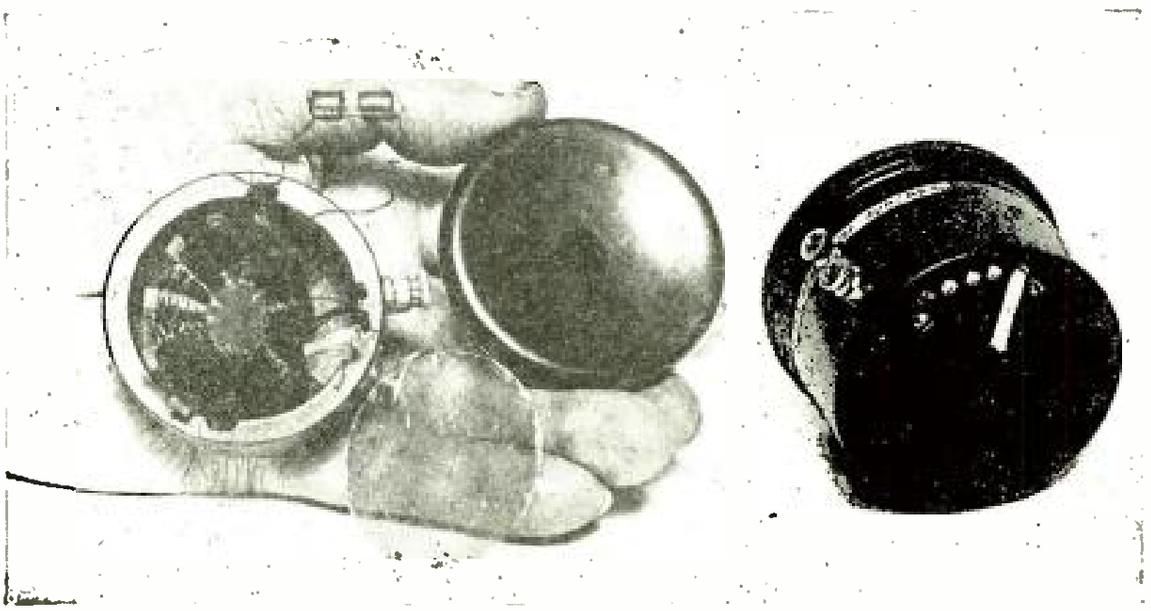
a score of 100.

The commercial first-grade applicant must know how to adjust, operate and care for his apparatus, correct its faults and change from one wavelength to another. He is required to transmit and receive by ear at a speed of not less than 20 words a minute in Continental Morse. For these tests a word is agreed to consist of five letters. He must also know how to care for a storage battery and other auxiliary power apparatus, and he will be examined upon his knowledge of international regulations of radio communication and the requirements of the acts of Congress to regulate radio communication. An operator who holds a commercial first-grade license or a commercial extra first-grade license is qualified for employment at any ship or land station.

The commercial second-grade examination covers the subjects given for the first grade, but the questions asked are not as comprehensive in character. To operate in this class, a speed of only twelve words per minute is required.

All American steamers carrying radio outfits must keep a continuous watch for distress signals. On cargo vessels, one first or second-grade operator is required, but the man to relieve him may be any member of the crew or other person qualified to recognize the distress signal when it is included with other words and to recognize the call signal of his own ship. He must also be able to test the apparatus with a buzzer to determine whether it is properly adjusted to receive signals.

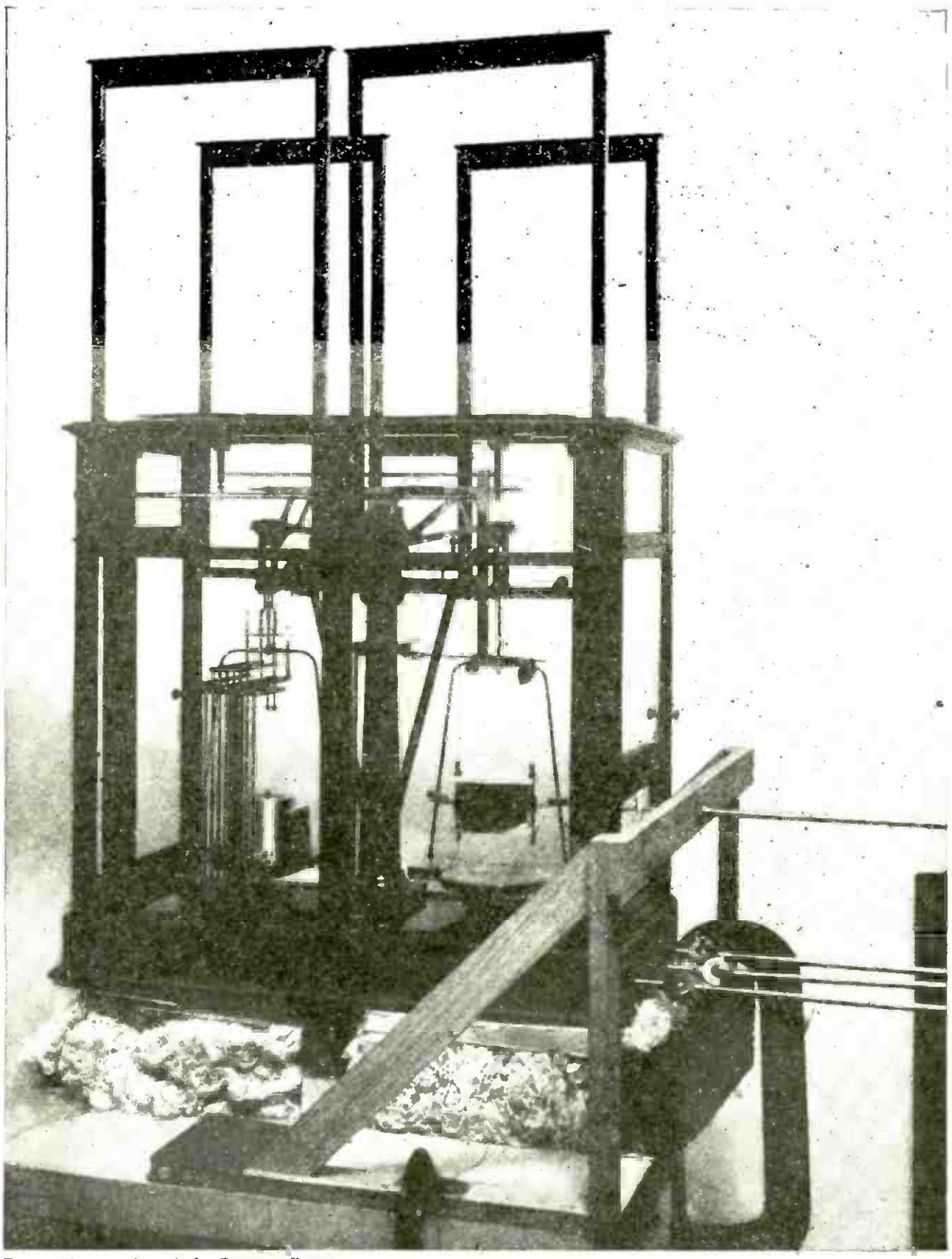
All the foregoing are licenses granted to commercial radio operators. There is another license which, while classed as a "commercial grade," may be issued to amateurs. It is known as the Experiment and Instruction grade. It has, however, no reference to the instruction of radio operators as such, but is required by those who operate stations carrying on scientific experiments but are unable to obtain commercial operators' licenses. To obtain this license the operator need know only the essential parts of the radio laws and regulations and be able to recognize distress and "keep out" signals, but he has to satisfy the radio inspector that his scientific attainments warrant his receiving a license of this class.



Kadel & Herbert

A RADIO RECEIVER THE SIZE OF A WATCH

This tiny tuner is properly enough the work of a St. Louis jeweler, Mr. J. A. Key. It contains a spider web coil with five taps. Binding posts connect to the antenna and ground wires.



From a photograph made for POPULAR RADIO

THE MOST SENSITIVE SCALES IN THE WORLD

Here is shown the apparatus that weighs the crystal with an accuracy of at least one-thousandth of a milligram. The weighing instrument is so delicate that the body of a person in the balance room would change the temperature of the metal parts and thus introduce an error that would be ruinous.

Testing the Einstein Theory with a Topaz

Is there an "ether push"? Is there indeed an ether?* These are questions that the scientists of the Bureau of Standards at Washington are trying to solve in their own way by an extremely delicate method for weighing a topaz crystal in different positions, in order to determine whether or not there is an actual ether "drift."

By ERNEST S. CLOWES

THE latest attempt to test the Einstein theory and to detect the ether experimentally is now in progress in the laboratories of the Bureau of Standards in Washington. It makes use of some very large single crystals, notably of the largest gem topaz ever found, a stone which happens to be in the collections of the National Museum.

The experiment consists in weighing this topaz in different positions on one of the most delicate balances ever constructed, and with an accuracy never before attained.

The experiment is really a test of gravitation. Dr. Paul R. Heyl, who is conducting it, is trying to find out whether the topaz crystal always weighs exactly the same in whatever position it may be placed, or whether it weighs a little more when it is right-side up than it does when it is laid on its side. If it turns out that the crystal always weighs exactly the same, it will be a big argument for the Einstein theory. If the crystal changes ever so little in its weight the Einstein theory will require modification.

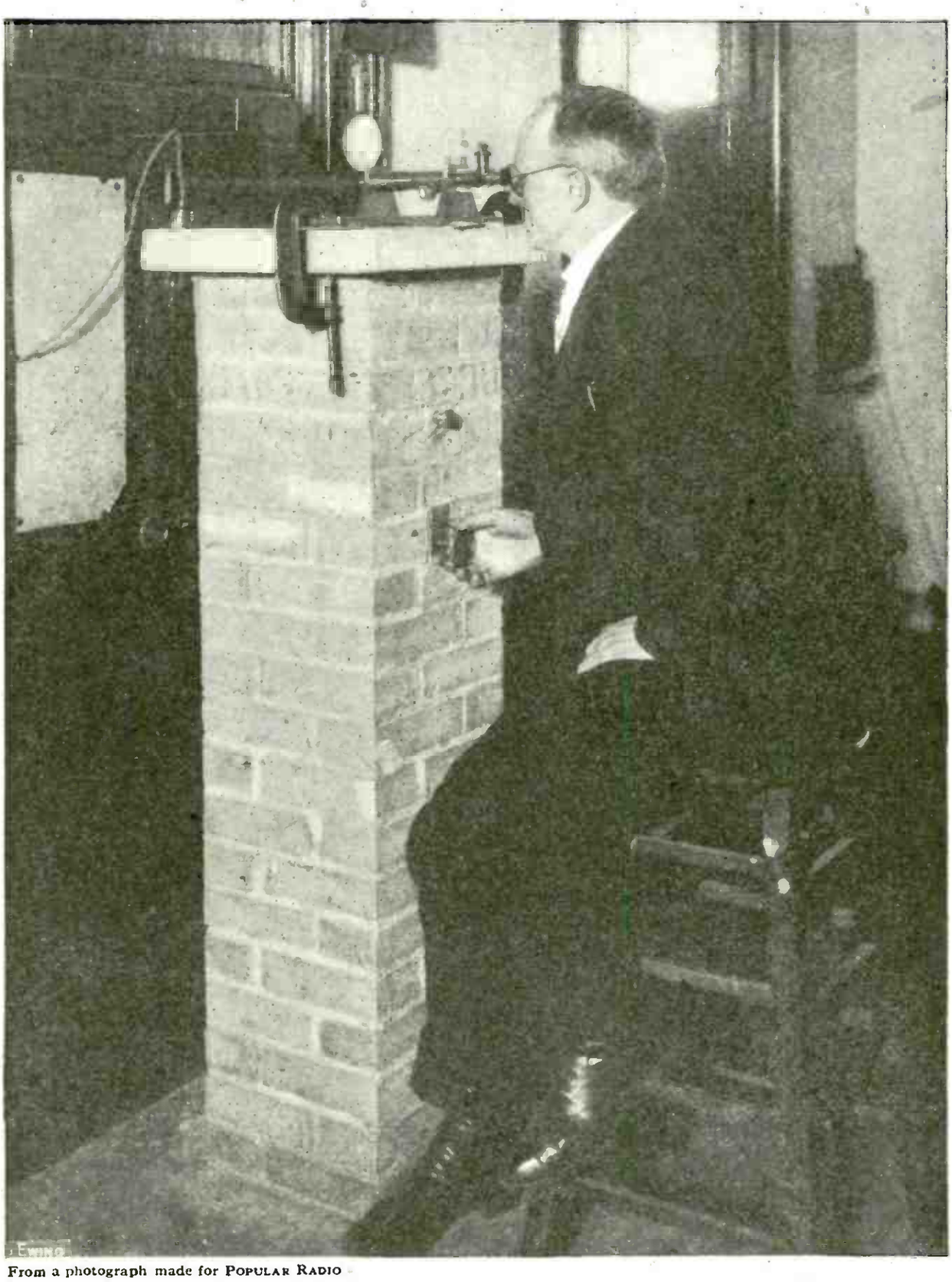
The weighing is, of course, merely a device to detect any change in the force of gravitation between the earth and the crystal. All the theories of gravitation, from Newton down to Einstein, have pictured gravitation as some kind of a push or pull in the ether, like, for instance, a bombardment of the atoms of matter by particles of the ether.

Einstein, on the other hand, says that no ether of this kind really exists. There can be no pushes or pulls on matter by it. Gravitation, according to him, is a property of space, a kind of warp or kink in the ultimate substance of the universe which merely *seems* to us to be a push or a pull.

Now if the ether theory is right the push of the ether on the topaz crystal ought to be, Dr. Heyl thinks, different depending upon the position of the crystal. In substances that are not crystals all the atoms inside them are arranged every which way, like loose nails in a keg. But in crystals all the atoms have a regular arrangement, as though all the nails in a keg were carefully packed with their points all in one direction.

Any push of the ether, therefore, on the atoms inside the topaz crystal ought to have one value when the crystal is turned so that its atoms are pointed, so to speak, toward the ether push, and a slightly different value when it is turned in a different direction so that the push comes against what we might call the sides of the atoms. If there is any such difference it would show up as a difference in weight—and that is

*Charles P. Steinmetz, "There Are No Ether Waves." in POPULAR RADIO for July, 1922. Sir Oliver Lodge, "Are There No Ether Waves?," in POPULAR RADIO for November, 1922. E. E. Free, "Radio and Relativity," in POPULAR RADIO for April, 1923.



From a photograph made for POPULAR RADIO

DOES AN OBJECT WEIGH EXACTLY THE SAME IN ALL POSITIONS?

That is the question that Dr. Paul R. Heyl is attempting to answer. The actual weighing is done by means of control rods which run through the wall of the weighing chamber and terminate in a stone column upon which is located the recording apparatus. This precaution assures the constant temperature necessary for so delicate a balance.

what Dr. Heyl is endeavoring to detect.

He first weighs the great topaz crystal in one direction. Then he turns it around through a right angle and weighs it again. The weighings must be correct to one part in a billion and the crystal to be weighed must be of considerable size, hence the use of the great topaz and the world-beating accuracy of Dr. Heyl's experiments.

The stone actually weighs a little more than three pounds. It is a white topaz, without the familiar yellow color of the ordinary gem, and it measures about five by four inches. It has been weighed to within about a thousandth of a milligram, or much less than the weight of a hair.

The balance used is of the ordinary chemical type for refined weighing of substances up to about five pounds. The unusual part is the extraordinary care that Dr. Heyl takes in using it. To begin with, the balance is, like all chemical balances, in a glass case. This case stands in the middle of a brick-walled, unheated cellar room about ten feet square, with double doors, no ventilation, and during the weighing, no lights. The final weighing is done by the experimenter who sits outside the brick wall and controls the balance by means of rods extending through it, watching the swings of the balance arm by the motion of a minute beam of light reflected from a tiny mirror on the arm.

That is for the completion of the weighing. The early stages are carried out in the usual way with the experimenter in the weighing room. When weights have been adjusted to the crude accuracy of about one part in a million or less, the experimenter prepares for the final touch. The entire balance case is surrounded by movable walls of a cork composition about two inches thick, leaving just room for the control rods and the small beam of light to come through. This is to protect the balance from any change of temperature during the weighing.

The operator then puts out the light. leaves the room, shuts the double doors, and leaves the whole affair alone for an hour or more. This is to enable the balance to come to constant and uniform temperature—a most essential feature of the experiment, for a difference in temperature between the two arms of the balance of something like a thousandth of a degree would introduce a ruinous error of something like one part in a hundred million. After everything has come to a uniform temperature the final weighing is made.

So far the experiments have confirmed the Einstein theory. The topaz, which is the only gem stone yet weighed, weighs exactly the same no matter what its position on the scale pan of the balance. It fails, therefore, as all the other tests have failed up to the present, to detect any experimental evidence of pushes or pulls due to the ether.

Does this settle the matter for good? Dr. Heyl thinks not. The big topaz says that Einstein is right, that the ether cannot be detected. But there are at least four other different crystal forms, having different atomic structures, which Dr. Heyl wants to test in the same way before he calls it a decision. These other crystals will be tested at once.

"Einstein has won the first round," says Dr. Heyl, "but there are four more rounds to be fought out. Final decision will be announced before fall."

A European Scientist's Conception of Ether

Few problems have so seriously engaged the scientists of the world as "the ether hypothesis," indeed. the conceptions of ether and ether waves have furnished the most plausible and easy-to-understand explanation of radio phenomena. In the next issue of POPULAR RADIO *will appear an article on this live subject by one of the most distinguished physicists of Europe—Prof. Emil Wiechert of the University of Goettingen.*

First Aid to Incoming Signals

The vacuum tube may be likened to a town, the gate of which is the grid. A regenerative circuit buoys up and strengthens the weak signals that arrive in much the same way that the townsfolk would revive and resuscitate a runner who enters the gates of their town. This is accomplished in a vacuum tube circuit by sending out a helping current to meet and boost up the weak incoming impulses.

How the Vacuum Tube Works

ARTICLE No. 2: HOW WEAK SIGNALS ARE REGENERATED

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

ALMOST everyone has heard of the great Marathon runner who, after hurrying twenty-six miles with a message, fell exhausted on the outskirts of town, barely able to whisper the words of his message. Indeed, it took a very sensitive ear to catch them; then they were repeated one to another until all the people in the town had heard the news.

It was an all-important message. If the town folk had known he was coming, they would have dispatched someone with a stimulant to assist him, help him bring the message into town.

In a way, the voice-controlled radio

frequency wave is like a runner coming from afar, weak, but still able to convey a message. And just as he crosses the borderline of a town (the electron tube) he is met and carried on the shoulders of friends (electrons) who pick up his message and straighten it out (rectification) and strengthen it (amplification).

De Forest's introduction of the third electrode (grid) into the electron tube through which the "runner" enters, did not, of course, mark the birth of radio, but it certainly signalized the day radio attained its majority—its twenty-first birthday, so to speak. And if the triode or tube assumed importance on the introduction of the grid, that importance became greatly augmented the day the tube got married—the day it became properly hooked up with the local battery circuit so that a maximum output (regeneration) would result from the strength of the local battery circuit. As good an amplifier of weak radio frequency impulses as the triode proved to be, its value became greatly enhanced when the impulses became strengthened by feeding back part of the plate circuit energy into the grid circuit while the impulses are entering the tube.

"When an oscillation is induced in an antenna by a passing wave," says a radio engineer, "the current in the plate or local battery circuit would have a radio frequency variation as well as the audio frequency variation that causes the telephone receivers to function. In other words there are present in this circuit a radio frequency current and an audio frequency current superimposed on the direct current.

"In the ordinary audion circuit with which we are all familiar no use is made of this radio frequency plate current, but in the regenerative circuit on page 202 the radio frequency plate current flows through the tickler coil and so induces a radio frequency voltage in the secondary coil coupled with it. If these coils have the correct relative polarity, the voltage induced in the secondary will reinforce the radio oscillation in the grid circuit. This is, in turn, amplified by the tube, thus further increasing the plate current, and increasing the audio frequency current through the telephones. Hence the regenerative effect of the tickler coil is cumulative. By careful adjustment with the secondary, the oscillation may be built up to be much stronger than it would be without regeneration; and therefore the response in the phones is increased accordingly."

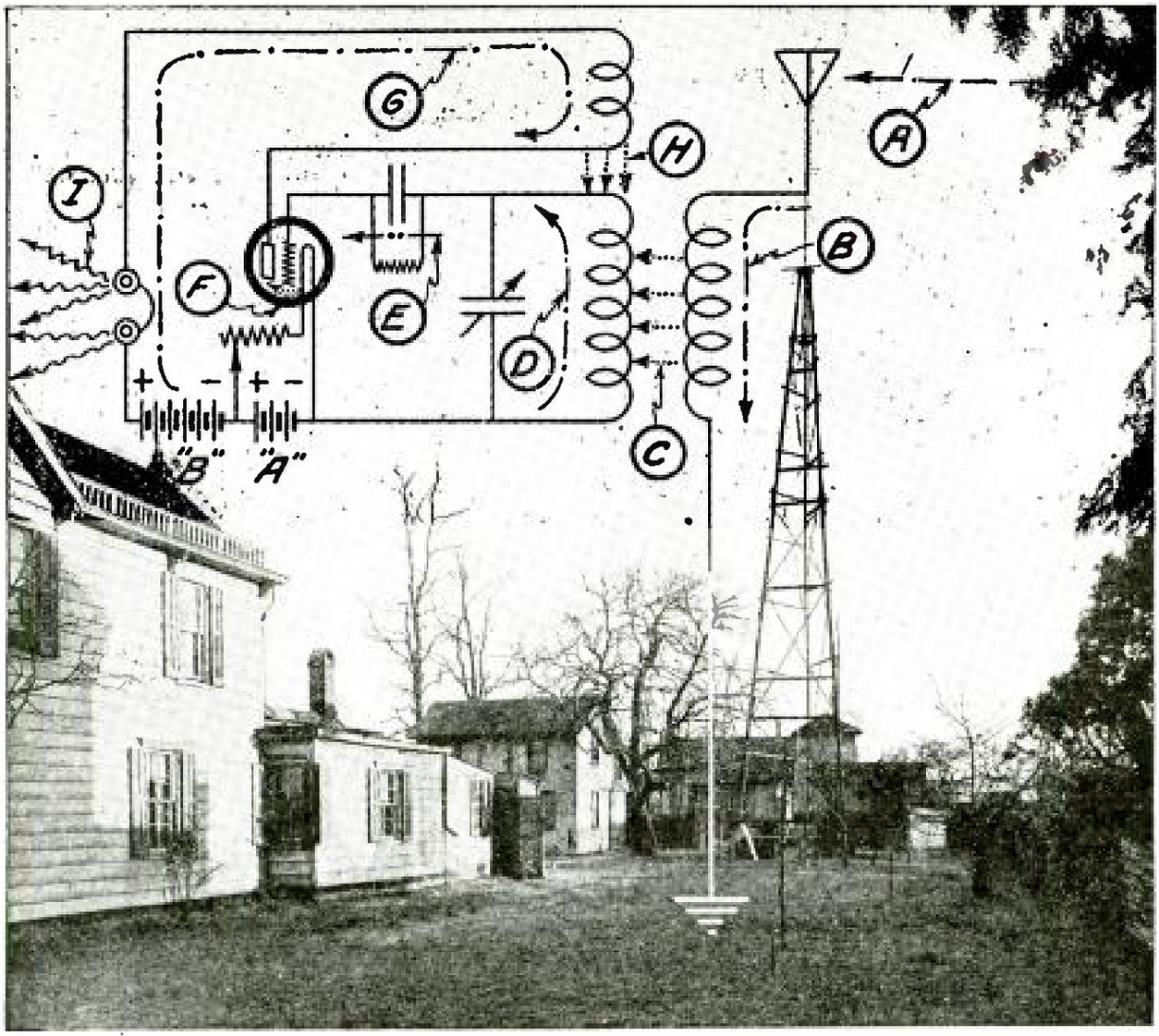
So much for the technical explanation.

While trying to learn the secrets of the vacuum tube, Edwin H. Armstrong reasoned that if the local battery circuit, instead of confining its energy to the tube only, could extend its influence into the input circuit, something of a progressive nature might happen. He found that by tapping the local battery current by means of a tickler coil and introducing this strength into the grid circuit during the time the radio frequency oscillations were going through the tube, that they became greatly strengthened and that the output of the tube was greatly increased. He also found that the output of the tube could be fed back into the original grid circuit by means of coupling transformers, through the tube again, again, and again, the oscillations becoming each time stronger and stronger.

Strange as it may seem, the "message," after going through the tube, may be led back through a circuit to go through the tube once, twice or three times, each time coming out stronger than before; and all in the twinkling of an eye!

Let us train our eyes again on the runner coming weakly into town (the tube), bearing an all-important message.

The helpers of this town establish circuit outposts (tickler coil) a little distance away from the town to ginger up the runner with a stimulant, so that he may bound into town fresher than he would have, and be helped immensely by the local organization there, with the re-



From a photograph made for POPULAR RADIO

HOW THE REGENERATIVE CIRCUIT OPERATES

The passing radio wave A, strikes the antenna and induces in it a feeble high-frequency oscillation or current B. This flow of current through the primary coil causes a magnetic transfer of energy C, to induce a similar current D, to flow in the secondary coil, and thus supplies the grid of the tube with a voltage impulse E. When the grid is charged with E, it causes a flow of electrons F, from the filament to the plate which results in a current G, which flows thraugh the plate or feedback coil. From the plate coil there is a second magnetic transfer of energy H, to the secondary coil which results in a greatly strengthened current D, a greater voltage E, and therefore a much greater electron stream F and an amplified plate current G. In this way the circuit feeds the weak incoming energy through the tube a number of times until it is strengthened sufficiently to make powerful sound waves I, issue from the receivers.

sult that he, or the chorus representing him (amplification), would then be in a position to leave that town (tube) very much stronger.

The greater the variations in the oscillations introduced through the grid, the greater the variations in the local battery current, and consequently the louder the signals that may be obtained through the phones. Obviously, however, there is a limit to the number of times a "runner" may enter and re-enter the town; he cannot be shunted about too much, else he may get dizzy and commence to "oscillate."

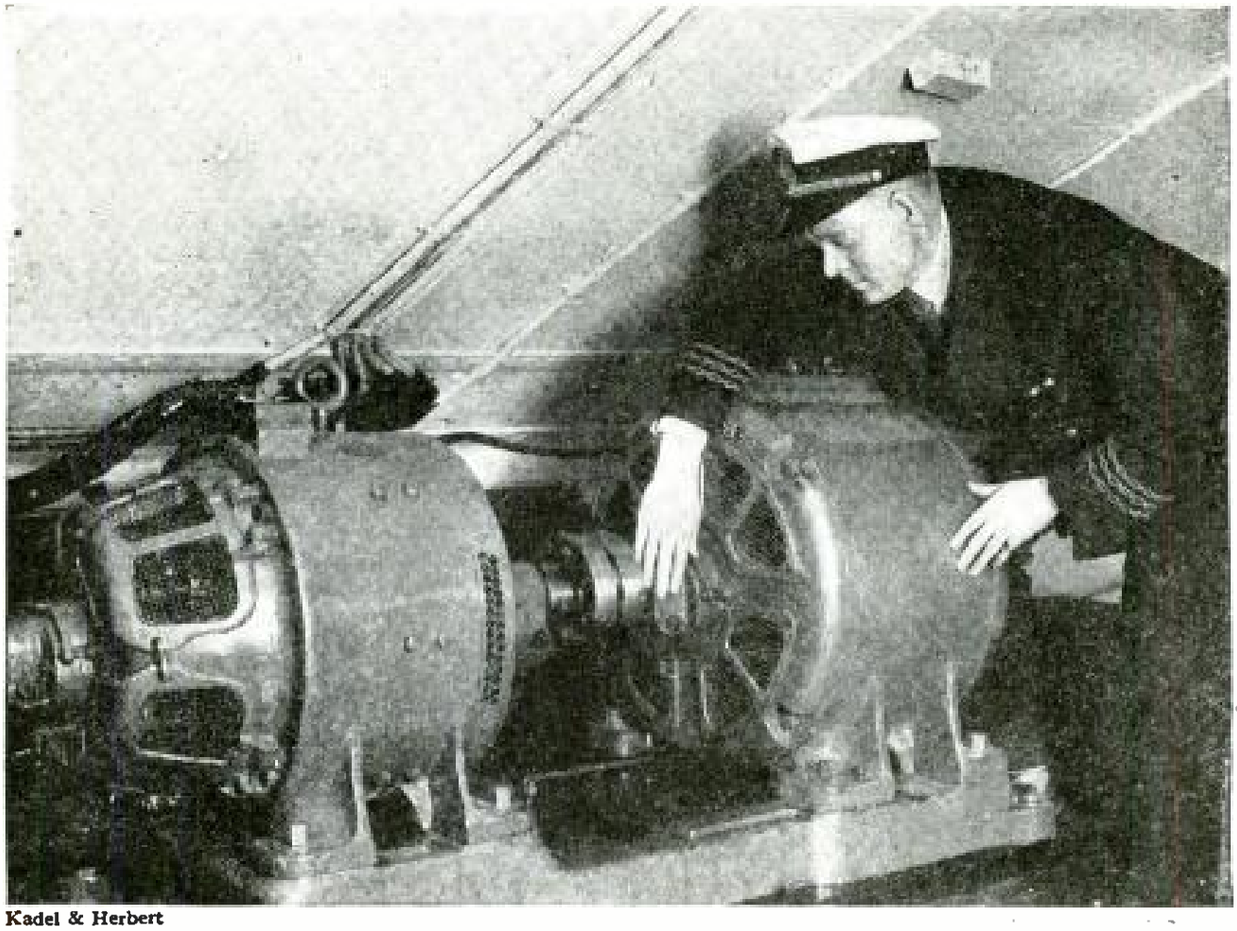
Just so in radio receiving; too much regeneration or "feeding back" and a dizzy confusion or howling will be the

result—the tube becomes a first-class oscillator. But just lately a method has been devised whereby a "runner" may be spun round and round the circuit many times without losing his balance. The radio frequency impulses are controlled in such a way that extreme amplification becomes possible, and oscillations that would otherwise happen are effectively choked off. A super-runner has arrived, so to speak—one capable of handling very short wavelengths—"super-regeneration."

Armstrong has lately evolved this method (super-regeneration) whereby, by an automatic action allowing the building up of a current to a very high amplitude for an instant followed by a short period of damping to prevent oscillation, an enormous amount of amplification is obtained. This action might be likened to the action of a quick interchangeable switch, feeding alternately and synchronously a negative and positive resistance into the grid circuit.

Thus the "runner," or radio frequency message, becomes strengthened without upsetting his balance (without causing him to become dizzy and confused) amplified to a degree of a million times or more. This is a development permitting the use of extremely short wavelengths and almost unlimited amplification.

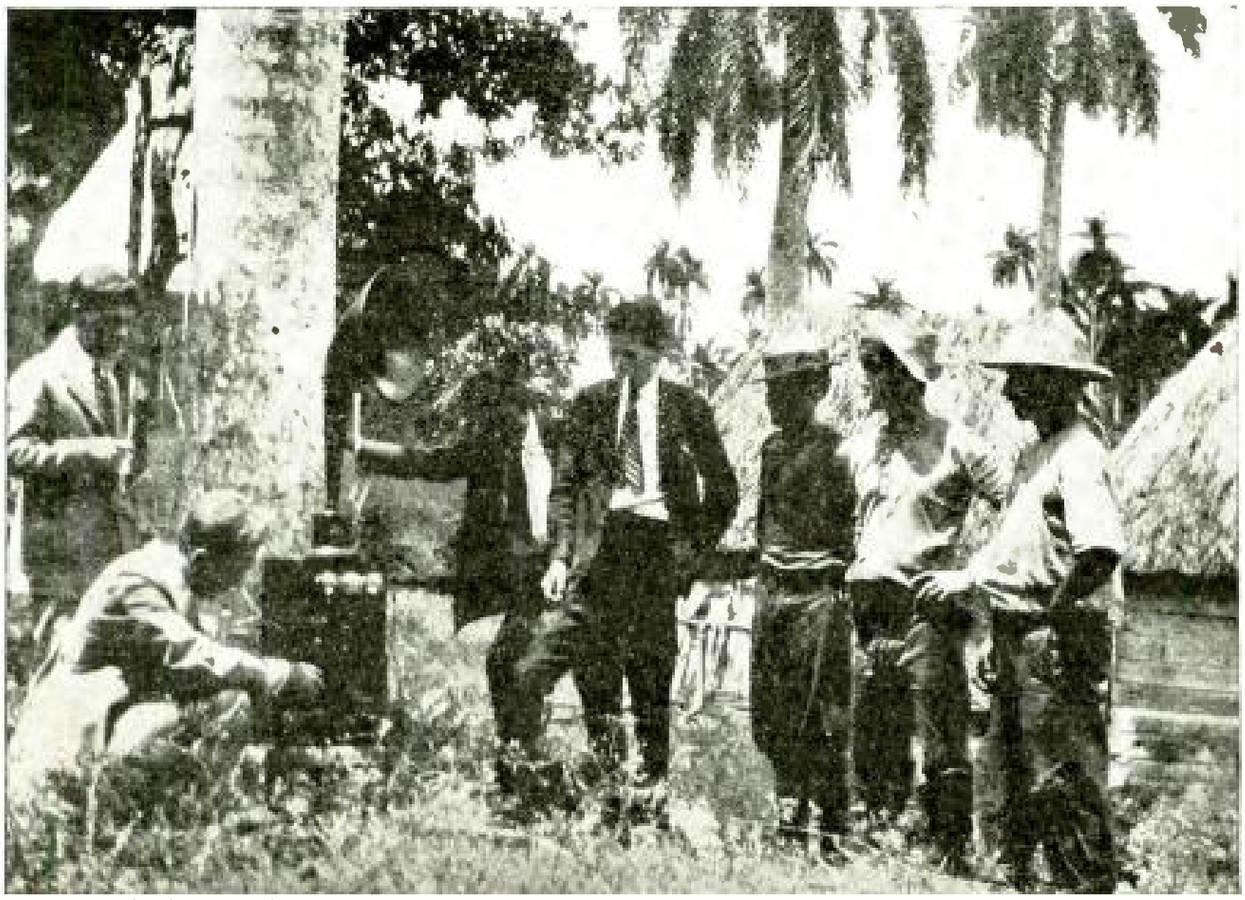
But amplification in itself is a very wonderful story—how the original feeble impulse, or signal, after being rectified and regenerated in the first tube may be led on through succeeding stages of amplification, transformed, strengthened and passed on again and again, until—all of which we shall later picturize.



Kadel & Herbert

THE POWER BEHIND THE RADIO VOICE OF THE LEVIATHAN

Here is chief operator Pickerell examining the bearings of the large motor-generator which furnishes current for the high-powered C.W. and radio telephone transmitter on Uncle Sam's great liner. This is the largest and most complete vacuum tube installation that has been installed on any commercial vessel.



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ADVANCE AGENTS OF CIVILIZATION

When the officials of station PWX of Havana transported their receiving apparatus into the wilds of Cuba for the purpose of testing reception, they introduced radio to the natives—to whom the wonders of a new world are now being opened.

RADIO—*the* PACIFIST

Wars are based upon disagreements; disagreements are based upon misunderstandings—misunderstandings of motives, of temperament, of problems. Radio, which recognizes no geographical boundaries, is already beginning to bring the peoples of the world into closer contact in business, in culture, in social life; it is destined to be perhaps the most powerful factor for peace that the world has ever known. This article tells why and how.

By MAJOR-GENERAL JAMES G. HARBORD

THE other night I heard an official of the American Relief Administration tell over the radio of the fearful conditions that he and his co-workers had encountered in Russia; of communities cut off from the rest of the world and nearly depopulated by starvation; of "civilized" people who had reverted to cannibalism; of the unhindered sweep of preventable disease.

I sat in the comfort of a modern home and the latest marvel of science brought to my ears the best music and art and human thought. I had but to push a button and there came to me the words of men like these who are shaping the course of history. At my service were all of the comforts and conveniences of modern civilization. Yet measured in terms of the swift flight of the message I heard, less than a quarter of a second from my easy-chair were

millions upon millions of human beings who have never heard of radio and who do not know the meaning of science or modern civilization!

They may have not progressed from the condition of their ancestors, thirty centuries ago. How swift has been the march of scientific discovery, and how tardy, in comparison, the development of mankind!

Here, it seems to me is disclosed the big job of radio—to be the messenger of a new age to the countless millions of human beings who are still living in the dark ages.

I do not mean that we must make our radio broadcasting stations heard in Russia or China and then provide the inhabitants of those countries with receiving sets. The problem is a more practical one than that, and we are well on the way to its solution. America is rapidly completing a great world wide system of radio communication, which is linking to the great centers of culture and commerce many peoples who are now isolated.

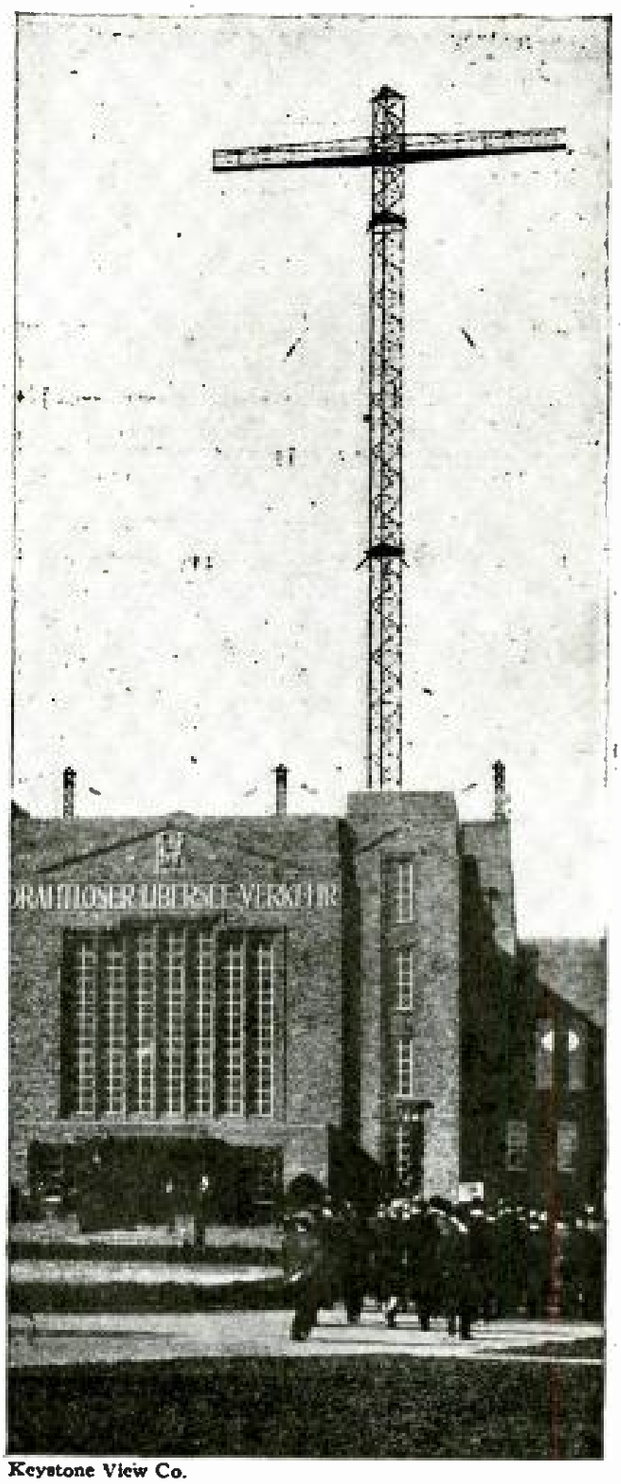
In completing this system of intercourse, I think we shall have accomplished more than all the wars in history to insure and perpetuate peace on earth.

Let us put the situation on a more practical basis. Let us suppose that $5,000,000 were placed in your hands with instructions to spend it to the best possible advantage in securing the peace of the world. What would you do with it?

That very problem confronts the trustees of a fund established by the late Andrew Carnegie, with just such a purpose and just such instructions. Among the trustees are such men as Elihu Root, Nicholas Murray Butler and other leaders of our day who have given deep thought to the problem of how world peace can best be assured. How are they spending the money?

Five million dollars is a lot of money. But measured in relation to the immensity of that problem, it dwindles to insignificance. But the use of this fund has had very definite and apparent results. It is being spent *to promote free intercourse and understanding between peoples.*

Communication leads to understanding and understanding leads to peace.



Keystone View Co.

A GERMAN LINK IN THE RADIO NET

A corner of the great station at Nauen, which was opened in 1920, and which is regarded as one of the finest stations in the world.

What more practical way could be found, then, to promote peace and good will on earth than to provide the physical means for communication between nations. If I had $5,000,000 to spend in promoting the peace of the world, I would invest it in some enterprise for extending radio communication—and with a perfectly clear conscience.

Of course, I do not pretend that such altruistic motives alone have inspired the present world program of radio expansion. Dreams are worth nothing if no accomplishment comes of them; and accomplishment is built of more solid stuff. Radio communication is reaching out to every nook and corner of the globe because there is a definite demand for such communication and the enterprise can be operated at a profit. Those who will profit most immediately from the extension of radio service are the commercial interests which will make most use of it. But this fact makes radio none the less a useful instrument for the fulfillment of higher motives.

Underwood & Underwood

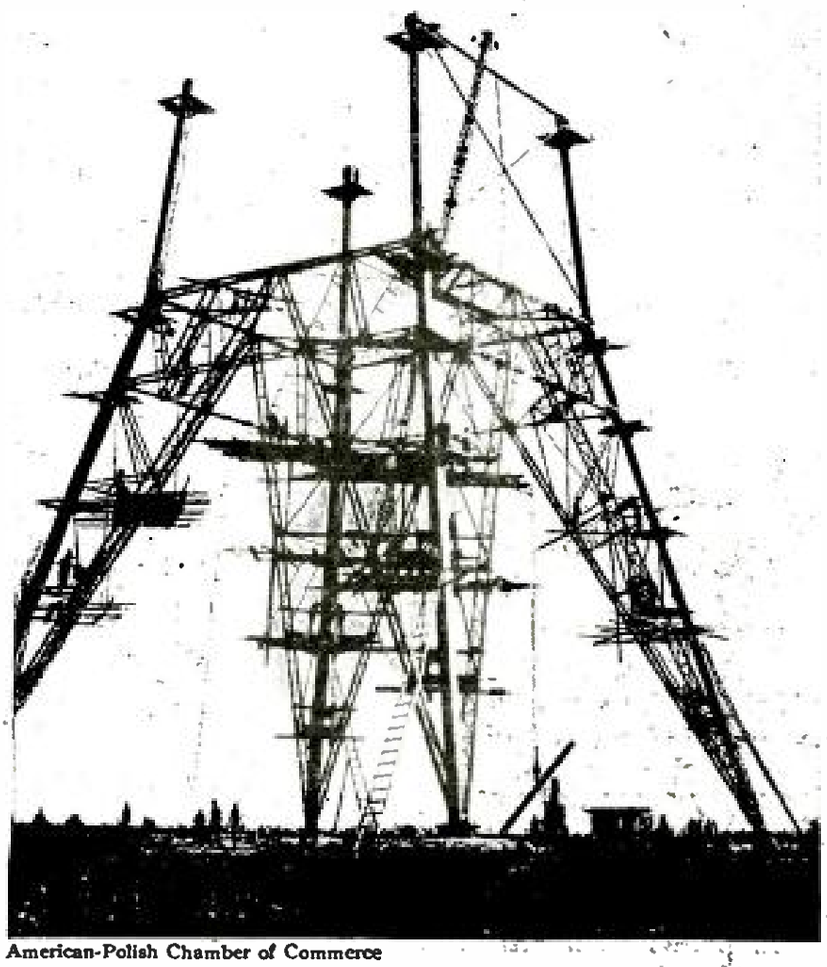
GENERAL HARBORD BROADCASTS A BALL GAME

The author of this article, snapped at Franklin Field in Philadelphia, while talking into the microphone through which the side-line reports of an Army-Navy football game were sent.

It has been said that commerce follows the flag. It is more literally true that commerce follows communications. And commerce not only stimulates the flow of the material things of life between nations, but it engenders a stream of human thought, and brings men into closer contact and sympathy.

Broadcasting by telephone is but one of the marvelous developments of radio in the past few years. Although the public has heard less of it, there has been a parallel and quite as wonderful expansion of the radio telegraph. Until the war, the radio telegraph was used chiefly as a means of communication between ships at sea and between ships and the shore. Those shore stations which existed were for marine use. It is true that messages were exchanged across the Atlantic but there was no commercial radio traffic to compare with that handled by the submarine cables. The American Expeditionary Force in France first demonstrated the commercial possibilities in radio in establishing the great radio station at Bordeaux. For the first time a station was built purely for connecting two land points, and during the later days of the war this station worked twenty-four hours a day, handling the vast volume of official business between General Pershing's headquarters and Washington, and besides transmitted a good share of the news so eagerly awaited at home.

Since the Armistice there has been a remarkable expansion of radio telegraph



American-Polish Chamber of Commerce

ONE OF THE GREATEST ANTENNA TOWERS EVER BUILT

One of the ten great structures of its kind that are being constructed in Poland, that will enable that nation to enter the new world of the ether.

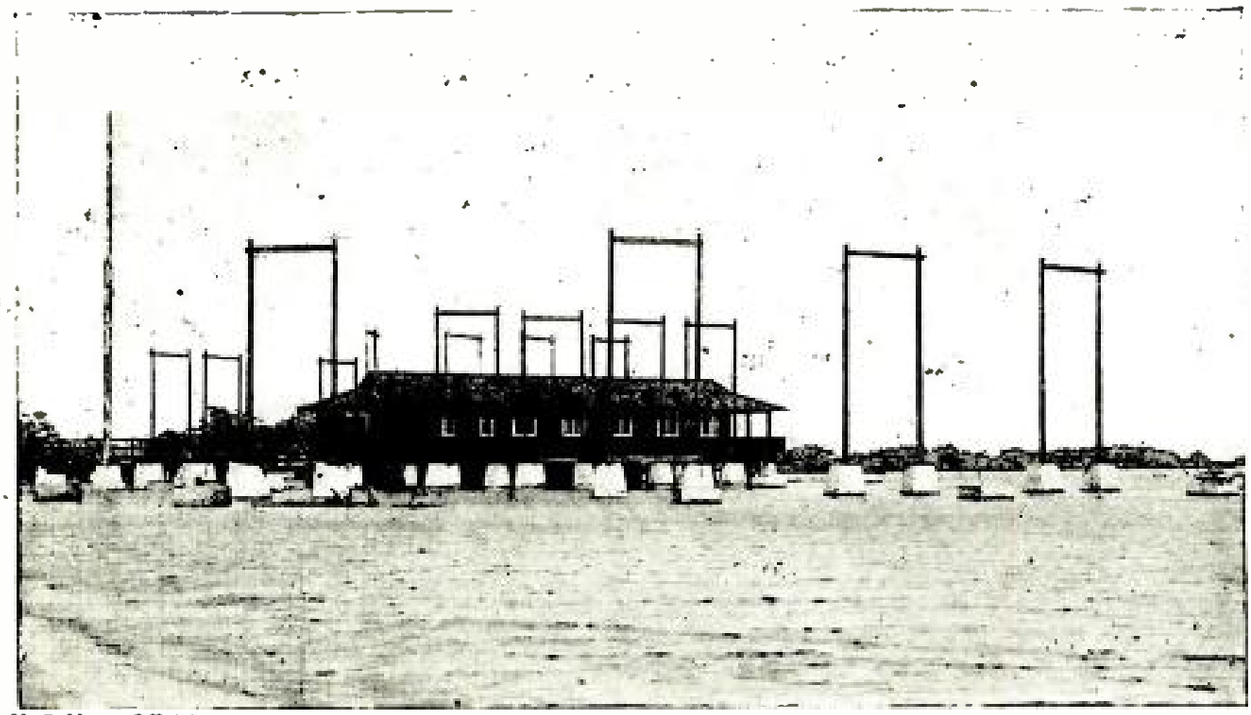
all over the world. England and France have built extensive systems to link the home countries with their distant colonies. Germany, stripped of her possessions, has concentrated on a great system of internal radio communication.

At the present time the Radio Corporation of America operates six great transmitting stations on the Atlantic Coast for trans-oceanic traffic and all of them are connected by land wires with a central office in New York where the transmitting and receiving actually takes place. These stations now provide direct communication with England, France, Germany and Norway. Other stations now contemplated or under construction in foreign lands will link New York with the Argentine and Brazil in South America, and Poland, Holland, Italy and Sweden.

Across the Pacific, a station in San Francisco now provides communication with the Philippines and Japan, by way of Hawaii. Three large stations are being constructed in China and a service to Australia is being planned.

Although many of these projects are being carried out in co-operation with foreign governments or corporations, the plan and leadership is typically American and it is America which is the focal point of all of these circuits of the ether. No other country has such a program under way.

Perhaps, here, I ought to clear up one or two points of doubt. What of



U. S. Navy, Official

A RADIO STATION BUILT ON CONCRETE PILES

This remarkable station was built by the U. S. Navy at Wailupe on the island of Oahu, Hawaii, as part of Uncle Sam's radio system that encircles the globe.

the cables? For many years these cables have provided an invaluable means for international communication. But a cable is expensive to lay and it is justified only between points where there is heavy message traffic. There are seventeen transatlantic cables and nearly all of them run between New York and London. So far the commercial development of the radio telegraph has supplemented and paralleled the submarine cables, but the chief advantage of radio lies in the fact that it can be utilized between points where a cable would be economically impossible. I have not the slightest expectation that radio development will make the cables any less useful, but I do expect the radio to far surpass the cable in usefulness to mankind.

Another point on which there is much popular confusion is the value of the radio telephone for talking overseas.

Because the telephone has so far surpassed the telegraph on land, many people expect it to do so in the field of radio communication. Already successful experiments have been conducted looking to the early establishment of a radiophone service to Europe, and undoubtedly we shall have such a service.

But consider the fact that while a message is being transmitted by radio, whether by telephone or telegraph, some $15,000,000 or $20,000,000 worth of equipment is tied up. The cost of the message depends mainly on the time required for transmission. Now we have perfected and in daily use automatic machinery to transmit messages by telegraph at the rate of from 100 to 200 words a minute. Of course, no one can talk as fast as that, so the cost of a telephone message by radio will be correspondingly greater. For the present, at least, the radio telegraph will remain the main dependence in inter-continental communication and the telephone will be restricted to that class of messages where the cost is a minor consideration. As to laying telephone cables on the floor of the sea, in the present state of the art, this is impossible, excepting for very short distances.

While the dots and dashes of the Morse code may be less romantic than the projecting of a human voice

through the ether for thousands of miles, the results will be no less important. And what will be the results?

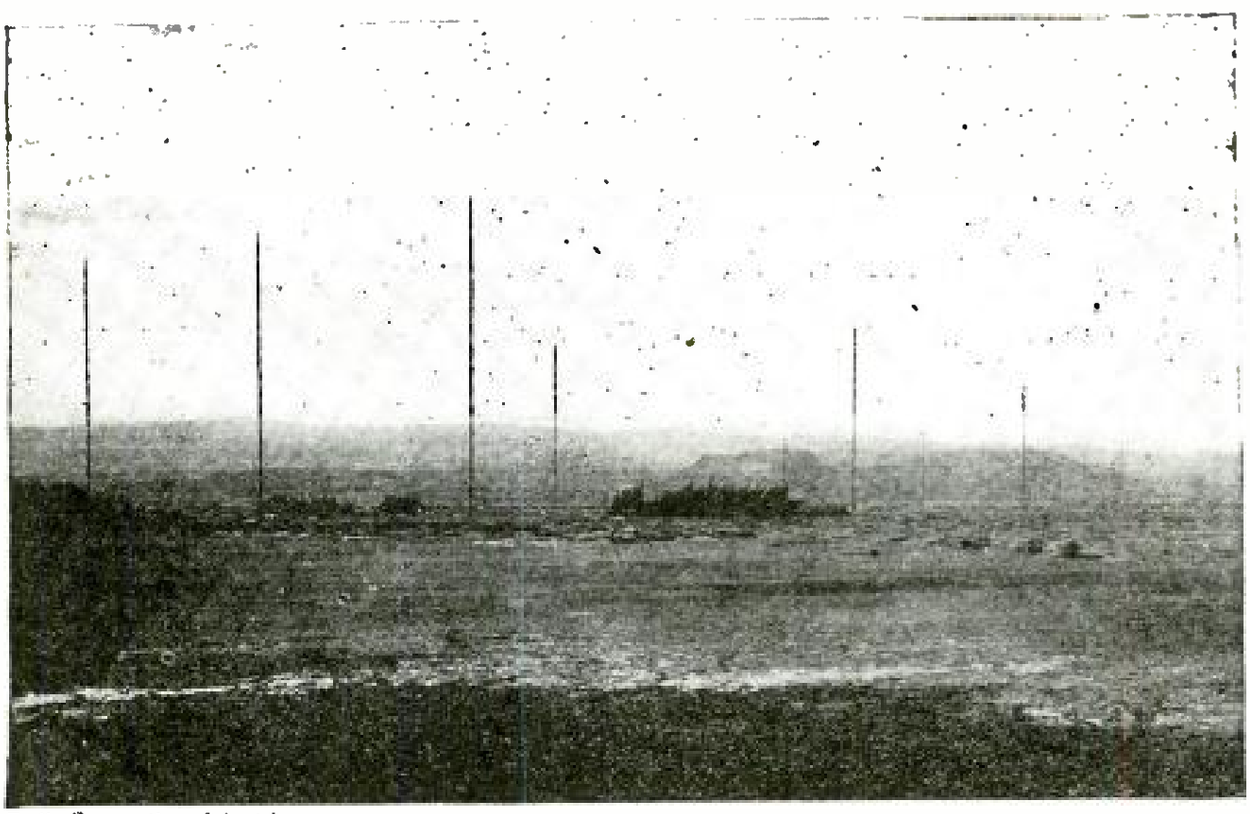
The first and most noticeable result must be a very great advantage to American foreign commerce. Just as London has been the center of cable communication with great advantage to her commerce, so New York is the center of radio communication and American business will profit from that fact. We are finding it increasingly easy to do business beyond our own shores as the ether circuits are extended, and the completion of these new services will mark, I believe, the beginning of a new era of expansion of American foreign commerce.

But it is the social and political, rather than the economical results, which most intrigue me. Among the first and largest users of each new lane of communication are the press bureaus which serve the world's newspapers with the very latest news of the day.

Linking up two countries by radio invariably means that the press service to both is improved in volume and accuracy. The people of each come to understand each other better, as they hear more of the happenings from abroad.

There is a specific example in the case of Japan. More news and more reliable news of each country has appeared in the press of both the United States and Japan since the establishment of radio service, and I feel confident that the improved political relations between the two countries in the past few years is due in no small measure to that fact.

Travelers in Australia often have had cause to complain of the inadequacy of the news from America. That is no fault of the Australian newspapers. Likewise, the dearth of news about Australia in our own press is not be-



Radio Corporation of America

THE ETHEREAL VOICE OF THE FAR EAST

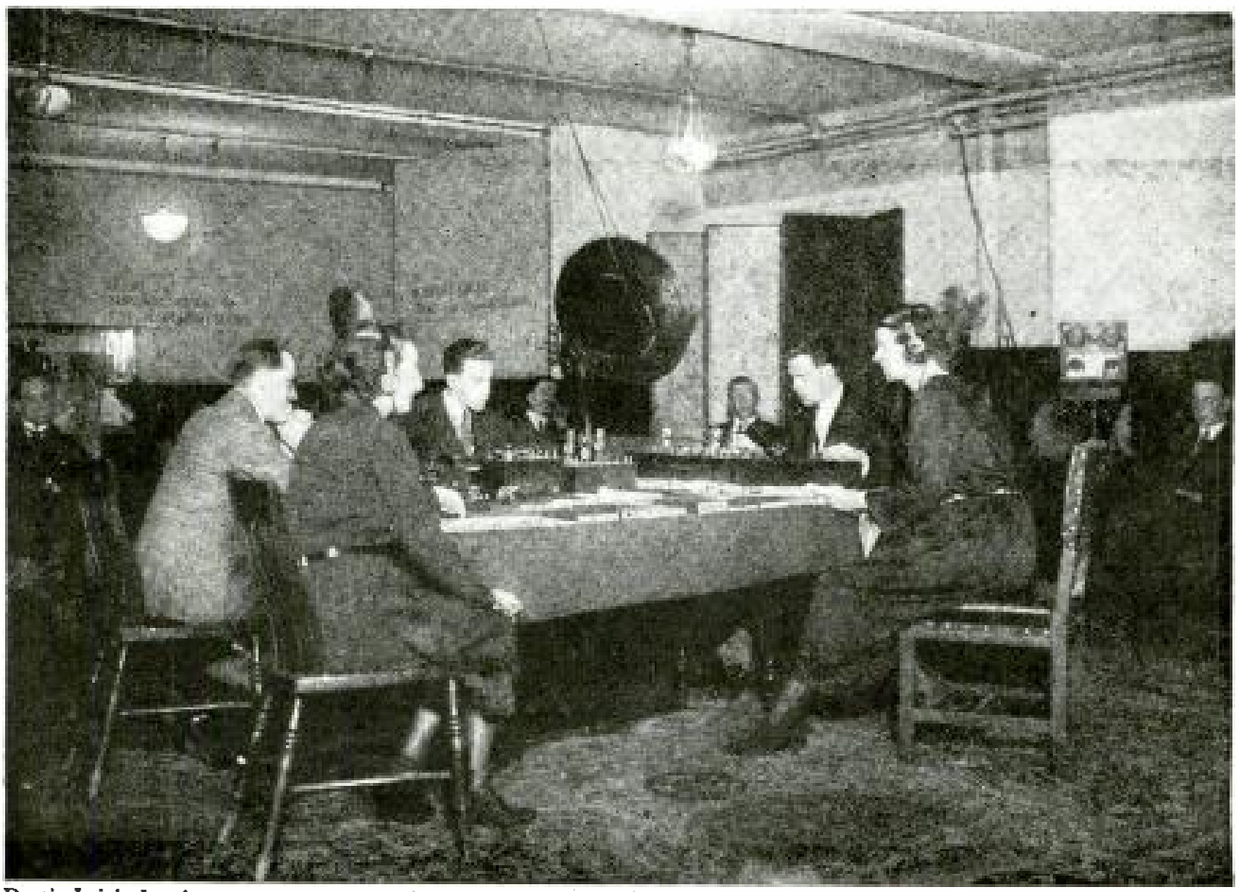
The slender antenna masts of the Japanese station KGI, in Kahuku, each about 300 feet high. They support many miles of wire that are necessary for high-power, high wavelength transmission.

cause happenings there are uninteresting, but because there is no direct means of communicating the news.

Direct communication between our Pacific coast and China may have even more far reaching results. China, after centuries of lethargy, is awakening under the persistent influence of western civilization. Particularly the influence of America has been felt there.

This has been due, in some measure at least to America's passion for "uplifting." We think of the Chinaman as an inferior being. But there is no basis for such an assumption. Some scientists, who have studied the matter carefully, have concluded that the oriental mind is just as keen as the occidental, and, given equal opportunity, the yellow race may prove just as progressive as the white. Closer contact with our civilization through the agency of radio will undoubtedly speed up the rejuvenation of China's own. Just what the results will be I cannot forecast.

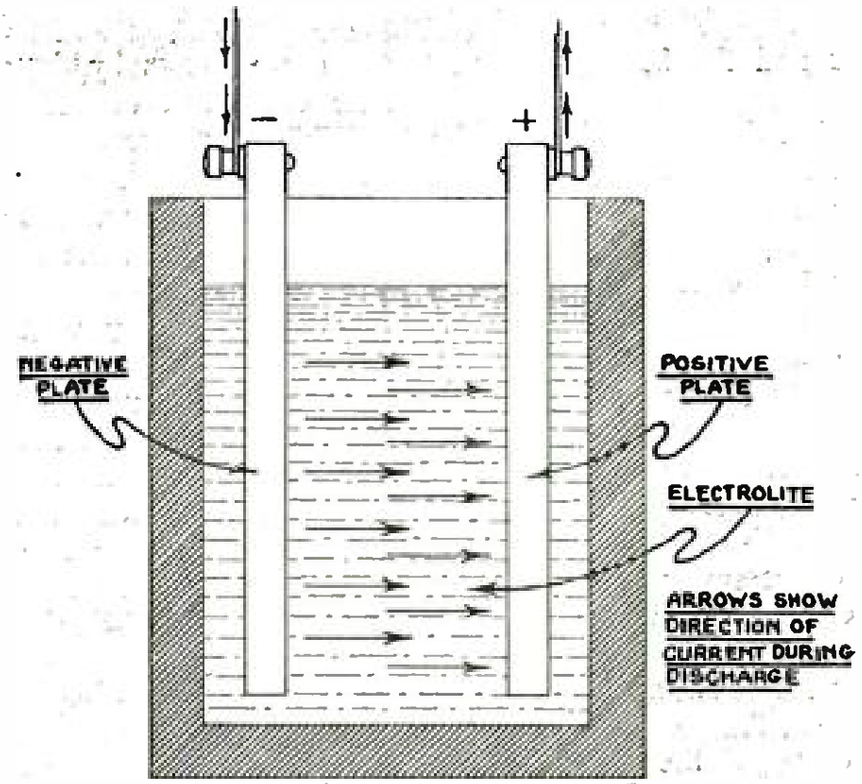
I have often heard it remarked, upon casting a mental glance over the troubled face of this earth, that we are about to sink back into another series of Dark Ages. If the old admonition "As ye sow, so also shall ye reap" was literally true, the outlook would appear gloomy enough. But as a matter of fact the modern world is just beginning to reap the harvest sown by the Newtons, the Huxleys, the Darwins, and all of the other searchers after knowledge in the past. And one of the fruits of this harvest is radio, which, I believe, will develop into the greatest and most practical medium for bringing about international understanding and peace that the world has ever known.



Dorein Leigh, London

THE "LISTENING-IN LOUNGE"

That is the term applied to that corner of the rest room which a London department store has equipped with a radio set for the entertainment of its customers.



HOW A BATTERY DISCHARGES

FIGURE 1: *When a battery discharges the current flows outside the battery, through the circuit, from the positive terminal to the negative terminal. The flow inside the battery is from the negative to the positive, through the electrolyte, as indicated by the arrows.*

HOW TO MAKE A

Battery Charging Rectifier

At a Cost Ranging from $1.00 to $2.00

By ARTHUR R. NILSON

THE charging of the storage battery is a problem that has to be solved by every radio enthusiast who operates a vacuum tube set. A storage battery may well be compared to a living organism, which soon dies and must be discarded if it is neglected. On the other hand, a little regular care, water and food—which in the case of the storage battery is water and charging—prolongs its life over a long period.

When a storage battery is discharging, the acid in the electrolyte (liquid) mixes and combines with the active material of the plates. For this reason the specific gravity of the electrolyte, which depends entirely upon the ratio of acid to water, varies as the battery becomes charged and discharged. When the battery has completely discharged most of the acid has gone from the water and combined with the plates, leaving an electrolyte that consists largely of water.

When the battery is charged the reverse action takes place; the acid is driven out of the plates back into the water. If all of the acid is not thus driven out, the battery is not completely charged. If this happens a number of times the acid tends to clog up the porous active material (spongy lead)

of the plates and the battery becomes sulphated.

It is seen that the route taken by the acid is either into or out of the plates and that this direction of movement is controlled by the direction in which current flows in the battery. When a battery is discharging, the direction of the internal e.m.f. between the plates is from negative to positive as shown in Figure 1, and that during charge the flow is in the opposite direction. It is necessary, therefore, that the charging current flow in one direction only; in other words, that direct current be used. An alternating current cannot be used because the direction of flow changes periodically. This is shown in the oscillogram in Figure 2.

In this diagram the electromotive force takes a positive direction for 1/120th of a second and a negative direction the next 1/120th of a second; 1/60th of a second is necessary for a complete reversal of current. Such a current is a 60-cycle current; it is the kind supplied to most lighting circuits.

If a rectifier or some other method of eliminating one direction of flow is introduced in the circuit the pulsating direct current that is shown in Figure 3 results. The lower or negative side of the curve shown by dotted lines is the flow eliminated by the rectifier.

While it is true that the rectified current does not maintain a steady value while flowing, it is uni-directional and therefore suitable for the charging of storage cells.

There are many ways of rectifying an alternating current. Some of the most commonly used and efficient pieces of apparatus are the mercury-arc lamp rectifier, the Kenotron and the Tungar rectifiers, the mechanical rectifier, and the type of rectifier to be described in this article, called the electrolytic rectifier.

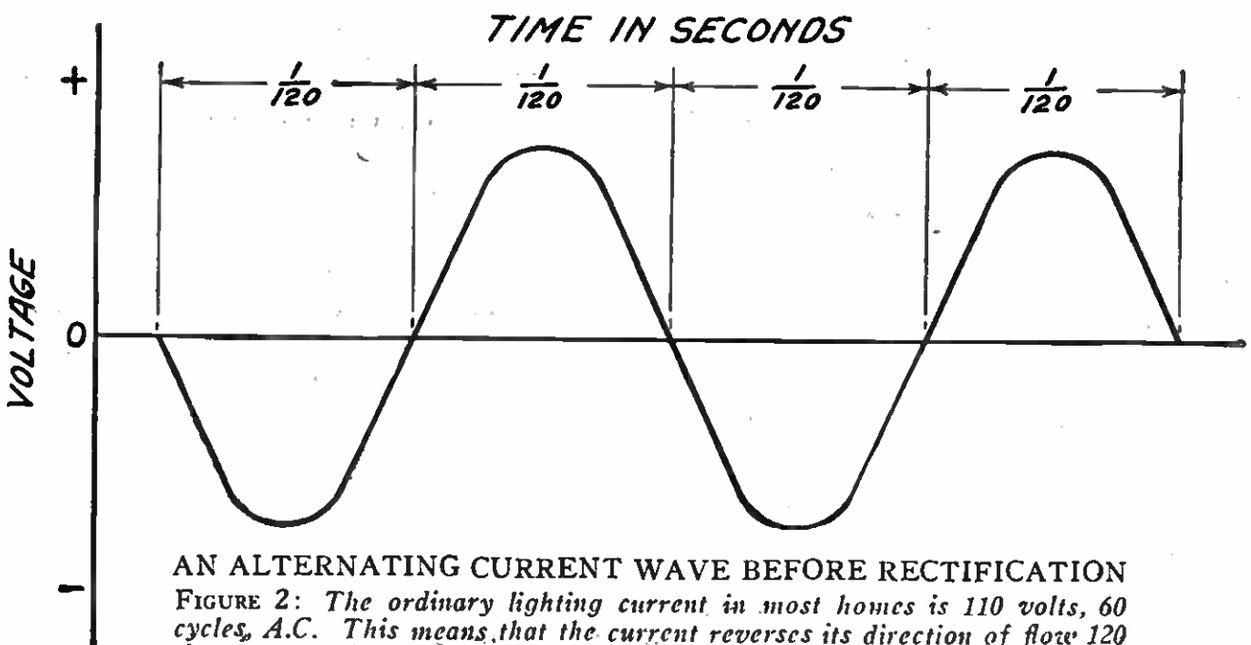
How to Build the Rectifier

The electrolytic rectifier is perhaps the one most easily made by an experimenter who has only a few tools. A photograph of the completed rectifier and resistance is shown in Figure 4. The following materials are necessary:

2 mason fruit jars—pint size;
2 strips of aluminum; size—6 inches by 1 inch by ⅛ inch;
2 strips of lead, size—6 inches by 1 inch by ⅛ inch thick;
A few ounces of borax;
4 terminal posts.

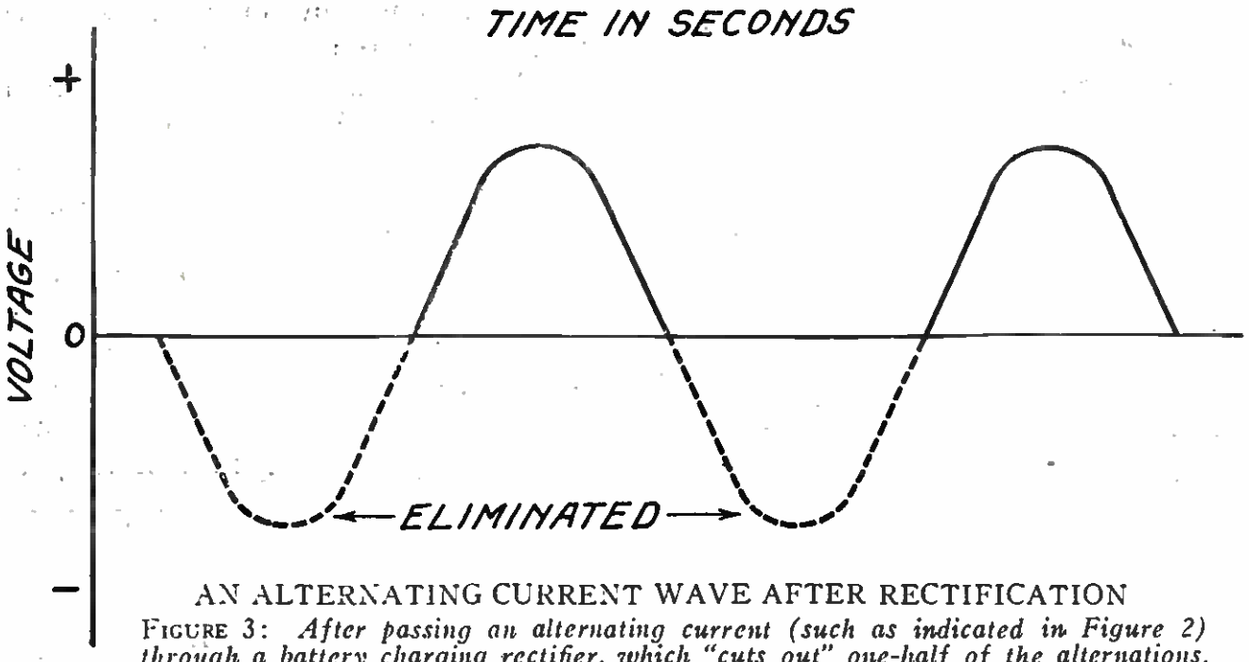
The construction is so simple that a lengthy explanation is unnecessary. A close study of the photograph will show that the two strips are bent and hung over the edge of the jar into the electrolyte.

The electrodes as noted in the list above



AN ALTERNATING CURRENT WAVE BEFORE RECTIFICATION

FIGURE 2: *The ordinary lighting current in most homes is 110 volts, 60 cycles, A.C. This means that the current reverses its direction of flow 120 times a second. In this form the current is useless for charging a battery.*



AN ALTERNATING CURRENT WAVE AFTER RECTIFICATION

FIGURE 3: *After passing an alternating current (such as indicated in Figure 2) through a battery charging rectifier, which "cuts out" one-half of the alternations, a pulsating direct current is left which can be used to charge a storage cell.*

are of lead and aluminum, cut to the sizes given in the list.

The electrolyte consists of two pints of water to which has been added about three heaping teaspoonfuls of borax. A new electrolyte should be prepared and substituted every few weeks. This is necessary because the electrolyte becomes saturated with aluminum particles which come off the positive plate and mix with the electrolyte, thereby lowering its resistance. The lead plate does not wear away.

The jars used are the pint size mason fruit jars which may be purchased in any hardware or grocery store.

The terminal posts should be one-inch round head brass machine screws with two nuts. Their size should be 8/32 or 10/32 thread.

The jars should be set into a wooden rack as shown in the photograph. A rack such as the one shown can be made of whitewood and stained any desired color.

How to Operate the Rectifier

While in operation the rectifier "boils" due to the heat produced by the current that flows through the electrolyte between the lead and aluminum electrodes. The water is therefore evaporated and it is necessary to add water to take the place of that lost by evaporation. It is not necessary to add more borax; this element does not reduce itself by evaporation.

A connecting lead-wire to hook the rectifier up to the lighting circuit is necessary. This should be as long as required and should have a screw plug fitted to one end so that it may be screwed into a light socket. Spring clips should be soldered to the other ends for clipping it onto the rectifier and resistance terminals as indicated in Figure 5.

A double-pole double-throw switch to change the battery from charge to discharge will be found convenient and may be connected as in Figure 5.

It is important that the two sets of aluminum plates and the two sets of lead plates be connected together, with the jars paralleled and also that the aluminum strip electrode of the rectifier be connected to the positive terminal of the storage battery. If the polarity is not marked on the battery it may be determined in any of the following ways:

1. Cut a potato in half, and insert the two leads from the battery; a green formation will take place around the positive terminal.
2. A direct current voltmeter will read correctly only if connected positive to positive and negative to negative. Get a reading on the voltmeter and note the markings on the connecting posts.
3. Dip the terminals of the battery into a glass of water into which a little salt has been dropped, being careful not to let them touch; bubbles will appear at the negative terminal.
4. Use a polarity indicator; this may be purchased in any electrical supply store.

The rectifier and storage battery should be installed in the cellar near the electric meter. This, of course, will necessitate running two wires up to the radio set but it removes the possibility of any of the sulphuric acid coming in contact with furniture and carpets.

If the battery is installed in any place where it may injure fabrics or furniture, it should be kept scrupulously clean. It is well, any way, to keep the lead connectors and terminals coated with vaseline. Always unscrew the caps while the battery is on charge so as to allow the gases which are generated to escape.

The generation of gas (shown by bubbling)

in the electrolyte while the battery is being charged indicates that the battery is nearing the full charge point. After this has been going on for four hours it is safe to assume that the battery is fully charged.

How to Make the "Resistance"

It is necessary to insert a resistance in the line; such a resistance may be a 100-watt lamp or a water rheostat, made as shown in Figure 6.

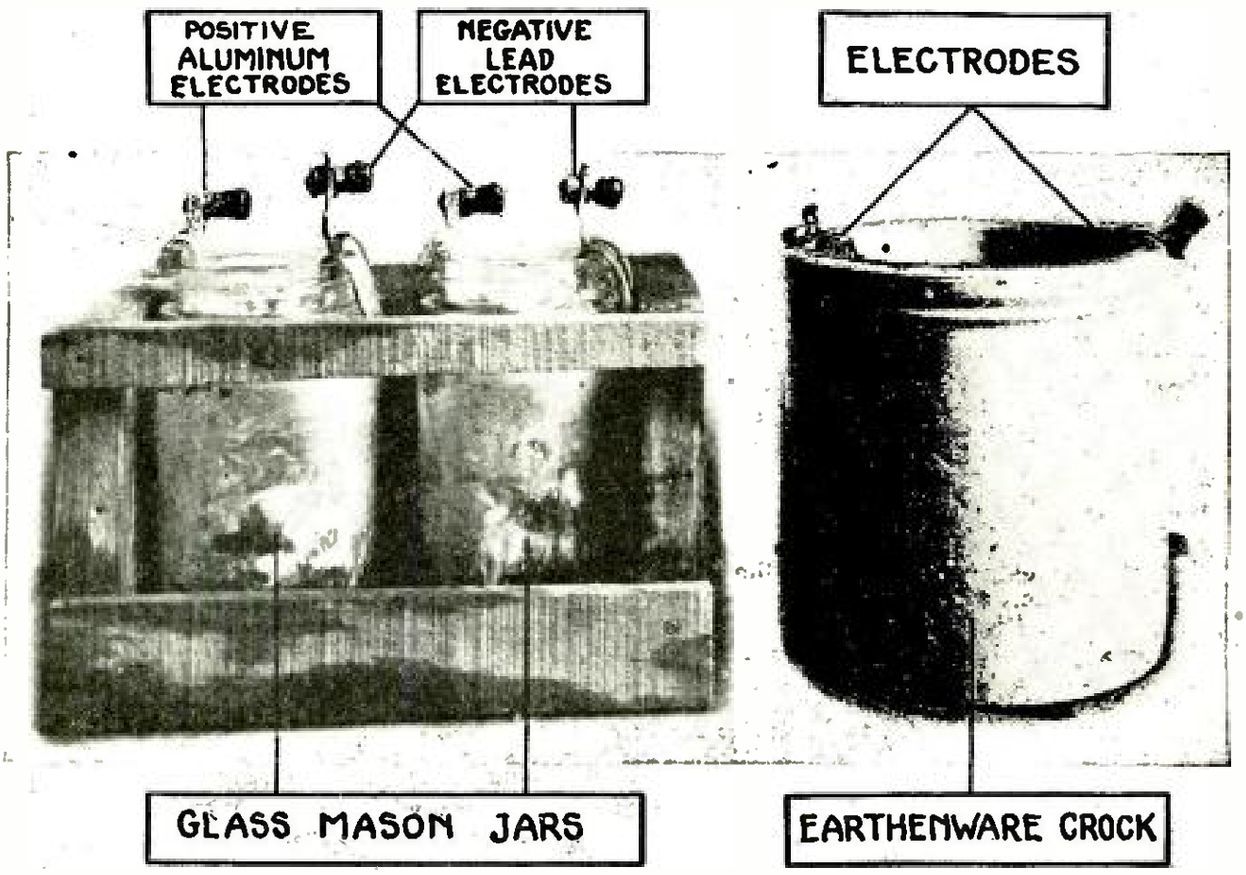
The jar for this should be 6 inches by 8 inches in size. The electrodes should be lead and carbon. Connect the lead to the negative side of the line. The electrolyte should consist of pure water to which has been added a half teaspoonful of salt.

Practical application has shown that only two rectifying jars are necessary for the ordinary 40 or 60 ampere-hour battery. If, however, a battery of larger capacity is to be charged, three jars in parallel may be used to cut down the time necessary for charging. Two jars may be used in any case, but the higher the capacity of the battery the longer the time that is necessary for charging.

Before the completed rectifier is put into use it should be connected across the lighting circuit line for several hours until the plates have taken on a crust or deposit. The plates are then said to be "formed."

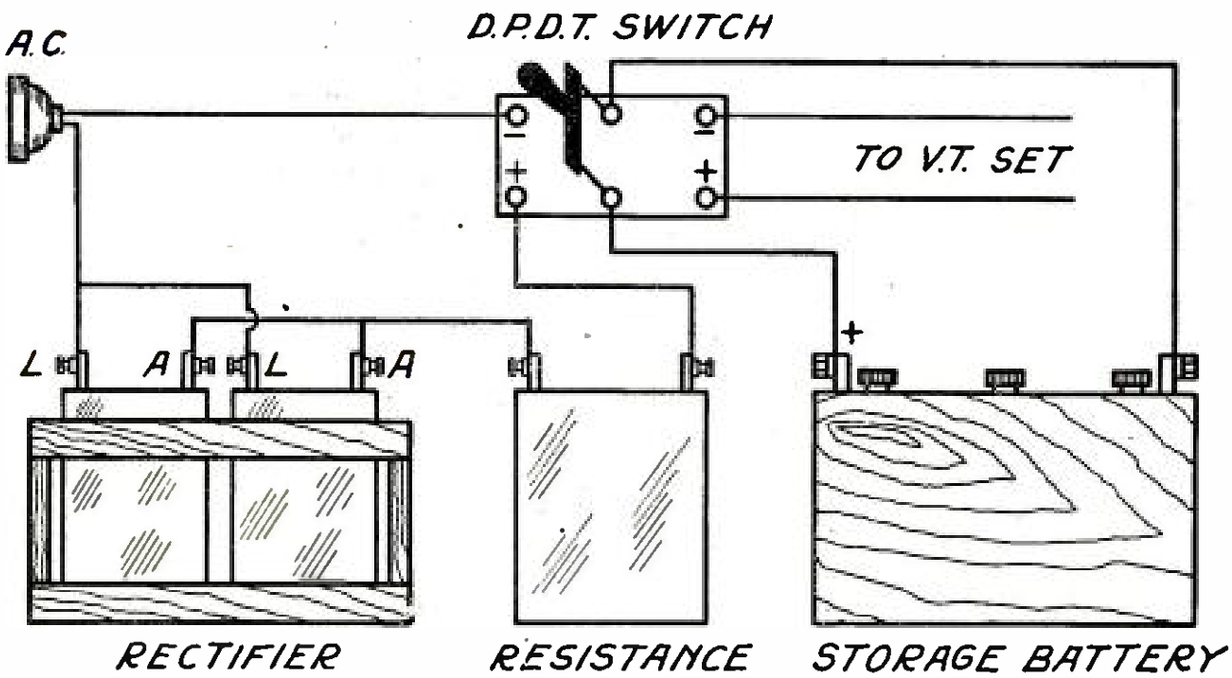
This is necessary because the rectifier, when it is first connected to an alternating current line, acts only as a resistance, and if it were connected to the battery without first having the plates formed, it would allow alternating current to flow through the battery.

In other words, the rectifying action of this type of cell depends on the chemical action which takes place in the thin crust or deposit on the aluminum plates, and if the plates are not first formed they will not rectify efficiently.



THE COMPLETED RECTIFIER AND WATER RHEOSTAT

FIGURE 4: *The rectifier jars are set up in a wooden rack, and an earthenware crock is used to hold the electrodes of the water rheostat. With these two units the radio fan may charge his own batteries at home from the A.C. lighting mains at small cost.*



HOW TO WIRE UP THE CHARGER

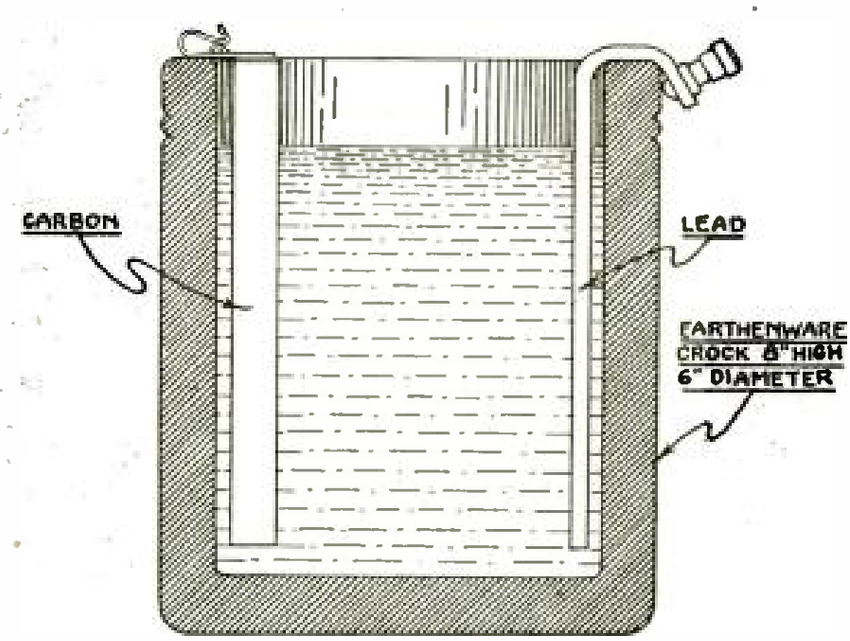
FIGURE 5: *The circuit diagram for connecting up the rectifier, the rheostat, the storage battery and the change-over switch. By throwing the switch to the left the battery is put on charge and by throwing it to the right the battery is connected to the vacuum tube receiving set.*

The only part that has to be replaced in the cell is the aluminum plate, which eats away after a period of usage.

The above type of rectifier has been used for many months by the writer, and it has given him uniformly excellent results and the cost per charge has been extremely low.

HOW THE WATER RHEOSTAT IS PUT TOGETHER

FIGURE 6: *The rheostat consists of an old earthenware crock which is filled with water to which has been added a half-teaspoonful of salt. The lead and the carbon electrodes are then immersed in the liquid on opposite sides of the crock.*



How to Build a Simple Honeycomb Receiver

In the next issue of POPULAR RADIO—for October—will appear a complete detailed description of a home-made set that may be built by any radio novice who is handy with tools at a cost of about $15.

Brown Bros.

IMPORTANT MEMBERS OF THE CAST OF THE BROADCAST PLAYS OF THE FUTURE

The drama that must depend entirely upon sound must differ in its technique from the drama that appeals to the eye as well. The thunder and crash machines and the sounds of galloping horses will, indeed, figure among the thrilling features of the new theater of the ether.

My Drama Is Broadcast

The personal adventures and impressions of an eminent playwright who participates for the first time in a production of a comedy without costumes or "props" in a transmitting station

By JESSE LYNCH WILLIAMS

"Dear Mr. Williams:

I write at my wife's request, to express her great appreciation of the play *Why Not?* broadcast this afternoon. She is confined to the house with a cold, and the play was a perfect treat to her. She heard every word, and the changing voices made it most intelligible. It was a great pleasure to me to hear she had been so well entertained during my absence.

Very truly,

...."

THAT is one of nearly a hundred letters we received after broadcasting our comedy from station WOR, at Newark. They came from all kinds of people, all parts of the east.

One of them was from a farmer's wife in a remote corner of Pennsylvania. She asked me please to tell her whether it "ended happily. Were they reunited at the end of the play?" She

explained that as she was obliged to go out and milk the cows, she was not able to listen in after the second act. Of course, I wrote and told her about it, because such genuine interest is most flattering to an author, and because she would not be likely ever to see the play, even on the road.

It was a very interesting experience, this broadcasting of a play, and a novel one. Since we did ours, Miss Jane Cowl has broadcast her entire performance of *Romeo and Juliet* with great success, direct from the stage. In our case, however, the entire company made an expedition from Manhattan to the broadcasting station, accompanied by the director, Mrs. Shelley Hull, and the author, myself. The only "stage property" we carried along was a cocktail shaker!

We were conducted in state (and taxi cabs) to the station and were ushered into a sort of a padded cell which they called a studio, though one of our comedians called it "the mortuary chamber." It was a very silent place, draped with curtains to prevent the intrusion of noises from the outside, and, as we found out before the performance was over, it was well nigh air-proof as well as sound-proof. The men perspired and the ladies got headaches.

We were asked to seat ourselves around a small table, about the size of a stand for holding a cigar humidor or a vase of flowers; only in this case there was placed upon it a curious disc-like instrument of which I forgot to inquire the name—it was the transmitter, I suppose. One of the radio experts informed us that it cost three thousand dollars, or maybe it was thirty thousand dollars—I don't remember, but we were all supposed to be awed. And we were. We said, "Just think of that!" and "My! My!"

We were all impressed by this novel experience of presenting our play to the largest audience in the world, not one member of which we could see. But we were impressed in such different ways! The two charming children in our cast have radio sets of their own and they were merely impressed with the interest and excitement of being "behind the scenes" at a radio station—just as ordinary young people, not professional actors, are always excited and impressed when they have a peep behind the scenes at the theater, an old story to the boy and girl in our company. The older members of the cast, however, were moved in a different way. They were not used to radio or to acting without make-up and for an audience they couldn't see. There was something uncanny and uncomfortable about it. They exchanged self-conscious glances, as if they were about to undergo an operation at a hospital and were trying to show one another that they were not in the least frightened. Some of them were frightened, however; one of the most experienced members of the company whispered to me, excitedly, "I would rather go through three first nights than speak my lines into that queer-looking instrument."

"I know I am going to miss my cues," said another. They all spoke in whispers, like people at a funeral.

"Oh, don't worry," said the director, "I have the script here and will prompt you."

"Must we talk awfully loud?" asked one of the ladies.

"Oh, no, just use your natural speaking voice," said the calmly smiling official in charge.

"My natural speaking voice is gone," she gasped. "I feel as if I couldn't do anything but swallow." And she swallowed.

"Have a glass of water," said I. So she swallowed that and felt better.

I, too, was affected strangely by the experience, but in an entirely different way. I had been informed the day before that it was up to the author to start the ball rolling by making a speech in regard to the Equity Players, the

"STATIC" FROM A COCKTAIL SHAKER

When this crucial scene was broadcast from the studio of WOR, a coin was used in the shaker to take the place of the ice. But the noise so closely resembled the sounds produced by static that the transmission room was thrown into consternation!

theatrical organization producing my play, and also that I must say something about the play and the players and describe the scenes which otherwise those "listening in" could not understand.

Now, if there is anything I hate and fear, it is speech-making. I never do it when I can avoid it and have been known to take a trip out of town for the express purpose of escaping such ordeals. But in this case it was put up to me in such a way that I could not escape. So the morning before we went over to Newark, I wrote a number of nice extemporaneous remarks.

But now when I was called upon to begin, a curious thing happened. Although I knew that there were between a quarter and a half a million people listening to me, I was as cool and collected as I am at this moment, writing this article! The reason was that I simply could not see any of you—for I take it that some of you who read this must have been among those present, or rather absent—that is why you did not rattle me. I simply read from my manuscript, knowing comfortably that nobody could see me read it. I was so cool that I even ran in one or two remarks that were really extemporaneous.

It was a great surprise to me as well as to my good friends of the company, who know my aversion to appearing before the footlights when unkind acquaintances in the audience, who also know how poor I am at that sort of thing, call "author! author!" at first nights, in order to scare me to death.

After making my "speech" (which I will say had the virtue of being short), it devolved upon me to introduce each member of the cast. I would read a description of the character and then state that it was to be played by Mr. or Miss So-and-so, adding:

"Ladies and gentlemen, it gives me great pleasure to introduce Miss Blank."

Whereupon Miss Blank would say to three or four hundred thousand fellow-citizens, "How do you do. I'm sorry I cannot see you," which would give me an opportunity to add, "I am more sorry that you cannot see *her*—she is very beautiful"—or something of that sort. We actually got some fun out of the ordeal.

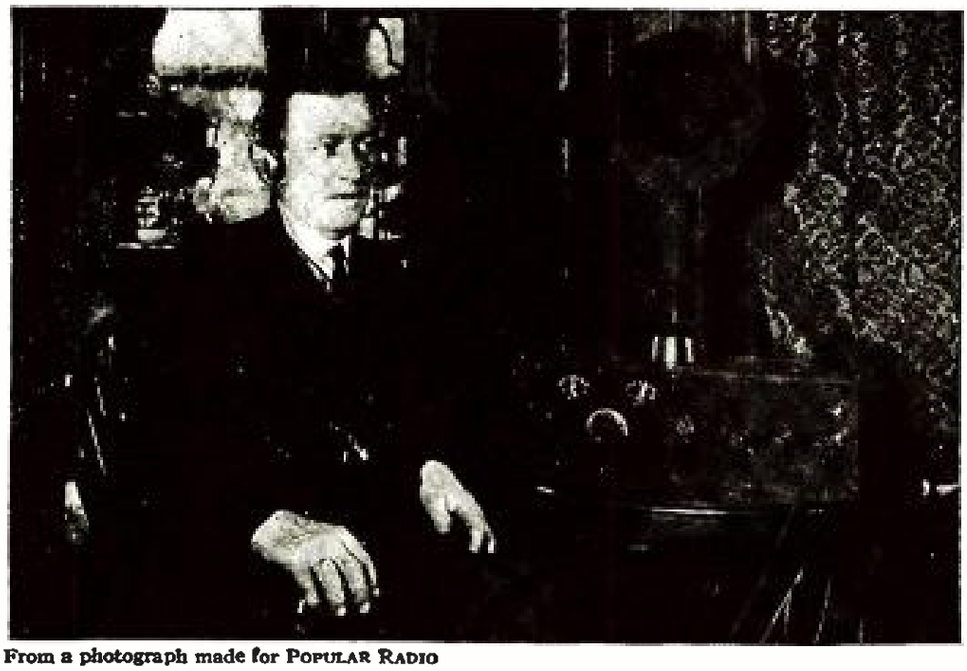
Then with the ringing of a soft-toned gong, to indicate the rising of the curtain, the action began. Of course, I cannot describe all that, except to say that the voices "came over" most successfully, as we afterwards learned from the many letters referred to. Probably one reason, in addition to the fact that they were well-trained voices, was that *Why Not?* is a comedy and, therefore, all the cast spoke conversationally, rather than oratorically or emotionally. One of the officials at WOR told me that certain lecturers and speechmakers are hard to hear because they become so worked up and eloquent that they shout and therefore their voices become blurred and indistinct.

There was one other problem we had to meet. Plays, of course, are not written merely to be *heard* but to be *seen*. For those listening in, there was nothing to indicate the exits, the entrances and the "stage business." For example, two people would be playing a scene and presently, without any apparent reason for it, from the point of view of those listening miles away, a third voice would suddenly butt in. I should think it would have been quite confusing, and I was surprised that our listeners were so kind in their comments in regard to this.

If I ever broadcast another play, I shall either write in some new material to take care of such contingencies, or else I shall have somebody on the job, even though I have to do it myself, to say to those listening, "At this point his daughter is seen entering from the garden. . . . Now she is looking all around the room for her father. . . . Now she discovers him, smilingly hiding behind the screen."

I have mentioned that a cocktail shaker was the only "prop" we took along with us. This was because the mixing of a famous cocktail plays a very important part in the first act of *Why Not?* The hero of the play is a gentleman in reduced circumstances, who, in order to get his adorable little daughter out of the hot, hateful city into the wholesome air of the country, impersonates a servant and secures a job as a butler in a large country house. His wife, equally a good sport, secures the position of parlormaid.

The play opens with her putting him through his paces as a butler, a sort of rehearsal of his new rôle. But he is a man of education and taste, and finding a discordant combination of colors in the flowers in the room, "pink and yellow together," indignantly dumps the pink roses into the coal-scuttle. Subsequently, they are found there by a caller who happens to be the friend of the family who had sent the flowers and didn't know any better than to commit this "crime in color." He, therefore, indignantly orders the new butler to put the roses back into the vase, but the butler refuses to do anything of the sort and finally, forgetting



From a photograph made for POPULAR RADIO

THE STAGE MANAGER LISTENS IN

The expression of mingled amusement and surprise is created by the hearing of the familiar voices which he had heard before only from behind the scenes of the theater.

his part and his place, tells the caller to "go to hell."

Later in the act, the new butler is about to be discharged by the master of the house for being "impertinent to one of our guests." The mistress of the house, however, is the woman this pseudo-butler had loved in his youth, but had fled from, although she loved him, too, because, as he tells her in the love scene, "you were so enormously rich and I was so romantically poor." She doesn't want him to be dismissed. She remembers that in the old days he had been pronounced by her father a great artist at mixing cocktails. Her present husband is also a connoisseur in cocktails—in consuming them, that is, not concocting them. So she suggests that he try one of the new butler's cocktails before the decision to discharge him is final. The master of the house agrees that if the new butler's cocktail proves to be a really notable success, his position will remain secure. So, with great elaboration and considerable comedy, the wonderful cocktail is composed upon the stage, tasted, tried a second time and pronounced a work of art. The situation is saved.

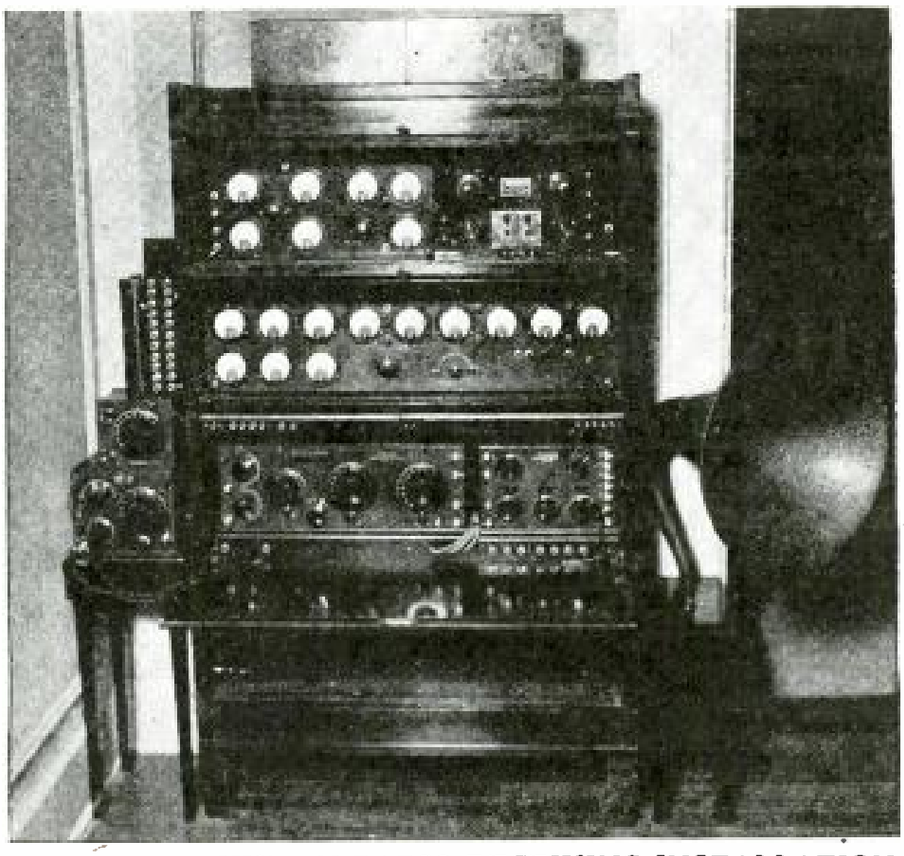
Now as we play it at the theater, real ice is used as well as grenadine to give the water (which plays the part of gin) a pleasing color, but as none of this, of course, could be seen during the broadcasting, instead of ice a couple of coins were placed in the otherwise empty shaker. At the proper moment, with the accompanying dialogue, the gentleman-butler began to shake it. In the studio where we sat around the transmitter, the noise of the coins in the shaker, deadened by the hand of the actor, gave a very good illusion of the gladsome sound of a cocktail coming into the world. But in the broadcasting room up on the roof, where an expert was regulating the waves (or whatever it is such experts do), this sudden and unexpected sound caused great consternation. "My God! Static!" he muttered and excitedly began pulling out stops like organ stops, adjusting multipliers and variable condensers, or whatever it is they adjust when "static" is heard.

It was not until after the play was finished that the expert discovered that he had been endeavoring, like Mr. Volstead, to suppress cocktails. Fortu-

nately, as in the case of Mr. Volstead, his efforts were not successful. So the joke was on him—again like Mr. Volstead.

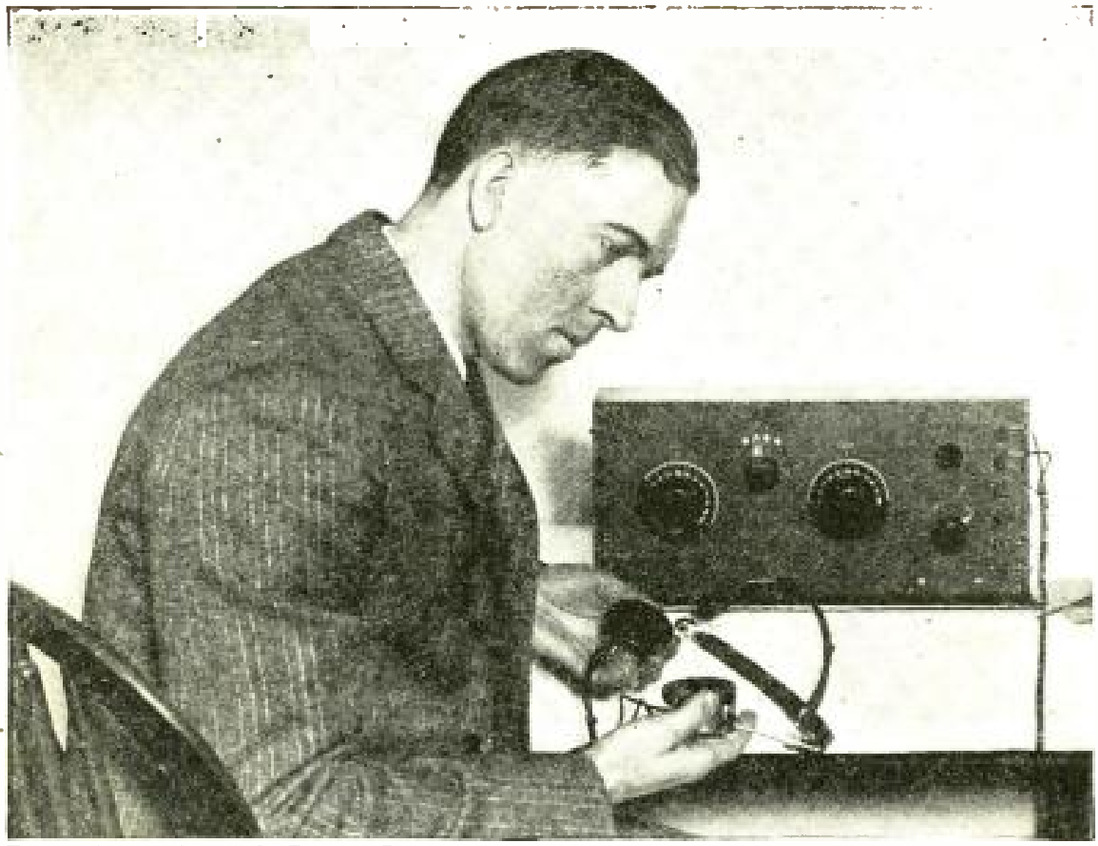
I referred at the beginning to that valuable transmitter (if that is really the name; I don't know any of the technical terms, but I hope my children will not read this article, because I should hate to have them ashamed of their father). We were all very much in awe of it, even before the experts told us that it cost three million dollars —or whatever was the impressive price. During the intermission, at the end of the first act, the boy member of the cast, who plays the part of Billy, being a great radio fan, like most modern boys, drew near to admire and examine it. One of the officials was explaining its unique virtues. My back was turned at the time, but suddenly I heard a horrible crash and turning beheld there upon the floor the thirty million dollar transmitter, broken to bits. There was a second's awful silence. I thought, of course, that our boy actor had dropped it. Terrible visions of lifelong indebtedness arose before us.

"That was very awkward of me," said the official, and I breathed again. He had done it, not the boy. He rang for his assistant, sent up to the broadcasting room on the roof for another, and in five minutes we went on with the second act.



AN ALMOST HUMAN RADIO RECEIVING INSTALLATION

With voltmeters and ammeters for each circuit to measure the currents flowing and check up the voltages, and with duplicate sets of "A" and "B" batteries both of which are minutely variable, this set, which employs both radio frequency and audio frequency amplification as well as two stages of power amplification, is so complete that it takes but little effort on the part of the operator to keep it working efficiently. Batteries are charged, cut in and out of service, a number of antenna systems interchanged at will, and any amount of amplification put into service by merely pushing in or pulling out the control plugs, that master the maze of complicated circuits in the interior of the sectional bookcase in which the instruments are mounted. The set is the property of C. E. Pettit, of Stuttgart, Arkansas.



From a photograph made for POPULAR RADIO

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

The author shows how to set the dials for the initial tuning operations; he has tuned the receiver to 360 meters.

HOW TO BUILD THE

HAYNES DX RECEIVER

This remarkably efficient long distance set may be built by any inexperienced novice who is handy with tools, at a cost of approximately $15. How to do it is described here in detail by—

LAURENCE M. COCKADAY, R. E.

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

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

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

The first is a lack of selectivity. Hence, along the seacoast or near a metropolis which has one or more high

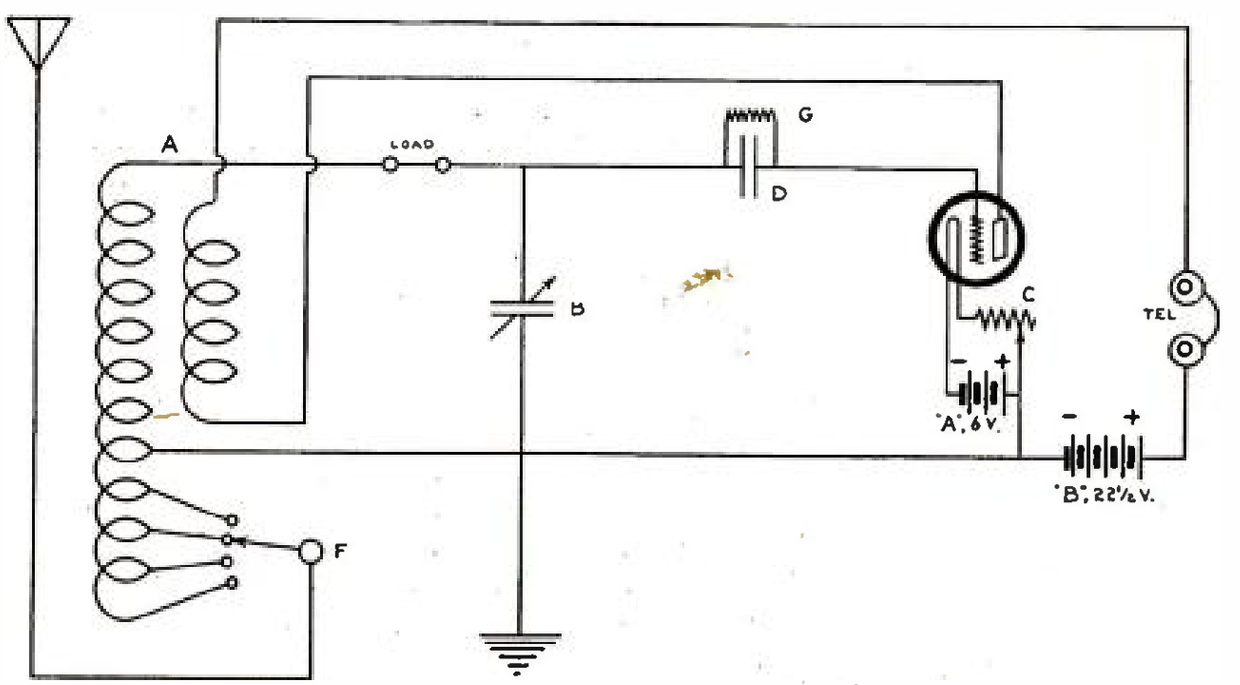
power radio telegraph stations or where several broadcasting stations are operating, this type of circuit is hardly practicable, due to the great amount of interference prevalent.

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

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

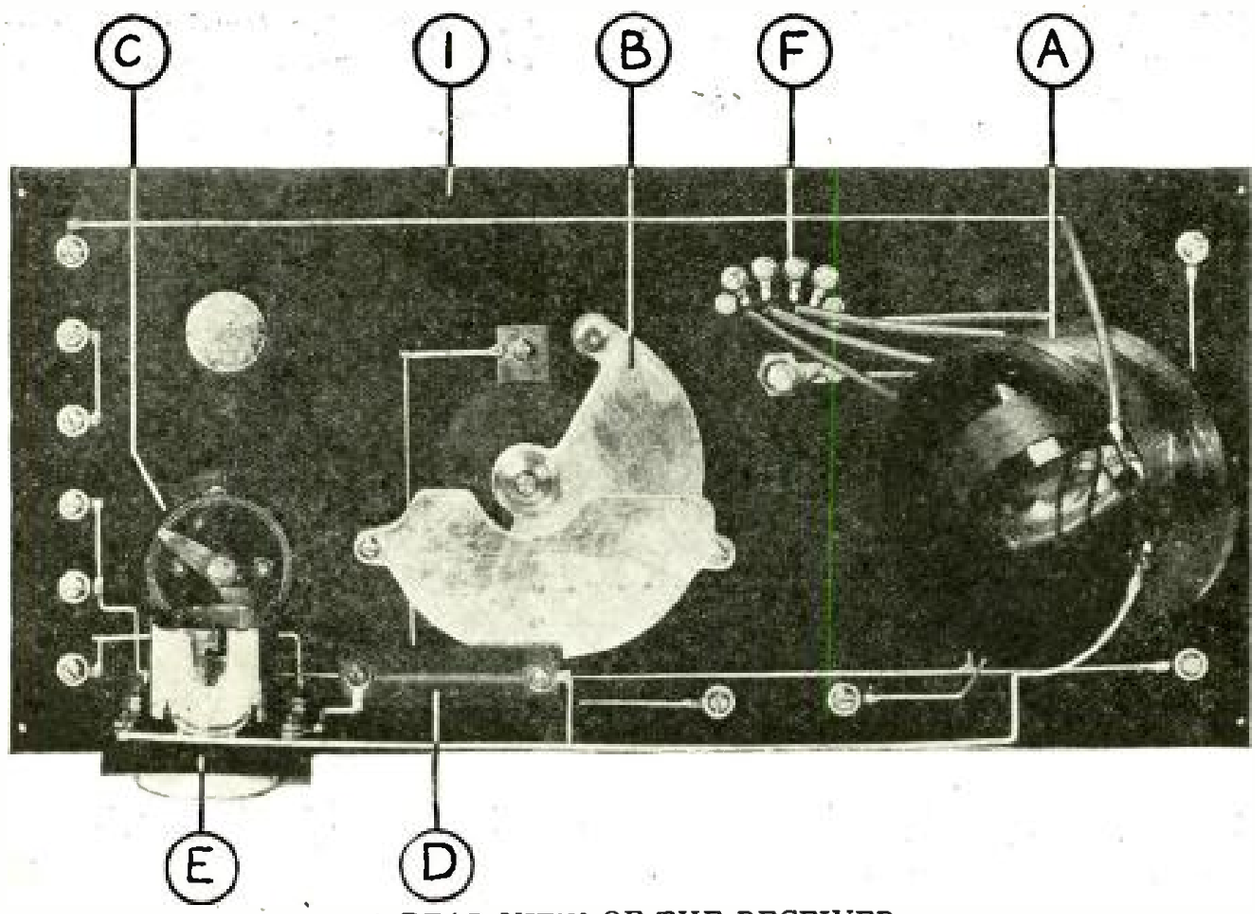
In the Haynes circuit, which is described here, practically nothing has been sacrificed. It is not a compromise, but possesses most of the good points of both of the above circuits with none of their disadvantages. The tuning is simple; similar to that of the ordinary single-tuned circuit. At the same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

Figure 1 is a schematic diagram of the new simplified regenerative circuit. Those familiar with radio diagrams will recognize the similarity of this hook-up



THE ELECTRICAL CONNECTIONS FOR THE PARTS USED IN THE CIRCUIT

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



A REAR VIEW OF THE RECEIVER

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

with that of the regular triple coil, tickler feed-back circuit—with one exception: *The primary circuit is semi-aperiodic* and is conductively coupled to the secondary grid circuit.

The primary circuit consists of the first few single-tapped turns on the stator or stationary winding of a vario-coupler while the remainder of this winding is used as a secondary. The rotor or movable coil is used as the tickler. One of the 180° type couplers is best, as it gives a much smoother regenerative control. Some of the winding should be removed from the rotor, leaving on about 35 turns for the average detector tube. A special coupler of this type is used in this circuit. This coupler has a low resistance stationary winding properly tapped. When used in this circuit it gives exceptionally sharp tuning and great signal strength. Ordinary 180° couplers with the usual number of turns on rotor will not be satisfactory.

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

Many modifications may suggest themselves to the builder to meet his particular fancy. However, the specifications given in the following instructions will produce an exceptionally good receiver for both amateur and broadcast reception.

The Parts Used in Building the Set

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

the correct places and connect them properly in the electrical circuit. The same designating letters are used in the text and the list of parts below.

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

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

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

How to Construct the Set

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

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

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

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

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

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

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

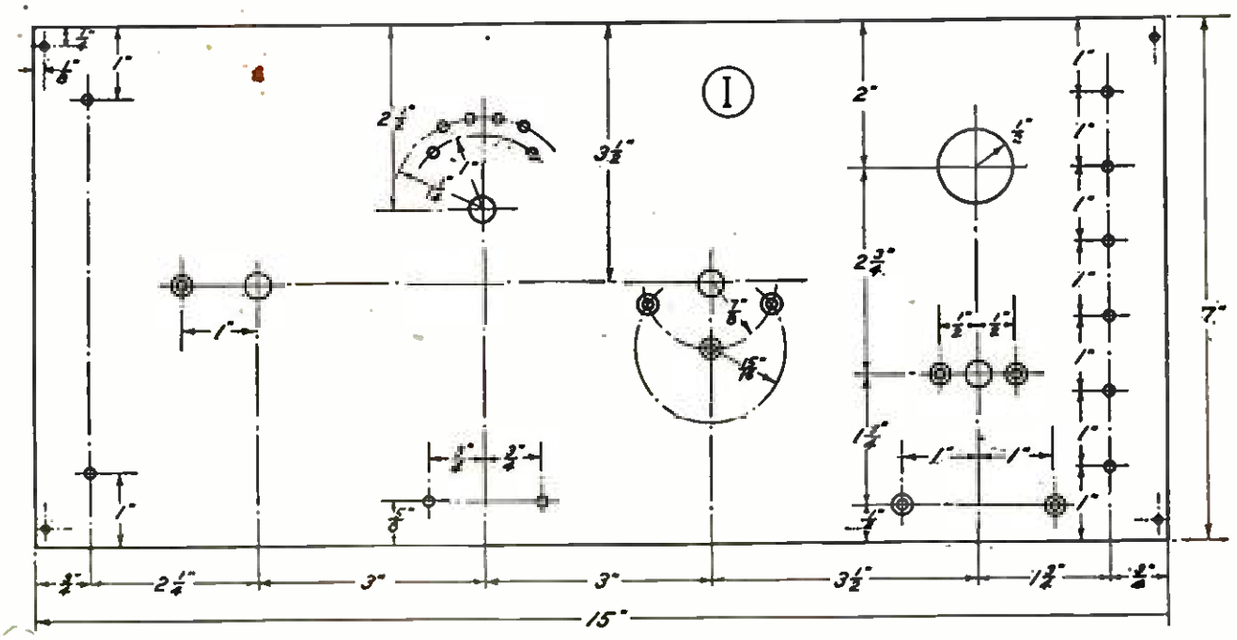
Then attach the condenser B, to the panel with three screws and put on the knob and dial B1, as shown in Figures 2, 4, and 5.

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

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

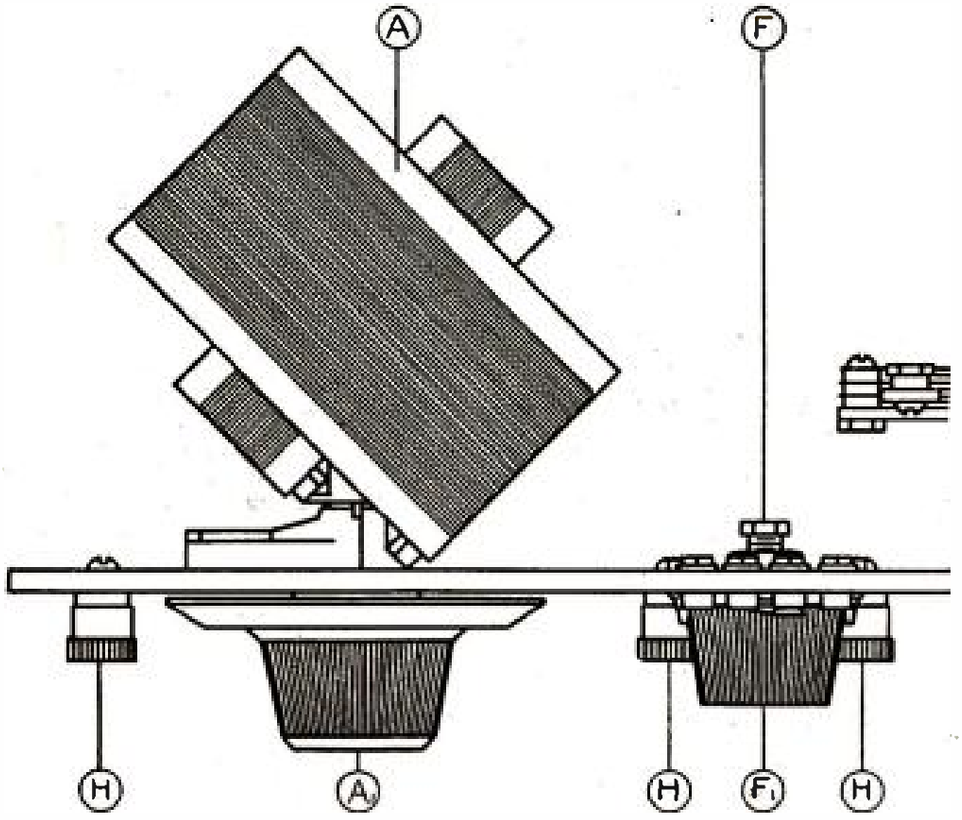
The small fixed condenser D, is supported by the wiring and this may be left until the set is connected up.

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



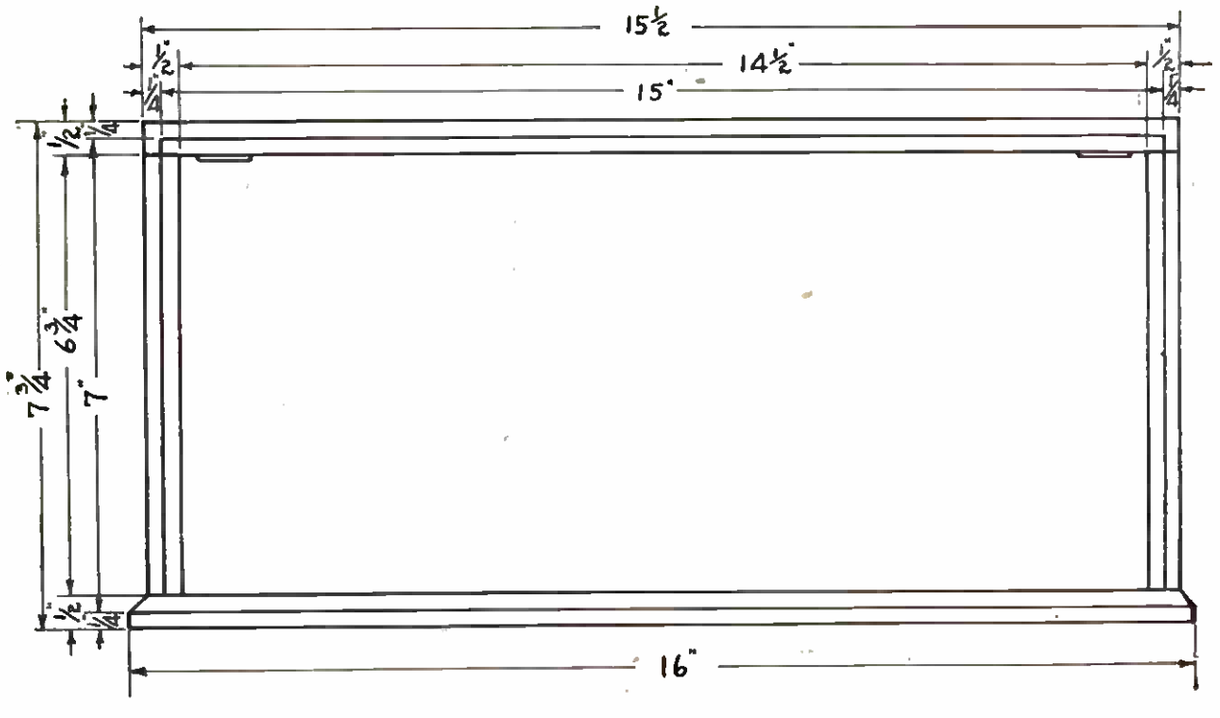
THE LAY-OUT OF THE PANEL

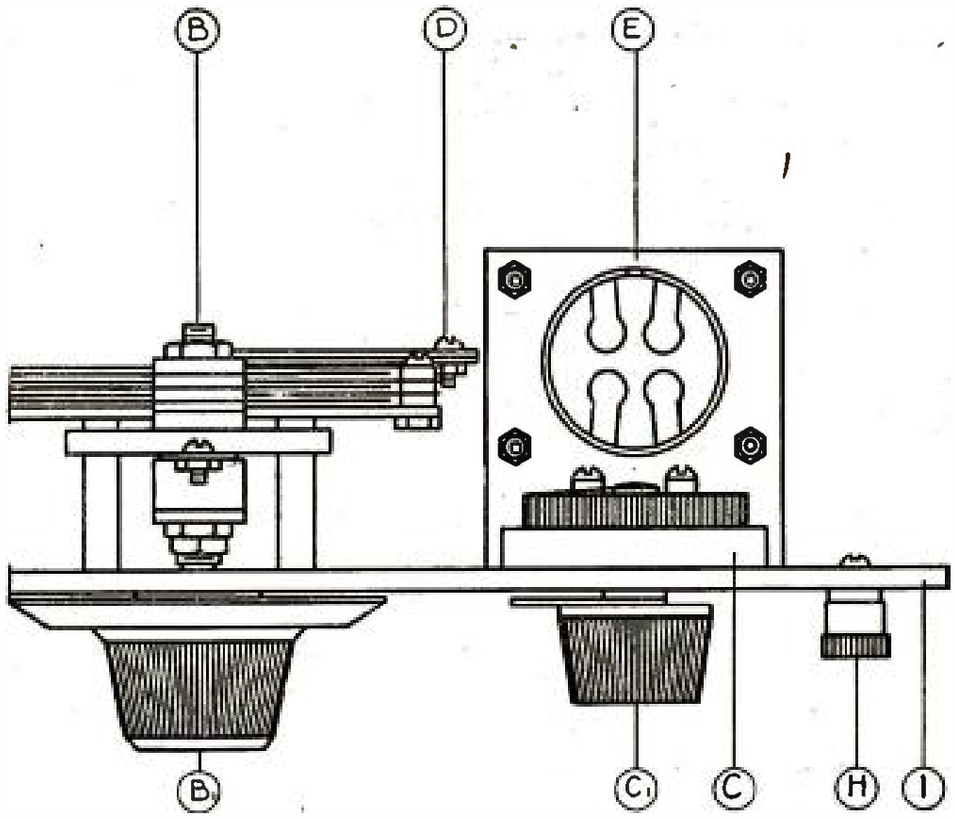
FIGURE 3: *This diagram gives the dimensions for the panel I and the spacing for the drill-holes for mounting the instruments that are specified in the text.*



THE WORKING DRAWING SHOWS HOW—

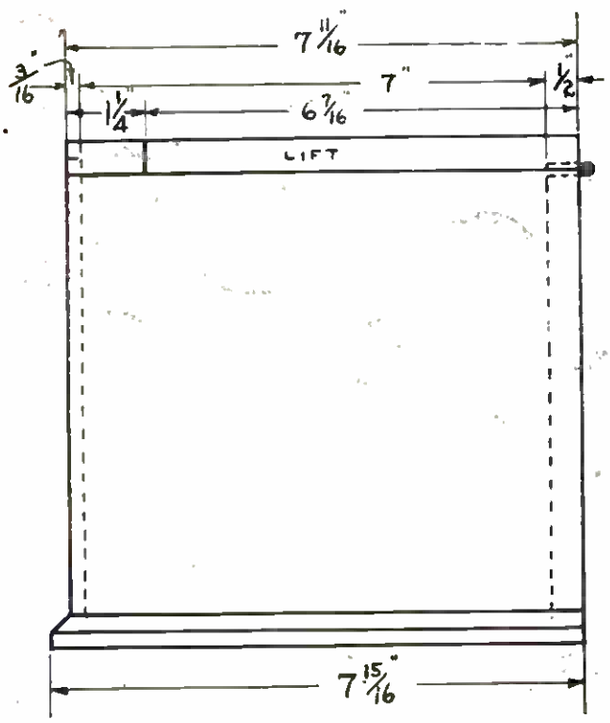
FIGURE 4: *A view of the set from above, showing the exact positions for the coupler, the condensers, the rheostat, the switch, the socket and the binding posts. The instruments will fit exactly as shown on this diagram if the drilling plan drawn in Figure 3 is followed out exactly.*





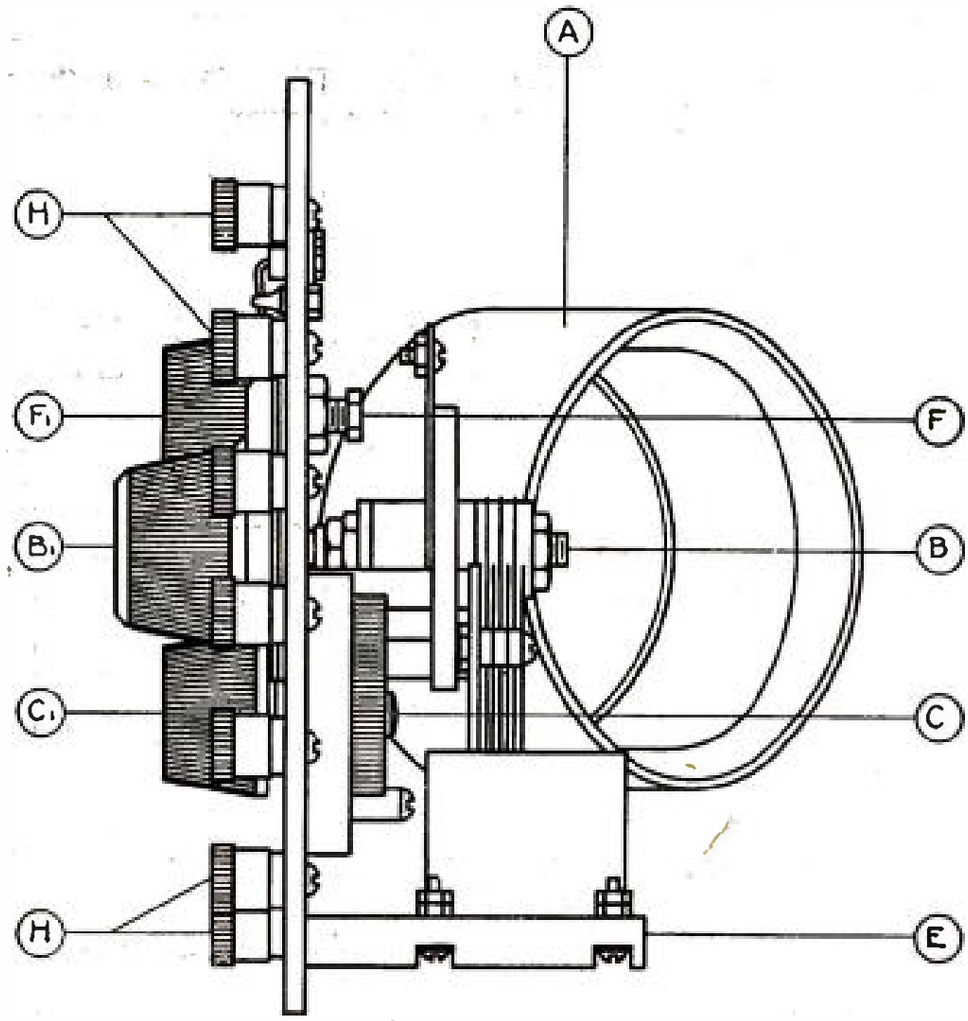
—TO PLACE THE INSTRUMENTS AND ASSEMBLE THE SET

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



HOW TO BUILD THE CABINET

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



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

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

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

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

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

How to wire the Set

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

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

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

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

The connections to lugs should be carefully soldered. Do not use acid as a flux, soldering paste may be used if care is taken not to use too much. Use very little and wipe it off again before applying the iron, otherwise it will

spread over adjoining surfaces and cause corrosion and leakage in the set. The author uses "rosin core" solder almost exclusively rather than paste or acid. This is somewhat harder to handle, however, and the surfaces must be thoroughly cleaned before tinning. This solder used in conjunction with the paste is a satisfactory combination and quite easy to manipulate. Make the soldered joints neat. A small drop of solder, properly run over the joint, is just as effective and much neater in appearance than large gobs which disfigure the wiring.

Operating Data

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

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

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

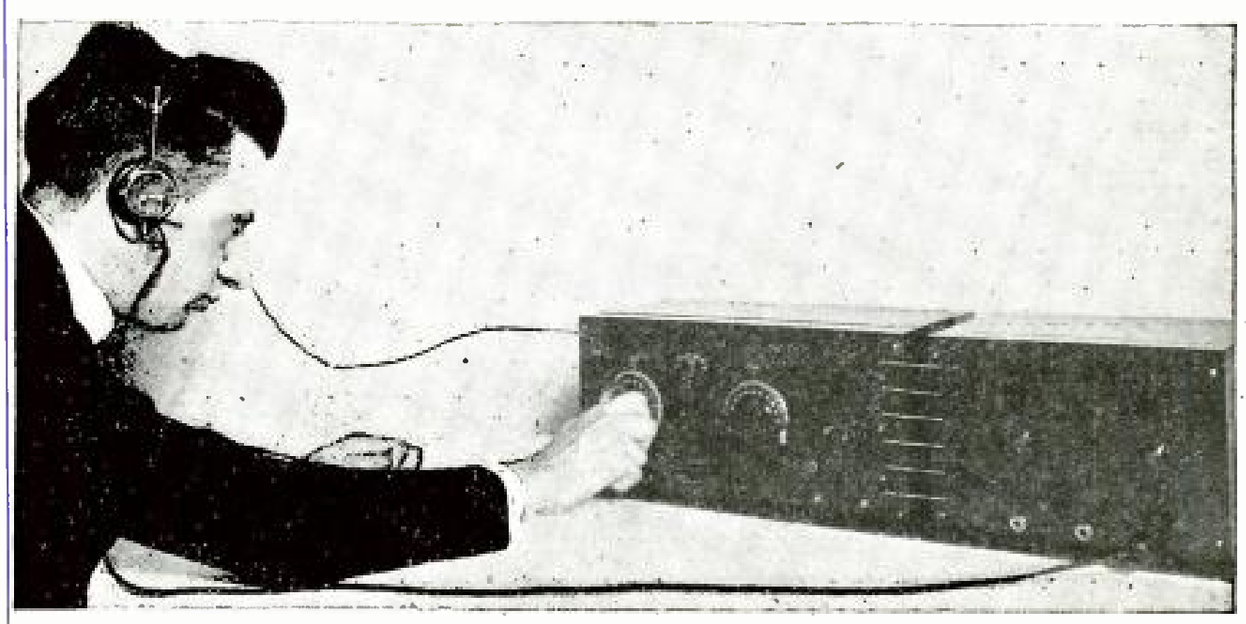
Loudest signal strength will usually be obtained when the primary switch F1, is set as indicated above, on the last tap, so as to include all ten turns on the primary circuit. However, if some undesired station is causing interference this switch should be moved back on one of the other taps and the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

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

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

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

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



¶ *How to add a two-stage amplifier to the Haynes DX receiver will be described in the next issue of* POPULAR RADIO*—for October*

Kadel & Herbert

EXPERIMENTING WITH A COIL IN THE LABORATORY

To determine the correct sizes and shapes for the coils used in radio receiving sets has occupied the attention of scientists for years. Their work has included tests on small coils and large ones. This picture shows a large coupler which proved efficient—but only a bulky set could contain it.

HELPFUL FORMULAS FOR

DESIGNING YOUR COILS

The proper design for the coils used in both sending and receiving apparatus is one of the most vital points in radio engineering practice. Indeed, the inductance coil may be considered the backbone of radio. This important contribution on the subject was written for POPULAR RADIO by the foremost physicist of England—

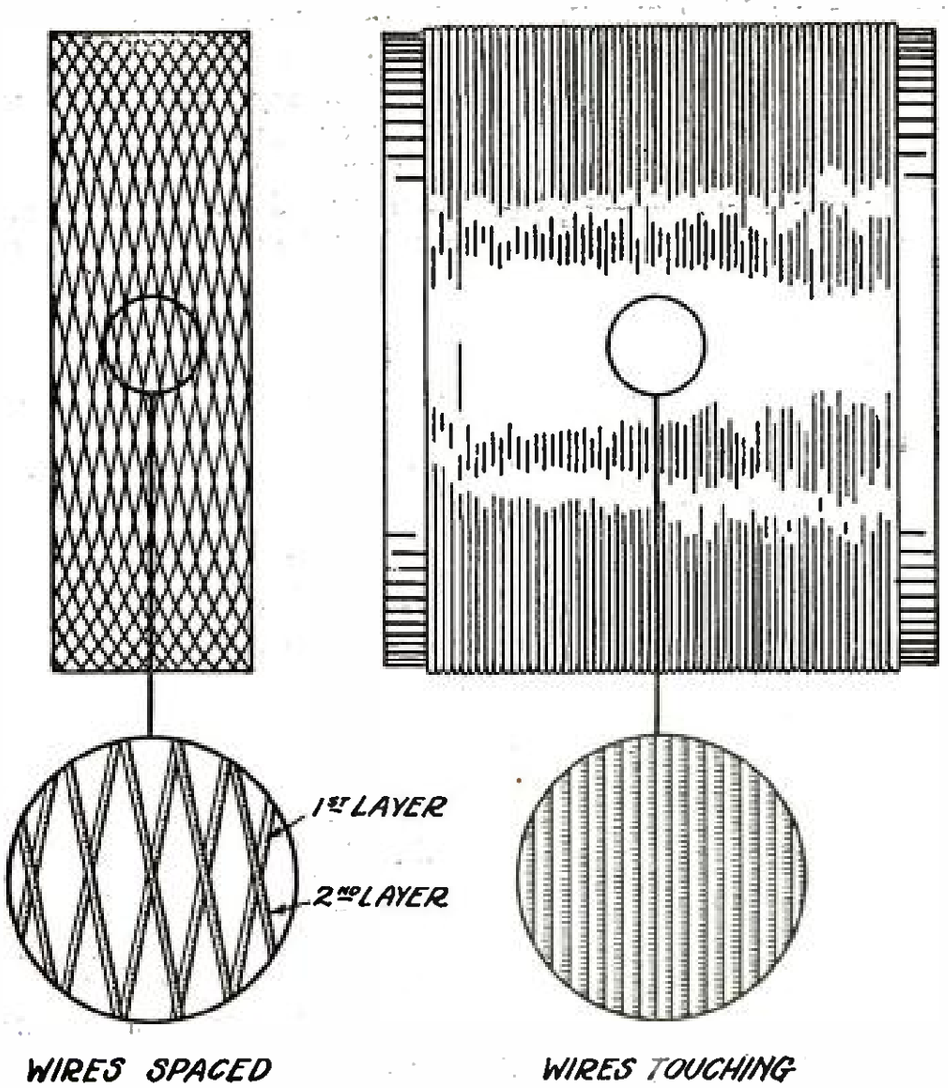
SIR OLIVER LODGE, F.R.S., D.Sc., LL.D.

IN the first place, to keep the distributed capacity to a low value the actual wire used in coils for a receiving set should be thin, so as to expose but little surface. The wire should be of the highest conductivity, but the smaller its diameter the better, so far as this desideratum is concerned. Also the shorter the length the better, since the capacity varies directly with the length. The only disadvantage of a very fine wire is that its resistance is high. But, after all, resistance does not much matter. For a receiving station the current is feeble, and the thinnest wire will serve. It may be coated with silk, cotton or enameled. And if a stranded core is employed, the enameling of each separate strand is sufficient to keep them isolated from each other.

But it is well to wind the turns of wire not too close together. Hence a fairly thick cotton covering might be applied outside the real insulation, so

as to diminish the capacity effect of each turn upon the others. The thickness of the ultimately covered wire may therefore, be three or four, or even ten times the thickness of the copper core; but I doubt if it is ever necessary or advisable to use a covering as thick as that. And were it not for the practical experience which has developed "basket" or open winding, I should have been disposed to advocate a close compact coil, wound so as to give maximum inductance for a given length. In any case, maximum inductance must be aimed at, whether the covering of the wire be thick or thin. I shall assume then that the wire to be used has an external diameter or thickness T, and that the copper core has the thickness *t*, and shall proceed to consider what is to be done with it.

Given the antenna capacity and the wavelength or range of wavelengths desired, we can at once determine the inductance or range of inductances necessary. Here is the formula, which gives the coil inductance as the square of the wavelength divided by forty times



TWO STANDARD METHODS FOR WINDING COILS

The coil on the left is known by numerous names, such as basket weave, honeycomb and duolateral; the turns of wire cross each other at an angle and therefore, the capacity between turns (called the "distributed capacity" of a coil) or between layers is low. Compare this method of winding with the coil on the right, which is an ordinary solenoid winding. Here the turns of wire lie right along side of each other and close together; the distributed capacity of such a coil is high, especially if a number of layers are wound over each other.

the antenna capacity; *everything being expressed in the same units of length**:

$$\text{Inductance} = \frac{\text{Square of wavelength}}{40 \text{ times the capacity}}$$

$$\text{that is } L = \frac{\lambda^2}{40C}$$

For instance, to receive on a wavelength of 200 meters with an antenna whose capacity is 1 meter, which would be a likely value for a single wire elevated by a pole 20 meters high, the coil must have an inductance,

$$L = \frac{40{,}000}{40} = 1{,}000 \text{ meters.}$$

that is, 1 kilometer, or 10^5 centimeters, or a tenth of a millihenry. To get a wavelength of 1,000 meters with an antenna of 2 meters capacity would need an inductance

$$L = \frac{10^6}{80} = 12{,}500 \text{ meters,}$$

that is, 12½ kilometers or 1¼ millihenry. Twice this value would be needed if the capacity of the antenna were halved. But if the wavelength were to be doubled the inductance must be quadrupled.

Now, to get the necessary inductance in a coil, using the smallest length of wire, we shall show in another chapter, what has already been stated, that it must be wound on a frame of the following shape and dimensions, *viz.*, a disc coil of external diameter 14 units, of internal diameter 8 units, and with the channel for the wire a square, 3 units to a side. There remains only to determine the size of the unit which will give the required inductance L, for wire of given external thickness T. The formula for determining the actual size of the coil's external diameter D, is:

$$D^5 = 66.6LT^4$$

And once having determined D, the size of the coil is known in every detail, also the number of turns of the given kind of wire, and the length of wire necessary.

The use of this formula will be best illustrated by an example.

Suppose the inductance required is one millihenry, that is to say, 10 kilometers or 10^6 centimeters; and let the thickness of the covered wire be 2 millimeters or 1/5 centimeter; then D^5, comes out from the above formula as

$$D^5 = \frac{66.6}{625} \times 10^6,$$

or a trifle more than 10^5; and therefore the extreme diameter D = 10 centimeters practically. The internal diameter *d* will then be

$$d = \frac{8}{14} D = 5.7 \text{ centimeters;}$$

the breadth of the coil b, or the side of the square channel in which the wire is wound will be,

$$b = \frac{3}{14} D = 2.142 \text{ centimeters;}$$

the number of turns n, of covered wire of thickness five turns to the centimeter will be

$$n = \left(\frac{b}{T}\right)^2 = 115;$$

the mean radius of a turn r, is,

$$r = \tfrac{1}{4}(D + d) = 4 \text{ centimeters;}$$

and hence the total length of wire is,

$$l = 2\pi nr = 27.6 \text{ meters.}$$

Or it may be more convenient to work with inches, so far as the workshop dimensions are concerned. If we are dealing with the same inductance

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*See Appendix for explanation. The following table will effect conversion from conventional capacity units to length units: the latter being in many respects more convenient except for large capacities:

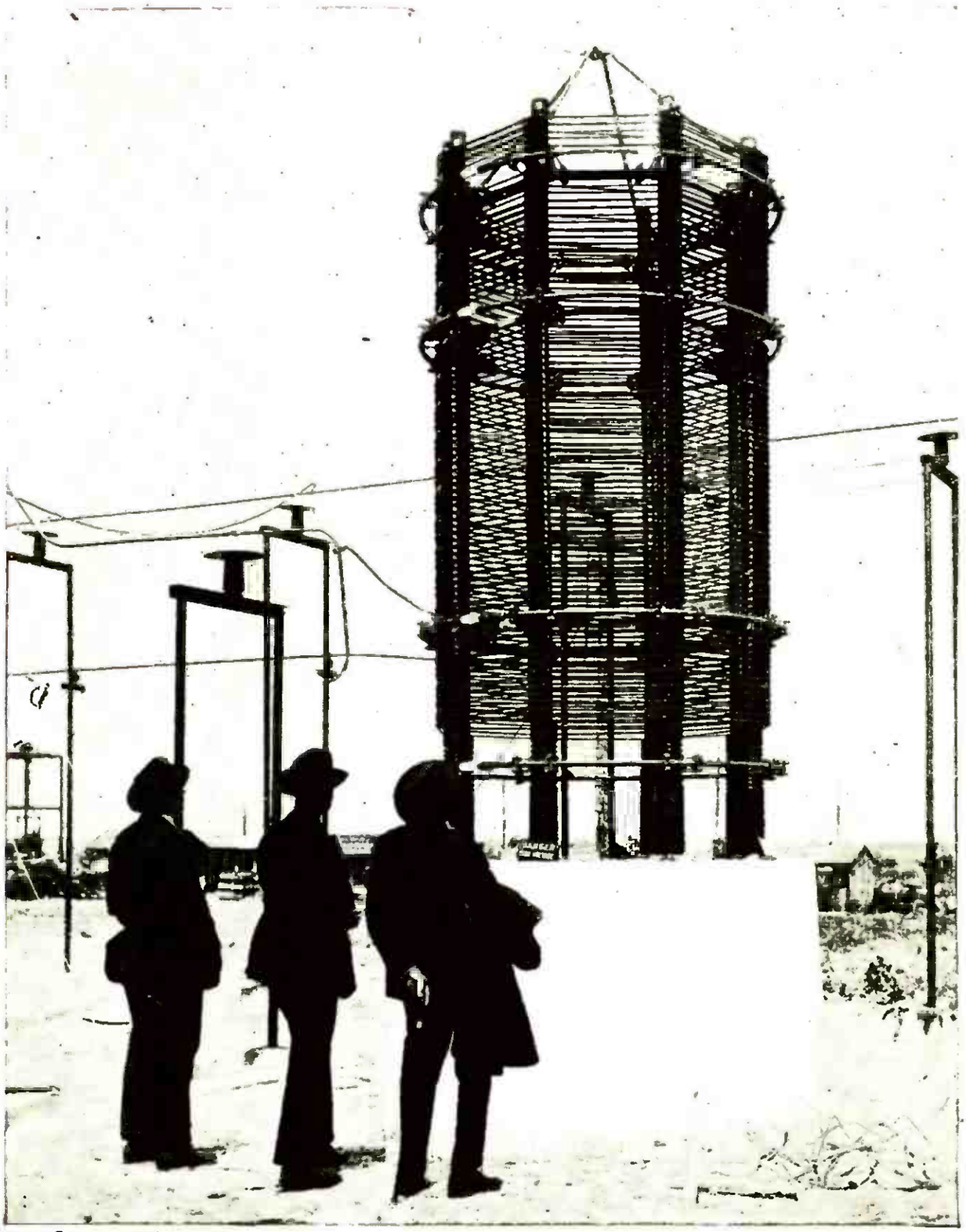
1 microfarad = 9 kilometers
1 millimicrofarad = 9 meters
1 micromicrofarad = .9 centimeter

For practical purposes a capacity expressed in micro-microfarads may be interpreted at once as nearly equal to the same number of centimeters. A ten per-cent allowance can be made if desired, for a centimeter is ten percent bigger than a micromicrofarad.

For *inductances* the conversion is still easier:

1 henry = 10,000 kilometers = a thousand million centimeters
1 millihenry = 10 kilometers = a million centimeters
1 microhenry = 10 meters = a thousand centimeters
1 millimicrohenry = 1 centimeter

Hence, to express inductances in centimeters is always quite easy.



Radio Corporation of America

ONE OF THE BIGGEST COILS IN THE WORLD

Here is shown one of the great tuning inductances used at the large central radio station at Rocky-Point, Long Island. Compare the size of the coil with height of the men standing in the foreground. If this coil were not efficient there would be enormous losses in the power surging back and forth in the huge transmitting antenna. Although your coil is tiny, if it is not properly designed the losses in it may be just as large—relatively.

we must divide 10^6 centimeters by 2.54 to bring it to inches. Or we may take as example a round number: Let the required inductance be L = 400,000 inches, while T, the thickness of the wire, = 1/10 inch. Then we can reckon the external diameter of the coil, in inches, as:

$$D = \sqrt[5]{\frac{66 \times 400{,}000}{10{,}000}} = 4.84 \text{ inches.}$$

So that the internal diameter will be d = 2.72 inches. And the side of the square channel b = 1.03 inch. The number of turns will be,

$$n = \left(\frac{b}{T}\right)^2 = 106,$$

and the length of the wire used,

$$l = \tfrac{1}{2}\pi\,(D + d) = 1{,}260 \text{ inches or } 35 \text{ yards.}$$

The result we see is not a large coil, even for so thick a covered wire. By diminishing the thickness of the wire the coil can be much decreased in size. For if the size of the channel is given, then the use of a wire of half the thickness will give a 16-fold inductance, because it depends inversely on the fourth power of the thickness. This is indeed obvious. For if the wire is half as thick, double as many turns can be put in each layer, and there will be twice as many layers, so the number of turns altogether is quadrupled. And as the inductance depends on the square of the number of turns, that will be magnified 16 times.

As regards size of bobbins for a given thickness of wire, we can make this statement: doubling the linear dimensions of the bobbin for a given wire will magnify the inductance of the resulting coil 32 times. This is not quite so obvious, but it clearly appears from the formula, since L varies with the fifth power of D, and $2^5 = 32$. Meanwhile the question obtrudes itself: Where does the 66.6 come from?

That, however, is rather a long story, and must be the subject of another chapter.

APPENDIX

A PLEA FOR EASY SPECIFICATION

By Sir Oliver Lodge

When working with ordinary coils and condensers in the laboratory, the specification of capacity in microfarads is convenient enough, and so is the specification of inductance in terms of henries or secohms. But when working in radio wavelengths, it is convenient to have the antenna capacity, and the inductances associated with it, expressed in terms of length because the geometric mean of those two lengths—that is, the square root of their product—gives the wavelength direct when multiplied by 2π, that is practically for rough estimate, by 6. Six times the square root of the inductance and capacity multiplied together is a close approximation to the wavelength; and in predetermining the inductance required for any given case this must surely be a handy rule.

Capacity in electrostatic measure is a length, and inductance in electromagnetic measure is also a length. The truth is that in all units—that is to say, in absolute measure—capacity is really K times a length, while inductance is μ times a length. And it is natural to express the one in static measure, under the convention that $K = 1$, and the other in kinetic—that is, magnetic—measure, with the totally different convention that $\mu = 1$. For the one has to do with charge, and the other with current.

The capacity of an ordinary amateur antenna is some simple fraction of its height or linear dimensions: about one-twentieth of the length of an isolated thin single wire measures its capacity. But the fraction may vary for different antennas from a twentieth to about a twelfth, as will be shown later. A microfarad is far too big a unit for convenience. A millimicrofarad, or even a micromicrofarad, has to be employed, and they are by no means convenient. The length corresponding to a microfarad is 9 kilometers. So a millimicrofarad is 9 meters, and a micromicrofarad is nine-tenths of a centimeter; that is to say, 10 micromicrofarads equals 9 centimeters. So that for a rough estimate it may be taken as a centimeter, though it is a trifle smaller.

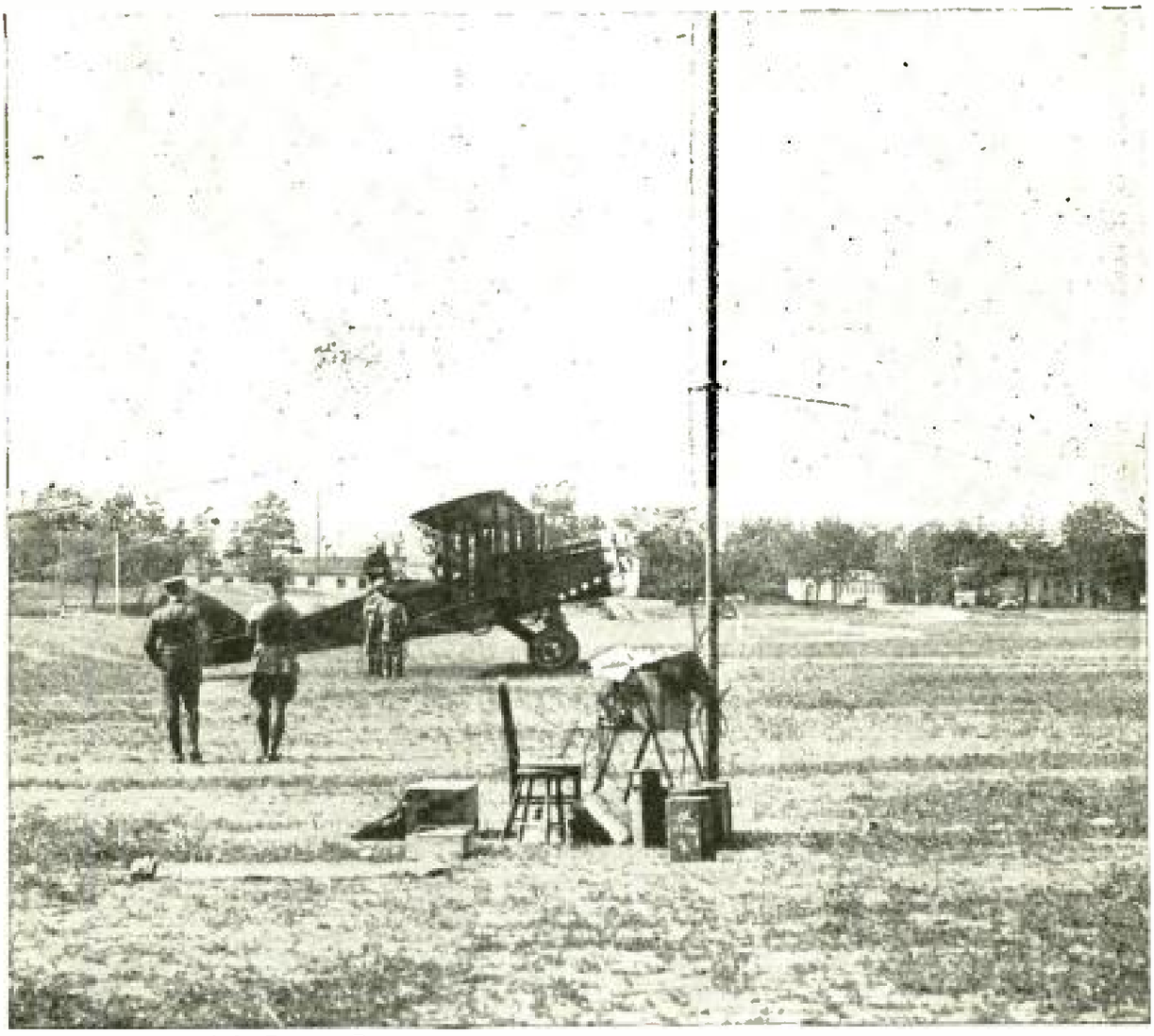
On the other hand, a henry is 10,000 kilometers. So a millimicrohenry—or what is sometimes called a billihenry—is exactly 1 centimeter. While a microhenry is 10 meters, and a millihenry 10 kilometers.

Conversion from one set of units to another is always a nuisance. But after all a henry and its sub-multiples have no particular meaning which the imagination can seize hold of; whereas the length of a meter or a kilometer is easily imagined. Hence it might be well to have the coils used in radio thus marked—that is, marked in terms of length—using any unit of length that is handy for the purpose and suitable to the coil. Thus, take an antenna with a capacity of 1 meter, and put a coil of 10,000 meters inductance in series with it. The geometric mean of the two is 100 meters, and the wavelength, therefore, 600 meters.

The meter as a rule is the most convenient unit of length under the circumstances, since wavelengths are commonly so specified. But some people prefer to work in centimeters; and it is easy enough to remember that a billihenry is 1 centimeter. The farad is not a convenient unit. It was always much too big; but it can be remembered that a microfarad is equivalent to a length of 9 kilometers. In radio work, however, it is certainly more convenient to express capacity as a length, whether it be agreed to specify inductance also in that way, or not.

It is curious to note that a farad coupled to a henry would have a slow oscillation period of six seconds; and so give a quite inappreciable wave, 1,800,000 kilometers long. A microfarad connected to a henry of inductance would oscillate a thousand times in six seconds, and so generate a wave 1,800 kilometers long. Whereas a microfarad coupled to a microhenry would have a frequency a thousand times as great, and so might give a strong wave 1,800 meters in length; the same wave being also generated by a millimicrofarad coupled to a millihenry; which may be expressed as a 9-meter capacity and a 10,000-meter inductance.

The intensity of radiation increases very fast as the wave is shortened.



From a photograph made for POPULAR RADIO

THE ARMY'S PORTABLE GROUND STATION

Storage batteries are used for power, and the antenna system is supported by a collapsible mast that may be erected in sections in a few minutes. This mast also forms the support for the umbrella counterpoise that is shown above.

A "Radio Net" Controlled from the Sky

How the operations of an army may now be directed by portable radio equipment operating in co-operation between ground stations and airplanes in flight.

By PAUL McGINNIS

AIRPLANE communication that requires only an ordinary field radio set is now considered practical as a result of tests made in a "radio battle" at Camp Alfred Vail, New Jersey.

Observations made over theoretical front-line trenches about seven miles long were reported with accuracy, and orders were received from the ground through a radio set which was hastily rigged on the airplane under conditions that prevail in a sudden war emergency.

The test was made in the final maneuvers of fifty-eight officers who recently graduated from the Camp Vail Signal School, after nine months of training under Signal Corps instructors. Starting at camp in the early morning,

they established a smooth working "radio net" for an army division in less than two hours. No piece of apparatus was used in the airplane or in the land stations which was not portable by pack animals. Most of the equipment used could be divided into small enough units for men to carry. Storage batteries supplied power for the transmitters—and the batteries were the heaviest parts of the equipment.

The plane itself was borrowed from Mineola, Long Island, as it might be again if a real battle should suddenly take the place of the shadowy ether battle which went on with such smoothness. A transmitting set in which the handy "five-watters" of amateur fame, the little transmitting vacuum tubes which have often before handled big business, were used in the set which was mounted so hastily in the rear cockpit.

The plane's antenna was a single wire which was let down with a weight attached to the end, after the plane had cleared the ground, and drawn up before descending. The ground connection was fastened to the metal part of the engine and the frame of the machine, which formed a counterpoise. Phones equipped with rubber caps were placed inside the aviator's helmet, thus shielding his ears from the engine's noise.

The country in which the tactical battle was fought was typical woodland, with roads and paths crossing and recrossing and going nowhere in particular, and it was under such conditions that the various station units found their positions and spread the "net" which was under the direct control of the airplane.

With only two numbers for his instructions, the officer in charge of each station was required to find his proper position by means of a co-ordinated map, rig up his antenna and promptly call headquarters. In the case of the sets used in the trenches, the erection of the antenna required only a few seconds, for these employ a single loop of copper about four feet in diameter.

Other antennas, such as the one used by the station in immediate touch with the airplane, were strung from poles erected in sections and held in place by guy wires.

Interference, between the various stations of the net, was avoided by the use of vacuum tube transmitters throughout, which were sharply tuned.

A number of messages similar to those which are actually transmitted in battle were given to the various stations to send, and information from the airplane was received and relayed to headquarters with war-time precision. The plane could be heard for a number of miles outside the net as it flew over the "enemy's" country.

Transmission from airplanes both by telephone and telegraph was perfected toward the end of the World War, but the feat of placing an ordinary field set on an ordinary machine with practical results was almost unthinkable. Developments which made this latest test possible are *better tubes for transmitting* and *more sensitive receivers.*

How to Make a Simple Honeycomb Set

ANOTHER *valuable article of the famous "How to Build" series will be published in the coming—October—number of* POPULAR RADIO. *The total cost of the parts does not exceed $15.00. This set, like every set described in these articles, was actually built and tested and put into actual operation before the article was written. Ask your newsdealer to reserve your October copy now.*

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.*

New Regulations Concerning Amateur Licenses

THE Department of Commerce has authorized a broader band of wavelengths for general and restricted amateur radio stations, and has created a new class of amateur operator's license to be known as Amateur Extra First Class.

The new regulations provide that:

Licenses will be issued permitting the use of any type of transmitter (CW, spark, AC-CW, ICW, unfiltered CW and phone) with the restriction that when using pure CW they are authorized to use wavelengths from 150 to 200 meters and when using spark, AC-CW, ICW, unfiltered CW and phone the wavelengths from 176 to 200 meters only can be used. The types of transmitters must be specified in the application and the license.

Special Amateur Radio Station licenses will be issued permitting the use of pure continuous wave transmitters only, authorizing the use of wavelengths from 150 to 220 meters.

For the purpose of application to amateur stations, pure CW is defined as follows: A system of telegraphing by continuous oscillations in which the power supply is substantially direct current as obtained from (1) a generator, (2) a battery, or (3) a rectifier with an adequate filter. (A filter is not deemed adequate if the supply modulation exceeds five percent.)

General Restricted and Special Amateur Stations are not permitted to use a transformer input exceeding one kilowatt, or equivalent of this power based upon watt input to plates if tubes are used. (Where input rating of tube is not specified by manufacturer this rating will be considered as double the manufacturer's output rating.)

On licenses issued for amateur stations you will include the following: *This station is not licensed to transmit between the hours of 8.00 and 10.30* P.M., *local standard time, nor Sunday mornings during local church services.*

Special Amateur Stations must be operated by persons holding an extra first grade amateur operator's license, or a commercial first class operator's license, or a commercial extra first class operator's license. Applicants must also meet the requirements of Regulations 63.

A new class of amateur operator's license is hereby established to be known as "Amateur Extra First Grade." Licenses of this grade will be issued to persons passing the required special examination with percentage of at least seventy-five and code speed in sending and receiving of at least twenty words a minute, five characters to the word; who have had at least two years' experience as a licensed radio operator and who have not been penalized for violation of the radio laws subsequent to the date of these regulations.

* * *

A Useful Battery Cut-off

ONE of the greatest routine nuisances of a radio set is the necessity for turning rheostats on and off. This is an especially burdensome task in the case of some of the recent vernier rheostats which require several revolutions of the knob to bring the tube up to proper operating temperature. How this trouble may be overcome is described below:

Use special jacks that control the filament circuit, so that by the simple process of inserting the phone plug one not only connects the phones into the circuit, but also lights the tube. This is probably the ideal arrangement because it lights only the tubes that are being used. In other words, if the phones are plugged in the first jack only the detector tube will light; while two tubes are lighted if the plug is inserted in the second jack, and so on.

The one drawback to this plan, however, is

that the wiring up of these jacks is a complicated proceeding at best and in the case of a set that is already built, it means removing the present jacks, replacing them with the special jacks, and rewiring the whole thing.

I have found that I got practically the same results by a simpler process. I have simply installed an ordinary push-button battery switch at a convenient point on the panel of my set so that by pulling the button out the "A" battery circuit is closed, thus lighting the tubes. When I finish listening in I merely push the button to turn off all the tubes. Turning the filaments off in this way also cuts off the "B" battery, of course, as current will not flow in the plate circuit unless the filament is lighted. Thus the rheostats are left turned on at all times but can be adjusted as needed for critical tuning. To listen in on the detector alone the other tubes may be turned off by means of the rheostats or, a switch may be installed in one of the filament leads of each amplifier tube. For ordinary use, however, one switch controlling the entire "A" battery circuit is sufficient.

Such an arrangement is especially useful in a household where the family make use of the set during the day. The set can be left all tuned for a certain station and whenever that station is operating it will only be necessary to pull the button to listen in. Thus the family can enjoy the set in the absence of the owner, without the necessity of tuning in and without the danger of turning the rheostats too high with the possible chance of burning out a perfectly good tube.

Push button battery switches may be obtained with a red button and this button is the only part that appears on the front of the panel. The part behind the panel is about one inch in diameter and a half inch in thickness.

S. GORDON TAYLOR

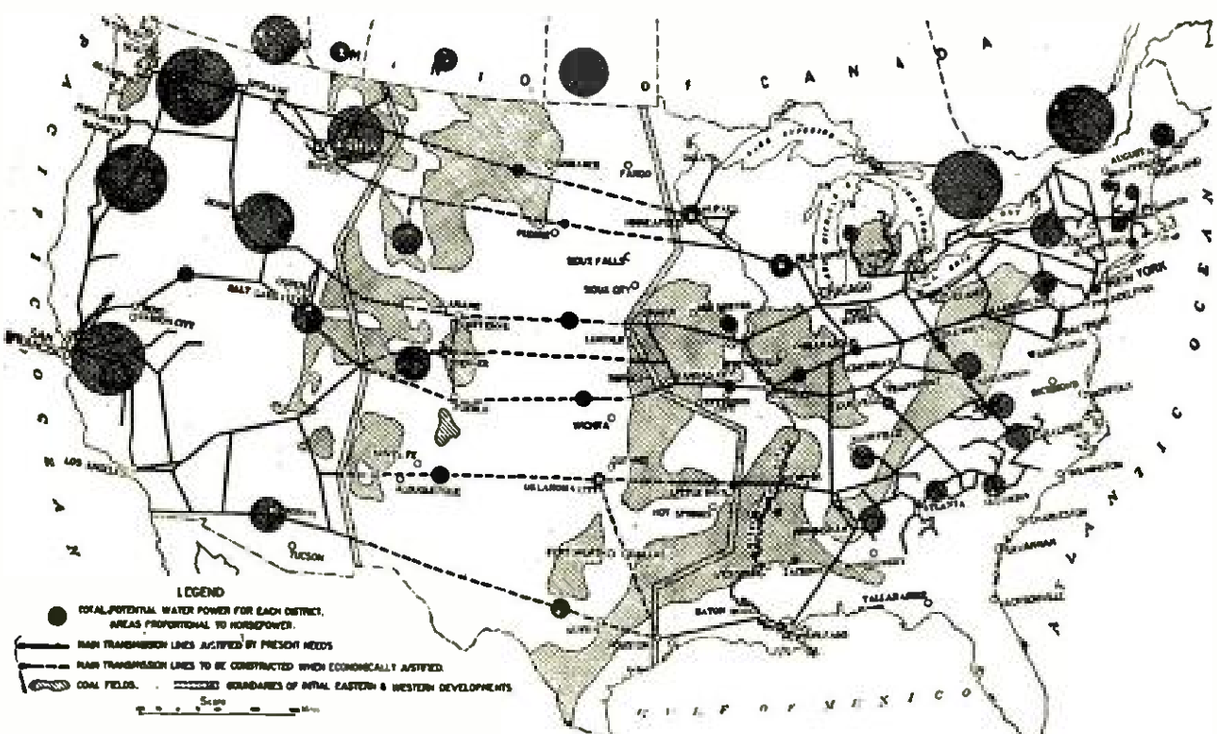
* * *

How to Test Your Headphones With a Tin Can

IN the May issue of POPULAR RADIO, was published a description of how to make a testing battery for your headphones for eleven cents. Here is a suggestion that comes to us from a fan in Oregon, who tells how to make one that is just eleven cents cheaper:

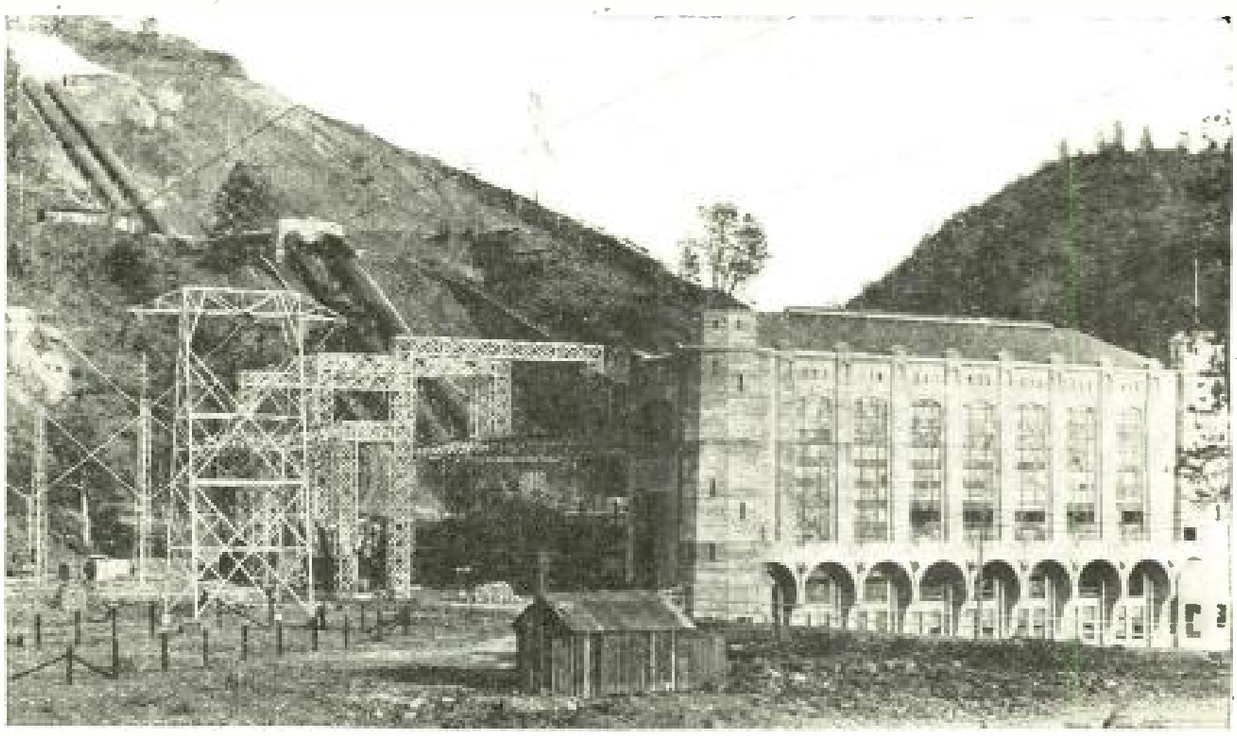
Take an ordinary tin can, or place your hand on any piece of zinc. Take one tip of your headphone cord and hold in the fingers of your other hand. Let the free tip drag across the tin can or piece of zinc. If a faint scratching sound results your phones are in good order.

O. E. SMITH



A PROPOSED PLAN FOR FURNISHING ELECTRICAL POWER TO THE ENTIRE UNITED STATES

Electric power development is of direct interest to the radio fan, not only because radio uses power but also because of the occasional interference by leakage from high-tension lines. This map—the last word in American power distribution—shows how Mr. Frank G. Baum, well known electrical engineer of San Francisco, proposes ta unite all the power plants of the country into one great super-power system. General Guy E. Tripp says of this plan: "The single system is nat only practical and desirable, but, in my opinion, essential to American progress."



WHERE MEN TALK
OVER HIGH TENSION CABLES

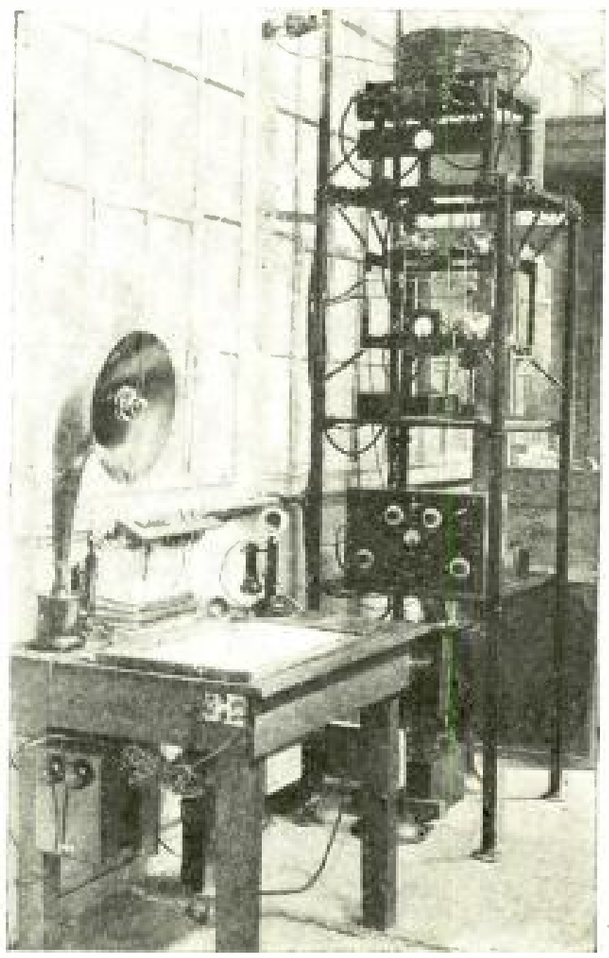
A unique application of "wired wireless." Below are some of the instruments that are used. The voice is relayed from the telephone to the radio transmitter by means of the loudspeaker which is connected to the telephone line and the microphone (at its mouth) which is connected to the transmitter.

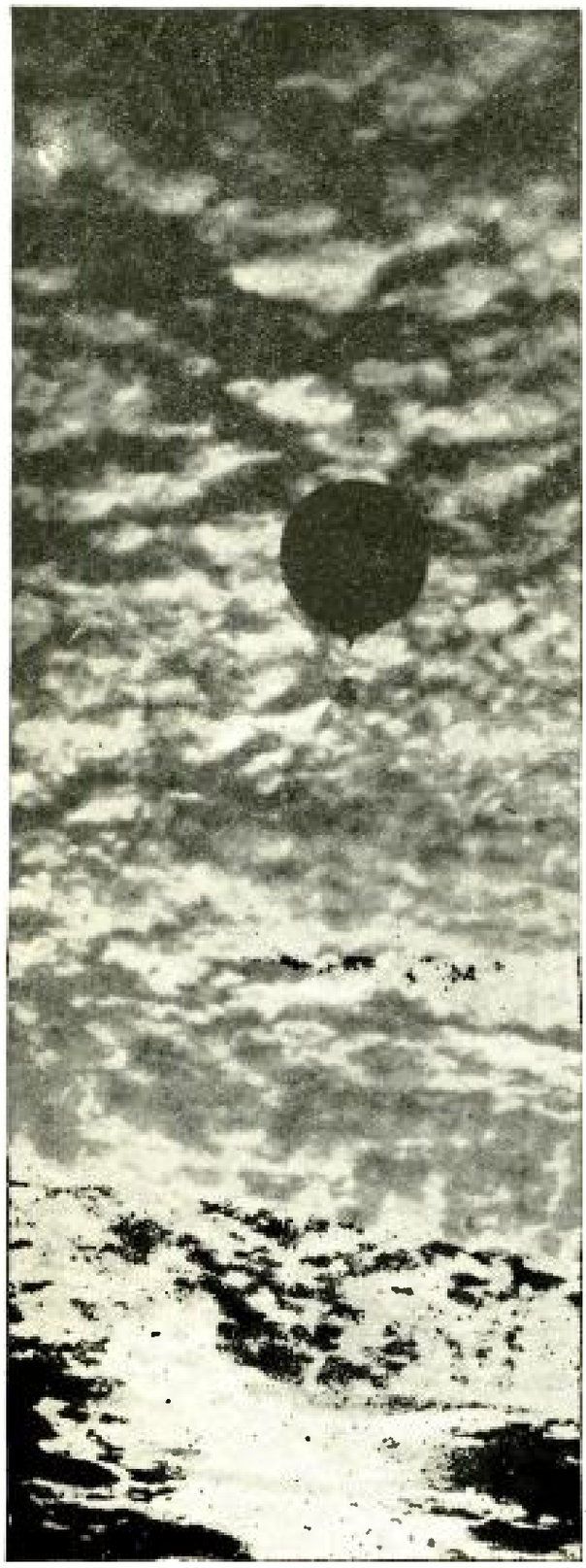
The Longest Guided Radio System in the World

WHAT is probably the longest system of guided radio in the world has recently been put into successful operation along a power line in California. Messages have been transmitted from a sub-station at Vacaville to the Pitt River power house 202 miles away.

The radio waves are transmitted along a 220,000-volt power line of the Pacific Gas and Power Company. They follow the course of the steel towers across country 120 miles in a straight line due north from Vaca-Dixon to Cottonwood; then they make a right angle turn and run for 82 miles to their destination.

Under this system of guided radio (or "wired wireless" as it is often called) the energy is not broadcast but is kept close to the high-power transmission lines. Consequently it does not interfere with normal reception except in the case of stations which are located in the immediate vicinity of the line.





These Balloonists Saw Lightning but Recorded No Static

One of the unexpected results of the National Balloon race was the report of one of the contestants who carried a radio set for the purpose of receiving weather signals. While the aeronauts watched thunderstorms below them no static effected their receiving apparatus.

Does Static Disappear in the Higher Altitudes?

STATIC, that mysterious interference to the reception of radio signals which is perhaps one of the greatest puzzles to radio experts today, may be confined to an atmospheric belt about the earth. At least that is the possible conclusion reached in special tests made by Ralph Upson, one of the country's most prominent aircraft engineers who was a contestant in the National Balloon race which started from Indianapolis on July 4.

Upson's chief purpose of carrying radio was to help him win the race. Five of the principal broadcast stations had arranged to send out special weather reports on upper air currents during the first night of the race and the following morning. In addition to Upson, the three army entries in the national race were equipped with similar sets. Lieut. Olmsted, one of this trio, won the race. Here is the tentative report of Upson's observations of the unusual immunity of his apparatus, made after the race:

"One of the outstanding happenings in the use of radio in the balloon race was that at altitudes of 3,000 feet and above we observed absolutely no static whatever, although we could see lightning at various points on the horizon.

"Andrus, my aide, acted as chief radio operator. He began listening in at 8.30 o'clock the night of the race. At first he could hear nothing but code signals, concerts from various stations and a radio drama that was being sent out from a Chicago station. For an hour, this was about all we could hear. Then at 9.45 o'clock, Central Standard time, Andrus picked up the latter part of the weather report being broadcast from WGY in Schenectady. We heard just enough of it to make us wish we had heard the entire report. However, our disappointment was short for a few moments later the whole report was repeated, every word being received clear and distinct. It was just the news we wanted.

"As a result of the information, we decided to go a little higher but not to try any high altitudes unless forced to it by thunderstorms. The report gave us full confidence of reaching New York state and possibly New England. Everything seemed so favorable that I turned in to sleep, leaving the balloon appendix partially closed. Then came the accident and you know the rest—a forced landing."

—RALPH UPSON

From a photograph made for POPULAR RADIO

HOW ONE AMATEUR MAKES A PERMANENT RECORD OF A FAVORITE PROGRAM

With the aid of a phonograph, Mr. R. W. Gates has succeeded in making remarkably good wax records of both music and speech broadcast from a nearby station. How he does it is described below.

Transcribing a Broadcast Program on a Gramophone Record

HERE is a novel idea that comes from a radio fan in Plainfield, N. J. Just what the legal aspects of his experiment may be, however, is a point for a lawyer to determine.

When a worth while program is being broadcast have you ever wished there was some way of keeping it to be repeated at your pleasure?

I have—and started to work on the idea. I took an old Edison phonograph that was driven by an electric motor and tried some recording, using my regular three-tube radio set, a Baldwin phone which I connected direct to the recorder and some old brown wax records (which I found in the attic) of the vintage of '96. My first trouble to overcome was the sparking of the motor which recorded much interference, so I discarded this apparatus for an old spring machine which was O. K.

Next, in order to get quality, I built up a five-tube set (two radio and two audio) which recorded almost perfectly except for volume, which at times was so great that it would knock the stylus all over the record. To overcome this I made a special chamber containing a butterfly valve, similar to a damper in a stove pipe, inserting it between the recorder and the phone; in this way I got perfect control of my last trouble, so that at present I am able to make records as perfect as any you might buy, with limitations only to the range of my receiving set.

R. W. GATES

* * *

A Practical Pointer on Varnishing Your Cabinet

HERE is a useful tip from an amateur who writes from practical experience:

Glued joints between wood surfaces that have first received a coating of shellac or varnish have a comparatively low or erratic strength. Government tests have proven this. For this reason the parts of the radio cabinet should, if possible, be glued first and shellaced or varnished afterward.

If the parts have been shellaced first, all joints should be carefully and thoroughly cleaned before application of the glue in order to make a strong joint that will be reasonably permanent.

Observation of this simple but valuable pointer will avoid possible joint separation for which a perfectly good glue or poor workmanship may be blamed.

ED. HENRY

Why We Cannot Send so Well by Day

SIR Oliver Lodge's article on the Heaviside Layer theory (in the January, 1923, issue) called forth this comment from a reader, who modestly explained that "when professors disagree, the student may be pardoned for expressing an opinion":

Sir Oliver Lodge takes the stand that without the Heaviside Layer theory it would be impossible, or at least difficult, to explain the deleterious effect of sunlight upon radio transmission. Furthermore, the existence of a Heaviside Layer seems to be a well substantiated fact.

But the mere existence of a Heaviside Layer does not prove that it bends, confines, reflects, or otherwise guides the radio waves.

No doubt Sir Oliver is right when he states that such a layer would be more or less distorted by the vertical currents which are caused by the midday heat of the sun. Even granting this, however, it is not necessary to conclude that this distortion is the cause of the poorer transmission by day. This poorer transmission is known to exist, but there may be some other explanation for it; in the opinion of the writer there is. And that explanation can be summed up in the one word *interference*.

As the sun's rays and radio waves are both, fundamentally the same — electromagnetic waves or disturbances in the ether—in all particulars except in length and in frequency, it seems evident that they could not both travel over the same route at the same time without interference.

Let us examine a case.

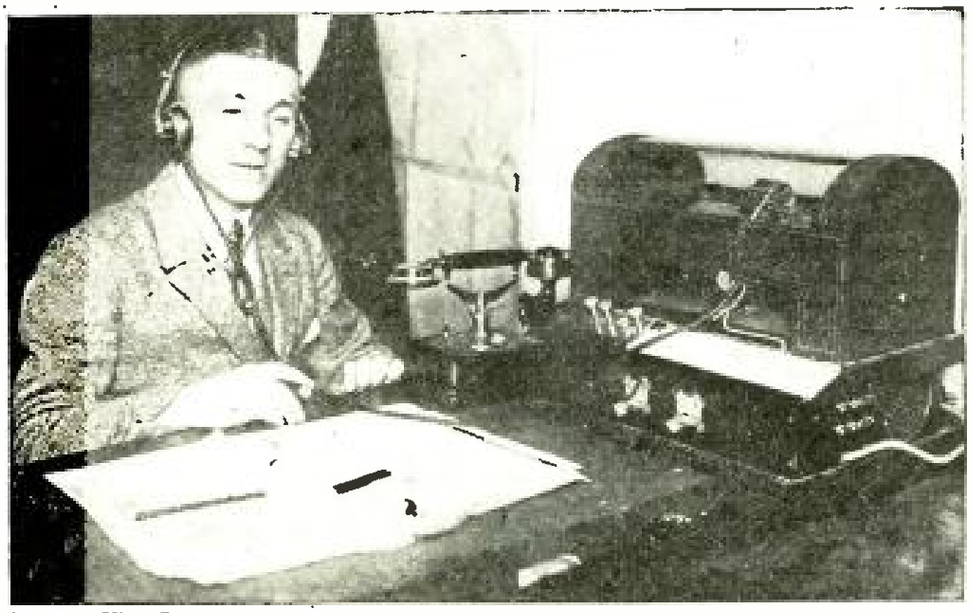
Suppose it to be early morning. Radio station A, is sending to another radio station, B, which is due west of it. The sun's rays and the radio waves, therefore, are traveling in the same direction. The radio waves are oscillating at a rate of several hundred thousand times a second and the sun's rays at a frequency that is infinitely higher, but both kinds of waves are moving at the same speed. Some of the time, therefore, the alternations are in the same direction and some of the time they are opposed. When they are in the same direction, the oscillations from the sun's rays cannot assist those from the radio station as their speed is the same, but when they are in opposition they can offer an impedance which reduces the amplitude of the radio waves.

A crude analogy may help to make this clear. If you are walking westward in a narrow street with a crowd of people and another crowd is going eastward in the same street, the people going in the same direction as yourself will not be of any assistance to you in reaching your destination, but those going against you will interfere with your progress.

If this hypothesis is correct, radio communication should be at its worst in the case I have named. We have it on the authority of Marconi that transmission is at its worst "when the line of the sunrise or sunset is between the two stations."

But to say that the "twilight line acts as either a reflector or an absorber of the radio waves" is not enlightening, and to claim that the partial ionization of the sunlight of the air near the earth which increases the air's conductivity "decreases the efficiency of transmission" is not clear or explicit enough to be convincing.

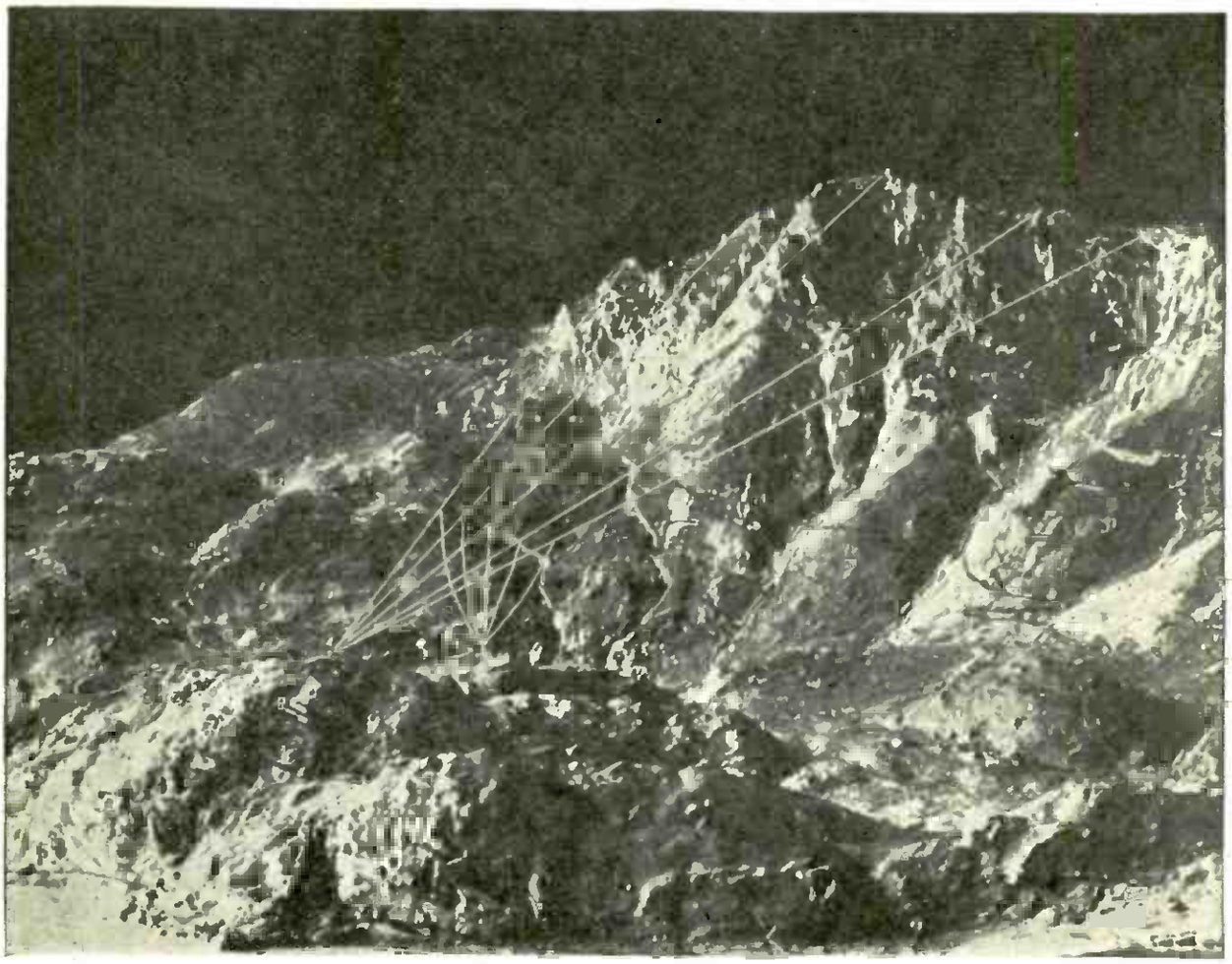
GAY PRENTICE BLESSING

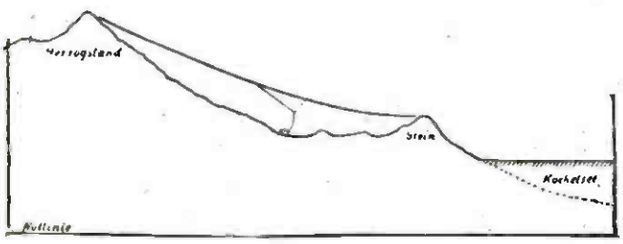


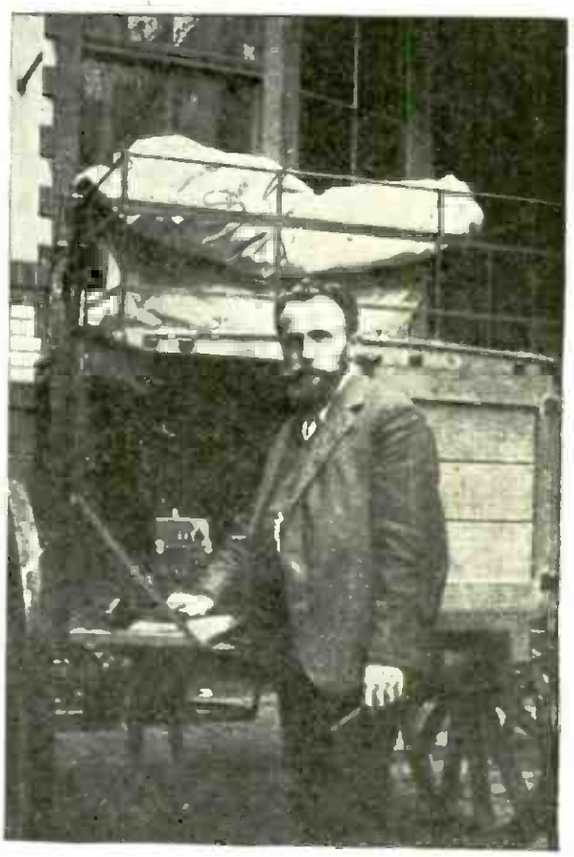
Keystone View Co.

A MACHINE THAT TAKES DOWN PHONE MESSAGES

This combination of telephone and dictaphone makes a record of incoming messages and repeats them in their original form. The device is applicable to radio.



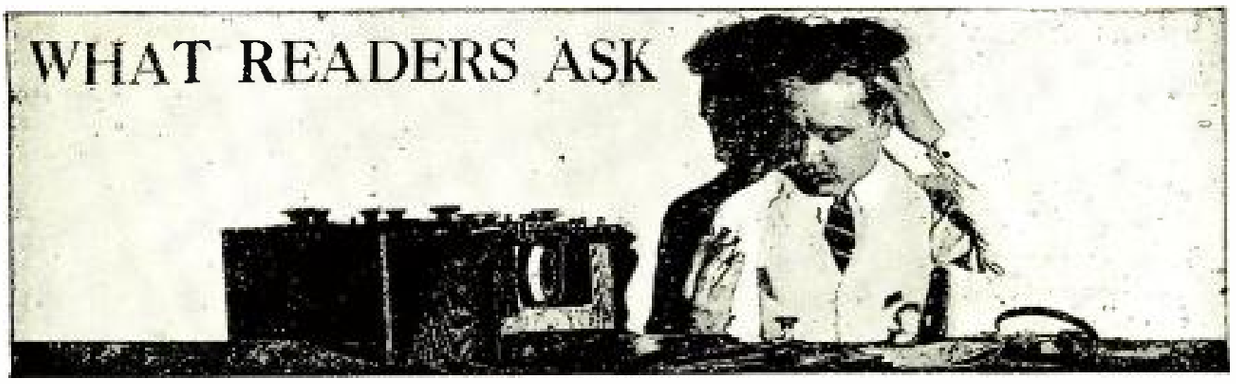




A RADIO STATION THAT USES A MOUNTAIN AS AN AERIAL TOWER

At this great transmitting station at Kochel in the Bavarian Alps, the antenna wires are stretched between two mountain peaks which are 1,732 and 904 meters in height, respectively. The small sketch shows how the lead-in is taken off in the center of the antenna and brought down to the operating building which is located in the hollow between the two peaks. The height of the mountain antenna is several times greater than the antenna on the Eiffel tower in Paris. The picture at the right shows Dr. Otto Scheller, one of the foremost radio experts of Germany and the chief engineer of the famous Lorenz Company.

WHAT READERS ASK



THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department, it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to co-operate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

¶ *In justice to our regular subscribers, the Technical Editor is compelled to restrict this special service to those whose names appear on our subscription list. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service and this sum must be enclosed with the letter of inquiry.*

QUESTION: Is it possible to use a microphone held up in front of a regular radio headset, so that the sounds from the headset will enter the microphone and thus amplify signals from a crystal receiver without the use of vacuum tubes? I do not know much about radio, but I have worked on telephone installation work for some time, and this scheme seems to present some possibilities.

JOHN E. WATKINS

ANSWER: This scheme will work on signals of fair strength if the microphone is connected in series with a suitable battery and a low resistance telephone. But there will be quite a degree of distortion in the output of the telephone on account of the acoustical difficulties between the diaphragm of the radio headset and the diaphragm of the microphone itself. In the long run it is much better to use a vacuum tube amplifier, as the former mentioned method never does give clear speech or music that would be really worth while listening to.

QUESTION: Is there any make of dry-cell tube that can be put into my present set, which employs the regular 6-volt tubes, without using an adapter or without having to change the sockets?

AUSTIN SERGEI

ANSWER: You may use the WD-12 in your set without making any changes except that you should use three dry-cells, connected in parallel, instead of the regular storage cells for your "A" battery.

* * *

QUESTION: Will you please give me a hook-up showing how to connect two stages of radio frequency amplification, a crystal detector, and two stages of audio frequency amplification to a vario-coupler.

CHAS. G. ADAMS

ANSWER: You will find the circuit you require in Figure 4 on pages 396 and 397 of the May issue of POPULAR RADIO.

QUESTION: Is it possible to use the four-circuit tuner with only one tube? If so will you kindly give me the proper circuit diagram showing how to connect up the instruments with a WD-12 dry-cell tube. I would also like to obtain a list of the parts necessary to use (with their constants).

H. G. BRADY

ANSWER: The circuit is drawn for you in Figure 1. The coils A, B, C and D, were fully described in the May, 1923, issue of POPULAR RADIO. The other parts you will need are the following:

E—vernier variable condenser, .0005 mfd.;
F—vernier variable condenser, .0005 mfd.;
G—mica fixed condenser, .00025 mfd.;
I—grid leak, 1 or 2 megohms;
C1—mica fixed condenser, .00025 to .00075 mfd.;
L—6 ohm rheostat;
Q—switch lever;
S—7 switch points;
Y—WD-12 dry-cell tube.

The capacity of the condenser C1, will have to be determined by experiment but it will be found to be within the two values given in the list. This is because the impedance values of the different makes of telephones vary so widely and this value is critical. A value should be chosen that will allow the circuit to oscillate just enough so that the condenser E, in the stabilizer circuit will have the proper control. If the condenser C1, is too large the circuit will not oscillate and if it is too small it will oscillate too much. It would be easiest to get three sizes, a .00025, a .0005, and a .00075 mfd. (the last may be made up of the first two in parallel) and try each one until the best results are obtained. Then leave the correct one in the circuit.

* * *

QUESTION: Why is it that some of the tubes on the market are all dirty inside of the glass? I have seen some of them that are yellowish and some that are brown or purple, and still some others that have a color something like oxidized silver. I asked a salesman in a radio store, and he told me that this discoloration didn't make any difference; in fact he said that the tubes that had it were often better than the clear tubes. Is this so?

R. ENSIGN

ANSWER: The new tubes usually are pumped to a very high degree of vacuum and at the time of evacuation there is injected into them a substance that helps make the vacuum still higher if the tube elements are heated at the same time. The various manufacturers use different substances for this purpose and this is the reason that the tubes sometimes have a deposit of one color and sometimes of another color. The tubes that are prepared by this method are usually superior to the old clear tubes, for amplification purposes, because they contain a higher vacuum and can be used with higher plate voltages and, therefore, produce greater plate currents and louder signals.

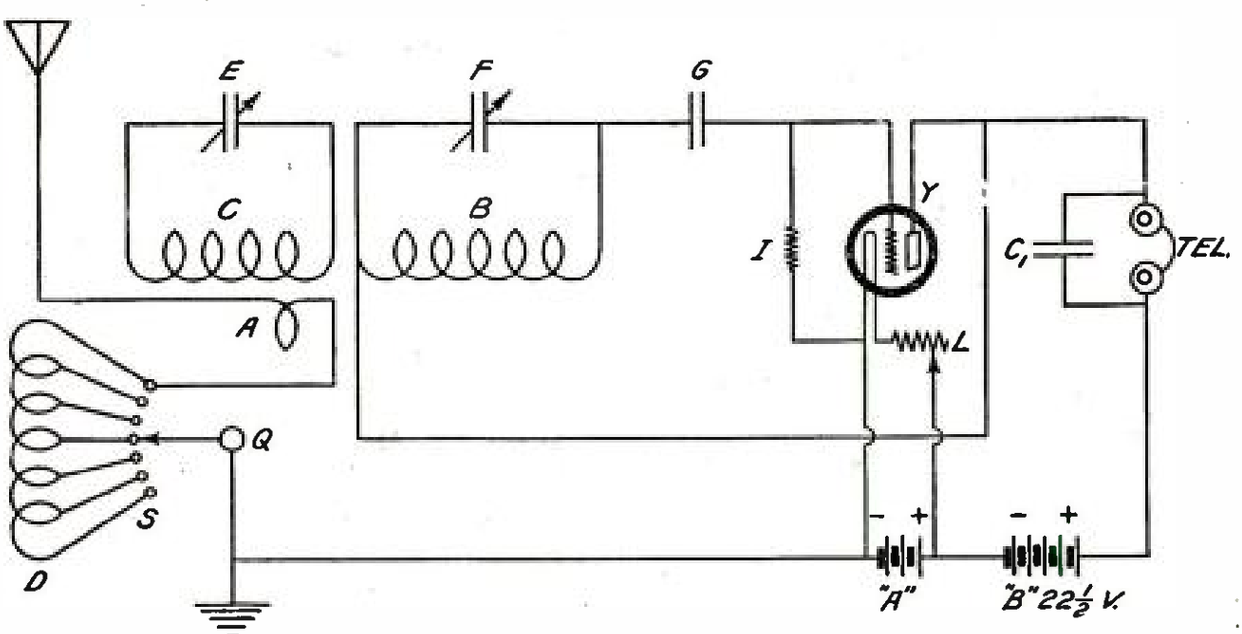
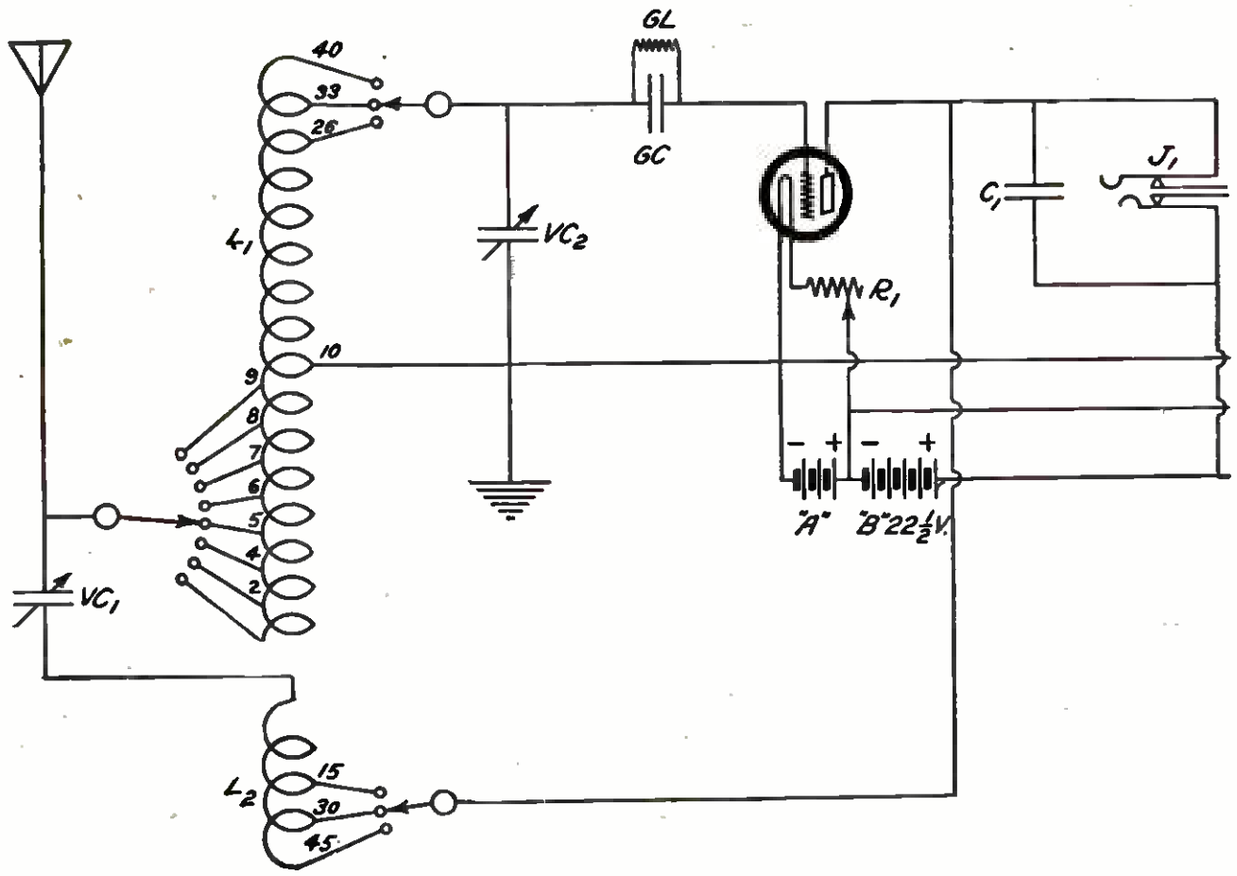


FIGURE 1

The four-circuit wiring diagram for use with a dry-cell tube receiver. The whole set may be made at a minimum expense and will give good results if good parts are used and the wiring job is done correctly.



QUESTION: I have built and have been using the Reinartz circuit, as given on page 296 of the April, 1923, issue of POPULAR RADIO, with great success. I have received broadcasting from all over the country on a single tube. Now, however, I feel that I have outgrown the single tube class and would like to try my hand at loudspeaker reception. I therefore would like to have you send me, or publish in your magazine, the complete Reinartz circuit with two stages of audio frequency amplification, using jacks for the detector, for the 1st stage and for the 2nd stage of amplification, so that I can use the telephones or the loudspeaker at will.

H. F. ANDERSON

ANSWER: You will find the circuit in the diagram of Figure 2. The parts used in your former set may be left just as they were and the following parts added:

C1—mica fixed condenser, .0005 mfd.;
J1 and J2—double-circuit jacks;
J3—single-circuit jack;
AFT1 and AFT2—audio frequency amplifying transformers;
R2 and R3—filament rheostats;
Additional "B" batteries.

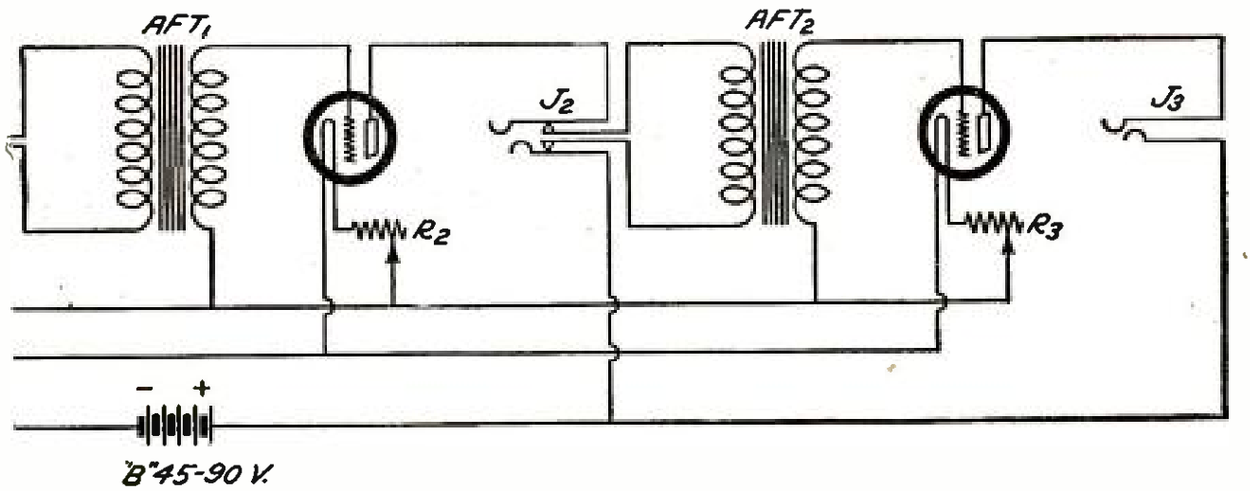
The values for the filament rheostats will depend upon the type of tubes used. Ask the dealer what resistance to use with the tubes when you buy them.

* * *

QUESTION: Why is it that I am able to tune in the local stations loud and clear, but have a great deal of difficulty in getting even fairly distant stations without a lot of squealing and howling? I am using a standard regenerative receiver (I am told it is) with one variocoupler and two variometers, and it takes me sometimes ten to fifteen minutes to tune in distance and sometimes they quit before I am able to get their call. Is there any way to overcome this trouble or at least partly eliminate it so that I can tune more rapidly? I find that when I get them almost tuned in if I reduce the detector rheostat just a little bit (it is very critical) they come in clear, but if I reduce it just a little bit too much the signals go out also. I am using a

FIGURE 2

This hook-up shows how to add two stages of audio frequency amplification to the Reinartz tuner. The transformer AFT1, should be of a high ratio.



UV-200 tube for the detector, with 22½ volts on the plate.

EVERETT THOMAS

* * *

ANSWER: It would eliminate a lot of the unwelcome oscillation in your set if you reduce the plate potential of the detector tube (say) between 16½ and 18 volts. The reason that you notice the trouble on distant signals and not on local signals is that the local signals are *stronger* than the self-oscillations but the distant signals are distorted because they are *weaker*, and, therefore, partially drowned out by the self-oscillation of the detector tube. By reducing the plate voltage as recommended you will be able to cut out oscillation and thus control regeneration to a much finer point with the plate variometer. This should eliminate your trouble.

* * *

QUESTION: What is the usual length of wire used in the flat horizontal span of a single-wire antenna for listening to broadcasting?

E. SPANGLER

ANSWER: The usual length is between 100 and 150 feet, not including the lead-in.

* * *

QUESTION: Must I use mica condensers in a five-watt transmitting set, or will paper condensers serve as well? I am going to use only 350 volts on the plate of the tube with the Colpitts circuit.

S. D. JONES

ANSWER: Mica condensers should be used. They should be tested to withstand a voltage of 1,000 to 2,000 volts.

QUESTION: I am using the Hoffman charts for designing the coils for my receiving sets and find they work out very satisfactorily. Now, I want to design coils for a new set that I contemplate building especially for broadcasting. Will you kindly tell me the wavelengths between which the new coils should operate to take in the total band upon which broadcasting is being done at the present time?

ERNEST N. WITHERS

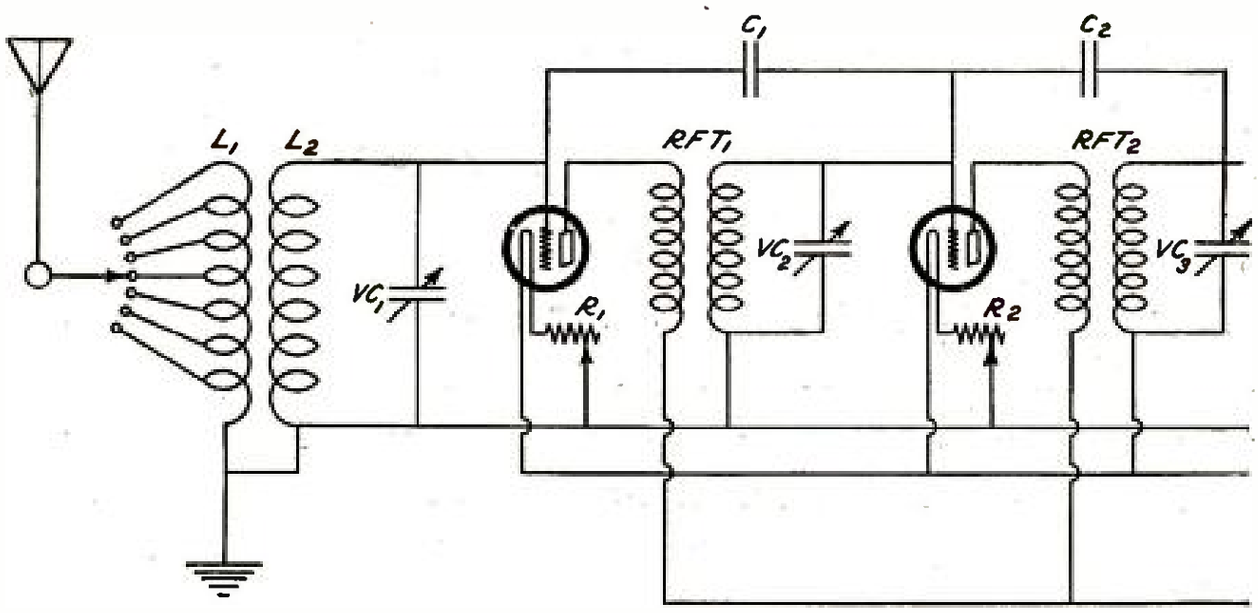
ANSWER: The minimum value you should use in the design of your coils should be a wavelength of 222 meters and the maximum should be 550 meters.

* * *

QUESTION: Can dry-cells be used to light the filaments of the ordinary 6-volt vacuum tubes, or will they burn too bright or too dim?

J. S. KNOGHT

ANSWER: Dry-cells can be used with the ordinary tubes but their use is not recommended because they will run down too quickly. The current drawn from the batteries is too high for the dry-cells to furnish for any length of time. Another drawback is the fact that the dry-cells when they begin to be exhausted fall in voltage very quickly, but when they are rested for a short time, they "pick up" and when the tubes are turned on again the voltage is liable to be high enough to burn out the filaments. It is better to use the tubes which are specially designed for the use of low voltages and low lighting currents, as the batteries will last longer.



QUESTION: I would like to get a diagram of the hook-up of the "neutrodyne receiver." Will you give it to me, together with list of the instruments necessary? I want to use two stages of neutrodyned radio frequency amplification, vacuum tube detector, and two stages of audio frequency amplification. Also let me have enough information as to the sizes of the coils so that I can construct them.

A. S. WORTH

ANSWER: The circuit diagram (Figure 3) contains the hook-up you have asked for. The parts necessary are the following:

L1 and L2—primary and secondary coils, respectively of an ordinary variocoupler;
VC1, VC2 and VC3 vernier variable condensers, .0005 mfd.;
C1 and C2—neutrodyne condensers;
C3—mica fixed condenser, .0005 mfd.;
R1, R2, R3, R4, and R5—filament rheostats;
J1 and J2—double-circuit jacks;
J3—single-circuit jack;
GL—grid leak, 2 megohms;
GC—mica fixed condenser, .00025 mfd.;
RFT1 and RFT2—special radio frequency transformers;
AFT1 and AFT2—audio frequency amplifying transformers.
Suitable "A" and "B" batteries.

The two neutrodyne condensers may be made by slipping two lengths of No. 14 solid copper wire into opposite ends of a piece of varnished cambric (spaghetti) one inch in length. When the set is put into operation the distance, between the two pieces of wire inside the tube, is varied until the circuits cease to oscillate when tuned to a particular wavelength.

The two transformers RFT1, and RFT2, are made by winding the primary coil, consisting of 16 turns of No. 24 SSC copper wire on a tube 3 inches in diameter. The secondary coil consists of 60 turns of No. 24 SSC copper wire on a composition tube 3½ inches in diameter. The primary coil is then fastened inside of the secondary coil and the two coils mounted at an angle of 30 degrees from the perpendicular.

* * *

QUESTION: What is a radio goniometer?

J. H. B.

ANSWER: The instrument referred to is known by the more popular name of direction-finder. It consists of a special receiving set for use with a loop antenna which revolves on a vertical axis and which picks up signals in one vertical plane only. By revolving the loop until there is a minimum of sound received in the receiver, the direction of the transmitting station may be determined from the receiving station. The most important use of the radio goniometer is to give bearings to a ship at sea in foggy weather.

* * *

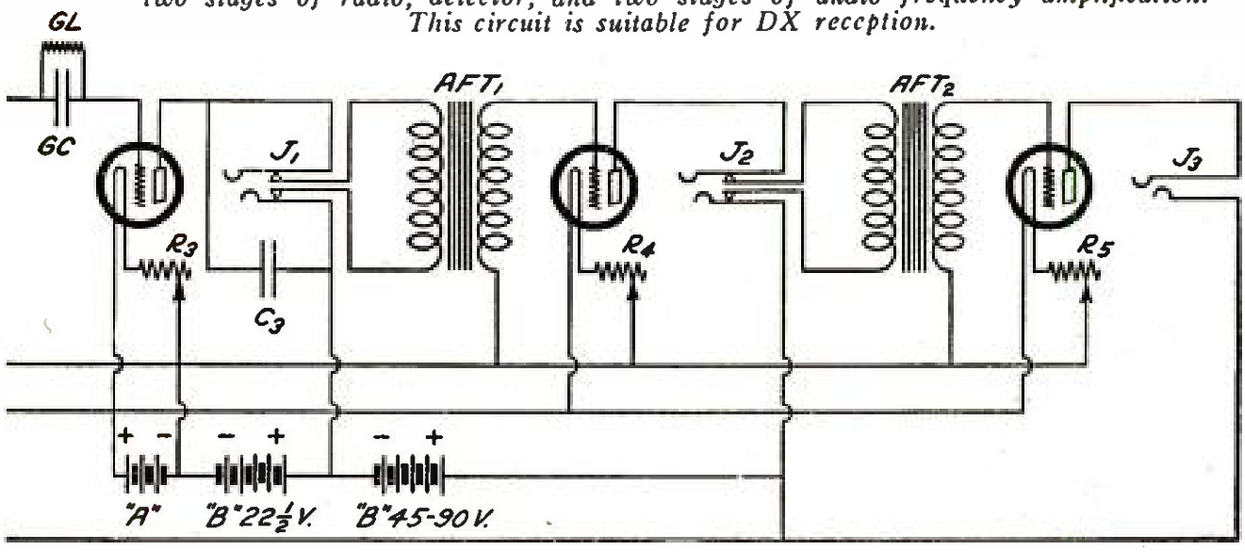
QUESTION: Will you please tell me where I can obtain the necessary information to enable me to construct at home a receiver similar to the Aeriola Senior single-tube receiver? How much should this cost me to build?

C. S.

ANSWER: You will find the necessary data contained in an article on page 49 of the July (1923) issue of POPULAR RADIO. The set should cost you no more than $16 if you make all the parts yourself.

FIGURE 3

The neutrodyne system of radio frequency amplification employing five tubes for two stages of radio, detector, and two stages of audio frequency amplification. This circuit is suitable for DX reception.



QUESTION: Will you please give me a good transmitting circuit for one bulb and a CW transformer for using AC on the plate? I want a circuit that is easy to get into operation and one that does not cost much to construct.

REGINALD HADDEN

ANSWER: The diagram in Figure 4 contains the circuit for your set. You will need a CW inductance L1, with four clips, a mica fixed condenser C1, .001 mfd., a mica fixed condenser C2, .0005 mfd., a paper fixed condenser C3, .1 mfd., and a mica fixed condenser C4, .001 mfd., a L-200 honeycomb or duolateral coil, and a grid leak of approximately 5,000 ohms resistance. The transformer may be one of several types on the market for supplying both the filament current and the plate current. C5, is a counterpoise antenna which should be at least as large as the antenna proper. The key (for telegraph) should be inserted in series with the primary of the CW transformer.

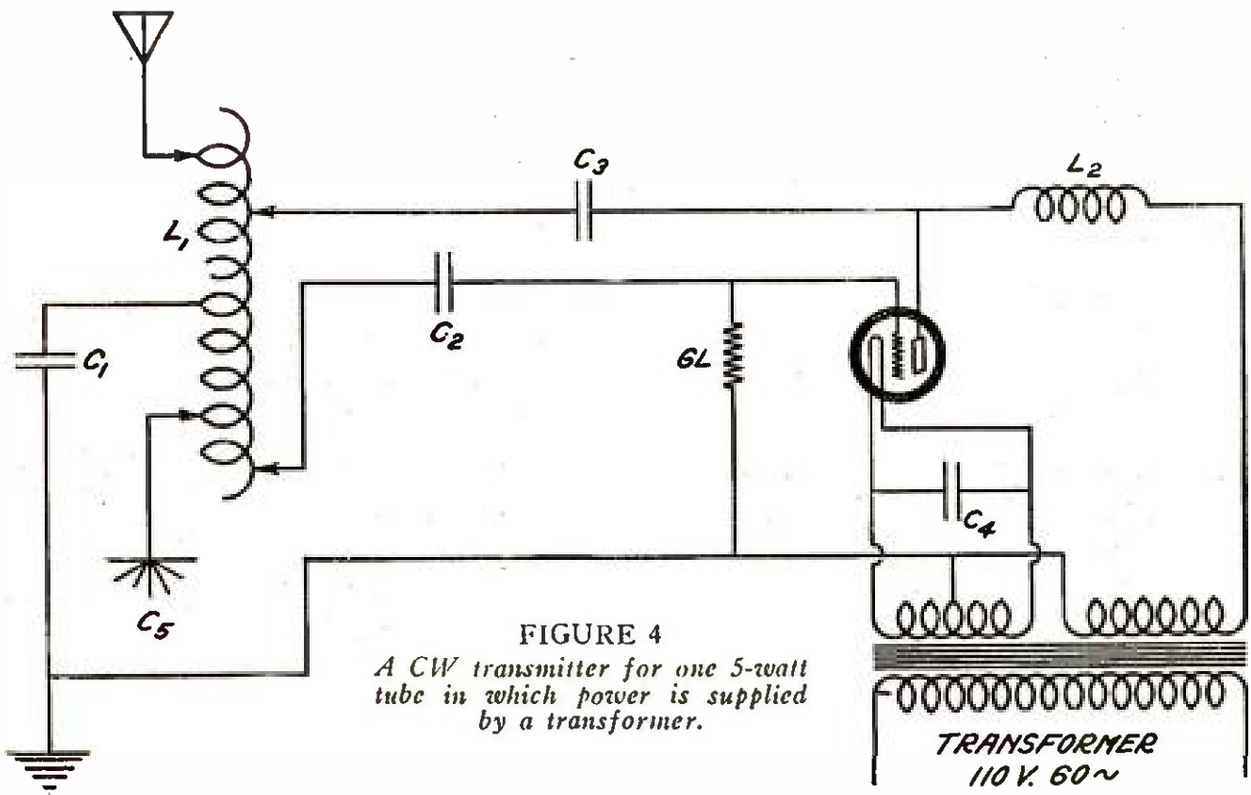


FIGURE 4

A CW transmitter for one 5-watt tube in which power is supplied by a transformer.

BROADCASTS

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

5,000,000 Fans Hear the President Speak

OVER 5,000,000 people are estimated to have listened in when President Harding's speech was broadcast by means of the pick-up system from a large hall in St. Louis a few weeks ago.

This experiment, which the average radio fan took as a matter of course, was really one of the most important in the history of communication in general and broadcasting in particular. It represents the successful solution of many perplexing transmission problems, which in the immediate future will mean that one man will be in a position to practically address the entire nation.

In this particular case the hall at St. Louis was equipped with microphones which in turn were connected to the transcontinental telephone lines. A connection was made to station KSD, in St. Louis, which broadcast the speech for the benefit of fans in that city and the middle west. The eastern end of the transcontinental line was connected to station WEAF, in New York City and the speech broadcast for eastern fans.

This test—which was over the greatest distance ever attempted with a broadcast station—coming immediately after the experiment whereby four different radiophone stations were linked up by telephone wires to a hall in New York City, shows the rapid steps being made toward the goal of national broadcasting.

At the present time such broadcasting involves tremendous expense, and is justified only upon the ground of experimentation.

* * *

A Stream of Water as an Antenna

EXPERIMENTS were conducted by the Bureau of Radio Research of the French Navy using streams of salt water pumped up from the sea and shot in a column into the air, which proved that transmission could be accomplished when employing this medium as an antenna. The regular transmitting apparatus was connected to the stream and communication was carried on over a distance of eight miles.

The use of sea water as an antenna is far less efficient that the regular metallic ship's antenna, but it would be found useful in case of an emergency in wartime if the regular antenna were shot away during an encounter.

* * *

The Radio Bug Begins to Bite Italy

THE prospect of initiating a broadcasting service in Italy appears to be somewhat more encouraging than it has been as "the wall of opposition which thwarted every radio plan has been demolished by the Fascist Government," according to *The Tribune,* New York. One company has agreed to pay a specified tax to the government in return for authority to start a broadcasting service; it proposes to tax its subscribers, but just how funds will be raised from this source is not revealed.

The proposed government tax on amateur transmitting sets will vary according to the power of the apparatus.

* * *

How Sweden Proposes to Regulate Broadcasting

SWEDEN will interpose no such handicaps upon its radio fans as have some other European countries, if the proposed law for regulating radiotelephony goes into effect. It will permit amateurs to build their own sets, requiring only that these shall be constructed in accordance with certain regulations. The Telegraph Department does not contemplate limiting within narrow margins the wavelengths on which amateurs may receive. The government proposes to erect the broadcasting stations and rent them to the Radiotelephone Company, which in turn will receive a rental from receiving stations.

No mention is made in the law regarding sending apparatus. The Telegraph Department will control receiving sets and supply them with a certain control mark, whereas the Radiotelephone Company will give permission to use such against payment of a license fee, 10 percent of which reverts to the state for the control privilege.

* * *

6,000 New Fans Monthly in England

ACCORDING to report, 6,000 radio fans a month are applying for receiving licenses in England, despite the red tape and rules governing reception of broadcasting.

A Paper that Depends Upon Radio for Its News

A NEWSPAPER that depends upon radio for its editorial matter is a unique venture recently undertaken in Alaska.

The Federal Government has recently decided to install a radio station at the Mayo silver camp in the Yukon district, thus establishing direct communication with the outside world. With such connections established, permitting the receiving of important news without a corps of reporters, it has been made possible for a publishing firm to ship a complete newspaper and job printing plant to Mayo City.

* * *

Radio Messages from Atoms

RADIO messages from the inside of atoms are our only hope, the scientists say, to find out what the ultimate structure of matter is like. Each atom sends out, especially when it is excited by a strong electric field, a set of ether waves of absolutely definite wavelength. The tuning, radio fans would say, is perfect. These waves are what appear as the "lines" of the spectrum, both the ordinary spectrum of light and the analogous spectrum of X-rays, which rays are the same as light, or, for that matter, as radio waves of any kind, except that their wavelengths are shorter. These ether waves that come out from the atom correspond, the scientist believes, to features of its internal structure and will enable us, in time, to discover what this structure is.

* * *

Do Our Ears Vary in Sensitivity from Day to Day?

WHEN you cannot pick up distant stations as well as usual the trouble may be due not to any fault of the radio transmission or with the functioning of your own set, but to changes in your own ear. A German experimenter, Professor Martin Gildemeister, has discovered, according to the *Journal of the American Medical Association,* that the acuteness of human hearing varies from day to day according to the health of the hearer. This is manifested most clearly in an ability to hear slightly higher tones on one's good days than on one's poor ones. The difference may be as much as 200 vibrations a second.

* * *

Does Electricity Keep Alive the Cells in Our Bodies?

ELECTRICITY grows more and more in importance as our knowledge of it increases. Scientists have been saying for a few years that all matter is made of electricity, that is, of electrons. Now comes a Philadelphia chemist, Dr. C. A. Butts, who believes as a result of his experiments that electricity inside the living cells of our body keeps them alive

International

THE FIRST JUDGE TO TRY A CASE BY RADIO

Judge John Rounds, of the Conciliation Court in St. Paul, Minn., is probably the first judge in the world to try a case by radio. Frank Yost suing C. E. Kopp for a radio set; Kopp had refused to pay for the set because he charged it "would not pick up distant stations." The judge could not tell what it would or would not do so he adjourned court and went to Kopp's house to listen in.

and in good health. On the other hand a little excess of positive electricity in the cells is so dangerous, Dr. Butts believes, that it may cause cancer.

* * *

Radio Music As a Curative

ONE by one the things we think are new turn out to be old. Music received by radio has been found soothing and beneficial, the doctors have been saying, especially to patients in the convalescent wards of the hospitals. Now comes Miss Frances Densmore, who has been studying the native music of the Indians for the United States Bureau of Ethnology, and reports that the ancient medicine men have been using musical rhythms, drum beats and rattles and the like, for many generations for exactly this same purpose. The rhythmic spells chanted by the Indian "doctors" over their patients may have had considerable curative value after all.

* * *

Sending Radio Waves to the Center of the Earth

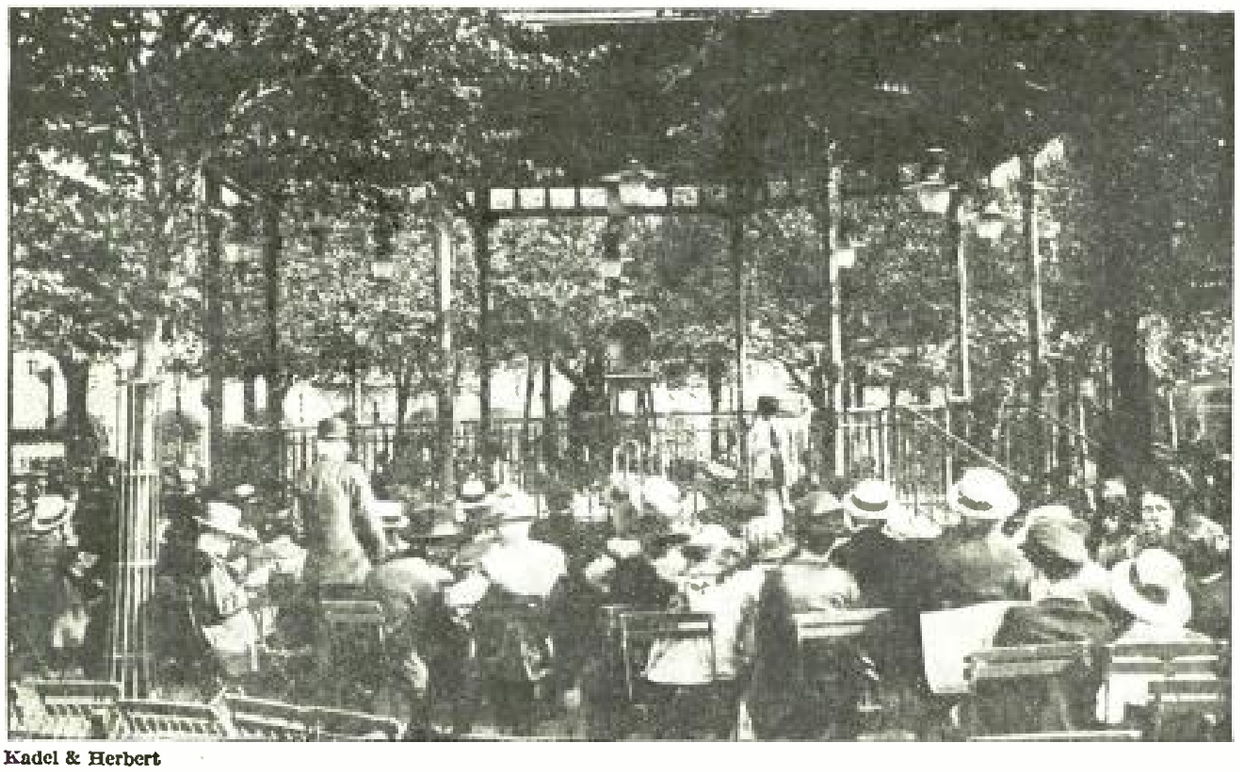
SCIENTISTS now propose to study earthquakes by radio. The way in which the shock from an earthquake is transmitted through the central part of the earth possesses some mysterious features which none of the present scientific theories can explain. To study these earthquake waves directly is difficult because the earthquakes cannot be induced to happen exactly according to schedule, when the scientists are all gathered round in the laboratory and ready to observe them. So it is proposed to explore the nature of the inside of the earth by radio waves instead. Beams of the waves can be directed, the experts think, downward into the ground and from the way these beams are bent or reflected inside the earth much can be learned about what really exists a thousand miles or so down under our feet.

* * *

The Passing of an Old Radio Ether Mark

SEAGOING radio operators, many skippers and landsmen who listen in will note a change in the "voice" of NAA at Arlington. The peculiar tone of the old Fessenden spark will no longer carry the time signals, weather reports and information of interest to mariners; this famous spark set (installed in December, 1912), was replaced recently by a new tube transmitter.

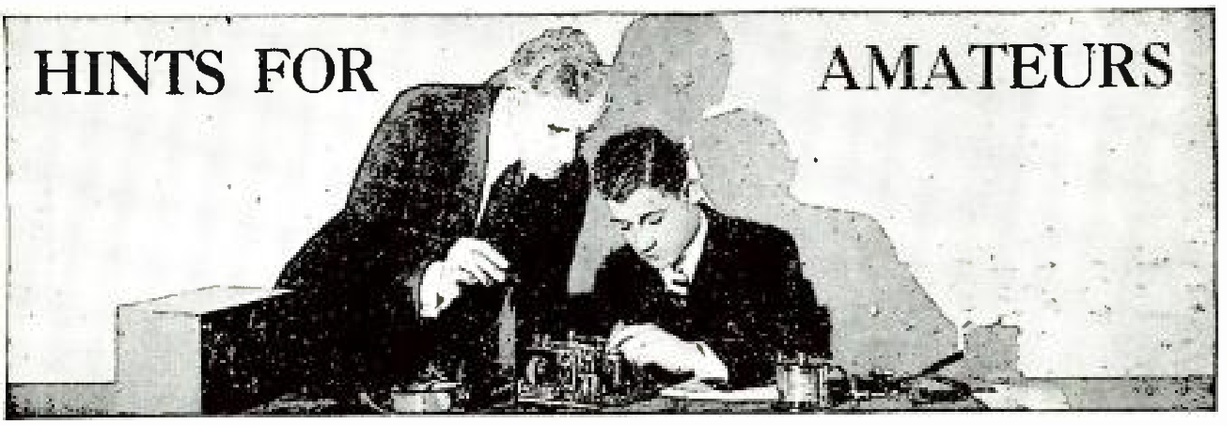
Operating on the same wavelength, 2,560 meters, the new set will carry all the governmental broadcasting that was formerly done on the spark. Although its power is not quite as great, the range of the tube set by tests has proven a little greater than the old 100 K.W. spark. After eleven years of almost constant operation, the Fessenden set is to be retired from active service; it is understood that it may be presented to the National Museum, where many radio experts believe it should have the honor accorded to the early locomotive of Baldwin and the Morse telegraph key.



Kadel & Herbert

RADIO TAKES THE PLACE OF A MILITARY BAND

The band-stands of Paris are losing none of their popularity merely because the musicians are miles away—as the people who gather around them are now hearing better programs played by larger orchestras whose programs are broadcast in many parks at once. This is one of the stands on the Champs Elysee.



Do not burn the thoriated filament tubes at too great a brilliancy; do not turn up the filament rheostat above normal. This will force too much current through the filament and release the electrons so fast that the filament will become "run out" of free electrons in a short time. The filament will burn all right but there will be little or no signals.

The correct current for the C-301-a, or the UV-201-a, is ¼ ampere.

If your tubes are of the type mentioned above and they have stopped working and still the filaments appear to be in perfect condition you can bring them back to usefulness by burning them at the correct filament current (¼ ampere) for an hour or so without the "B" battery being connected to them. This will cause a redistribution of thorium atoms around the surface of the filament which will again start and maintain the requisite stream of electrons for proper operation.

* * *

WHEN learning the code, do not study by the eye, but do it by the ear. Do not learn that the letter A, for instance, is represented by a dot (•) followed by a dash (—), but, from the first effort to memorize the code, learn that the letter A *sounds* like Dit-Da-a-a-ah (say it with your mouth); the letter B *sounds* like Da-a-a-ah—Dit—Dit—Dit, and so on.

* * *

Do not use acid soldering flux under any consideration.

THE loop receiver described in the August issue of POPLAR RADIO receives up to a wavelength of about 515 meters. It can be made to tune up to the higher broadcasting wavelengths by the addition of two small Telos mica condensers made for this purpose, which are connected directly to the vario-transformers.

* * *

AN easy way to sharpen up the tuning in a set is to put up another wire, the same length as the original antenna wire and running parallel with it. The new wire should not be closer than four feet to the first wire.

This will increase the capacity of the antenna system and will allow the use of a smaller coil in the antenna circuit which will decrease the resistance and permit looser coupling.

* * *

Do not use a "B" battery when its voltage drops below 60 per cent of its original value. A battery in this condition will have an increased resistance and will reduce the strength of signals and cause all sorts of extraneous noises. Get a new battery.

* * *

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

* * *

MAKE the grid wires in that set of yours as short as possible and keep them isolated from the other circuit wiring.

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

* * *

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

* * *

A small quantity of vaseline taken on the finger and rubbed on the contacts of a switch will keep the contacts from wearing and grinding themselves away. Contrary to what one would naturally think, this also insures a *better* electrical contact.

This stunt is used in most of the large electrical research laboratories on delicate measuring instruments.

* * *

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

* * *

In wiring up a set it is a good plan to use little copper tabs (obtainable in almost all of the electrical stores) for making connections to the instrument terminals and the binding posts. The tabs are inserted underneath the screw of the binding posts and the wires soldered to the tab. Then if you want to tear the set apart to try some other circuit you do not have the instruments all gummed up with solder. The tabs come away *clean.*

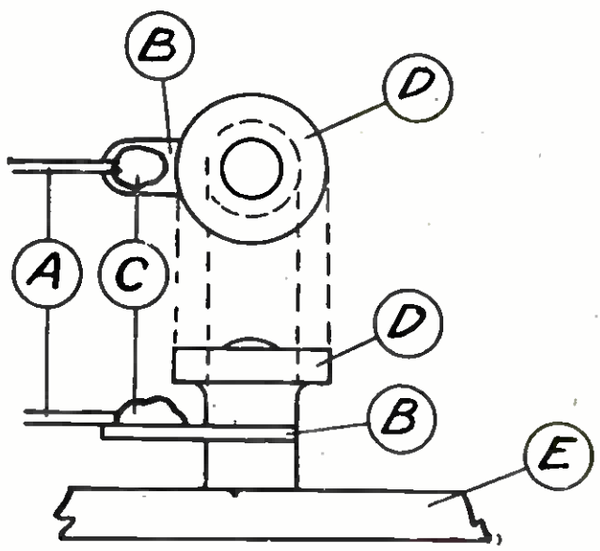
Always turn down the rheostats when you first connect up a new set that you have just completed, and try out a single tube in the sockets before putting in all the tubes. This will save two or three tubes if you have made a mistake in the connections.

* * *

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

* * *

Oil should not be used on the bearings or movable parts of radio sets. Some (quite a few) of the instruments on the market make use of the metallic bearings for the connections to the movable parts and these would be seriously affected by the film of oil between the bearing surfaces.



HOW TO USE THE TABS

The connecting wire A, is fastened to the copper tab B, by soldering C, and the tab is then inserted underneath the thumbscrew D, of the binding post which is attached to the particular instrument which is being connected in the circuit. This makes a neat connection without marring the instrument. Besides, it is easier to use the tabs as their mass is small in comparison with the whole binding post which must be heated.

"STATIONS I HAVE HEARD"

IF *you are getting good results with your receiving set, tell your fellow-readers of* POPULAR RADIO *how you get them. Give the call letters of the stations you hear, the locations of them, the type of apparatus that you are using and* HOW YOU ARE USING IT.

WHAT PATIENCE WILL DO WITH A CRYSTAL SET

WITH patience and almost nothing else, Francis L. Urry, in Salt Lake City, Utah, makes his crystal cover a distance of 700 miles as a regular thing. His tapped tuning coil does the work without the assistance of a variable condenser.

He hears five stations in Los Angeles, Cal., 700 miles away—KHJ, KFI, KOG, KWH and KFCL, and three others 500 miles away, KLX, Oakland, Cal., and KPO and KUO, San Francisco, Cal.

* * *

FOUR TUBES NOT ENOUGH

"I CAN tune in almost anything from Calgary to Porto Rico," writes T. D. Goresline of Gardner, Kans., "with my four tubes. Please tell me how to add two stages of radio frequency amplification."

He admits that he is a bug and says he is just getting interested after tuning in 142 phone stations and approximately one million code stations. He is using the "Real DX Receiver" described in the January number of POPULAR RADIO, with a third stage of audio frequency amplification.

* * *

A CHALLENGE FOR ONE-TUBE OPERATORS

WITH a single-circuit tuner that employs a variocoupler and variable condenser, Ted Lehman of Ashland, Ky., thinks he has a record for consistency hearing KFI and KHJ of Los Angeles, Cal., 2,100 miles away. During twenty-four consecutive nights he heard KFI 16 times and KHJ 13 times. His list of ninety-six stations includes three in Canada, two in Cuba, four in Texas and three in Colorado.

"I use a vernier rheostat," he writes, "and turn it until I hear a click in the phones. This is the point at which I get the clearest signals, although I sometimes brighten up the filament for long distances.

THE HIGH SELECTIVITY OF THE FOUR-CIRCUIT TUNER

"I BUILT the Cockaday Four-Circuit Tuner, using a plain wooden panel and no shellac, and I go right through the ether and pick out what I want," says W. K. Young of Kansas City, Mo. Using only one tube he readily tunes in WGY, Schenectady, N. Y.; WSB, Atlanta, Ga.; WFAA, Dallas, Tex.; KFDY, Brookings, S. D., and most of the other powerful stations in between.

* * *

USES POWER TUBE FOR HIS SPEAKER

WITH a detector tube and two stages of audio frequency amplification in a double-circuit regenerative hook-up, Noel Ferree of Hamilton, O., covers the whole of the United States, and with a five-watt power tube, he puts all his stations on a loudspeaker. KFI of Los Angeles, Cal., and PWX of Havana, Cuba, can be heard in a large room adjoining that in which he operates his loudspeaker, he says, and they come in as clear as they can be heard with phones.

* * *

THE NAVY SMILES ON THE FOUR-CIRCUIT TUNER

"I AM much enthused over Cockaday's latest invention," writes E. G. Meister of Buffalo, N. Y. "When I showed it to John C. Haderer, formerly Chief Radio Electrician, U. S. Navy, for a test and a critical inspection, he was so much taken with it that he said he would discard all thoughts of variocouplers and variometers in building future sets, and use only this circuit."

The following stations are a few of the 31 which come in so loud on a loudspeaker that the "B" battery current must be cut down: WDAP, Chicago, Ill.; WBZ, Springfield, Mass.; WMC, Memphis, Tenn.; WBAP, Ft. Worth, Tex.; WSY, Birmingham, Ala., and WLAK, Bellows Falls, Vt.

WHAT CAN BE DONE WITH A SIMPLE SET

A DISTANCE of 1,100 miles covered with a crystal set made quickly from standard parts is reported by Glenn Grimes of Tuttle, Okla. A variocoupler, a variable condenser, a piece of galena, a phone condenser and his phones enable him to pick up KDKA of East Pittsburgh, Pa.

The night on which he heard Pittsburgh was still and clear. He has often heard WOC, Davenport, Ia.; WBAP, Fort Worth, Tex., and WKY, Oklahoma City, Okla. His antenna is a single wire 120 feet long and 38 feet high.

* * *

HE USES SPIDER-WEB COILS

WHEN properly used, a dry-cell tube in McCreary, Manitoba, Canada, can pick up every broadcast program from PWX of Havana, Cuba, during a period of two weeks, according to Ronald L. Harper.

Three good spider-web coils in a double-circuit regenerative hook-up bring him 121 different stations. He uses an antenna made of a single wire 204 feet long, strung 45 feet above the ground. A grid condenser of .0005 mfds. capacity is a great help in picking up distant stations, he says.

Some of the stations he has heard are KXD, Modesto, Cal.; KWH, Los Angeles, Cal.; KPO, San Francisco, Cal.; WOO, Philadelphia, Pa.; WEAF, New York City; KGW, Portland, Ore.; WSB, Atlanta, Ga., and CFCA, Toronto, Canada.

* * *

30 STATIONS ON A CRYSTAL DETECTOR

NOT claiming to break the distance record for the crystal, but upholding the loose coupler as one of the simplest means of receiving well, Joseph Shearer writes from Buckley, Wash., to say that he has picked up 30 stations, many of which are from 500 to 700 miles away, with his set which uses a loose coupler and a crystal detector.

Shearer built the coupler at home from instructions printed in POPULAR RADIO for July, 1922. He uses a 43-plate variable condenser in the antenna circuit, and his antenna is 175 feet long and 50 feet high. His phones are of the 3,000-ohm type.

He hears KDN, KUO, KPO and KFDB of San Francisco, Cal.; KFCL and KHJ of Los Angeles, Cal.; KDYL and KZN of Salt Lake City, Utah; KDYS of Great Falls, Mont., and CFCN, CFAC and CHCB of Calgary, Alta., Canada.

* * *

156 STATIONS ON TWO TUBES

WITH two tubes in a set that employs three honeycomb coils, W. C. Aylesworth of Bridgerville, Pa., reports hearing 156 stations with new ones coming in every day. The coils he uses are the usual primary, secondary and tickler, and the amplification is audio frequency.

Among the distant stations are KOP, Detroit, Mich.; KDZW, San Francisco, Cal.; WGI, Medford Hillside, Mass.; PWX, Havana, Cuba and CJGC, London, Ontario, Canada.

HE IDENTIFIES 190 STATIONS

BURDETTE M. SMITH of Le Mars, Ia., has received and positively identified 190 stations since last November and he reports that he uses only three tubes. His trick lies in skillful manipulation of a good single-circuit receiver. He finds that he must tolerate considerable interference, much more than would be necessary with a double-circuit tuner, but he covers the whole continent and he is satisfied. With the new wavelengths he is getting less interference, and he is out for a new record with three more tubes for radio frequency amplification.

His set employs a variocoupler and primary condenser, both of the vernier type, in a regenerative hook-up, with a detector tube and two stages of audio frequency amplification. His aerial is 45 feet high and 175 feet long, including the lead-in. Storage battery tubes are used throughout.

On April 18, between the hours of 8.15 and 11.45, he managed to pick up 37 stations including WOC, Davenport, Ia.; WJZ, Newark, N. J.; KFDY, Brookings, S. D.; WGV, New Orleans, La.; WBAP, Ft. Worth, Tex.; KPO, San Francisco, Cal.; KWH, Los Angeles, Cal., and CFCN, Calgary, Canada.

* * *

HIS EXTRA TUBES ARE USELESS

E. KAMPF of Washington, D. C., has five tubes in his set, but he uses a detector and one stage of audio frequency amplification almost exclusively. He finds that his radio frequency amplifiers do not work well with an outdoor antenna and his single-circuit regenerative hook-up, and even with a loop antenna they make his hook-up too complicated for efficiency. With two tubes, however, he receives 129 stations, covering a good half of the continent.

* * *

MAKES RECORD WITH AN OLD CIRCUIT

THE old stand-by circuit which is usually voted as the easiest to construct from standard parts when long range and general good reception are desired, is lauded by Maitland and Spencer Roache of Philadelphia, Pa. It is the regenerative circuit using a variocoupler and two variometers with three tubes and a single wire on the roof. The Roache set brings in 80 cities in the United States, Canada and Cuba, with a total of 60,000 miles.

* * *

COCKADAY MAKES HOLLYWOOD FAMOUS

THE first record of coast-to-coast reception with the Cockaday Four-Circuit Tuner built from the description in the May number of POPULAR RADIO comes from Hollywood, Cal. W. Russell has picked up PWX of Havana, Cuba, several times.

"I have yet to find any one getting better results no matter what equipment he has," writes Russell. "I never saw a better set."

He receives CFCN of Calgary, Canada; WBAP of Ft. Worth, Tex.; WOC, Davenport, Ia., and a long list of others throughout the country, using only one stage of amplification. His aerial is 30 feet high and 250 feet long, running north and south.

HEAR YE!

THE beautiful tone of a Stradivarius or the wonderful technique of a famous voice cannot be reproduced by inferior headphones.

The successful performance of your receiving set depends upon the quality and perfection of the headset you purchase.

Twenty-five years of constant and painstaking manufacture by the Holtzer-Cabot Electric Co. has produced for you the perfected No. 2 Universal Headset.

This light weight, sanitary set reproduces positively and faithfully with an exceptional purity of tone and extreme sensitiveness.

Holtzer-Cabot No. 2 Universal, $8.50
Holtzer-Cabot No. 4 National, 5.50

If your dealer is unable to supply you, write us direct, giving us his name

We shall be pleased to send you a copy of our booklet, "What You Should Know About Radio Reception."

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Perfect Performance Guaranteed

ACE

Type V
Armstrong Regenerative Receiver $20

Formerly known as Crosley Model V

For performance no receiver at its price can equal it

An Evansville, Ind., man writes, "The other night I tuned in Kamach, Hawaii, and held the concert for one hour. The music was clear and the speaking distinct." This is indeed a tribute to efficiency.

Ace Receivers are licensed under Armstrong U. S. Patent 1,113,149.

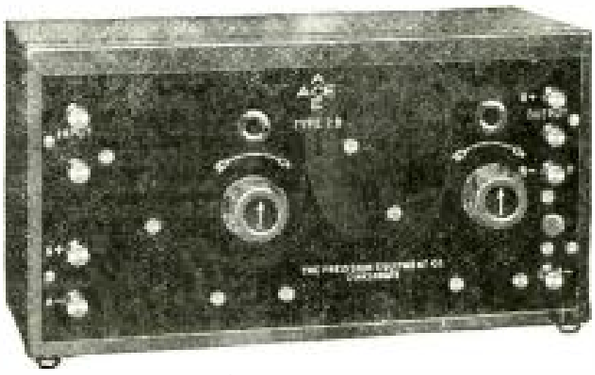
All Ace sets are equipped with the Crosley multistat, the universal filament control rheostat, for all makes of tubes.

Wave length range 200 to 600 meters.

Ace Instruments perform all we claim—and more besides.

Live Jobbers and Dealers are eagerly taking advantage of the sales these instruments and the other Precision instruments and parts are bringing them.

Free catalog on request



ACE Type V

THE PRECISION EQUIPMENT COMPANY

Powel Crosley, Jr., President

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Chicago Office, 1311 Steger Bldg., 26 E. Jackson Blvd., R. A. Stemm, Mgr.

Philadelphia Office, J. H. Lyte, 65 North 63rd St.

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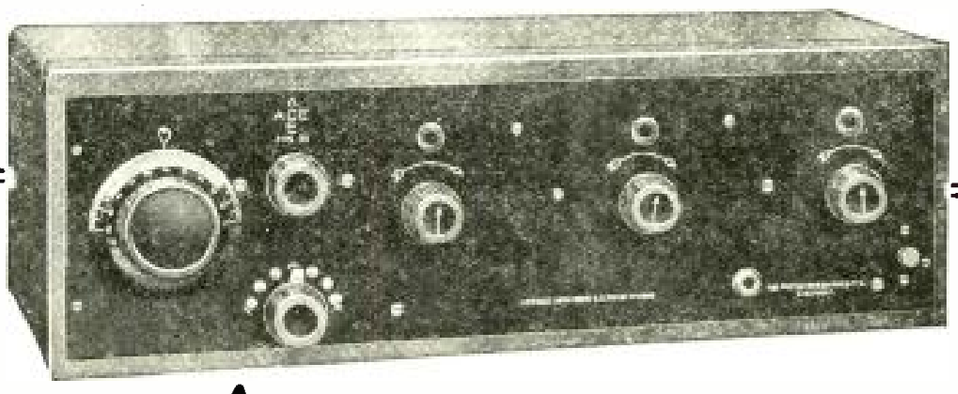
A New Radio Triumph



ACE TYPE 3B

Wide Range—Steady Performance—Sure Results

IN any field of endeavor, there is always one concern that seems to continually outstrip the others in new improvements.

In its Ace Type 3B, The Precision Equipment Co. offers the most remarkable 3 tube radio receiving set on the market. Without hesitation, we claim that the Ace 3B will out-perform any other set of its class and many that cost two and three times as much.

The Ace 3B is a regenerative receiver licensed under Armstrong U. S. Patent 1,113,149. It contains a detector unit and 2 stages of audio frequency. In addition, it uses all the new Crosley features such as filament switch, jack, new Crosley molded sockets and condenser with molded plates. Price $50.

A special battery Cabinet has been built to fit the Ace 3B. It is a beautiful piece of mahogany furniture in which all the necessary batteries can be stored. Price $15.

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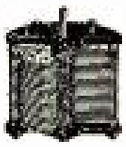
BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS



M812—43 plate .001 Mfd. $1.73
M813—21 plate .0005 Mfd. 1.43
M814—11 plate .00025 Mfd. 1.32
M815—3 plate Vernier 89c

These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Genuine bakelite end plates of high dielectric and great mechanical strength. Sturdy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with any inferior cheap condensers offered. We guarantee them to please you or your money back.

COMBINATION VERNIER VARIABLE CONDENSERS

M824—23 plate .0005 Mfd. Price $2.89
M826—43 plate .001 Mfd. Price 3.45

The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial. Separate small knob mounted above dial controls a three-plate vernier condenser. This arrangement permits of very fine tuning. High-grade design and construction. Finely finished. Suitable for panel mounting.

INDUCTANCE "HONEY COMB" COILS

Carefully made — fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm enamel impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Meters	Art. No.	Not Mntd.	Art. No.	Price Mntd.
25	120- 250	M301	$0.39	M320	$0.89
35	175- 450	M302	.42	M322	.96
50	240- 720	M303	.49	M323	1.04
75	390- 910	M304	.54	M324	1.08
100	500- 1450	M305	.58	M325	1.13
150	600- 2000	M306	.63	M326	1.17
200	900- 2500	M307	.72	M327	1.26
250	1200- 3500	M308	.78	M328	1.35
300	1500- 4500	M309	.82	M329	1.36
400	2000- 5000	M310	.97	M330	1.57
500	2800- 6100	M311	1.12	M331	1.63
600	4000-10000	M312	1.27	M332	1.78
750	5000-12000	M313	1.43	M333	1.93
1000	7900-15000	M314	1.70	M334	2.28
1250	9750-19500	M315	1.92	M335	2.49
1500	14500-26500	M316	2.18	M336	2.65

COIL MOUNTINGS

M340—Three coil mounting $3.95
M341—Two coil mounting 2.95

High grade fine looking mounting. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil.

GALENA DETECTOR

Easy fine adjustment. Crystal mounted in cup. Moulded base and Knob. Brass parts polished nickel finish. M732—Each 59c

This Guarantee Protects You. Examine the goods we ship you. They must suit you in every respect. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

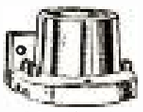
VACUUM TUBES

Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.
M105—Detector UV200 or C300 ..... $4.30
M112—Amplifier UV201A or C301A. Each $5.95
M115—5 Watt Transmitter 7.70
M107—WD11 1¼ volt 5.95
M101—WD12 or C12. Each 5.95
M102—UV199 or C299. Each 5.95
M109—WD11 adapter. Each 48c

VACUUM TUBE SOCKETS

Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections. Right angled contact springs.
M140—For Standard Base Tubes. Each 39c
M108—For WD11 Tubes. Each ... 49c

PORCELAIN BASE AND TUBE



M144—Crosley for either panel or table mounting for Standard Base .. 36c

High Grade combination type for panel or table mounting Metal tube. Highly insulated base. For Standard Base Tubes.
M146—Each 45c

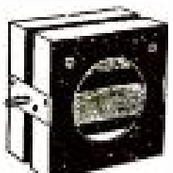
GRID CONDENSER

M162—Mounting holes spaced to fit lugs of above leak Cap. .00025 MFD. 8c
M163—Same as 162 but higher grade. Enclosed in metal case 39c

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed.
M100—Each 19c

VARIOMETER



M410—Completely assembled, price $2.10
Perfect in design and construction. Accurate wood forms. Correct inductive ratios. Solid baked windings, positive contacts. Highest efficiency.
M411—Not assembled but all parts complete, except wire, including winding form $1.48

VARIO-COUPLER

With this loose coupler and two variometers, together with the necessary other parts, a highly efficient tuning set can be made. Easily mounted on panel. Primary winding on formica tube. Inductively coupled for 180 to 600 meters. Multiple taps permit fine tuning.
M415—Price, completely assembled. .$2.45
M416—Not assembled, but all parts complete. Price, except wire 1.18
M417—Rotor ball only. Each 29c
M408—Bakelite Stator tube only. Ea. 35c

RADIO FREQUENCY AMPLIFYING TRANSFORMER

M995—Each $3.95
This transformer will get the long distance stations loud and clear. Permits of easy sharp tuning. Helps cut out static and interference. Makes your set sensitive enough to use a loop aerial. Enclosed in metal case affording perfect shielding. Suitable for panel or base mounting. Because of its special design can be mounted in any V. T. socket. Works with any make of tube. Wave ranges 150 to 550 meters. Wiring diagrams included.

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

As high as three stages can be used without howling, due to proper impedance ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.
M234—10 to 1 Mounted. Each ..$3.48
M235—10 to 1 Unmounted. Each. 2.95
M236— 3 to 1 Mounted. Each 3.40
M237— 3 to 1 Unmounted. Each. 2.85

FILAMENT CONTROL RHEOSTATS

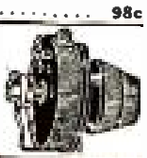
Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
M130—Each 45c

Best grade. High heat resisting base. Diam. 2½ in. cap. 1½ amp. Resistance 6 ohms. 1¾ in. Knob with pointer.
M132—Each 45c

POTENTIOMETER

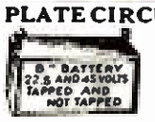
Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 200 or 400 ohms.
M133—Each 98c

VERNIER RHEOSTAT



Gives exceedingly fine control of a battery current. A necessity for best receiving results.
M135—Each 89c

PLATE CIRCUIT "B" BATTERIES



You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.
M180—Signal Corps type, small size, 15 cells. 22½ volts. Each 95c
M184—Variable Large Navy size, 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each $1.80
M188—Combination Tapped 45 volts, 30 cells, 6½x4x6 battery. Tapped to give 45, 22½, 21, 19½, 18, and 16½ volts. Handles both detector and amplifier tubes. Ea. $3.55

DETECTOR CRYSTALS CAREFULLY TESTED

M736 Galena, Arlington tested, per piece 19c
M 738 Silicon, Arlington tested, per piece 19c
M735 Tested, Galena, per piece 9c
M737 Tested, Silicon, per piece 9c

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

USE BARAWIK STANDARD PARTS

YOU SAVE MONEY WHEN YOU BUY FROM US

FAST SERVICE — THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

SOLID BARE COPPER WIRE

Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
M240—100 ft. coil 49c
M242—500 ft. coil $2.35

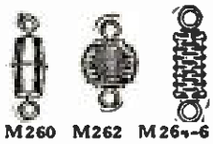
Solid Bare Copper Wire, size 12
M244—100 ft. coil 67c
M245—500 ft. coil $3.05

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for antennas.

M248—100 ft. coil 72c
M249—500 ft. coil $3.20

ANTENNA INSULATORS



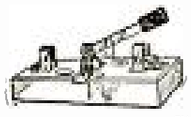
M260 M262 M264-6

M260—Size 1x3¼. Two for 17c
M262—Size 2⅛x3¼ Two for 55c
M264—Size 1½x4. Two for 69c
M266—Size 1½x10½. Two for $1.29

OUTDOOR LIGHTNING ARRESTER

M980—Price $1.58
Protect your instruments with this lightning arrester. You cannot afford not to. Weatherproof porcelain case. Air gap type. Permanent. **Durable.** The most practical quality arrester obtainable. Underwriters approved.

PORCELAIN BASE SWITCHES



Fine white porcelain bases. Copper contacts and bindes. Can be used as antenna switches.

M385 Single Pole Single Throw. Each 20c
M383 Single Pole Double Throw. Each 32c
M384 Double Pole Double Throw. Each 50c

SWITCH LEVERS

Moulded composition knob. Exposed metal parts polished, nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

M380—1" Radius }
M381—1¼" Radius } Each
M382—1½" Radius } 15c

SWITCH LEVER STOP

Brass, polished nickel finish.
M386—Dozen 18c. Hundred $1.05.

ONE-PIECE DIAL AND KNOB

Moulded of highly polished black composition with clean plain engraved scale and numerals in contrasting white enamel. Ribbed knob to fit the hand. An attractive neat pattern.

M900—2¼" Diam. for 3-16" shaft. Ea. 19c
M901—2¼" Diam. for ¼" shaft. Ea. . 19c
M904—3" Diam. for 3-16" shaft. Ea. . 25c
M905—3" Diam. for ¼" shaft. Ea. . . 25c
M906—3½" Diam. for 3-16" shaft. Ea. 35c
M907—3½" Diam. for ¼" shaft. Ea. . 35c

GUARANTEED QUALITY GOODS

at money saving prices. You can build the parts purchased from us into your set and feel confident of the best results. If what you want is not shown here write us for prices—we have every part for your set ready for quick shipment and the prices are right.

RADIO JACKS AND PLUGS

Finest grade jacks. Improved design. Best materials. Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅜ in. thick.

Jacks only
M390—Open circuit. Each . . 43c
M391—Closed circuit. Each. 49c
M392—Two circuit. Each . . 60c
M393—Single-cir. fila. control. 69c
M394—Two cir. fila. control . . 85c

M395—Plug. Large space with set screws for attaching cord. Each 35c

COMPETITOR JACK AND PLUG

Well made, durable, smooth working. Interchangeable with any standard jacks and Plugs. Solder connections. Nickel finished metal parts.

M387—Open Circuit Jack. Each . . 27c
M388—Two Circuit Jack. Each 35c
M389—Standard Plug. Each 35c

BINDING POSTS

M370-2 M376-8

Brass, polished nickel finish. Washer and 6-32" screw extending ⅝".

M370—Large size—barrel and knob ¾" long. dozen 85c
M372—Smaller size—barrel and knob 9-16" long. dozen 70c
M374—Large size with composition knob. dozen 50c
M376—Large size with hole for phone tip or wire, dozen 80c
M378—Small size with hole for phone tip or wire, dozen 35c

STORAGE BATTERY

A very high grade battery made especially for radio Service. Guaranteed. Properly cared for will give years of service for filament lighting.

M194-6v., 40 amp. size. Each . . $10.00
M196—6-v., 80 amp. size. Each . 12.50

Price does not include transportation

CABINETS

Fine-looking cabinets solidly built. Made of genuine solid mahogany in elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

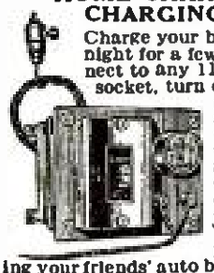
Panel Size	Inside Dimensions High	Wide	Deep	Art. No.	Price Each
6x 7"	5½"	6½"	7"	M420	$2.48
6x10½"	5½"	10"	7"	M422	2.75
6x14"	5½"	13½"	7"	M424	3.30
7x14"	6½"	13½"	7"	M423	3.60
7x18"	6½"	17½"	7"	M426	3.90
7x21"	5½"	20½"	7"	M425	4.20
9x14"	8½"	13½"	10"	M428	3.70
12x14"	11½"	13½"	10"	M430	4.40
12x21"	11½"	20½"	10"	M432	5.25

SOLID GENUINE CONDENSITE CELERON PANELS

Notice our very low prices in this fine quality grade 10 genuine solid sheet Condensite Celeron (a product with mechanical, chemical and electrical properties like formica and bakelite). Machines well without chipping. Won't warp. Waterproof. Highest mechanical and di-electric strength. Attractive natural polished. Black finish which can be sanded and oiled for extra fine work.

Panel Size Inches	⅛" thick Art. No.	Price	3-16" thick Art. No.	Price	¼" thick Art. No.	Price
6x 7	M450	$0.50	M460	$0.75	M470	$0.98
6x10½	M451	.75	M461	1.18	M471	1.47
6x14	M452	1.05	M462	1.55	M472	2.05
7x14	M458	1.20	M468	2.60	M478	2.40
7x18	M453	1.55	M463	2.30	M473	3.10
7x21	M457	1.78	M467	2.65	M477	3.60
9x14	M454	1.60	M464	2.30	M474	3.10
12x14	M455	2.10	M465	3.10	M475	4.15
12x21	M456	3.15	M466	4.65	M476	6.20

HOME CHARGER BATTERY CHARGING RECTIFIER



Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips.

Prices are Transportation Paid.
M201—For 6 volt battery $12.95

BARAWIK QUALITY HEADSETS

These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellen with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are brass in fine polished nickel finish. Polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.

M770—2000 ohm $3.75

OTHER STANDARD BRAND HEADSETS

M751—Murdock 56, 2000 ohm $4.20
M752—Murdock 56, 3000 ohm 4.95
M764—Frost, 2000 ohm 4.20
M766—Frost, 3000 ohm 4.85
M756—Red Head, 3000 ohm 5.78
M758—Western Electric, 2200 ohm . $9.50
M754—Baldwin Type C with plug . 11.75
M755—Baldwin Type C unit 5.50
M768—Brandes, Superior 5.40
M769—Brandes Navy 6.95

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

Give the Boys the Credit

RIGHT on the shoulders of America's boys and young men rests the success of the radio business. It is their curiosity, their ceaseless energy, their enthusiasm, that have sent radio surging over the entire country to the tune of more than two and a half million sets.

It's the boys that are keeping the retailers' stores crowded with eager buyers. Their home-made sets are the seeds from which have sprung the fine expensive sets the grown-ups buy. They've inoculated their parents with the radio virus. Dad says, "If we're going to have radio, we'd better have it right," and straightway starts out on a radio hunt, with his son acting as guide, adviser, buyer and constructor.

THE AMERICAN BOY
"The Biggest, Brightest, Best Magazine for Boys in All the World"

takes the radio manufacturer's message right to 500,000 enthusiastic, energetic, go-getting boys in well-to-do families. It places his product before an army of youth, averaging 15½ to 16 years of age. It reaches them at an age when their knowledge of radio is respected by their elders; when their buying power is ever growing to greater proportions; when they're forming buying habits of a lifetime for themselves.

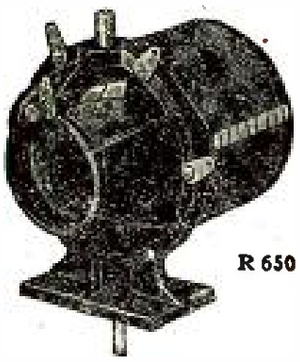
By advertising in THE AMERICAN BOY you not only win a great army of ready buyers for your product, you enroll just that many energetic, boosting salesmen.

Copy reaching us by September 15th will catch the November issue.

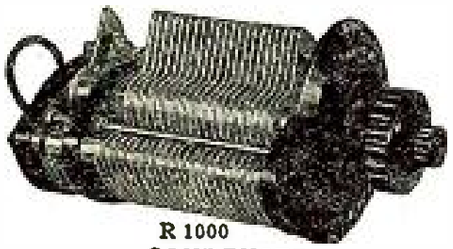
THE SPRAGUE PUBLISHING COMPANY
(Member A.B.C.)
548 Lafayette Boulevard, Detroit, Michigan

R 1125
AUDIO FREQUENCY TRANSFORMER
Exceptionally well made and dependable. Completely shielded in aluminum case.

R 675
VARIOMETER
Embodying the highest electrical efficiency. Moulded brown bakelite, split bronze bearings. Obtainable in two sizes.



R 650
VARIOCOUPLER
The finest that can be produced. Moulded brown bakelite, split bronze bearings: winding tapped at 15 points for very close tuning. Obtainable in two sizes.



R 1000
CONDENSER
With Vernier and pigtail connection. Obtainable in 43 plate, as above and 23 plate sizes.

for perfect reception use

Gilfillan Radio Parts

If you want most satisfactory results use "Gilfillan" parts in your Radio set. Accurately made of finest materials in accordance with the latest scientific standards.

Have your dealer show you Gilfillan Radio Parts. A few of them are illustrated here. You'll find them to be just what you want—and extremely low priced for quality construction.

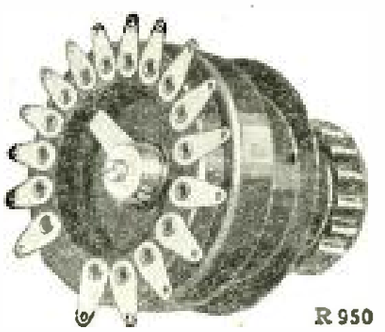
If your dealer can't supply you with Gilfillan parts, write us for descriptive folder and price list.

DEALERS: Gilfillan Radio Parts offer a splendid merchandising opportunity. Write us for detailed information.

GILFILLAN BROS., INC.

1815 W. 16th St., Los Angeles, Cal.
1925 McGee St., Kansas City, Mo.
225 W. 57th St., New York, N. Y.

Genuine Gilfillan Radio Parts carry this trade-mark. Look for it.



R 950
PRIMARY INDUCTANCE SWITCH
15 point. Provided with solder lugs. Moulded bakelite, black knob and dial.

Gilfillan Radio Parts are not sold for use on patented circuits.

Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City

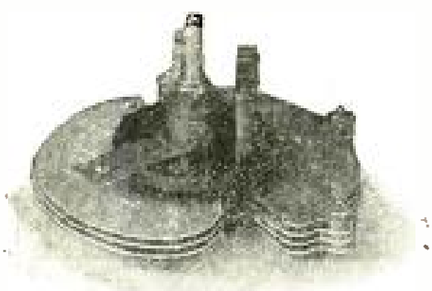
A. J. HAYNES
Assoc. Institute of Radio Engineers
Designer of the Haynes Circuit and the Haynes Selector

THE HEART OF THE FAMOUS HAYNES CIRCUIT

The Identical Parts Used by Mr. Haynes in His Own Personal Receiving Set—Assuring the Utmost in Selectivity, Long Distance Range, Economy and Simplicity of Arrangement. Invaluable to experimenters converting ordinary simple regenerative sets to include the Haynes Circuit.

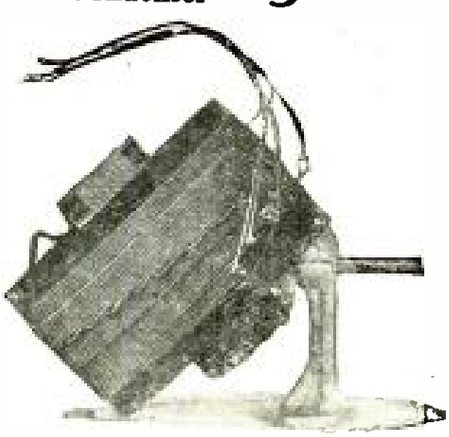
GET the full value from your Haynes Circuit by using only the special Haynes Condenser.

Meets every requirement—extreme low minimum capacity and maximum capacity of exactly .00023 mfds. Designed primarily as a secondary tuning condenser of the highest precision, it became the heart of the Haynes Circuit. No other condenser is exactly like it, no other achieves just the right balance between perfect selectivity and overcritical adjustment.



The Haynes Condenser $3.50

Second in importance is the vario-coupler. Any good coupler will do, but the Haynes bank wound coupler has been designed to assure absolutely perfect results. Supplied with necessary adaptations already made. Furnished with only the taps you actually use and just the right number of turns on the secondary. You can't possibly go wrong. Leads already attached and soldered. Bank winding provides 100% efficiency on higher broadcasting wave lengths.



The Haynes Bank Wound Coupler . $4.35

1000 Miles for $15.00

The outstanding feature of Mr. Haynes' own set is its simplicity and compactness of arrangement with all the instruments panel mounted.

Most experimenters find it well worth their while to substitute parts recommended by Mr. Haynes for those they may have on hand.

Haynes .00023 Condenser	$3.50
Haynes Bank Wound Coupler	4.35
Fada Rheostat	.75
Fada Socket (Panel Mounting)	1.00
Switch Arms	.20
4 Switch Points and 2 Stops	.06
10 Binding Posts	.50
2 3-inch Dials	.90
1 Dubilier Grid Condenser .C0025 m.fds. (with leak mounting)	.45
1 Grid Leak 1 meg	.35
Bus Bar, Solder, Copper Lugs and all miscellaneous material	.55
7x15 Grade A Hard Rubber Panel	1.50
Panel Drilled for Mounting all the above instruments (extra)	1.50

Accessories

7 x 15 solid mahogany cabinet, piano finish, $4.25; Haynes-Griffin Head Phones (2200 ohms) $4.75; W. D. 12, U V 201 A or U V 199 Vacuum tubes, $5.85; 22½ volt variable B Batteries, $1.25; 1½ volt dry cell A batteries, 35c each.

All these items are in stock—prompt shipment will be made—carriage charges prepaid

HAYNES-GRIFFIN RADIO SERVICE, Inc. 41 W. 43rd St. New York City

New York's Largest Radio Store

Another Use For Loud Speaker

When the static is too great for radio reception your AUDIOPHONE Loud Speaker can be used with the Bristol Phonograph Record Reproducer on your phonograph. Then you may have concert or dance program without interruption.

Attached instantly without mutilating the instrument in any way—the Bristol Phonograph Record Reproducer can be used with any make of phonograph.

Equipped with such an outfit there are no disappointments—it is always ready—never fails. For dance music you have the equivalent of an orchestra, but without the expense.

The tone of the phonograph thus amplified through the AUDIOPHONE has volume enough to fill large rooms and the quality is round—smooth—and beautiful—entirely free from mechanical noises.

Remember that the same AUDIOPHONE Loud Speaker is used in common for both radio reception and phonograph record reproduction.

AUDIOPHONE

Write for Bulletin 3007-L and we will advise where you may hear a demonstration.

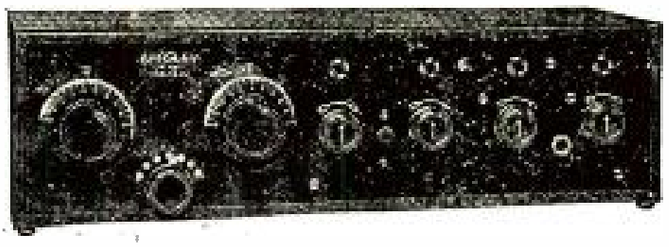
THE BRISTOL COMPANY
WATERBURY, CONN.

Branch Offices:

Boston New York Pittsburgh Philadelphia
Detroit Chicago St. Louis San Francisco

CROSLEY EFFICIENCY INCREASED

Price
$65



The New Crosley Model X-J

THE Crosley Model X, famous throughout the United States for perfect performance, is now offered to you with even greater refinement of detail in the new Crosley Model X-J.

Some of the new features of the Crosley Model X-J which make for greater distinction and beauty are:

1. Knobs and Dials—larger, easier to control and better looking.
2. Filament Control Switch—snaps filaments on and off.
3. Jack—Allows you to plug in with head phones on three tubes. When tuned in, just pull the plug and you are switched to the loud speaker.
4. Elimination of Binding Posts on Front Panel—By removing the binding posts to the rear, the beauty of the set is greatly enhanced.
5. Sockets—The old white porcelain sockets are replaced with black compound sockets which are just as efficient and better looking.
6. Condenser—The New Molded Crosley Condenser made of a specially prepared compound will out-perform any condenser on the market.
7. Multistat—Allows use of all makes of tubes. (Now a feature of the standard Model X.)

Of course the regular Model X will be continued at $55.

CROSLEY BATTERY CABINET

That the unsightly batteries may be completely housed, a beautiful, wax finished mahogany cabinet is just being introduced to fit either the Crosley Model X or X-J.

This cabinet makes the set entirely self contained and greatly adds to its beauty.

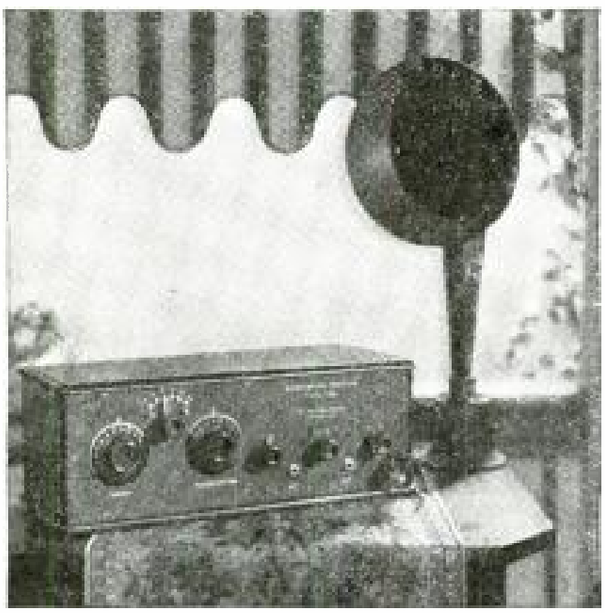
Price, $16.00

CROSLEY
Better—Cost Less
RADIO PRODUCTS

New York Office — C. B. Cooper, 1803 Tribune Bldg., 154 Nassau St.. Beekman 2061.
Boston Office—B. H. Smith, 755 Boylston St., Room 316.
Chicago Office—1311 Steger Bldg., 28 E. Jackson Blvd., R. A. Stemm, Mgr.
Philadelphia Office—J. H. Lyte, 65 North 63rd St.
St. Louis Office—Robert W. Bennett Co., 1326 Syndicate Trust Bldg.

Write for descriptive pamphlet
For sale everywhere by good dealers

CROSLEY MANUFACTURING CO.
916 Alfred Street **Cincinnat**



The New Tuska Popular No. 225

Regenerative Receiving Set, $75 without tubes, batteries, or loud speaker. Licensed under Armstrong Patent No. 1,113,149. Special circular 15-C sent on request.

Like a good old reliable friend

YOU turn to your Tuska radio set with perfect faith that it is always ready to be called upon. There is no fussing or coaxing—no apologies for its shortcomings. Year after year you can count upon this reliability of performance. New models will come, as in pianos and fine motor cars. But few will discard the old and buy the new for the sake of minor refinements. The Tuska set represents the highest point in radio development to-day; you can buy it for the future with confidence.

The Tuska is the ideal set for busy people who want the thrills of radio without the tinkering. It is simple to operate. You turn two dials, listen, and select the exact program you want from the dozens which fill the air. Nothing is forced upon you by the limitations of your set—every broadcasting station within hundreds of miles is within the call of your Tuska. A letter from Prince Albert, Saskatchewan, Canada, says, "We have tuned in clearly over 100 stations, and most of them are more than 1000 miles away."

Tuska sets are built under the personal direction of C. D. Tuska, a nationally known radio pioneer and builder of fine apparatus. For a dozen years Mr. Tuska has been keenly critical of all radio parts and sets bearing his name. As a result, the Tuska seal is recognized as a guarantee of the most thorough New England craftsmanship—and there is no better.

We will gladly send you the name of a near-by dealer who can show you the Tuska.

THE C. D. TUSKA CO., Hartford, Conn.

First to hear across the sea

A Tuska Receiving Set was the first to receive foreign amateur trans-Atlantic code during the international tests.

TUSKA TRADE MARK RADIO

Tuska distance records

During 12 years that Tuska Radio Apparatus has been in use, we have accumulated records of long distance radio reception that have never been surpassed.

TUSKA RADIO

There's Magic in the Air

THE night has a thousand voices. You can sit at home in your easy chair and hear the news and songs and music of a hundred cities when you own a Paragon Three-Circuit Receiver.

Pluck from the air the music to meet your mood; grand opera or jazz, chorus or orchestration; organ recital or church service. Listen, play by play, to the big athletic contests, lectures, speeches; to weather, crop and market reports; to the bed-time stories for the youngsters.

PARAGON

Reg. U.S. Pat. Off.

RADIO PRODUCTS

With a Paragon Receiver you get what you want when you want it—complete messages and clear music from the station you tune in on. Until you have listened in with a Paragon three-circuit Receiver, you cannot guess the real pleasure and fascination of radio.

Long before broadcasting popularized radio with the general public, Paragon equipment was the choice of the experienced amateur. He will tell you today that if you want quality and satisfaction, Paragon Radio Products are the best and safest buy on the market.

An illustrated Catalog of Paragon Radio Products Is Yours For the Asking.

DEALERS—The Adams-Morgan Company has an interesting proposition to make to reputable radio dealers who believe in quality merchandise. Details on request.

ADAMS-MORGAN COMPANY
20 Alvin Ave., Upper Montclair, N. J.

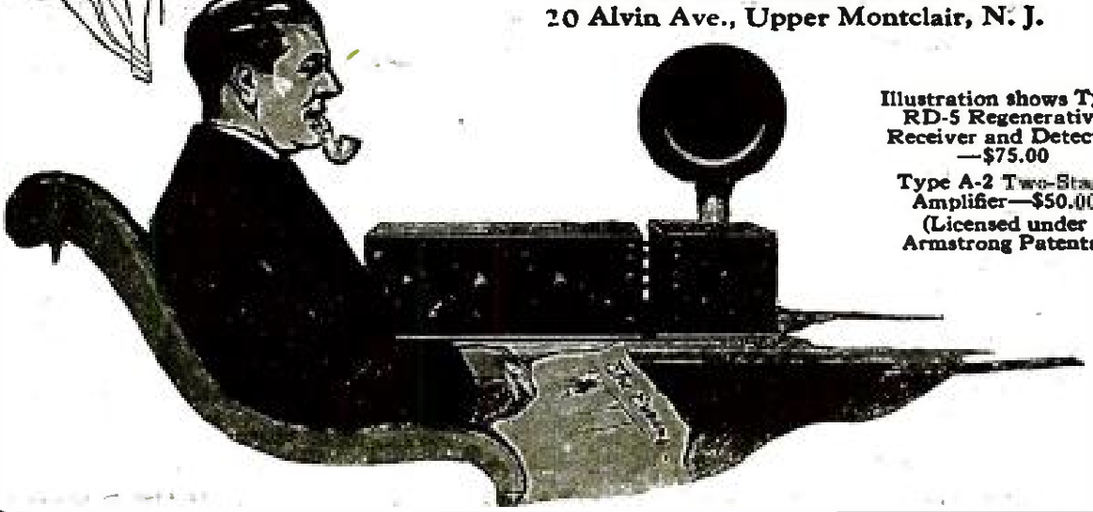


Illustration shows Type RD-5 Regenerative Receiver and Detector —$75.00

Type A-2 Two-Stage Amplifier—$50.00
(Licensed under Armstrong Patents)

The Singer –ALIVE– in your home!

MUSIC MASTER yields the actual, *living* voice of the vocalist—not an imitation or interpretation.

You hear the true timbre of the singer's tones, each expression of individuality, every nuance of personality—with the nicely balanced support of the orchestra or piano as it follows the artist.

MUSIC MASTER, the voice of Radio, and the "Stradivarius of Reproducers," is a marvel of clearness. It does not twist radio tones, but conveys them to you faithfully—exactly as produced by the artist at the instant.

Hear MUSIC MASTER talk for itself at your radio dealer's. Make comparisons. Assure yourself that it has no equal.

JOBBERS and DEALERS: Write now for full description of the entire GERACO Line and prices.

14-in. Home Model, $30
21-in. Concert Model, $35

Geraco Phonograph Attachment

Makes an effective loud-speaker out of any Victrola or Columbia Phonograph, $10 complete.

General Radio Corporation

Makers and Distributors of High-Grade Radio Apparatus

PHILADELPHIA
S. W. Cor. 10th and Cherry Streets

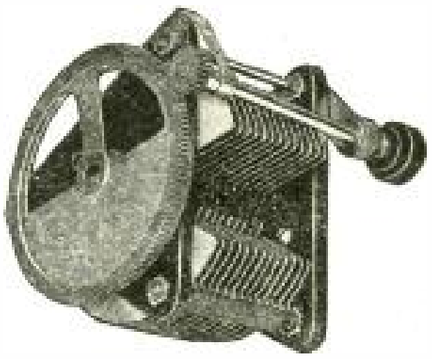
CHICAGO PITTSBURGH

Dealers Everywhere

Music Master
RADIO REPRODUCER

If you're building a Set—

Type 231



Type 247

Here are the essentials!

Type 301

Type 299

1. A quality Condenser—type 247—fitted with reduction gearing for fine capacity adjustment:

2. A Rheostat (or Potentiometer)—type 301—designed especially for UV-199 and 201A tubes:

3. A UV-199 Tube Socket, ruggedly built of molded Bakelite, with phosphor bronze springs:

4. And the well known General Radio Co. Amplifying Transformer giving maximum amplification without distortion.

All of these are guaranteed by the General Radio Company.

For dependability and results build your set around these essentials.

Ask for Bulletin 914U. It contains our complete line of receiving equipment.

Prices:

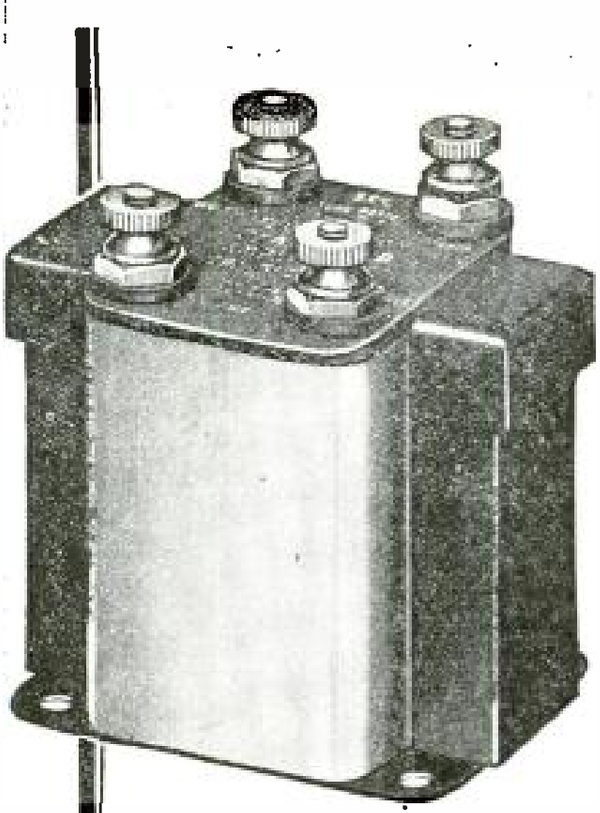
Type 247 Variable Geared Condenser	$3.25 to $7.25
Type 301 Rheostat 10 or 30 Ohms	$1.25
Type 301 Potentiometer 200 Ohms	$1.25
Type 299 Vacuum Tube Socket	$0.75
Type 231 Amplifying Transformer	$5.00

General Radio Company

Manufacturers of Electrical and Radio Laboratory Apparatus

Massachusetts Avenue and Windsor Street
CAMBRIDGE MASSACHUSETTS

5569



The New

THORDARSON

Super Transformer

More than a quarter of a century has been devoted by Thordarson engineers to the design and development of power transformers ranging in size from the smallest bell ringer to the first 1,000,000 volt transformer the world ever saw.

That knowledge and practical experience has been intelligently devoted to devising an Audio Frequency Amplifying Transformer that would produce the greatest volume consistent with *true tone quality*.

Here it is—its specifications and efficiency under all atmospheric conditions and over all audible signals, ranging from 100 to 7,000 cycles have been tested and endorsed by the foremost radio engineers in the United States. Thousands of these new amplifying transformers are daily furnishing the means to greater pleasure and entertainment to discriminating radio amateurs and experimentors.

Developed and manufactured entirely by Thordarson engineers in the Thordarson plant

It is not merely an assembly of bought coils, core iron, etc., as is the case of most audio frequency transformers in the market.

Core is made of .007 highest grade silicon steel, No. 36 gauge, the cross section of which measures ¾ inch—twice that of the usual type transformer. Coil is *square layer wound* of No. 40 wire to fit the square core. The winding process and machinery were designed and developed exclusively by Thordarson.

The basic principle and construction of this new Thordarson product are scientifically, electrically, and mechanically correct. Exhaustive tests and experiments have proved conclusively that:

1. Core losses are reduced to a minimum.
2. Over-saturation of the core is eliminated.
3. When in use the resistance of the plate circuit of one tube and the resistance of the grid circuit in the following tube are balanced to a degree heretofore unequaled.
4. The received energy is increased sufficiently to actuate loud speaking devices without distorting the incoming signal.
5. The volume produced is as great as *pure tone quality reproduction will permit.*

The new Thordarson amplifyer is the choice not only of thousands of amateurs and experimenters, but an increasing number of leading receiving set manufacturers now specify Thordarson Transformers as standard equipment.

Make your own test

Words nor pictures nor specifications alone can do justice nor prove the superiority of Thordarson products. Let your own ears guide you in your comparison.

SOLD AT ALL GOOD DEALERS

PRICE, MOUNTED ONLY

6 to 1 ratio transformer . $4.50
(with Red Label)

3½ to 1 ratio transformer 4.00
(with Blue Label)

THORDARSON
ELECTRIC MFG. CO.
Huron and Kingsbury Streets, Chicago

JEFFERSON

Amplifying Transformers

have gained an enviable reputation for audibility and amplifying power. In tens of thousands of receiving sets they are insuring 100% amplification—increased range, super-sensitivity, and the elimination of howling and distortion.

This positive preference rests on the unmistakable superiorities of design and operation which make Jefferson Amplifiers the choice of discriminating radioists.

FIVE JEFFERSON TYPES

The five Jefferson types meet the demand for an audio-frequency transformer for every requirement. In this assortment you are sure to find the transformer which will make your set super-sensitive, and enable you to tune in distant stations with ease, and freedom from distortion.

Radio Bulletin Sent Free

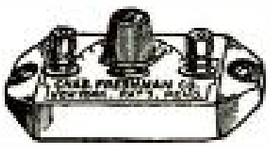
Jefferson Electric Mfg. Co.

427 S. Green Street Chicago

FRESHMAN RESISTANCE LEAKS

The largest and most Complete line in the World

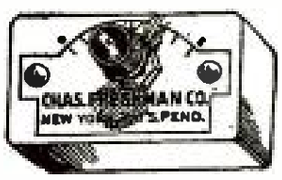
Our new construction of all types Variable Resistance leaks produces a product which we can now guarantee as being scientifically correct, mechanically perfect and built for unusual durability.



Every tube and every circuit requires a different leak resistance. You do not know what value is necessary until your circuit is tested. Freshman Variable Resistance leaks give an unbroken range of 180 degrees from zero to five megohms.

Base Mounting Type with either .00025 or .0005 Freshman Condenser **$1.00**

Without Condenser..... 75c

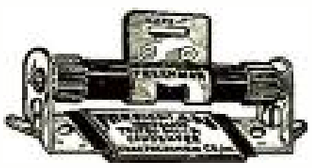


PANEL MOUNTING Freshman Variable Resistance Leaks

will enable you to get stations you have never heard before. Can be mounted on any panel in a few seconds. The latest and most essential part of an efficient tube set.

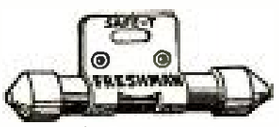
With either .00025 or .0005 Freshman Condenser **$1.00**

Without Condenser.....75c



FRESHMAN "FIX-O" Fixed Resistance Leak Combination —4 in One

Freshman Condenser .00025, Leak Mounting Freshman Resistance Leak, Safe-T Handle Price Complete **65c**



FRESHMAN FIXED Resistance Leak With Safe-T Handle

The only Resistance Leak using no carbon, graphite or lamp black. Guaranteed to remain *permanently constant*. Furnished in any value of Resistance from ¼ Megohm up **30c**

FRESHMAN NOISELESS Tested Mica Condenser and Leak Mounting

The Freshman Condenser is so designed that constant equal pressure is exerted over the entire area of the condenser plates and the mounting is part of the condenser itself, which makes this new product the only True and Perfect Leak Mounting on the market.

Combination Condenser .00025 and Leak Mounting... **40c**

All Freshman Products at your dealers—otherwise send purchase price and you will be supplied without further charge.

Also ask your dealer for our free diagrams of the Neutrodyne, Flewelling and Kaufman Circuits.

Chas. Freshman Co. Inc.
Radio Condenser Products

106 Seventh Avenue New York

You Can Fill One of These Big-Pay Positions Waiting in Radio!

$2500 to $10,000 a Year

NO other training offers such opportunity for success as a Certified Radio-trician. Honor, power, position, wealth—all are easily possible for those who enter this great new profession NOW, while it is growing.

Now the Easiest Growing Business

Radio has jumped into the front rank of the world's great industries, yet it is only in its infancy. Its vast, amazing possibilities are as yet undiscovered in a large measure. And great as it is today, it will be a thousand times greater tomorrow! The man who gets into Radio today—who prepares NOW to grow up with this wonderful new science—will have a great share in its glorious future.

Master Radio at Home

To the ambitious man, Radio offers greater opportunities for success than any other profession or trade. It offers you a wonderful position, interesting work, and a fine salary. Radio spells SUCCESS.

The National Radio Institute, known the world over as the largest Radio Training Organization, will prepare you quickly in *your spare time at home* to qualify for the position you want. Hundreds of our graduates are today reaping big returns from their instructions. Some of them are radio inspectors and engineers. Others are in charge of land and sea stations. Still others are in charge of radio departments in stores or are in business for themselves.

Pick Out the Job You Want We Will Help You Get It

Brief list of the positions in the radio field today and the salaries paid.

Radio Mechanic, $1,500 to $4,000 a year.
Radio Inspector, $1,800 to $4,500 a year
Radio Salesman, $2,000 to $10,000 a year.
Radio Engineer, $3,500 a year and up
Radio Executives, up to $15,000 a year
Radio Instructor, $200 to $500 a month
Radio Draftsman, $7 to $15 a day
First Class Ship Operator, $105 a month, all expenses paid.
Second Class Ship Operator, $95 a month, all expenses paid.
Third Class Ship Operator $85 a month, all expenses paid.
Commercial Land Station Operator, $150 a month and up
Broadcasting Station Operator, $125 to $250 a month.

Big Money—Easy Work

Most of our graduates when they started our course, knew little or nothing about Radio. Yet, in a few short months, our instruction qualified them to earn big money as Certified Radio-tricians. The same instruction, the same help that brought quick success to these men, is now offered to you. You have the same opportunities, you have the same prospect they had. Take advantage of them. Get into Radio NOW. Grow up with it. Advance with it.

Send for FREE Book

We have just prepared a wonderful book which is filled with the latest information about

the wonderful opportunities in this newest and fastest growing profession. It will be sent to you absolutely FREE. Send for this book. It will tell you all about how we prepare you for, and help you to get or secure the wonderful positions open in this fascinating field. Mail coupon for this book NOW! National Radio Institute. Dept. 32-I, Washington, D. C.

National Radio Institute, Dept. 32-I, Washington, D. C.

Send me your wonderful book, "Your Opportunity in Radio" with full particulars about the opportunities in Radio, and how you will quickly train me in my spare time at home to become a Certified Radio-trician. Also tell me how your free Employment Service will help me to a position and particulars of your special short-time offer.

Name.....Age.....

Street.....

City.....State.....

BUILD YOUR OWN HAZELTINE-NEUTRODYNE RECEIVER

With these FADA Neutrodyne Parts, one can successfully construct his own Neutrodyne circuit radio receiver

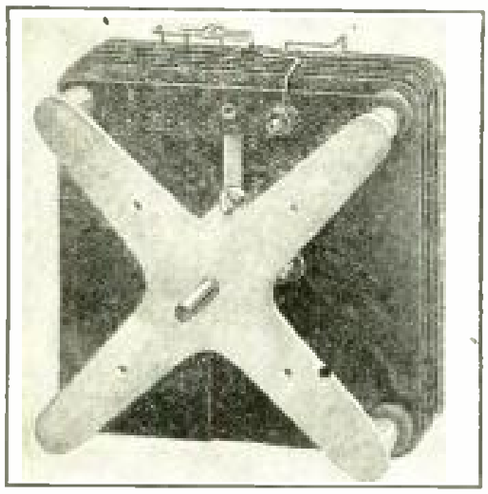
Use FADA Parts

The combination package pictured combines three FADA "Neutroformers," and two "Neutrodons" and a very complete booklet telling "How to Build Hazeltine Neutrodyne Receiver."

For only $25.00 you can purchase these essential FADA Neutrodyne Parts, and be assured of success with your home-made Neutrodyne circuit Receiver.

Extra copies of the 32-page "How to Build Hazeltine Neutrodyne Receiver" booklet will be sent for 50c.

F. A. D. ANDREA, INC.
1581-D Jerome Avenue, New York City



Write for FREE booklet on Radio Frequency Amplifiers by Lester L. Jones

Vario-transformers

Used in the

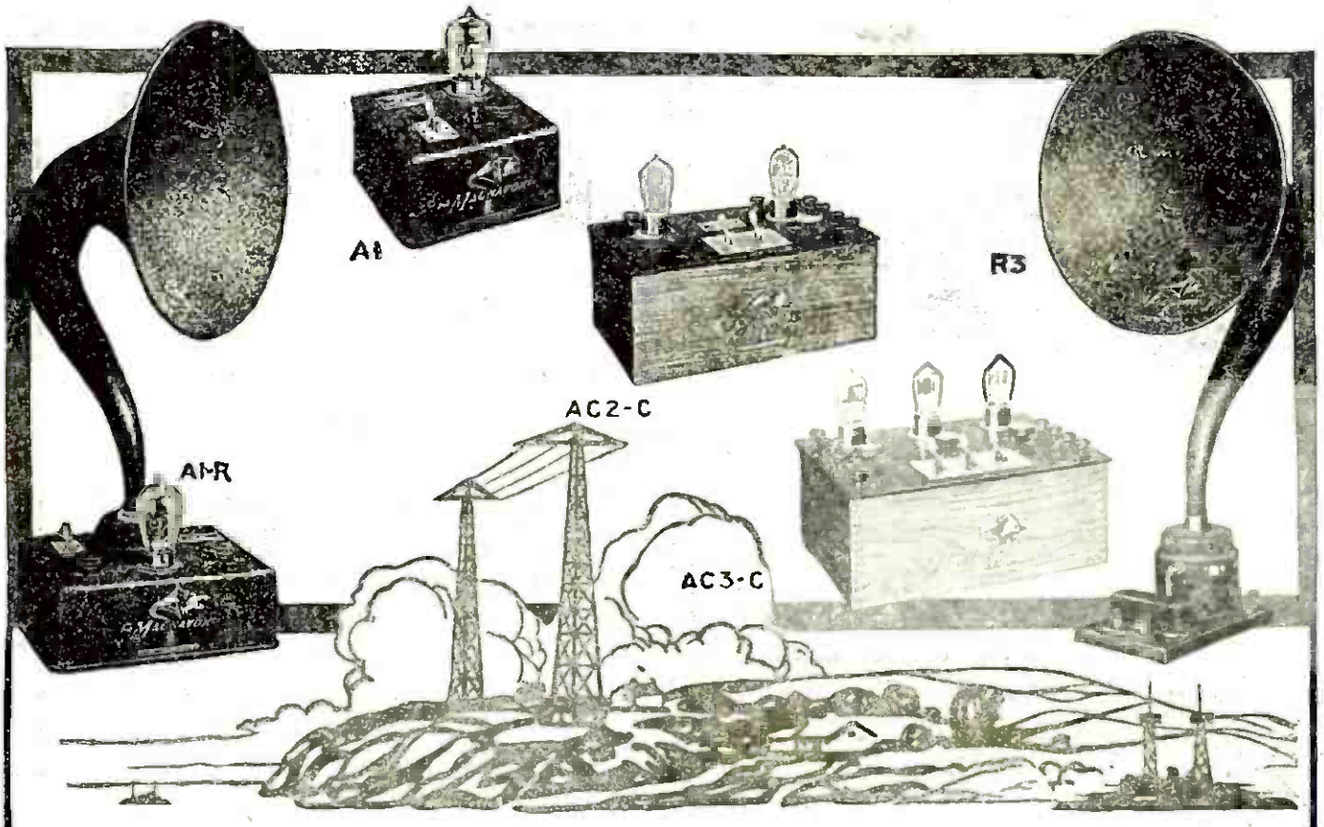
TELOS ACMEDYNE

circuit are guaranteed to give the greatest radio frequency amplification and selectivity.

Telos Vario-transformers are the only practical devices for obtaining tuned radio frequency amplification in one unit. Type TC4 for wave length range of 180 to 610 meters.

DANZIGER-JONES, Inc.

145A Prince Street **New York City**



Radio Takes Another Step Forward

THE new Magnavox models (rapidly being distributed to the trade) extend and supplement the already famous Magnavox line, which now includes a Magnavox for every receiving set.

A brief summary of Magnavox products is given below:

Magnavox Reproducers

R-2 with 18-inch curvex horn.	$60.00
R-3 with 14-inch curvex horn.	35.00
M1 with 14-inch curvex horn; requires no battery for the field.	35.00

Magnavox Combination Sets

A1-R consisting of Reproducer R3 and 1 stage of amplification.	$59.00
A2-R consisting of Reproducer R3 and 2 stages of amplification.	85.00
A1-M same as A1-R but with Reproducer M1	59.00
A2-M same as A2-R but with Reproducer M1	85.00

Magnavox Power Amplifiers

A1—new 1-stage Power Amplifier.	$27.50
AC-2-C—2-stage Power Amplifier.	55.00
AC-3-C—3-stage Power Amplifier.	75.00

Ask your dealer for demonstration. Interesting booklet will be sent on request.

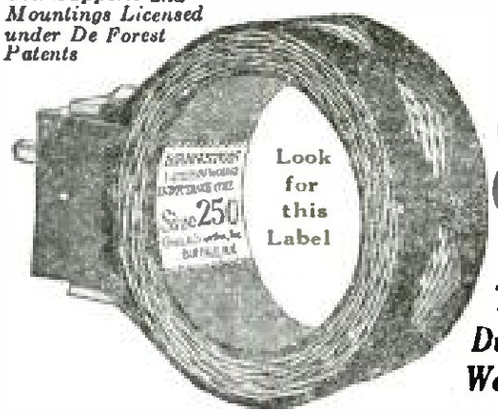
THE MAGNAVOX COMPANY
Oakland, California
New York Office: 370 Seventh Avenue

MAGNAVOX PRODUCTS

The only complete line of Reproducers and Power Amplifiers

8-T

Coil Supports and Mountings Licensed under De Forest Patents



Insist on the Genuine

They are Duo-Lateral We call them

BRANSTON Lateral Wound Inductance Coils

No other method of tuning has approached the wonderful flexibility of the Honeycomb Coil in changing to different wave lengths. If you are in doubt, ask your "Old Timer" radio friend why sets using Honeycomb Coils are better.

With Branston Honeycomb Coils you can get closer tuning, greater selectivity, greater range. Two outstanding features of the Branston Coils are—no dead end losses and ease of operation.

Send 2c in stamps for Series 1 "Hook-Up" Circular showing five good Honeycomb hook-ups and Catalog of famous Branston Radio materials. Write today giving your dealer's name. If he can't supply you, let us know.

Chas. A. Branston, Inc.
811 Main St. Buffalo, N. Y.
In Canada—Chas. A. Branston, Ltd. Toronto, Ont.

BRANSTON RADIO

$15.00

F. O. B. CLEVELAND

Type 6 charges 6 to 8 Volt storage battery from any 110 Volt 60 Cycle lamp socket at average rate of 6 amperes

Contactors *Can't* BURN or STICK

They also permit a desirably high charging current that makes for quick and easy storage battery charging.

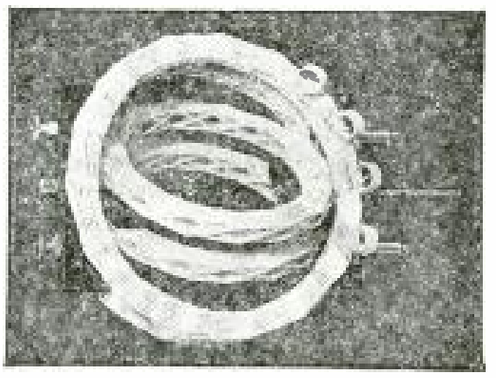
Buy from your dealer. There's a type for every need. If he cannot supply you, write for literature or enclose remittance covering express or postal charges on 9 lbs.

Dealers Write for Complete Details in Bulletin No. 44. It's Free!

The France Mfg. Co.

10344 Berea Road Cleveland, Ohio

Pioneer Manufacturers of Patented Battery Chargers



R. M. C. Diamond Weave Variocoupler

Wound to eliminate capacity and dielectric losses. Low distributed capacity—high inductance.

Panel mounting requires very small space; screw holes covered by 2" dial.

Adaptable to all circuits requiring variocoupler. Provided with seven taps, equally spaced, on primary. Bushed bearings.

R. M. C. Variometer similar in construction. Gives extreme maximum and minimum values. Highest quality in material and workmanship.

Variocoupler..... $4.25
Variometer..... 4.25

Write for catalog on other diamond weave coils, and Radio Frequency Transformer.

THE RADIO MANUFACTURING COMPANY
of Springfield, Massachusetts
Dept. B 97 Dwight Street

MA-13

—of special interest to Radio Dealers!

One of Chicago's oldest and largest exclusive radio stores sold more Mu-Rad Receiving Sets in 1922–23 than all other types of Receivers combined!

Mu-Rad sells—and sells!

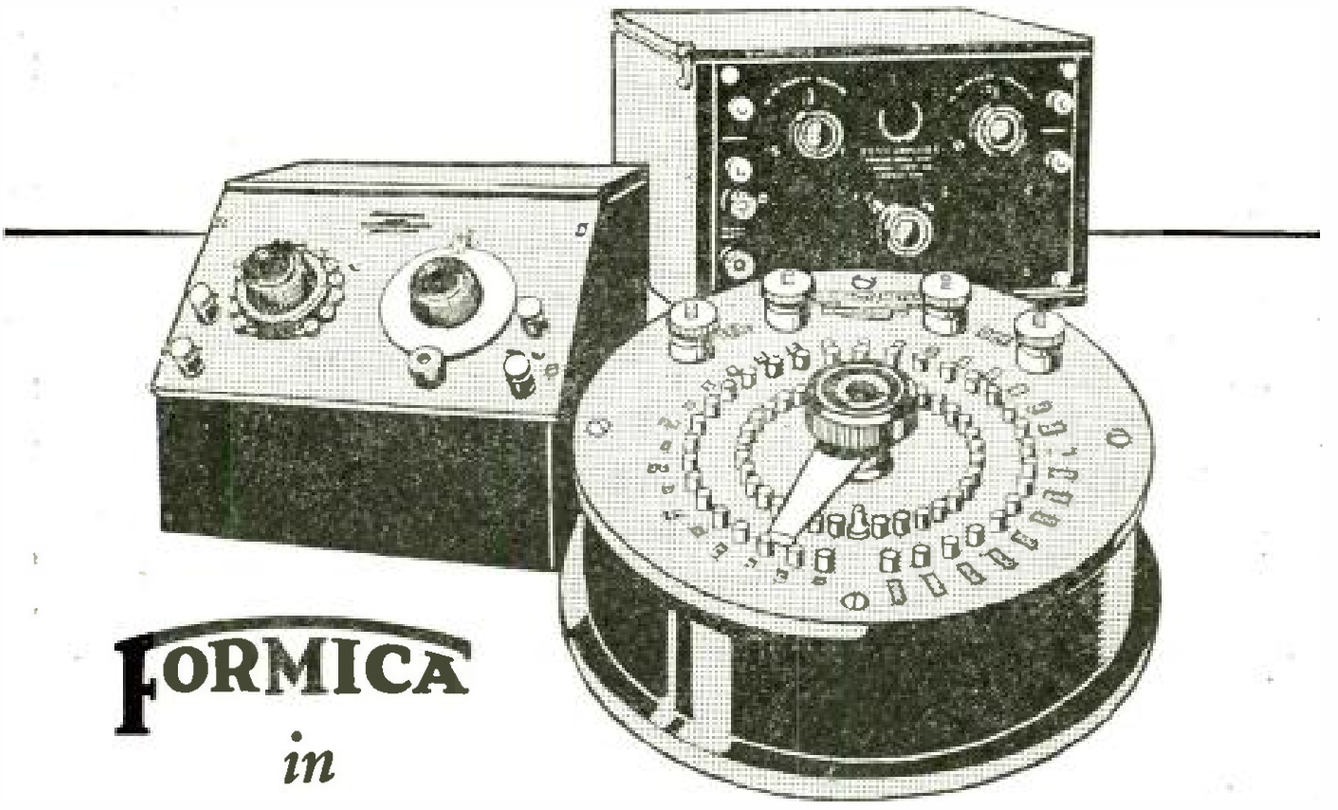
That fact has been repeatedly verified by our many other Mu-Rad dealers in the middle-west. Why not join them? Why not enjoy as they do the ***assured profits*** of good radio merchandise well advertised (see page 49 of this magazine)?

Write for a Mu-Rad Franchise

To get complete details of our special Mu-Rad proposition will not obligate you. Write also for a copy of our hand-book catalog of other profitable radio merchandise. Write today before someone else in your neighborhood gets exclusive Mu-Rad privileges.

Chicago Radio Apparatus Co.

Jobbers of Good Radio Merchandise
General Offices: 407 S. Dearborn Street, Chicago



FORMICA *in* GENERAL RADIO *Apparatus*

THE General Radio Company, makers of precision instruments for use in radio and electrical work, is one of the oldest as well as the most consistent users of Formica.

The high quality of the General Radio product is assurance to amateurs and dealers everywhere that when they use Formica insulation, they are using the best material that the market affords.

Formica service is as good as the product. It supplies promptly a panel or tube of just the size that is wanted—no need to confine yourself to so-called standard sizes that some one else wants to sell.

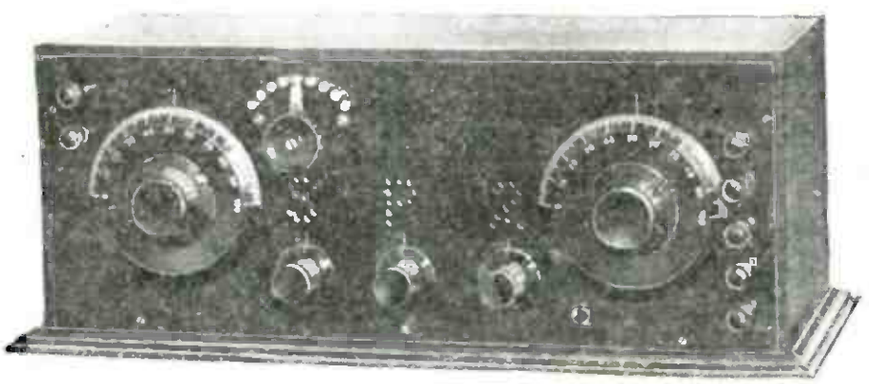
THE FORMICA INSULATION COMPANY
4641 Spring Grove Ave., Cincinnati, Ohio

SALES OFFICES

50 Church Street . . New York, N. Y.
422 First Avenue . . . Pittsburgh, Pa.
1042 Granite Bldg., Rochester, N. Y.
415 Ohio Building . . . . . Toledo, Ohio
1210 Arch Street . . . . . Philadelphia, Pa.
1819 Lyndale Ave., S. Minneapolis, Minn.
Sheldon Building . . . . San Francisco, Cal.
Whitney Central Bldg . . . . . New Orleans.
414 Finance Bldg . . . Cleveland, Ohio
9 S. Clinton Street . . . Chicago, Ill.
313 Title Building . . Baltimore, Md.
47 King Street . . . . Toronto, Ontario

FORMICA
Made from Anhydrous Redmanol Resins
SHEETS TUBES RODS

S P 2



MR. DEALER—are you looking for a receiver that will reduce your service expenses to practically nothing; will stay sold; can be sold on what it will do and not on talks about its superior circuit and incorporation of this or that; a receiving set that can be sold on an unconditional guarantee; is efficient, sound and thorough in every respect? THEN YOU ARE INTERESTED IN THE S. P. 2 RECEIVER. Your letter head will bring you our proposition in detail together with complete catalogue.

Catalogue 101 A—*A complete catalogue of radio equipment and valuable radio information mailed to the "radio fan" on receipt of 10 cents in stamps.*

PITTSBURGH RADIO SUPPLY HOUSE

963 Liberty Avenue **Pittsburgh, Pa.**

S P 2

Radio Catalogue Free—

Write us a post card—

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 set for $32.50 equalling sets at $60.00 elsewhere—a $23.50 set that under favorable conditions has a radius of 500 miles and more.

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 the house nearest you. Address Dept. 38-R

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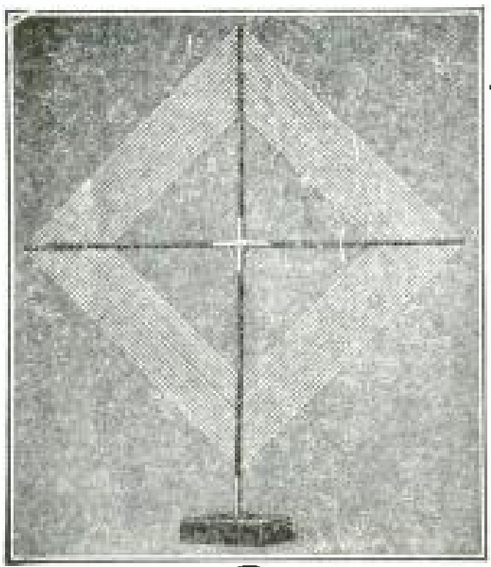
The Oldest Mail Order House is Today the Most Progressive



HARTMAN

LOOP AERIAL $10.00

Light—Substantial—Efficient—Directional
4 inch molded dial-detachable base.
Hartman loops stay taut and true.
33½ in. wide—36½ in. high—15 turns—4 in. dial.
Write for bulletins on Hartman Radio parts.
THE HARTMAN ELECTRICAL MFG. CO.
Mansfield, Ohio

"UNITED"

Radio Instruments Will Multiply the Joy of Your Radio Evenings

Our new million dollar plant with its unequalled equipment of precision tools and one staff of trained radio experts have enabled us to develop condensers and transformers which offer

1—Finer tuning, under more perfect control.

2—Clearer reception, from any distance,

3—Welcome freedom from discordant noises.

"United" Audio-frequency Amplifving Transformer Magnetically shielded, Ratio 5 to 1. Price $4.50.

"United" Variable Condensers, with new Vernier. Dial Adjuster

43 plate $6.50	5 plate $5.00
23 plate 6.00	3 plate 4.75
11 plate 5.50	Postpaid

Try your Dealer First. If he does not carry the line, remit to and give us his name and address.

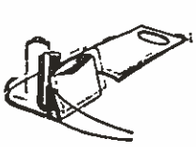
UNITED MFG. & DISTRIBUT'G CO.
9705 Cottage Grove Ave.
Chicago, Ill.
New York Office:
50 Church St., New York, N.Y.
San Francisco Office:
709 Mission St.
San Francisco, Cal.

Na-ald Special Socket
No. 499

It's the contact that counts

A careful examination will show that each contact in Na-ald sockets and adapters is of a wiping nature on a broad surface, and of sufficient tension, and so designed that tension is permanent, no matter how often the bulbs may be removed and how much the connecting prongs in the tubes vary.

It is little realized that sockets are being sold which, owing to faulty choice or control of material, develop current leakage from plate to grid that rob many otherwise well-made sets of their efficiency. Na-ald sockets in their design avoid all these troubles.



De Luxe Contact

NA-ALD SOCKETS

No. 499 Socket, 199 tubes	$0.50
No. 429, Adapter, 199 tubes	.75
No. 400, De Luxe, 200 tubes	.75
No. 401, Small Space, 200 tubes	.35
No. 411, W. D. 11 Tube	.75
No. 450, Two in One. W. D. 11 or 200 Tube	.50

Booklet with diagram of Hazeltine's Neutrodyne Circuit and other selected circuits, packed with each Na-ald product.

Na-ald De Luxe
No. 400

Alden Manufacturing Co.
Manufacturers of Sockets for Every Tube and Requirement
Dept. C 52 Willow St.
Springfield, Mass.
CABLE ADDRESS: ALDENCO

RADIO PRODUCTS NA-ALD

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static?

John A. Burrichter, 207 East Ohio Street, Indianapolis, Indiana, writes:

"My set is about ten blocks from one of the local stations and when they started broadcasting, it meant that ended everything for the evening. After your Wave Trap was installed, they were tuned out completely.

Had expected with the approach of warm weather to take down my set until next fall, but while other local 'Listeners In' are almost entirely cut off by STATIC, I am enjoying the programs just as much as in the cold months.

Have covered distances that heretofore have been impossible and really consider the Wave Trap the greatest invention since radio."

The Original Wave Filter $8.50 Prepaid

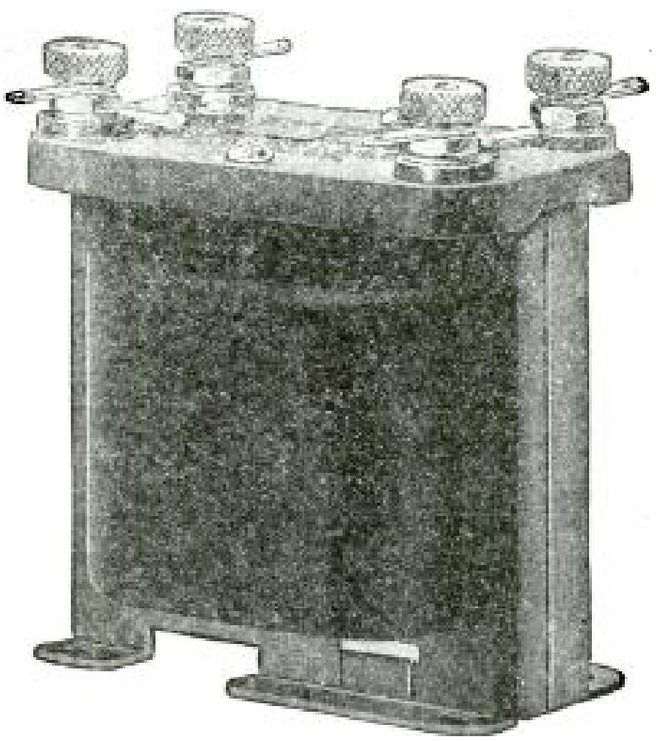
use FERBEND Wave Trap

TRADE MARK
PATENT APPLIED FOR

21 E. SOUTH WATER ST. CHICAGO

Volume! Clarity!! Delight!!!

With Correct Hook-up— Proper Inductance and Capacity —and Good Detection



You Are Assured a New and Better Amplification— Maximum Volume— Minimum Distortion

With Kellogg Shielded Type Transformers

Correct audio frequency amplification is important in the satisfactory operation of loud speakers. Proper amplification [with KELLOGG transformers] results in a clear reproduction with minimum distortion and maximum volume.

Kellogg transformers are designed to overcome any defects of existing types and to furnish the very best of amplification.

They are built complete by the Kellogg Company, using magnet wire with the very best insulation, and of exactly the correct number of turns. The metal case is heavily enameled in maroon with a Kellogg Bakelite connecting rack. The laminated cores of silicon steel are correctly proportioned and shaped for the most effective electrical field.

The primary and secondary binding posts are accessibly placed at the top of the transformers, and clearly marked so that there need be no error in connection.

Every Kellogg transformer is thoroughly tested before leaving our plant and we guarantee the purchaser a product of exceptional efficiency.

No. 501—Ratio 4½ to 1—$4.50 each
No. 502—Ratio 3 to 1— 4.50 each

Kellogg Switchboard & Supply Company

Adams and Aberdeen Streets · Chicago

"How I Located My Trouble"

A Massachusetts radio enthusiast tells of a happy discovery that finally solved his difficulties.

"I COULDN'T figure out what was wrong with my radio set," states a Fitchburg business man whose experience is interesting because it shows how one simple little adjustment will sometimes make such an amazing improvement in results.

"I had erected my antenna in just the right way, had connected up my different parts with the greatest care, had added improvements that were designed to bring my apparatus to the highest possible perfection," he continues.

"I spent a good many hours talking over my problems with dealers and experts. I followed one suggestion after another. But still the same old trouble!"

Do You Have This Trouble?

"In spite of all my efforts, when I wanted to hear some particularly interesting broadcasting program, other stations kept breaking in; I found difficulty in getting long distance points; and intermittent squeals, whistles and howls would persist, no matter how I tuned or adjusted my dials.

"I was pretty nearly convinced I'd have to get some high-priced installation man to come out to my home and set me right, when purely by chance I happened to pick up a copy of POPULAR RADIO—and thumbing through its pages I found the very answer to my problems!

"There in black and white, diagrammed and explained, was a simple, practical suggestion that turned the trick for me."

The One Best Way to Get Results

Many other radio enthusiasts, too, who want to get the **most** out of their sets have found in POPULAR RADIO many an idea and practical suggestion that has made a world of difference in their enjoyment of this fascinating pastime, and saved them hours of experiment and costly error.

If you don't already *subscribe* to POPULAR RADIO, don't miss this opportunity of getting the magazine regularly at your permanent address.

By subscribing now, you save a dollar. POPULAR RADIO soon goes to $3 a year, so if you act promptly you get a year's subscription for only $2.

Your Questions Answered *FREE!*

Then, too, as a regular subscriber, any questions you wish to ask of the Technical Editor will be answered **free of charge.** This is one of the most valuable features of POPULAR RADIO's service, and is the same service for which non-subscribers pay 50 cents for each question asked, and they say it's worth many times what they pay. *Yet you can get this same added service absolutely free.*

The Coupon Entitles You to This Service

Simply fill out and mail the attached coupon today and your subscription will start with the very next issue. If you have some problem to put up to our Technical Editor now, send in your question with the coupon and he will be glad to straighten you out. This is a privilege to which all subscribers are entitled, and we want you to take full advantage of it.

But do not delay sending in your subscription. Get POPULAR RADIO regularly each month and don't risk missing any of its scores of helpful and practical suggestions.

POPULAR RADIO, Dept. 93,
9 East 40th Street, New York City

Please put me down for a year's subscription to POPULAR RADIO, beginning with the October issue. I am enclosing $2 in full payment which also entitles me to free use of your Question and Answer Department for a full year.

Name .....

Address .....

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RA *(No extra for Canada. Foreign countries 25 cents postage extra.)*

MU-RAD RECEIVERS

The Ultimate in Radio Reception

To bring the news of the Greek victory over the Persians at Marathon a runner was dispatched to Athens, 24.85 miles away. Reaching the market place, he cried out, "Rejoice, we conquer!" and fell dead.

The New Star in the Radio World

EVERY ADVANCE of civilization has depended upon the progress of communication. From the Athenian runner, to the instantaneous transmission of intelligence by radio is a triumph of science. As one Athenian runner was preferred over another for speed and accuracy, so today MU-RAD Receivers are chosen for the most perfect reception of radio broadcasting. Four thousand miles and more are spanned with delightful ease by the MU-RAD Receiver. Uses only a two-foot loop aerial. Utmost efficiency with utter simplicity. Guaranteed conservatively for 1000 miles reception. *Be satisfied with nothing less than the ultimate attainment of the radio science — a Mu-Rad Receiver.*

WRITE FOR LITERATURE

MU-RAD LABORATORIES, INC.

809 FIFTH AVE. ASBURY PARK, NEW JERSEY

A Great Money-Saving Opportunity!

Glance over this big list of magazine clubbing offers that POPULAR RADIO has arranged for your benefit. Here is your chance to get almost any magazine you want—and by ordering now with a year's subscription to POPULAR RADIO you get *both* magazines at rock bottom prices that cannot be duplicated later on.

FOR a limited time only, we offer this broad selection of leading magazines at very special bargain prices with a year's subscription to POPULAR RADIO.

If you are already a subscriber to POPULAR RADIO, these special club offers allow you the privilege of renewing or extending your subscription at a great saving of money. . If you are not already a subscriber, don't delay taking advantage of this opportunity to get POPULAR RADIO and *your choice* of these other leading magazines at *greatly reduced prices.*

As announced on the "Pages with the Editor" of this issue, the subscription price of POPULAR RADIO will soon be advanced from $2 to $3 a year. Yet all of these magazine combinations are figured at a price for *each* magazine far lower than even the present subscription prices.

There is hardly a home where one of these magazines does not already bring pleasure and profit to *some* member of the household. The magazine requirements of your whole family for the coming year can be taken care of *now*, by simply checking the club offer you want and mailing the coupon to us with your remittance.

But do not delay. Our special arrangement with these other publishers is for a few weeks only. After that, the prices on these clubs will be advanced. And by acting *now* you safeguard yourself, in addition, against POPULAR RADIO's raise in price, which will soon be effective.

POPULAR RADIO, Dept. 91,
9 East 40th Street, New York City.

Enclosed is $..... Please see that yearly subscriptions are at once entered in my name for each of the magazines I have checked in the special bargain club list at the right.

Name.....

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Your Favorite Magazines at Lowest Bargain Prices!

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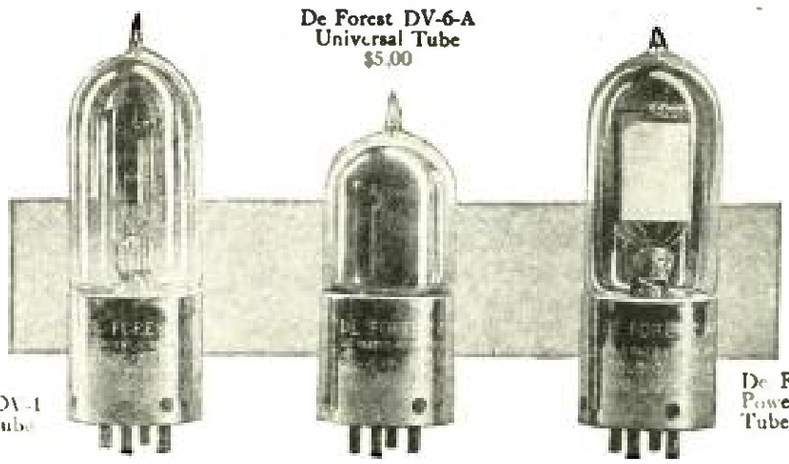


De Forest DV-6-A
Universal Tube
$5.00

De Forest DV-1
Dry Cell Tube
$6.50

De Forest DV-2
Power Amplifier
Tube (wet cell)
$6.50

The More You Know About Radio the More You Rely on De Forest

Without Lee De Forest's discovery of the vacuum tube there would be no radio today. All radio broadcasting, all radio receiving by means of tube sets, rests on De Forest patents.

De Forest has been a pioneer in radio since 1900 and De Forest is a pioneer today. That is the reason for the great success of the De Forest Reflex Radiophone. That is the reason for the success of the new De Forest tubes—DV-1 Dry Cell Tube, DV-6-A Universal Tube, DV-2 Wet Cell Power Amplifier Tube.

If you want a radio receiving set with a range on indoor loop of from 1,500 to 3,000 miles, depending on atmospheric conditions; if you want simplicity of control, clear reception without distortion and without extraneous noise; if you want operation on either wet or dry cells—see the De Forest Reflex Radiophones at the De Forest agent's today.

The D-7-A Reflex Radiophone is a three-tube set at $125.00; the D-10 Portable Reflex has a drawer in its cabinet for dry batteries and is a four-tube set at $150.00. No matter what you pay, you can't get greater radio satisfaction.

Whether you buy your set complete, or build your own from the laboratory tested De Forest parts, you can rely on De Forest, the greatest name in Radio.

De Forest Radio Tel. & Tel. Co.

Dept. P, Jersey City, N. J.
Western Sales Division
5680-12th Street, Detroit, Mich

De Forest Portable Reflex Radiophone type D-10, which operates on wet or dry cells, has a reception range of from 1,500 to 3,000 miles on indoor loop; has drawer for all necessary A and B dry cells. Price $150.00.

Radio Catalogs Free

Send a postcard for De Forest's Free Radio Catalog with full details and prices on sets, tubes, and parts.

De Forest products are sold only through exclusive agents, direct to the public for your protection. The De Forest Company will be glad to hear from representative men in various communities who wish to become exclusive De Forest agents.

Something New in Radio

Hear Your Local Concert Perfectly Through a LOUD SPEAKER With This One Tube Set, Operated By Dry Cells

Etherphone
The SUPER SENSITIVE RADIO RECEIVER

The latest development in the radio field. An instrument with all the advantages of multi-tube sets, requiring but a single UV-201 Tube, operated by dry cells; giving the perfection of reproduction heretofore only obtainable in the simple crystal sets. **GUARANTEES RECEPTION OF FROM 20 TO 30 MILES THROUGH A LOUD SPEAKER. STATIONS FROM 200 TO 800 MILES AWAY CAN BE HEARD CLEARLY THROUGH A HEADSET.** In it the tube does double duty, first amplifying the incoming signals at radio frequencies, after which they are rectified, or detected, by a sensitive crystal, and then passed back through the same tube at audio frequencies. Wonderfully compact, simple to operate and offered at a price much lower than that of multi-bulb sets.

Price of Instrument Alone **$45**

Price Complete Including Loud Speaker Ready to Listen in **$75**

DEALERS

Write for attractive proposition.

ECONOMY Four ordinary dry cells will give service of 100 to 125 hours. Or three or four blocks of B batteries will last six months or a year.

RANGE In tests we have consistently heard (during summer months) Stations: WLAG—Minneapolis; WMC—Memphis; WDAP—Chicago; WOC—Davenport; WGY—Schenectady, and frequently WBAP—Fort Worth; WFAA—Dallas; WSB—Atlanta.

VOLUME Equals that of a two or three tube set, easily operating a loud speaker on local broadcasts and at times on distant reception.

TONE QUALITY Attains perfection owing to the clearness obtained through its crystal detector.

PORTABILITY Easily carried when touring or camping; also ideal for use on a boat.

Write for Descriptive Folder. For Sale by Reputable Dealers, or if Not Carried in Stock, can be Ordered Direct from the—

Radio Apparatus Co.
40 West Montcalm St.
Detroit, Michigan

Carries Great Messages Around the World

THAT statement adequately expresses what is perhaps the greatest influence of radio in developing and bettering human fraternal interest, not only between the people of one community, of one country, of one state, or even a single nation, but between all nations and all peoples of the world.

Be these messages from government leaders—from the heads of the world's greatest educational institutions or from those who stand foremost in the arts of the world—they will serve to bring the human race into closer contact.

In the past ages great orators and writers, famous poets and musicians have swayed the destinies of nations, and have been instrumental in the rise and downfall of mighty empires.

In the future these same influences of similar great minds will, through radio, create a better understanding and a greater fraternal spirit between the people of the nations.

It is the vacuum tube that has made possible this broad and far reaching application of radio telephony, and that plays the most important part in the operation of your receiving set.

Cunningham Vacuum Tubes, standard for all makes of receiving sets—built by one of the world's largest manufacturers with unlimited resources—are the product of years of manufacturing experience and the creative genius of the engineers of that great scientific organization, the Research Laboratory of the General Electric Company.

Cunningham Radio Tubes

C-301A—6 Volts ¼ amp Amplifier	$6.50
C-299 —3 Volts .06 amp. Dry Battery Det. and Amp.	$6.50
C-300 —6 Volts Gas Content Detector	$5.00
C. 11 —1.1 Volts .25 amp. Dry Battery Det. and Amp.	$6.50
Special Base	
C- 12 —Similar to C-11 with standard base	$6.50

Patent Notice: *Cunningham tubes are covered by patents dated* 11-7-05, 1-15-07, 2-18-08, *and others issued and pending. Licensed for amateur, experimental and entertainment use in radio communication. Any other use will be an infringement.*

CUNNINGHAM
National
Tube Week

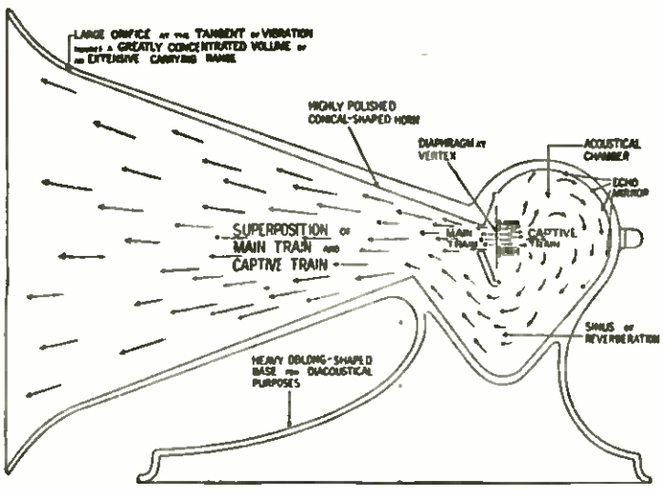
September 24 to October 1, 1923

E. T. Cunningham Inc.

Home Office
248 First Street
San Francisco, Cal.

154 West Lake Street
Chicago, Ill.

30 Church Street
New York City, N. Y.



ECHO-TONE

GIVES FIBRE NEEDLE TONE TO THE RADIO PHONE

A REAL PORTABLE LOUDSPEAKER

Unaffected by Climatic Conditions

NO PART TO BREAK OR JAR OFF

IDEAL FOR

Vacation, Outing or Travel

NO PULP to Crumble
NO WOOD to Warp
NO TIN to Bend

But

CASTED ALUMINUM for DURABILITY

Now Equipped With
A TONE REGULATOR

Retail Price $35.00

WILLIAMS RADIO COMPANY

Radio Tone Specialists

1438 Washington Blvd., Detroit, Mich.

GIVE YOUR EARS A TREAT!—USE

"RED-HEADS"

3000 Ohms

With Military Head-Band and Cord

Now $6.50

At your dealers or direct on receipt of price.

A Triumph in Radio Receiver Design

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Newman-Stern Building
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BARKELEW

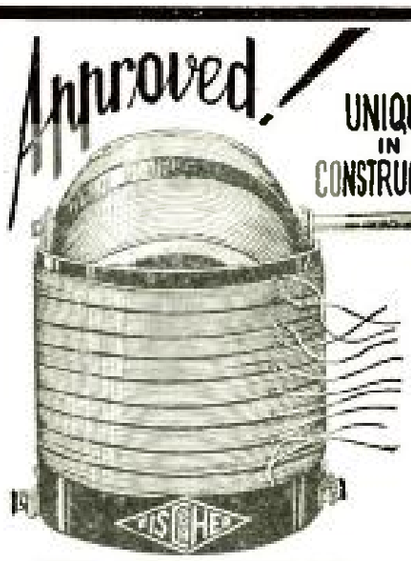
FOUR-PHONE PLUG

for

STANDARD JACKS

The BARKELEW ELEC. MFG. CO.

MIDDLETOWN, OHIO.



THE CENTICOUPLER

Approved by every Radio Fan from the Technical Wizard to the Woolworth Shopper

Approved because it is scientifically unique in construction, because it makes a 1000 meters with ease, because it has a genuine bakelite stator and a kiln dried rotor, because it is bank wound, because each tap eats up its 100 meters neatly, because—but why write history? See for yourself.

Get One for $5

20 Diagrams with Each Instrument FREE

For sale at your dealer—otherwise send the $5 directly to the manufacturer and you will be supplied at once postpaid

G. H. FISCHER & CO.

123 Liberty Street
New York City

POSITIVE RESULTS

are being obtained by thousands of satisfied users of the

EASTERN COIL SETS

for the

COCKADAY CIRCUIT

The remarkable features which are making this circuit more popular each day are its simplicity of construction and control—wonderful selectivity—distance records—clearness and loudness of reception, and the fact that all capacity squealing, interference, etc., are eliminated.

Made as per specifications of Mr. Cockaday, using No. 18 wire with D coil bank-wound.

COMPLETE SET OF B, C AND D COILS—PRICE..... $2.75

Hook-up directions and material list furnished free with each set of coils.

Mail Orders Filled. Dealers Communicate

EASTERN RADIO MFG. CO.
22 Warren Street, Dept. PR New York, N. Y.

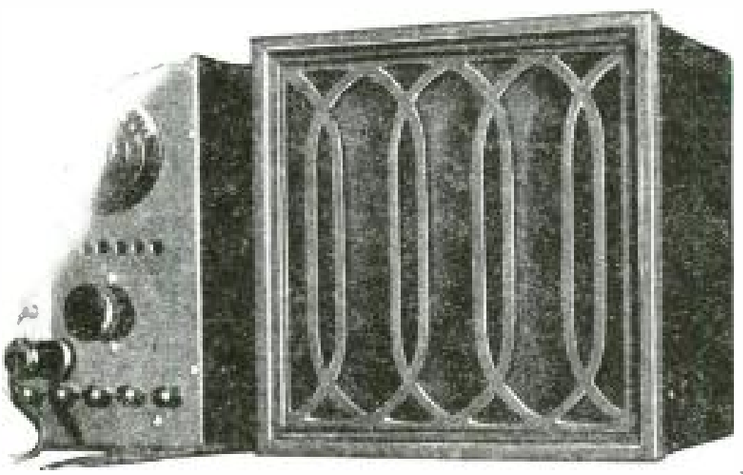
Let Radio Experts Buy for You

This Service Is Free

Why hunt from store to store? Save time, trouble and money—a group of Radio Experts in New York will act as your *personal representative*, buy for you any standard make of radio equipment you want, from the smallest part to a complete set, either assembled or unassembled, and deliver it to you prepaid—all for less than if you did your own buying. Satisfaction guaranteed. Also disinterested advice on all radio problems—free. Write for plan.

PERSONAL SERVICE PURCHASING BUREAU
505 Fifth Ave., Desk 12, New York

The new Timmons Talker with stationary magnet. The Gothic scroll design is the same as the adjustable type. Price $25.



A New Timmons Talker—With Stationary Magnet

—*the adjustable type, too, has been made even better*

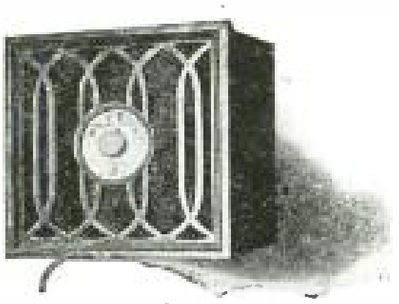
Both Timmons Talkers are built around the principle of reflected tone—a scientific method of amplifying and then reamplifying music or the voice so that volume is attained without losing any of the fullness or roundness of either, and without forcing tubes.

Reflected tone requires two horns. These are hidden from view behind a finely executed design of mahogany-finish Gothic scroll.

We make both horns of metal and coat them with a substance developed in our own laboratories.

We would really save money by using wooden horns. However, metal horns finished with this newly developed coating have a naturalness and richness which no wooden horn could ever equal.

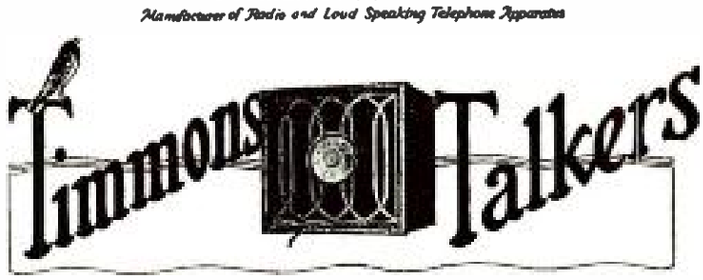
—But let your dealer show you a Timmons Talker. He'll be glad to demonstrate both stationary and adjustable types. Also ask him for the Timmons Talker folder, "Volume Without Noise." If for any reason he does not have any of these folders handy, we'll send one at once.



The adjustable type which now has a grill of Gothic scroll design backed by a screen of light gold color. Price $35.

Note in the illustration how the lines of Timmons Talkers are in harmony with those of all radio sets—there's no jarring conflict of shapes.

J. S. TIMMONS
339 East Tulpehocken St.
Germantown, Phila., Pa.
Manufacturer of Radio and Loud Speaking Telephone Apparatus



A Bigger, *Better* "Popular Radio" for Our Friends and Subscribers

—yet it will come to you without extra cost if you act at once!

TO our big family of POPULAR RADIO readers the addition of 56 more pages of reading matter in the November issue will be mighty welcome news.

For several months past, a great store of timely and interesting articles have been piling up on the Editor's desk. There wasn't sufficient space to run them all—practical hints for the radio amateur; helpful suggestions on how to get the most out of *all types of sets;* understandable articles by distinguished scientists written exclusively for POPULAR RADIO; questions, answers; hook-ups that work; thrilling stories and personal experiences filled with romance and adventure—just the kind of "live stuff" that has made this magazine so popular with our half a million enthusiastic readers.

So there is only one thing to do. We must increase the thickness of the magazine! Now there will be no space limitations to prevent getting these articles quickly to our readers. "Month by month POPULAR RADIO is growing bigger and bigger."

The Same POPULAR RADIO *—only more of it!*

You'll be tickled with POPULAR RADIO these coming months. The same helpful, practical, interesting articles will continue. There will be more of them. New departments will be added. Don't take a chance on missing any of these bigger, better issues. Become a regular subscriber and get the magazine each month at your home.

Although the price of POPULAR RADIO will soon advance to 25 cents on the newsstands and $3 a year, you can still get a full year's subscription, 12 issues, for only $2.00. But this offer is open for a short time only. Act at once!

Save Money by Acting *NOW*

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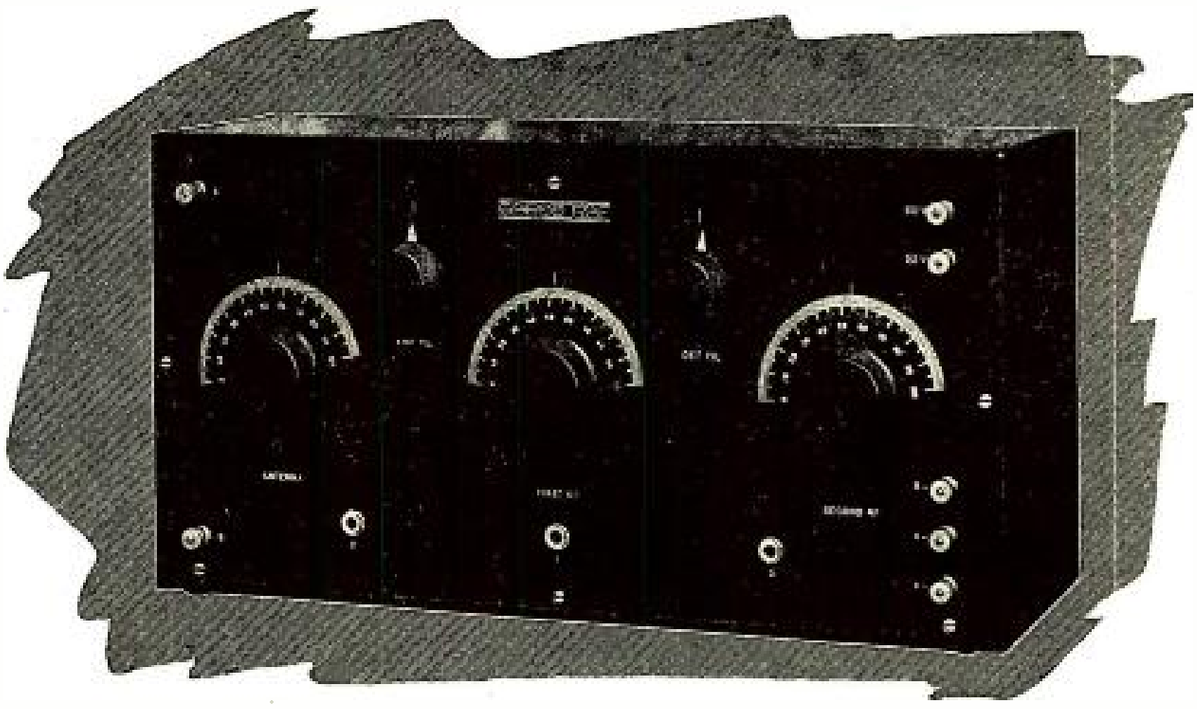

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—Harnessing waves to wire.
—How to make and install your own Receiving Set.
—How to tune a Regenerating Receiver.
—Symbols that help in reading diagrams.
—How to make soldered connections.
—How Radio waves are sent and received.

June, 1922

—Wireless that we can see.
—Can we talk to the dead by Radio?
—How to use your Radio Set in summer.
—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.
—How to use your Phonograph as a loud speaker.

August, 1922

—How machines are controlled by Radio.
—How Radio circuits are coupled and tuned.
—What "call letters" mean.
—Radio on your pleasure boat.
—How to make a variable condenser.
—The foolish fear of lightning.

September, 1922

—How to build the Armstrong Circuit Receiver.
—How the Vacuum Tube works.
—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 the crystal detector detects.
—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.
—Tricks with high frequency electric current.
—The most popular transmitting aerial.
—Right and wrong ways of adjusting the Regenerative Receiver.
—How to make a novel variocoupler.

December, 1922

—Radio on your motor car.
—How to select the best coil for your set.
—How to make and use a loading coil.
—How the Vacuum Tube detects.
—A Receiving Set that takes notes.
—How to make a series-antenna condenser.

January, 1923

(This issue, in which appeared Mr. Cockaday's full description of his "DX" Regenerative Receiver is completely exhausted. A circuit diagram of this 3-Circuit Tuner is found, however, in the Question and Answer Department of the April issue, 1923.)

February, 1923

—20 tips on tuning.
—The Hoffman measurement charts.
—Shall I use a "hard" or "soft" tube?
—A novel tuner for shutting out interference.
—How the Audio-frequency amplifier works.
—Pointers on aerials.
—How to add an Audio-frequency amplifier.

March, 1923

—Making moving pictures talk.
—A Receiver without batteries.
—What really guides Radio waves.
—How to get the greatest efficiency out of your Radio circuits.
—How to make a one or two-step Audio-frequency Amplifier.
—How to make a Multi-Layer Coil.

April, 1923

—Ether waves and the Einstein Theory.
—How to use Regeneration without Radiation.
—How to make a crystal detector from a spool.
—How the Vacuum Tube detects and rectifies.
—How to make a simple single tube Receiving Set.

May, 1923

(This issue, in which appeared Mr. Cockaday's description of his 4-Circuit Tuner, is completely exhausted. A diagram of the circuit adapted for use with dry-cell tubes is shown, however, on pages 164 and 165 of the August issue, 1923, which can be supplied.)

June, 1923

—How to use your Radio Set on your vacation.
—How the microphone transmitter works.
—How to build a good single tube receiver.
—How to make a crystal detector stand.
—How to determine the constants of your antenna.

July, 1923

—How to install your Radio Set on your boat.
—The ratio in size between your antenna and your coil.
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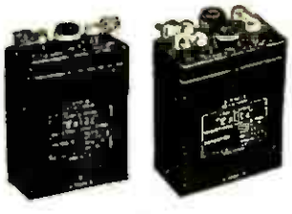

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