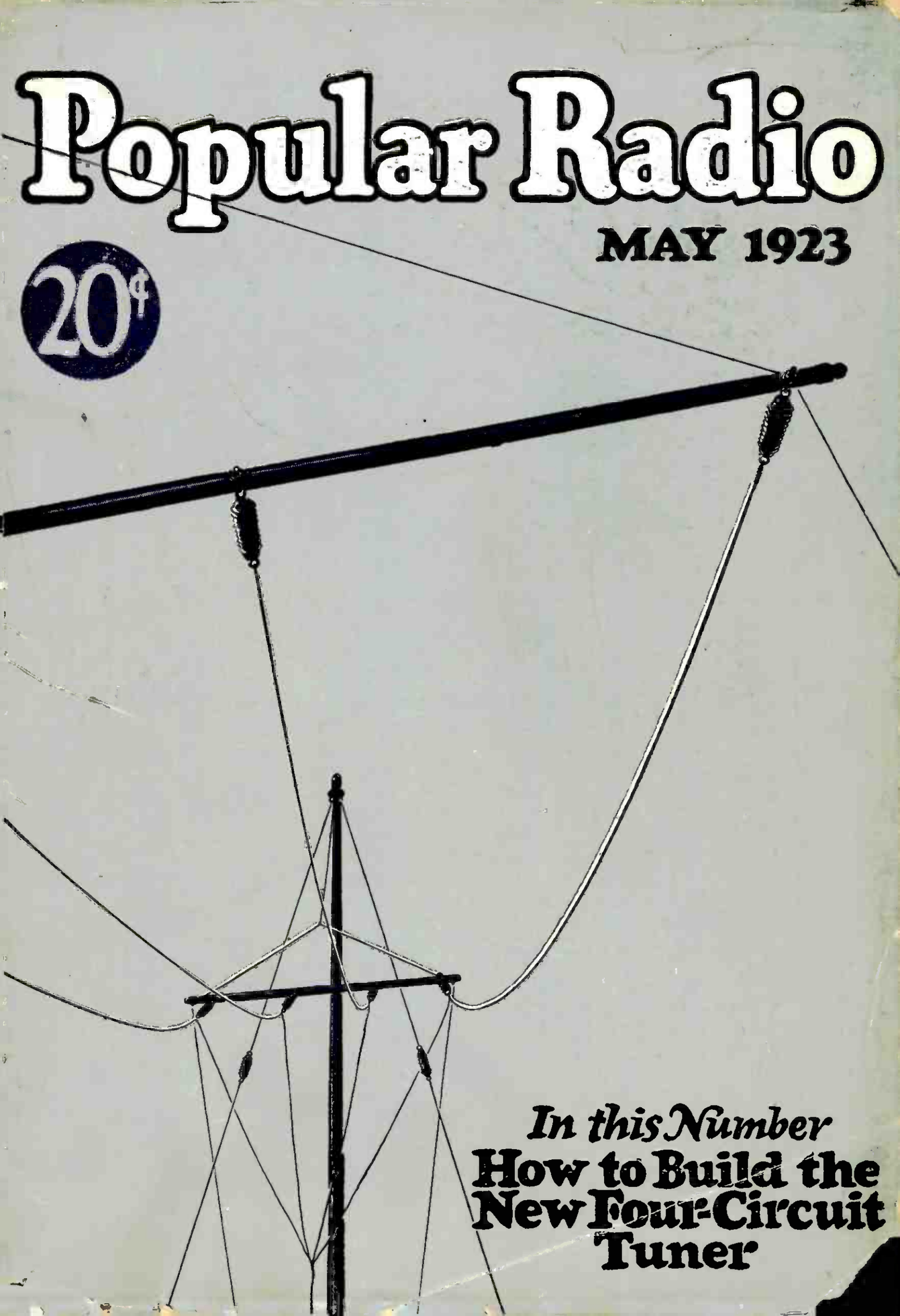
Popular Radio

MAY 1923

20¢



In this Number

How to Build the New Four-Circuit Tuner

Brandes

—Used by over 500,000

THE so-called amateur in radio is, in fact, an expert. Experimenting is the very breath of life to him. When it comes to the radio headset, however, you can't experiment. The headset requires precisional manufacture in every detail and painstaking study of acoustics to assure the matched tone quality in both receivers. A Brandes *Matched Tone* Headset can be depended upon as a basic requirement of successful experiment in getting radio from near and far distances.

¶ Send ten cents in stamps for the "Beginner's Book of Radio." It explains radio in terms that anyone can understand.

Distributors in Australia and New Zealand: International Electric Co., Wellington, N. Z.
Made in Canada and England by Canadian Brandes, Limited, Toronto and London.
Distributed in Canada by Perkins Electric, Limited, Toronto—MONTREAL—Winnipeg.

C. Brandes, Inc., 237 Lafayette St., N. Y. C.

Matched Tone

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

Radio Headsets

Dept. P.R.

POPULAR RADIO

EDITED *by* KENDALL BANNING

CONTENTS *for* MAY, 1923

(Cover design by Frank B. Masters)

VOLUME III NUMBER 5

DEPARTMENTS

VOLUME III MAY, 1923 NUMBER 5

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; Harvey Fisk, 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 $2.50 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.

Printed in U. S. A.

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

A Page with the Editor

EACH TECHNICAL QUESTION THAT WE ANSWER COSTS US 88 CENTS

Here is a picture of our Technical Editor, Laurence M. Cockaday (left) and his newest assistant, Albert G. Craig, studying some of the hundreds of inquiries that pour in from our subscribers. If YOUR *inquiry is somewhere in this pile, you will now understand why it is not answered by return mail.* BUT IT WILL BE ANSWERED!

WITH this issue POPULAR RADIO celebrates its first birthday.

* * *

DURING its eventful first year it has grown in bulk exactly 100 percent. Its advertising patronage has grown 785 percent. And its circulation has grown from nothing to somewhere about 100,000 copies a month—which represents a percentage so high that the Editor does not know exactly how to compute it!

* * *

GRATIFYING as is this remarkable evidence of material success—a success that has been made possible only by the friendly advice and co-operation of radio fans throughout the country—nevertheless the Editor is equally if not more concerned with the position of authority which POPULAR RADIO has attained in the world of science. How do the world's greatest scientists look upon us?

* * *

THE most conclusive answer may be found in POPULAR RADIO'S list of contributors—probably the most distinguished group of scientists ever assembled in any one magazine in so short a period. The list speaks for itself:

Sir Oliver Lodge, Guglielmo Marconi, Prof. James A. Fleming, Dr. Lee De Forest, General George O. Squier, Dr. Charles P. Steinmetz, Dr. Elihu Thomson, Dr. Henry Smith Williams, Prof. J. H. Morecroft, John V. L. Hogan, Paul Godley, Laurence M. Cockaday, Hudson Maxim, Dr. E. E. Free, Hiram P. Maxim, Nikola Tesla, Edwin H. Armstrong, Dr. Henry D. Hubbard, Dr. E. E. Slosson, Waldemar Kaempffert, John Hays Hammond, Jr.—to mention those that first come to mind.

And among its contributors of non-scientific articles are numbered authors whose names are known to magazine readers throughout the world.

* * *

To its rapidly growing number of subscribers, contributors and advertisers, whose essentially practical endorsement of the magazine has made its success possible, the Editor extends not merely thanks but congratulations.

* * *

AGAIN the flood of questions submitted to our Technical Editor by our readers is getting beyond control. Gratifying as this evidence is of the value of our Technical Editor's advice, nevertheless the accumulating mail is presenting a serious problem. How can the Technical Editor answer it all?

* * *

WE are answering *this* question in part by adding to our technical staff another radio expert, Mr. Albert G. Craig, with whom many of our readers are already acquainted. Mr. Craig graduated from Purdue University as an electrical engineer, and has had wide experience in important research laboratories. He is a member of the A. I. E. E., and a contributor to radio textbooks here and abroad.

* * *

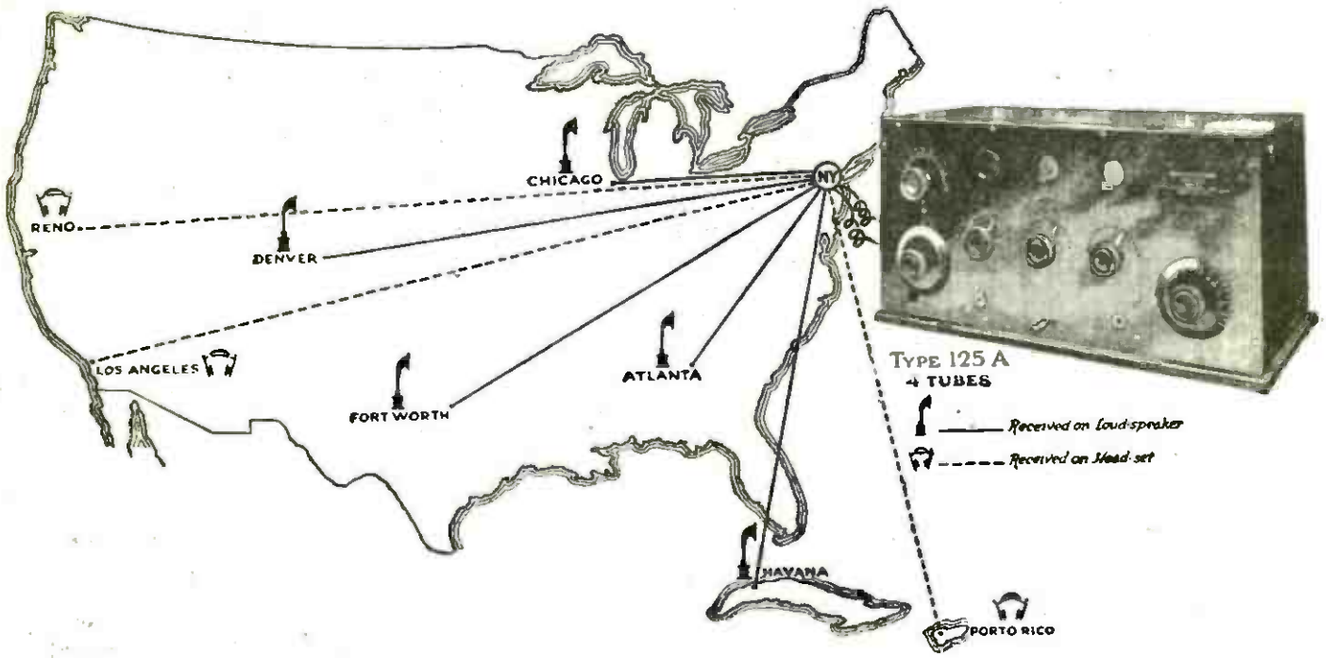
Don't put aside your radio set just because summer is near! In the next issue we will tell you how to use your set on your vacation—and give you specific, practical information on the subject, together with actual hook-up diagrams and photographs of successful installations.

Kendall Banning

Editor, POPULAR RADIO

CARDWELL PRODUCTS

Quality Radio Apparatus



Distance—Selectivity—Ease of Adjustment

CARDWELL RADIO APPARATUS is being used by the United States Navy, United States Signal Corps, and Bureau of Standards. The same rigid rules of manufacture and inspection are enforced in the production of amateur apparatus as in our Government and commercial work.

Cardwell Products include

Receiving Sets	**Transformers—Audio**
Amplifiers	**Transformers—Radio**
Condensers	**Couplers**

Descriptive Catalogue Mailed on Request.

—THE IDEAL RADIO FREQUENCY HOOK-UP—

This will be sent free of charge to those who wish to build an exceptionally fine set. An exceptionally good hook-up embodying long range and selectivity.

OUR INSTRUMENTS STAY SOLD

The Allen D. Cardwell Manufacturing Corp.

81 Prospect Street **BROOKLYN, N. Y.**

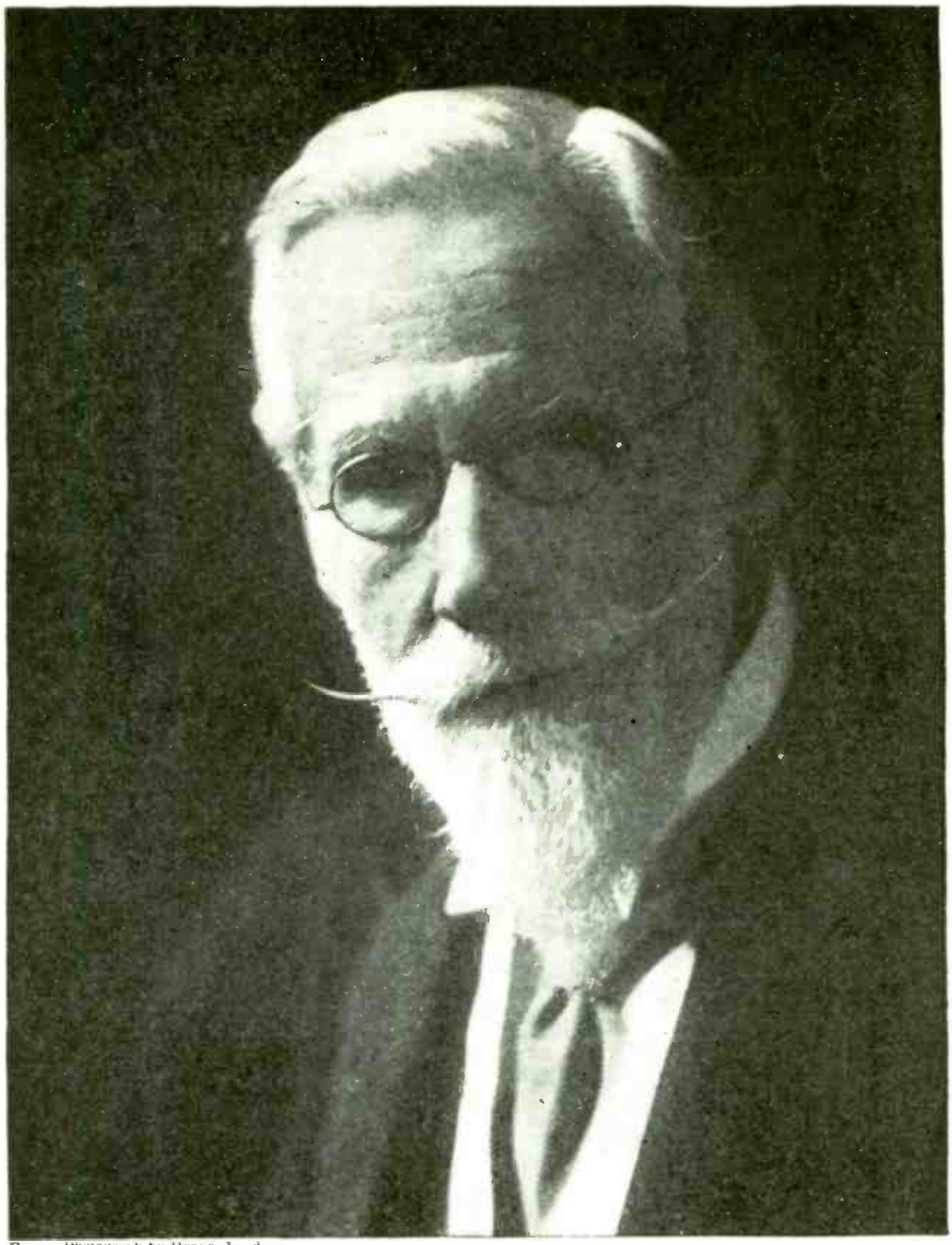
Underwood & Underwood

RADIO WILL HELP THE CHURCH

"THERE is, I know, a good deal of controversy as to just what effect radio is having or will have on church attendance. Judging from such letters as come to my desk from our invisible audience, I am led to believe that the effect will be favorable rather than unfavorable to church attendance."

A. Edwin Keigwin

PASTOR, WEST END CHURCH, NEW YORK



From a Photograph by Hoppe, London

The First Man to Create a Stream of Electrons in a Vacuum Tube

While Sir William Crookes *was experimenting with his own invention, the Crookes tube, in 1876 he noticed for the first time a glow discharge that "flew away from the cathode in radial lines." His investigations of this phenomenon led to the discovery of the X-ray by Roëntgen in 1895 and ultimately to the acceptance of the electron theory by scientists throughout the world.*

Popular Radio

VOLUME III MAY, 1923 NUMBER 5

Thoughts *that* Shake the Ether

Radio signals never come to an end. Scientifically, they go on forever. So does every physical and mental impulse that we create. Ether makes us, in fact, immortal—as this article by a distinguished inventor points out with startling vividness.

By HUDSON MAXIM, DS.C., LL.D.

THE most marvelous and the most mysterious thing in the universe, so far as man can conceive it, is the ether. From the ether all the worlds have been quarried and from the ether all life has sprung. The commandeering of the ether in the radio service is a thing so wonderful and so masterful as to make the ghosts gaze.

If, in telephoning by wireless from New York to San Francisco, the voice should travel at merely the speed of sound, more than four hours would be required for the first word to reach the ear of the listener; whereas, by radio, the voice is transmitted at the speed of light, (186,000 miles a second) so that there is no appreciable lapse of time in the transmission of the voice to any distance on the earth's surface.

If, however, it were possible to establish radio communication with the nearest fixed star, *Alpha Centauri,* it would take four years, even by radio speech, to cross the gap. With merely the speed of sound, it would take four million years for speech to reach the Centaur.

If one of our amateurs should pick up a radio message sent out to us from some planet that is circling a sun on the far frontiers of the Milky Way, he would know that the sender of the message lived and died more than twenty-five thousand years ago, and that the message had been on the way all that time—and this, too, coming at the speed of light. For the light by which we see such a star left there 25,000 years ago, when the Cro-Magnons inhabited Europe, along with the saber-toothed tiger, the hairy mammoth, and the wooly rhino-

ceros. From that time twenty thousand years had to pass before Egypt appeared on the far horizon of history. Babylon, Greece, Rome, also rose and fell during the five thousand years more before the message would reach the inhabitants of the earth, and also before the inhabitants of the earth would have the skill and knowledge to receive the message, and, perhaps, to translate it.

Time-honored sound is slow-paced compared with the speed of ether waves; still sound, too, has its marvels.

For example, on a quiet summer evening, one with keen ears can hear a katydid half a mile away. This means that that little insect, by rubbing its legs and wings together, is able to shake a cubic mile of air.

How much does a cubic mile of air weigh? Does it weigh a hundred pounds, a thousand pounds, or several tons? What do you think?

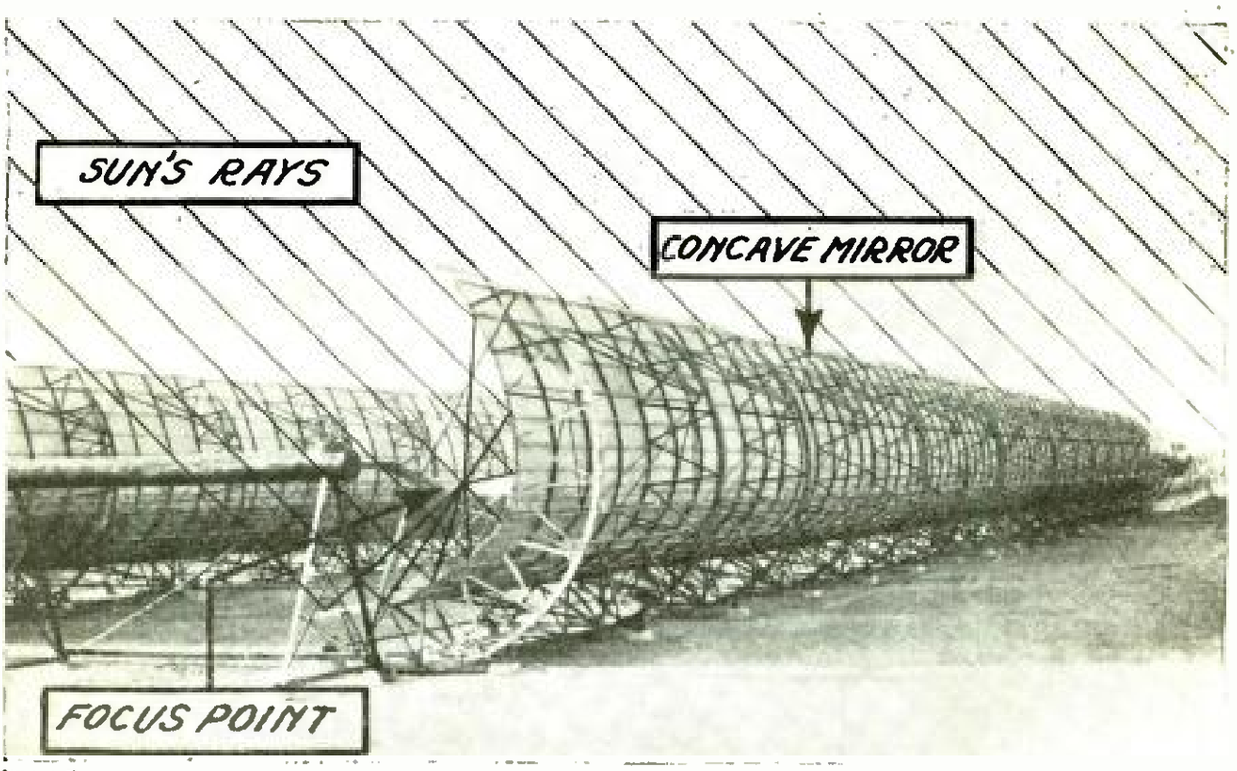
A cubic mile of air weighs more than six million tons—and that little katydid sets all that six million tons of air in rapid vibration!

A little chick-a-dee with its song thinks nothing of shaking up six million tons of air!

The ether about us is in a constant state of vibration of inconceivable intensity, but the ether of space fills up the gaps between the atoms of our body and so the vibrations pass through the space we occupy as freely as though it were a vacuum and, consequently, we are unconscious of the presence of them.

It would require a solid steel cable with a diameter equal to our earth, and having a tensile strength of 80,000 pounds to the square inch of cross section, to tether the earth to the sun, as the ether does by the force of gravitation.

Dr. Charles F. Brush, the great electrical inventor, of Cleveland, Ohio, has made some important discoveries upon the subject of gravitation. He has made some determinations, for example, which



Brown Bros.

HOW HEAT FROM THE SUN IS MADE TO RUN AN ENGINE

By means of these massive concave mirrors, the solar rays are concentrated upon a pipe that contains water; the heat thus obtained furnishes sufficient power to operate a low-compression engine. The "furnace" of its power plant is, in reality 96,000,000 miles away!

Brown Bros.

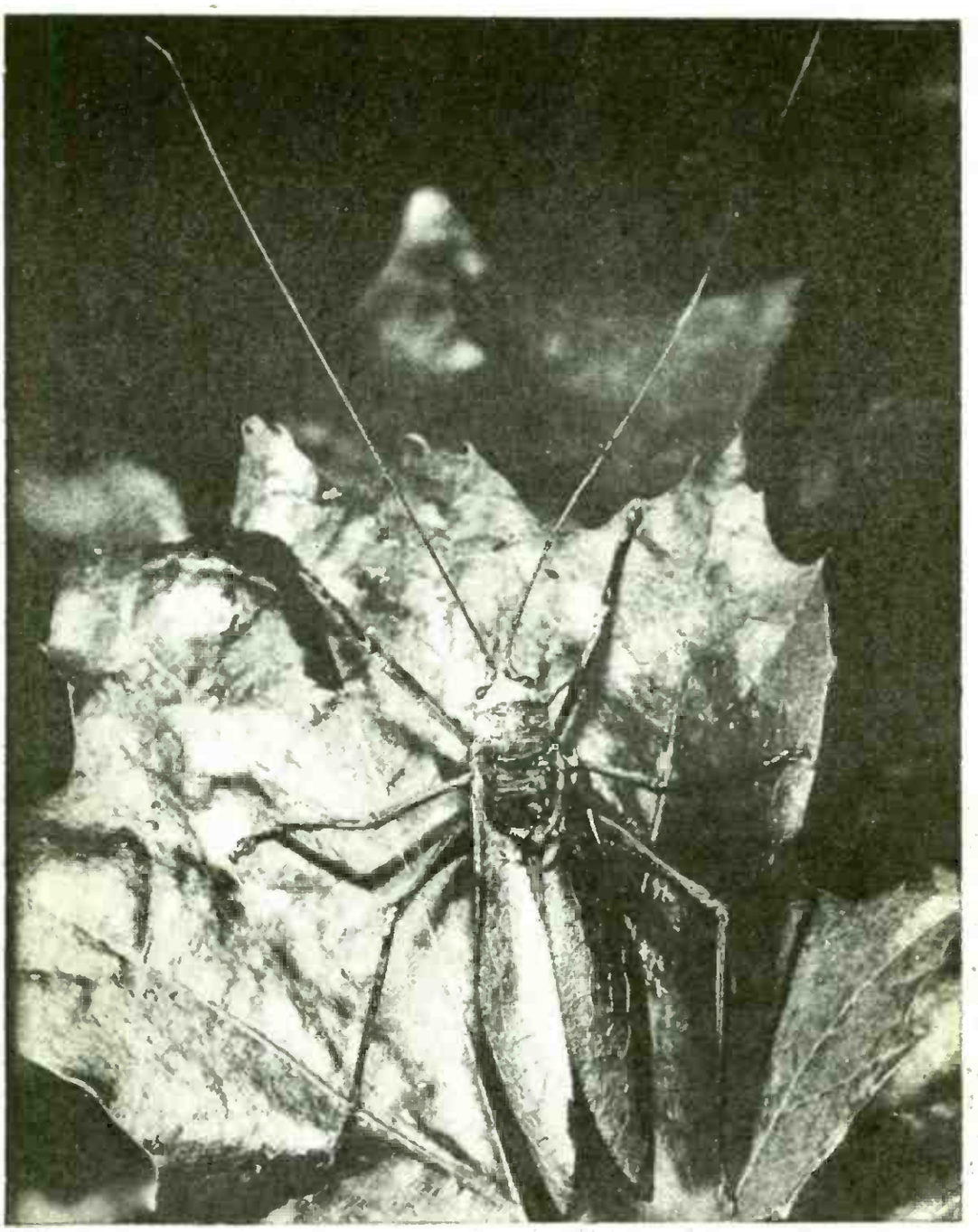
WILL WE RECEIVE RADIO MESSAGES FROM DISTANT PLANETS?

Radio impulses travel at the same speed as light—186,000 miles a second. A signal sent to us from some planet on the frontiers of the Milky Way, to be recorded today, would have had to start on its journey twenty-three centuries before Christ!

are most convincing, *that gravitation is a push instead of a pull;* that the impingement of ether vibrations tends to push all masses of matter toward one another, because a body casts an ether shadow in proportion to its mass toward another body to which it is apparently attracted. He has also further determined that there is a difference between weight and mass of certain bodies, for the reason that all bodies do not resist the ether exactly according to their mass, with resultant proportionate gravitative force.

If gravitation is a push instead of a pull, then, when on the side of the earth away from the sun, we are under an ether pressure of forty tons to the square inch and do not know it.

The intense agitations of the ether do not interfere in the least with the transmission of our radio messages, for there is room down in the regions of the ultimate for many different agitations to



Brown Bros.

ONE SMALL KATYDID CAN MOVE 6,000,000 TONS OF AIR

When this insect creates sound-waves that are audible half a mile away, he is setting in vibration a cubic mile of air. And air has weight that can be measured by means of the instruments of science.

abide together without interference. There are spaces which are relatively as enormous between things infinitely little as there are between the starry magnitudes of the heavens.

All of the suns in the universe have for all time been pouring their light and heat into space, which have been absorbed by the ether in the shape of vibrations which move onward and outward in all directions forever. Consequently, with time enough—and there has been time enough—the suns must of necessity have created an intensity of vibrations in the ether equal to that which exists on the face of a blazing sun. But all those vibrations do not exist as visual light and heat that can be sensed.

As a matter of fact, the latest discoveries in science indicate that not only

do the suns pour their light and heat into the ether, but also that the ether reciprocates by restoring to the suns their lost light and heat, through the intense bombardment or hammering of their masses by etheric vibrations. Professor Jeffries, of Cleveland, Ohio, a noted scientist, has reached the brilliant conclusion that it is the ether that keeps the suns hot.

Let us take one more look at the ether:

Every particle of matter on the earth is in a state of intense vibration. All living things on the earth are, by reflected light, sending their images out into the ether, where they will go on for ever. Even every thought we think shakes the ether. We may die, but the impressions which we make on the ether are immortal.

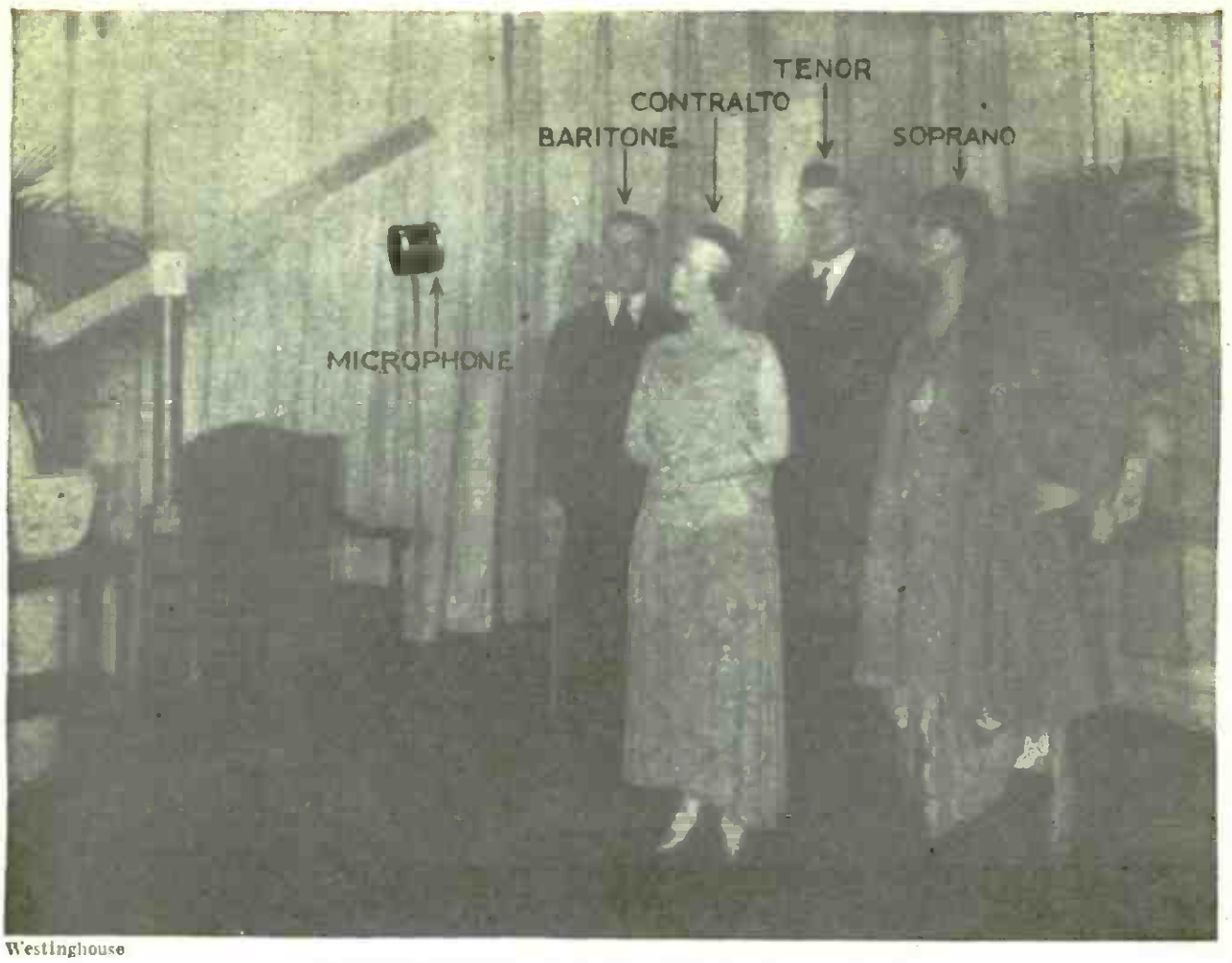
If we could fly out from the earth with a speed sufficiently great, we would overtake the rays of reflected light which left the earth thousands and millions of years ago. If we were possessed of infinite vision, we could, as we went, look back and see the history of the earth unravel. We could see all of our cities fade away into the primal forest. We could see man return to the hill-cavern, and then back to the ape-like animal, swinging on the trees of a tropical jungle. Farther back still to the lemur, and back —away back—to a little agile lizard in the reptilian age, flitting about and living by its wits among the giant saurians, which we should see wallowing in the ancient ooze.

We should see our ancestry unwind back to the fish, from whose fins the mind has forged the human hands. And from the fish we should finally see evolution devolve back to the moneron, a little speck of protoplasm, the parent of all life, plunged in the azoic sea.

Press Illustrating Service

"WE MAY DIE, BUT THE IMPRESSIONS THAT WE MAKE ON THE ETHER ARE IMMORTAL"

So Hudson Maxim expresses in a phrase the scientific hypothesis that the impulses that our bodies originate never come to a final (mathematically speaking) rest. This picture of the distinguished inventor of Maximite shows him at work in his experimental laboratory at Landing, New Jersey.



Westinghouse

HIGH VOICES HAVE MORE INTENSITY

Consequently the sopranos and tenors are placed farther from the microphone than the contraltos, baritones and basses, in order to give proper values to the transmsision.

Mixing Music in the Microphone

How the modern radio impresario is overcoming the mechanical difficulties that arise in the broadcasting of *ensemble* music in which each voice and each instrument must be blended into an harmonious whole

By C. L. LE MASSENA AND WILLIAM H. EASTON, Ph.D.

ANY new invention that becomes popular too suddenly, before its details have been thoroughly worked out, is apt to run foul of unexpected difficulties. Such was the case with the automobile, the submarine and the airplane. And such likewise has been the case with radio.

Urged onward by a too eager public, hundreds of broadcasting stations started operations with little knowledge of either the scientific or the artistic principles involved; in consequence, the noble art of music was in danger of being dragged into disrepute.

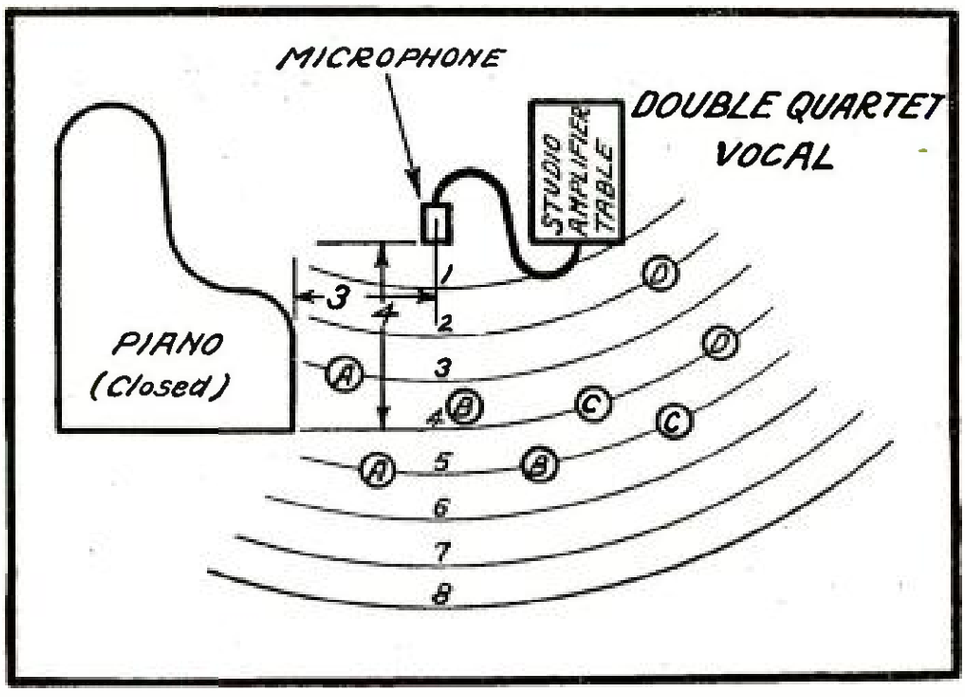
Music by radio presents many different and intricate scientific problems, such as the proper selecting, arranging and handling of the various elements that go to make up a musical production.

Radio broadcasting began with the phonograph, the player-piano and vocal

solos. Then came a rush of vocal and instrumental duets, trios, quartets, bands, orchestras and choruses. Now, groups of vocalists and instrumentalists, large and small, cannot be handled at random. In the concert hall the several divisions are carefully placed in accordance with the experience of many years, and because the sound waves have ample room to expand and travel to the ears of the audience, excellent results are obtained.

But in the broadcasting studio the space is small. There is no audience, only the microphone, and all tones have to reach this single point with exactly the right intensity. Nor are the instruments played in the same plane. Double-bass players stand, all others sit. The violin and viola are held under the chin, the cello between the knees. Flutes, fifes, trumpets and bugles are held high. Other wind instruments are kept low. Moreover, the players sit behind music-stands, so that the sounds are deflected upward from the music sheets. Finally, the characteristics of the average microphone are quite different from those of the human ear. It responds to certain voices much more readily than to others. In consequence, a grouping in the studio that would be satisfactory to a person who stands at the microphone might not be at all pleasing when heard by the radio audience.

Phonograph recording difficulties were overcome because the records could be studied before marketing them. Mistakes by singers or a wrong grouping of an orchestra were mere matters of detail. Poor molds were destroyed and new ones made until a satisfactory one was secured. But this is not the case with radio. Sounds, as originally emitted, go at once to the public. They cannot be recalled. Radio music must attain perfection through open experiment. The studio managers of all the better broadcasting stations listen in on radio receivers constantly, in order to check the character of the performances, and many stations have official outside critics who phone in comments and suggestions. Such arrangements are valuable at all times, but to put entire dependence upon them



THE CORRECT POSITION FOR A DOUBLE QUARTET

The basses and baritones (indicated by A) should be placed nearest to the microphone. The contraltos (B) come next; then the sopranos (C), and then the tenors (D). The arrangement takes into consideration the importance of the parts sung as well as the tone values of the voices.

Westinghouse

A Correct Grouping

Here the violin, saxophone and banjo—the more quiet instruments that carry the melody—are placed in the foreground, while the penetrating brasses and the loud percussion instruments, such as the piano and drums, are placed in the rear.

means too much public experimentation. Hence, accurate standards, that can be applied in advance, have been sorely needed.

In order to develop such standards in transmission of music, the Westinghouse Company assigned the task to A. G. Popcke, one of its engineers, who is also a musician. He spent months at the work, studying the radio qualities of every kind of sound and every possible combination of sounds. In this task he was assisted by the "modulation meter," an instrument specially developed by the Westinghouse Company for the purpose. This instrument, which resembles an ordinary ammeter, is connected in the microphone circuit and indicates the strength of the currents controlled by the sounds that reach the microphone. It has a scale from 1 to 100. Sounds producing currents below 10 on this scale are too weak to hear, while those producing currents above 90 are so strong as to cause blasting. Consequently, by watching this instrument, the modern operator obtains exact information as to the values of the sounds that are actually being broadcast.

If the modulation meter registers too high during a selection, the amplification of the microphone current is reduced, or the microphone is moved away from the musicians, until the sounds are softened sufficiently to be properly transmitted. If the meter registers too low, the amplification is increased or the microphone is brought nearer. In a similar manner, the radio intensity of each particular voice and instrument can be determined, thus giving exact data for groupings.

Some of Mr. Popcke's conclusions are at variance with what might be expected. Thus, for solo work, a bass singer must stand nearer the microphone than a tenor or a contralto, while a soprano must

Westinghouse

—and a Wrong Grouping

Loud instruments placed near the microphone tend to "blast" the transmission and to drown out the weaker-voiced instruments in the background. The drums are special offenders, and often ruin the broadcasting of orchestral ensembles.

stand farther away than any other singer. In a well-balanced mixed quartet, the contralto and bass are nearest, the soprano and tenor at greater distances. With an orchestra, the cello and double-bass are nearest, and the violins and violas are ranged in a semicircle behind the cello. The flute and clarinet occupy the next rank, the brass instruments next, and the drums are placed in a far corner. Singers of comic songs must stand closer to the microphone than singers of classical music, because the words of comic songs are the most important part and must be heard distinctly, whereas in classical songs, words and music are equally important. Where instruments and parts are duplicated (as with two violins, mandolins or saxophones) the players must play in exact synchronism or the sounds will become blurred.

The studio must be so constructed and draped that all echoes and reverberations are eliminated. There are different ways of doing this. In the WGI studio at Medford Hillside, Mass., the walls and ceiling are treated with a special acoustic felt, after the method that is employed in record-reproducing studios. The floor is covered with a heavy carpet. The WGY studio at Schenectady has a large rug on the floor and the windows are draped with loose, light curtains. In the Navy Department studio, NOF, at Anacostia, special sound-damping devices and paraphernalia are rigged up on the walls, ceiling and floor so as to prevent reverberation of sound waves and to insure good reproduction. In the Westinghouse studios the practice varies. At KDKA, Pittsburgh, and WBZ, Springfield, shirred burlap covers the walls and ceilings and heavy carpets cover the floor. The Newark studio, WJZ, is specially constructed of sound deadening

material, but experiment showed that the room was so long that echoes were formed. It was necessary to hang curtains across the middle of the room to eliminate this difficulty.

The result of these precautions is that to one speaking in a properly constructed studio his voice feels dead. We are used to hearing reverberations when we speak and the suppression of them seems unnatural. The absence of all outside noises helps to emphasize this effect.

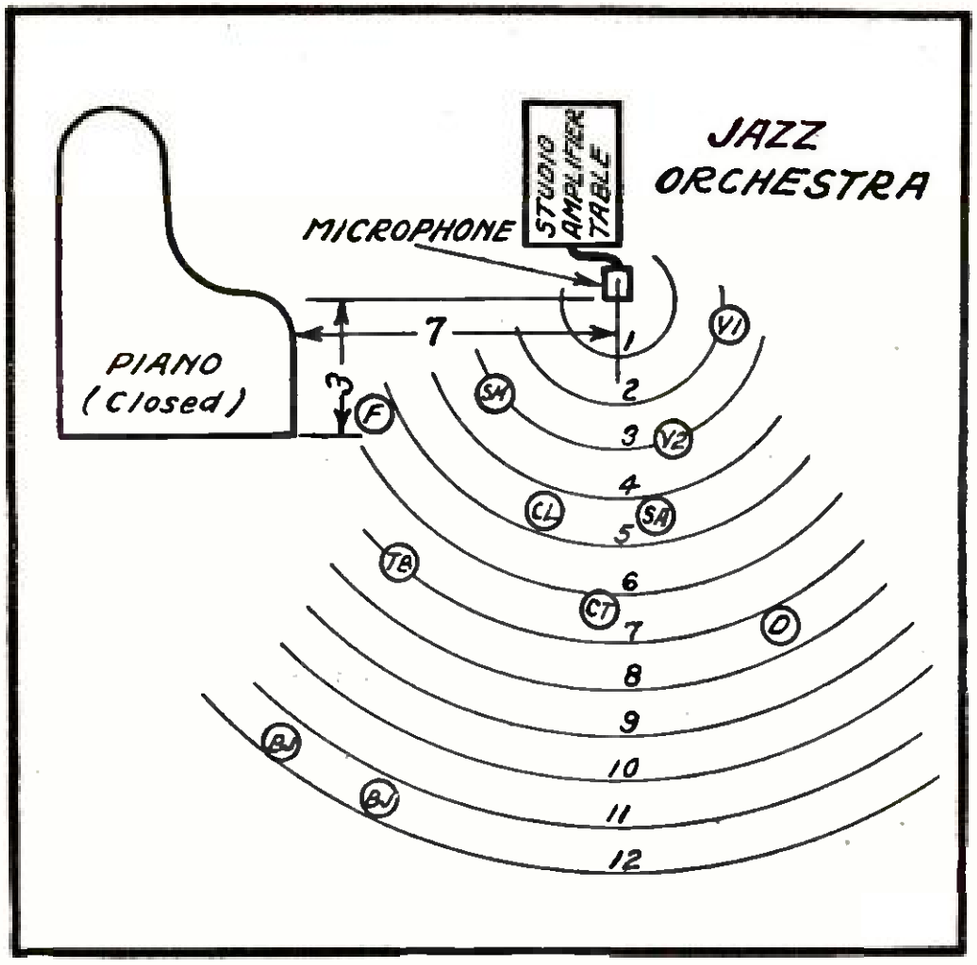
The piano is, as always, a special problem. When used for accompanying singers, it must be distinctly heard but must not drown the noises. Careful study was therefore given to the relative positions of microphone, piano, and soloists, and also duets, quartets and choruses. It was found that the greater the number of voices, the greater must be the intensity of the piano music at the microphone. Groupings were therefore worked out for each combination of singers. Mr. Popcke has reduced his findings to a series of charts, two of which are reproduced. These charts are used by the studio managers of the four Westinghouse stations—KDKA, Pittsburgh, WJZ, Newark, N. J., KYW, Chicago, Ill., and WBZ Springfield, Mass. Thus, all stations operate according to the same standards. Other stations are likewise experimenting along these lines. For example, at the General Electric station, WGY, at Schenectady, more than one transmitter is used for the broadcasting of a church service where the choir, the minister and the organ are in three different places, not in close proximity. In this instance, three microphones are used in parallel. Three microphones are used in broadcasting WGI programs from Medford Hillside; two are used exclusively for musical entertainments, orchestral concerts, choruses and solos and one is used for speaking.

The NOF station at Anacostia, D. C., is engaged in experimental work along lines of reproduction of speech and music, under the direction of the Bureau of Engineering, Navy Department. Much progress has been made in efforts to reproduce accurately and with correct intensity all sound waves. By means of a special microphone which is non-resonant to frequencies below 3,000 cycles, together with the proper adjustment of the vacuum transmitter circuits, sound waves of all frequencies below 3,000 cycles are reproduced well with respect to intensity and frequency. While this station has no fixed activities, it broadcasts band concerts twice weekly as part of the effort to solve one of the major problems under consideration, *viz.*, the quality of tone modulation. When one to three artists are singing or playing only one microphone is used, while in the case of an orchestra two are used. The instruments are placed at various distances from the singers or players according to the nature of the instruments and the classes of singers who are performing.

The acoustics of a studio represent a problem in three dimensions.

Suppose, for example, high C is struck on the piano. On exploring every cubic foot of the studio's interior, a point will be found where, due to the various echoes and reflected sound waves in the room, that note will be received at its best value. Now strike a deep bass note, and the chances are that that particular note will be best received at some other point because its waves will be echoed and reflected in a different manner. Obviously, therefore, the location at which a piano selection as a whole is best received will be a compromise; that is to say, will be the point where only the majority of the notes will best be received. Conditions are, of course, still worse when an orchestra is playing.

The consequence of this situation is that before using the charts the acoustic properties of the particular studio must be thoroughly known. The microphone must be placed in the best spot for the particular music to be broadcast and the



HOW AN ORCHESTRA SHOULD BE ARRANGED

The first and second violins (V1, V2) and the melody saxophone (SM) are placed close to the microphone; farther away are placed the saxophone that plays the accompaniments (SA), the flute (F), and the clarinet (CL). In the background are the cornet (CT), the trombone (TB), the drums (D), and the banjos (BJ).

musicians then arranged in accordance with the chart. However, if the studio is perfectly echoless and reflects no sound waves whatever, then all points within it will be equally good for reception. This degree of perfection is probably impossible to secure, but evidently the better the sound-proofing the less the distortion and the better the artistic results. KDKA's new studio, for example, has sound-proof walls; the walls, ceiling, and floor are covered with a heavy layer of felt and the walls and ceilings are draped and the floor has a thick carpet. The result is that the room is practically echoless, and the music broadcast is notably excellent.

During the pioneer days of radio there was no precedent to follow and little experimental knowledge to guide; therefore guesswork was inevitable. In broadcasting the Mozart opera, *The Impresario*, from WJZ last winter, the five singers were rehearsed before a dummy microphone, and were shifted so as to bring each singer before the recording instrument in turn. When several sang together, their heads came in close proximity. Today this arrangement would not be employed. The groupings would follow the new scientific method as described, unless one of the artists possessed an unusually powerful voice, in which case proper adjustment would have to be made.

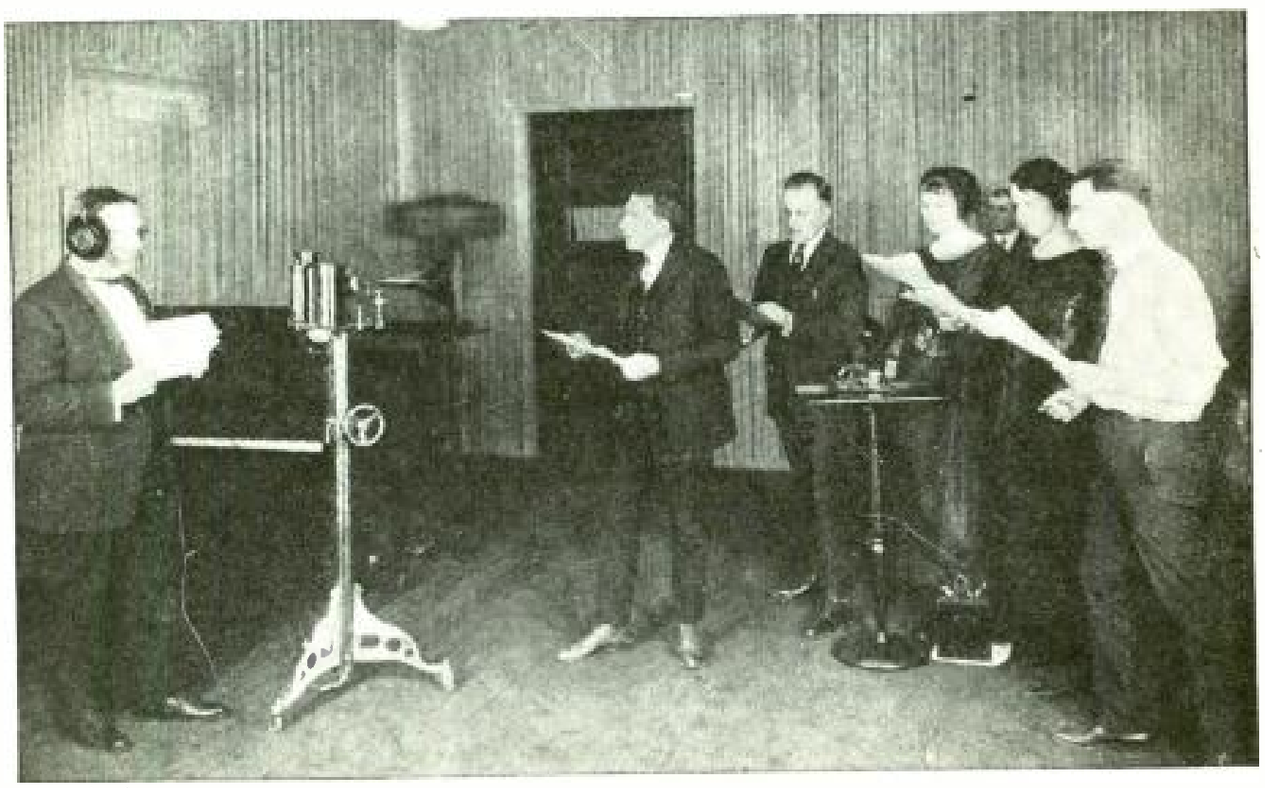
Much more difficult than broadcasting music from the studio is the broadcasting of grand opera from the opera house. The pioneer work of this kind was done by the Chicago Westinghouse station

KYW which transmitted practically every performance of the Chicago Opera Company during the 1921-22 season. For reasons that are obvious, no single microphone could handle soloists, chorus and orchestra. Several microphones were therefore installed in various parts of the stage and house. These were connected to a little switchboard in the wings, and an operator connected in first one and then another in accordance with the character, volume and location of the music and singers. The results, while interesting from an experimental standpoint, were not all that could be desired artistically.

The same may be said of attempts to broadcast symphony concerts where a large number of musicians are employed with but a single microphone and no scientific grouping of the instrumental bodies.

To get the best results, operas should be performed in specially designed studios and with specially selected forces. Not every opera is suitable for this purpose. William Wade Hinshaw, producer of Mozart's *The Impresario,* claims that only the lighter forms, where solo singers do most of the work, can be broadcast.

Many new problems have to be solved in order to obtain an operatic performance by radio of the highest artistic character. Large orchestras or choral groups are just as much out of place in a broadcasting studio as they are in a phonograph recording laboratory, because the fewer the combinations employed, the better is the effect. Scientific grouping and selection is therefore imperative. Soloists, chorus and orchestra must be arranged so that each group can function independently or conjointly as occasion demands. All of these things require further artistic and scientific investigation and experiment until a *modus operandi* is devised that can cope with grand opera requirements. Then radio music will have fulfilled its possibilities.



International

AN "UNDRESS PERFORMANCE" OF A PLAY

The broadcasting of a theatrical production from a studio (in this case from WGY) not only permits the actors to appear without costume and make-up, but enables each performer to advance and talk directly into the microphone. The director listens in with padded earphones and coaches his cast by means of instructions written on cards.

FOUR WAYS TO GET GOOD MODULATION

PART I

The four standard methods may be listed as (1), the use of the microphone in the antenna circuit for low-power transmission; (2), the use of a magnetic transformer; (3), grid modulation and (4), Heising modulation. The first two of these methods are here described by one of the foremost authorities in this field—

PROF. J. H. MORECROFT

IF we breathe quietly the lung pressure forces air in and out through the throat in a fairly uniform stream, but if we talk or sing the air emerges through the throat chambers in a series of puffs. A delicate mechanism for indicating air pressure placed near the mouth would show that the air pressure varied periodically above and below its normal value. The frequency of this pressure variation is determined by the pitch of the voice and the intensity or strength of the voice determines the amount by which the pressure of the air varies from its normal value. If the pressure-indicating device were so arranged, we might connect to it a lightweight pencil, and this, through a suitable system of motion-magnifying levers, would enable us actually to draw the form of the air-pressure waves.

Typical curves which might be thus obtained are shown in Figure 1; curve *a* is for a comparatively weak violin note about one octave above middle C of the piano, while curve *b* is for a more intense note, of more complex quality, with a pitch of about fifty a second.

The problem in radio telephony is to let these pressure waves of the voice act on the apparatus at the broadcasting station in such a way that a simple receiving circuit will send off pressure waves from the diaphragm of the head phones which are sufficiently like those actuating the transmitter for the voice to be clear and recognizable. If the pressure waves at the transmitting and receiving stations were actually drawn by an instrument of the kind I have suggested, the eye would probably not recognize them as the same, yet so wonderful an instrument is the human ear that it, in combination with the brain processes by which we are made conscientious of sound, would interpret them as the same.

The waves shown in Figures 1A and 1B are periodic waves; that is, the wave forms are repeated many times with approximately the same shape. This is the kind of wave given off when a vowel sound is sung, or a violin string bowed or a simple note on a wind instrument is sounded.

The voice contains many sounds, however, which are not periodic; sounds in which the wave forms do not repeat themselves. In this class fall all the consonants—the explosive sounds of the voice, such as p, k, t and s. The periodic or vowel sounds of the voice are much easier to reproduce by radio than are these consonants, in fact, practically all the improvement which will be made in the quality of radiophone transmission will come about by changes in the apparatus, at transmitter and receiver, to "get through" more of these consonant sounds. The next time you listen in with a loud speaker, try to analyze the sounds you hear and estimate how many of the consonants are coming through with their proper relation to the vowel sounds; you will be surprised to find how few of the consonants you actually hear. What you really hear is a series of vowel sounds; the brain generally "injects" the consonants to a sufficient extent to make the speech intelligible; when it doesn't do so you do not understand the speech. There may be plenty of noise there but when you listen to it carefully you will find that it is actually made of sounds that are practically nothing but vowels.

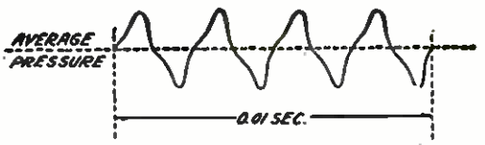


FIGURE 1A

A graphic record of a high musical note of a violin, one octave above middle C. Compare this record with that on the facing page.

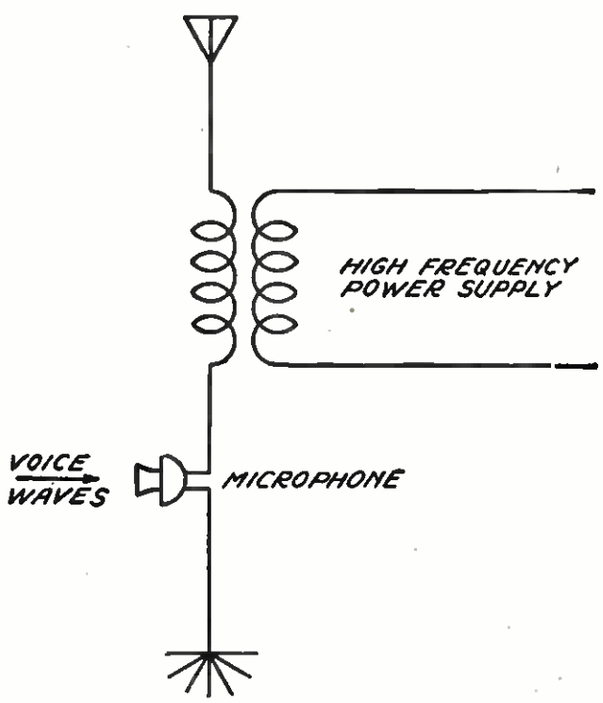


FIGURE 2

The most simple scheme for modulation. The microphone is connected in the ground lead.

At the broadcasting stations it is necessary to generate and radiate high-frequency, electromagnetic waves from the antenna, the frequency of which shall be essentially constant but the amplitude or intensity of which shall vary in a manner corresponding to the form of the pressure waves of the voice. The frequency of the waves sent off from the antenna must be very high (say of the

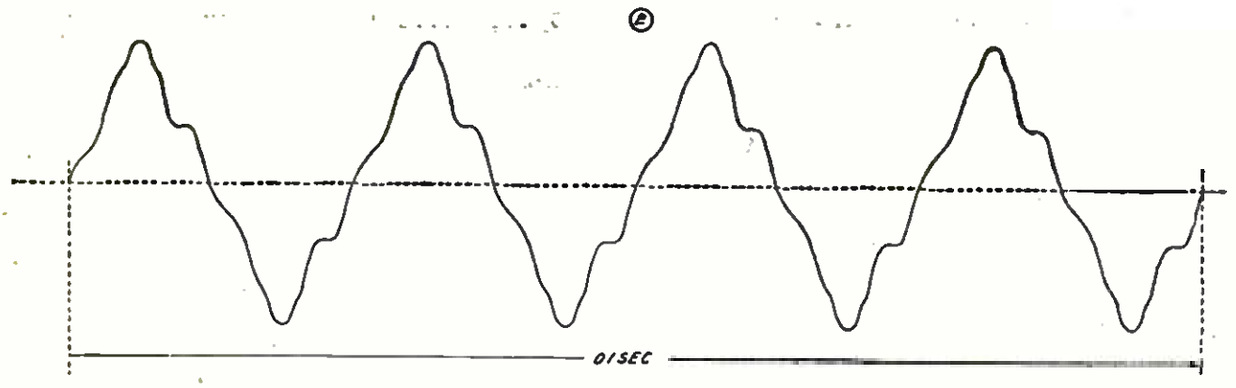


FIGURE 1B

A graphic record of a low note of a violin, of less than 50 vibrations a second.

order of one million a second), or else not much power will be radiated and the resulting signal at the receiving station will be correspondingly weak. The task of the radio engineer is, therefore, to generate at the station plenty of high-frequency power and arrange the generating apparatus in such a way that the minute power of the voice, measured possibly in the thousandths of a watt, can accurately control its activity. This minute power of the voice must be able to control perhaps a horsepower of electrical oscillations and control this power so decisively that it changes from practically nothing to a horsepower or more hundreds and thousands of times a second.

In some of the experiments in trans-oceanic telephony this extremely small power of the voice controlled the flow of energy from a two hundred kilowatt generator—not only made this tremendous amount of energy to flow and cease flowing into the antenna hundreds of times a second but made the form of this periodic fluctuation in energy flow conform closely to the pressure wave of the voice.

We shall consider some of the schemes by which this voice control of the antenna power is brought about.

The most obvious scheme and that first tried, is to put the microphone directly in the antenna as indicated in Figure 2. The high-frequency power for radiation from the antenna is supplied from some kind of a machine to the antenna through the coupling transformer shown.

The microphone consists essentially of a mass of closely packed carbon granules through which the current flows. Practically all of the resistance of such a mass of granules is at the points of contact of the various particles and this contact resistance varies greatly with the amount of pressure exerted on the granules. The metal diaphragm of the microphone, against which we talk, presses lightly against the mass of granules; hence it follows that by varying the pressure on the diaphragm the resistance of the granule contacts may be greatly changed.

When the voice waves impinge on the diaphragm it alternately presses and releases the carbon granules and so varies the resistance of the microphone as a whole.

With an arrangement like that given in Figure 2 the amount of high-frequency current that flows in the antenna depends directly upon the antenna circuit resistance and this is affected by the resistance of the microphone, because whatever current flows in the antenna must evidently flow also through the microphone. Hence the amount of antenna current, which determines the signal strength at the distant receiving station, fluctuates according to the voice waves that impinge upon the microphone diaphragm.

This arrangement has the advantage of simplicity and it was used in practically all of the early attempts at radio tele-

phony; it has many undesirable characteristics, however, and is seldom used today. Comparatively small amounts of power can be controlled in this fashion, as the microphone can carry only small currents without overheating. The scheme is very inefficient; 50 per cent or more of the high-frequency power supplied to the antenna is used up as heat in the microphone itself, and the amplitude of the antenna current does not directly follow the voice-wave pressure on the diaphragm of the microphone so that the variation of antenna current does *not* truthfully represent the voice wave; the *modulation* is imperfect.

Another scheme which has been used to some extent at both small and large radio transmitting stations is that indicated in Figure 3.

The high-frequency power is supplied as before from a machine or tube through the magnetic coupling as shown, but instead of placing the microphone in the antenna circuit, an iron-core coil is so placed. This iron-core coil is fitted with two windings, one connected in the antenna circuit and the other carrying a continuous current; the fluctuation of this continuous current follows the voice waves because the microphone is placed in series with this winding, as shown on the diagram.

The modulation in this scheme is accomplished by detuning the antenna. To absorb considerable amounts of power from the power supply the antenna must be accurately tuned to the frequency furnished by the power supply; any departure from this tuning will at once cut down the amount of power supplied to the antenna. Due to the magnetic properties of the iron core the amount of inductance of the coil depends upon the amount of current flowing in winding B so that the tuning and detuning of the antenna follow the fluctuations of the continuous current in winding B and this in turn, depending upon the resistance of the microphone, fol-

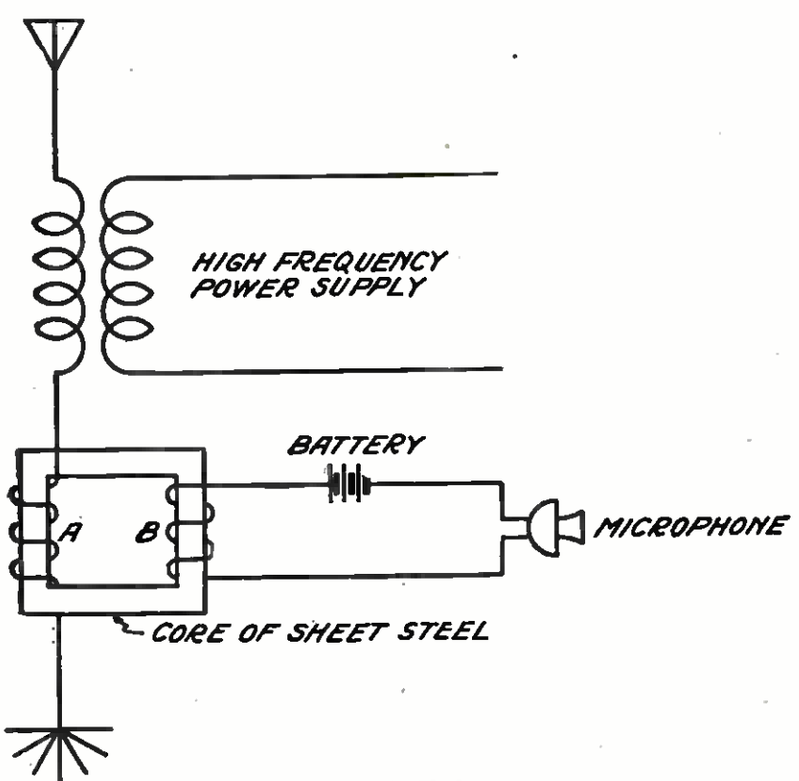


FIGURE 3

Another system for modulating in the antenna; it is called "magnetic modulation." This is accomplished by a special type of transformer which varies the tuning of the antenna circuit in accordance with the voice waves that are impressed upon the microphone.

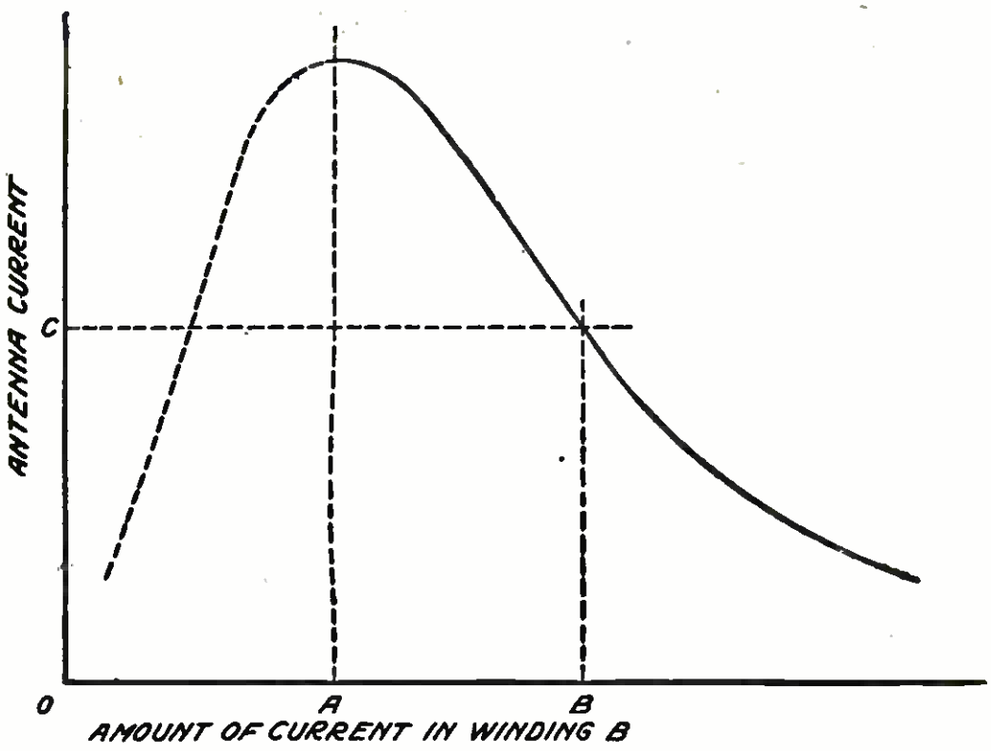


FIGURE 4

This curve shows the variation of the antenna current plotted against the variation of the microphone current. A change in the microphone current causes a change in the antenna current; in this way the radio waves are shaped into the form of voice waves.

lows the pressure of the voice-wave.

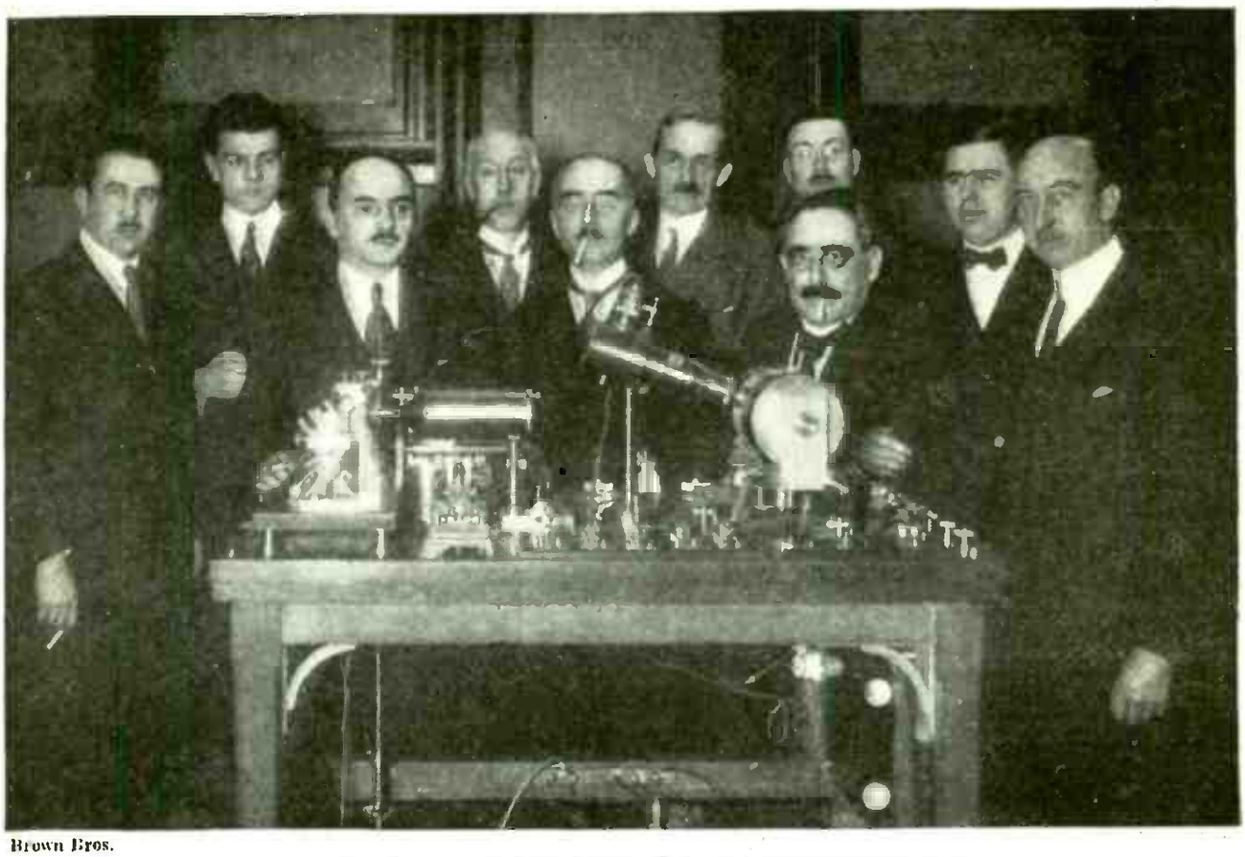
The variation of antenna current with the amount of continuous current in winding B is about as shown in Figure 4; the workable part of the curve is that shown in the full line. With an amount of continuous current equal to A the antenna is tuned to the power supply; so the antenna receives a maximum of power; for currents greater than A the antenna current proportionately decreases. Normally the antenna current is equal to OC and the amount of current in the winding B of the coil is OB. As the pressure on the microphone increases the current through B increases, thus decreasing the antenna current and if the pressure on the microphone decreases, thus increasing the resistance of the microphone the continuous current through B decreases and the antenna current as a result of this increases proportionately.

When this scheme was actually used for controlling the large Alexanderson alternator at New Brunswick it was found necessary to use several condensers suitably connected and the continuous current through coil B was not controlled directly by the microphone but was controlled by some large vacuum tubes, the grids of which were actuated by the microphone.

As the iron core is subjected to high-frequency magnetic reversals, because of the antenna current through coil A, it is necessary to build the core of thin sheet steel plates and these plates must be carefully insulated from each other. The plates used are generally not more than two or three thousandths of an inch in thickness.

"What Is the Best Kind of Modulation for My Set?"

In the next article of this series Prof. Morecroft will point out the way to answer this question. Specifically, he will describe the grid modulation (adapted for single-tube receiving sets) and the famous Heising modulation —the most efficient of all, and adapted to all amateur transmitting stations.



Brown Bros.

THE INVENTOR GIVES A DEMONSTRATION

When M. Edouard Belin of Paris recently arrived in New York, he exhibited his latest device before a group of scientists. In the above picture the inventor is the fifth man from the left.

Secret Signals by Radio

Up to the present time all signals transmitted by radio have been regarded as "broadcast," to be picked up by any receiving station within the transmitting station's range. The ingenious apparatus described in this article shows how the transmitted signals can be recorded intelligibly only by special receiving sets—thus opening up the possibilities of restricting the messages or pictures within any desired limits.

By PAUL McGINNIS

THE chances of intercepting radio messages sent by the "crypto" are so small that Edouard Belin, its inventor, knows no French shrug of the shoulders which will describe them. It is impossible to eavesdrop on its messages—if anything is impossible in radio.

The new device with which the noted French inventor has surprised American scientists in his visit to New York is used with his invention for transmitting photographs and written messages both by land wires and by radio which he is introducing in this country.

Six adjustable disks control transmission, and their combination is as difficult to guess as the combination of a lock on a bank safe. They split seconds for the transmitter. The transmission itself is an invention of world fame. It is able to transmit signatures accurately enough to be acceptable to banks. By it photographs and messages have been sent successfully from Paris to Bar Harbor, Me., and also from Beirut, Syria, to Paris.

The picture or photographed message to be sent is transferred to a brass cylinder and treated with chemicals so that it

dissolves and leaves only the emulsion. As the cylinder turns it makes electrical contact with a small point of metal resting upon the emulsion. The current that flows through the cylinder and the point of metal is varied according to the resistance of the light and dark parts of the emulsion.

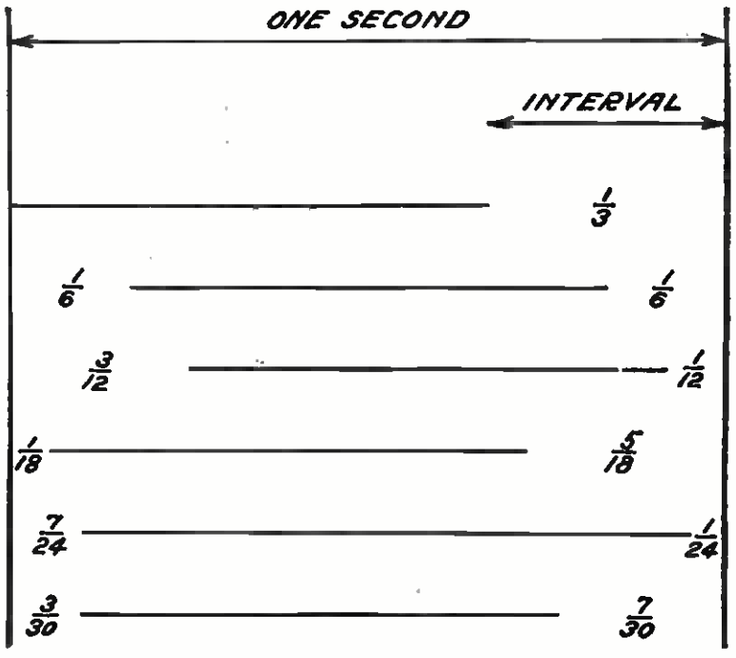
The current, with its variations caused by the light and shade of the photograph, is then superimposed upon a carrier wave and sent out in the usual manner employed to broadcast speech and music. The common modulation transformer is employed for this purpose.

The photographic message is received upon a sensitized cylinder similar to that used in transmitting. The two cylinders are timed to synchronism by a transmitted sound much like that of the metronome used for teaching rhythm in piano playing.

When the broadcast photograph is caught by the ordinary antenna and vacuum tube receiver, its pulsating current is led to an oscillograph where a loop of fine wire suspended in a strong magnetic field bears a mirror about the size of a pin-head. This small loop of wire moves back and forth as the current becomes stronger or weaker and changes the direction of an intense beam of light reflected by the mirror.

The beam of light moves over a glass slide which varies from opaqueness at one end to transparency at the other. After the light has passed through the slide, a lens concentrates it upon the sensitized revolving cylinder and reproduces there a small strip of the picture at each revolution.

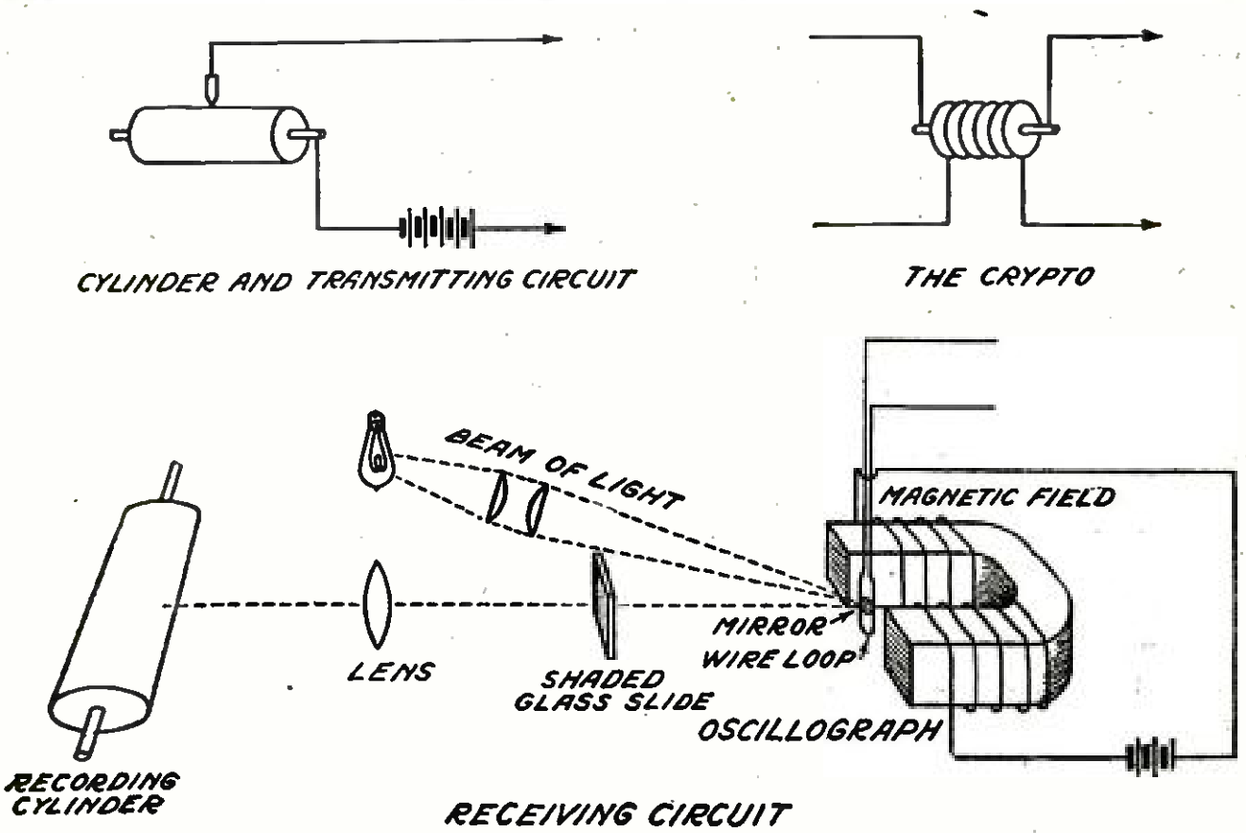
With these comparatively simple instruments, the picture can be intercepted and taken from the air by anyone, but with the addition of the crypto the task of listening-in becomes hopeless. One small strip of the picture or message sent out by one revolution of the transmitting cylinder might be received perfectly, but as the interval between revolutions is constantly changed the strips would not coincide.



HOW THE TRANSMITTING PERIOD IS VARIED

HOW THE RADIO SIGNALS ARE "SCRAMBLED"

FIGURE 1: *This chart shows how the "crypto" scrambles a picture or message transmitted by radio and makes it practically impossible for another receiver that is not equipped with it to solve or unravel the otherwise meaningless jumble of signals.*



HOW THE DEVICE WORKS

FIGURE 2: *The transmitting cylinder upon which the picture is made in bas relief varies an electrical current which is transmitted to the crypto and sent out over a telephone wire or by radio. At the receiving end the current is led into the reconverting apparatus (as shown above) and is changed into a light wave, of varying intensity, which is traced upon another cylinder, thus reproducing the picture. A crypto is used at both ends to scramble and unscramble the transmitted impulses and the two devices are run synchronously.*

If each revolution of the cylinder requires 2/3 of a second, there will be an interval of 1/3 of a second during which time the cylinder does not revolve or transmit. It is this inactive interval which is made use of to insure secrecy. This is done by distributing it in various combinations, part before and part after the given revolution.

As shown in Figure 1, the first revolution occupies 2/3 of the first second, after which there is an interval of 1/3 of a second. Since a different combination is used in the second revolution, the 1/3 of the first revolution is added to the 1/6 which precedes the second revolution, making a total of 1/2 second between the transmission of the first and second strips of the messages. The combined interval between the second and third strips is 5/12 of a second; between the third and fourth it is 13/36.

Unless the receiving apparatus responds exactly to these delicately timed intervals, the received message will be nothing but meaningless lines of light and shade.

The crypto controls the intervals by means of its six adjustable disks which move in synchronism with the revolving cylinder. Each disk bears the figures from 0 to 9, and can be adjusted to any figure in a moment. The six disks may be combined in 999,999 different ways. The chance to intercept the message, therefore, even with the aid of another crypto, is one in a million.

Ordinarily an inventor might be content to call such a machine a secret instrument and let it go at that, but Belin has gone one step farther. He has considered the possibility of an ear or an instrument sensitive enough to detect the intervals. To eliminate this he has dis-

guised them. What are called "parasites" or unintelligible signals are automatically sent out during the intervals. When they are transcribed, they form a meaningless strip of light and shade, but they are so much like a part of the message that any listening in would be unable to tell where the message stopped and the "parasite" began.

The device has its shortcomings when used with radio, but it is a large step in the direction of secrecy and so far it is the only invention which completely foils the eavesdropper.

Both static and interference from other stations will alter the current received and consequently affect the picture or message photographed on the receiving cylinder. But with added equipment, the invention is considered to be practical. A loop antenna will reduce interference from transmitting stations and from static almost half, and the methods of Marconi and others in sending unidirectional waves will reduce other objectionable features by another large fraction.

Marconi's beam of waves, sent out by an antenna shaped like the reflector of an automobile headlight,* cannot be intercepted by any station not directly in their narrow path. They may easily be applied to the crypto.

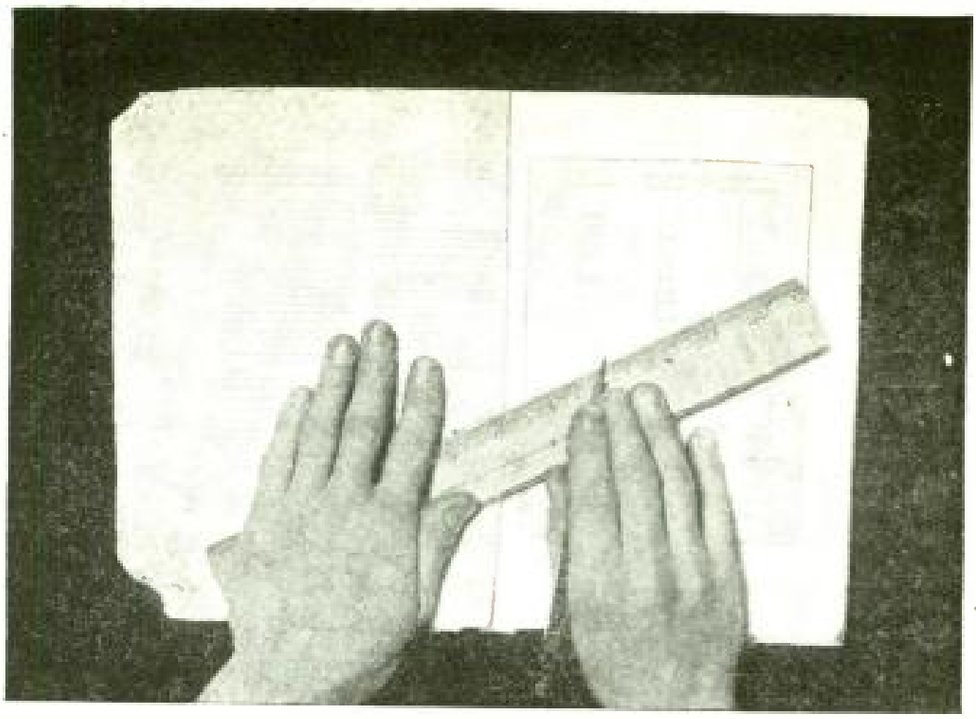
Belin's apparatus is now being installed to transmit press photographs in the United States. This is only the beginning of its service.

*See POPULAR RADIO for March, 1923.

© Underwood & Underwood

A UNIQUE RECEIVER IN A FOUR-INCH BOX

This midget set contains a dry-cell tube rheostat and a tuning transformer, and is capable of picking up signals from distant stations without the use of amplifiers. This receiver enables its designer, Dr. R. S. Piper, to hear broadcast programs from all over the United States from his home in Chicago. It is certainly one of the most powerful and effective receiving sets of so small a size and compact arrangement that has yet been constructed.



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

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

MEASUREMENT CHARTS

FOR DETERMINING THE CAPACITY OF A CONDENSER

ARTICLE No. 3

These remarkable charts have been developed especially for POPULAR RADIO by the inventor of the famous "radio slide rule." They not only insure accuracy in calculations, but save an enormous amount of time. The following article tells how to use the accompanying chart for determining the correct sizes of condenser plates that are designed to obtain any specified capacity.

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

BOTH the engineer and the amateur often have cause to make or to use condensers of a certain fixed capacity in testing out a new radio circuit. Sometimes they have a number of fixed condensers of unknown capacity on hand.

The condenser is an electrical device which has two or more conducting sheets that are separated by some insulating material (a non-conductor of electricity) in order to store up electrostatic energy. The capacity of such a condenser, which is usually measured in microfarads (mfd.) depends entirely upon the active area of the plates or sheets of conducting material, the distance separating them, and the kind of material (dielectric or insulator) which is used to separate them.

The formula for the capacity of a condenser follows:

$$C = \frac{A\,K\,.0000002248}{T}$$

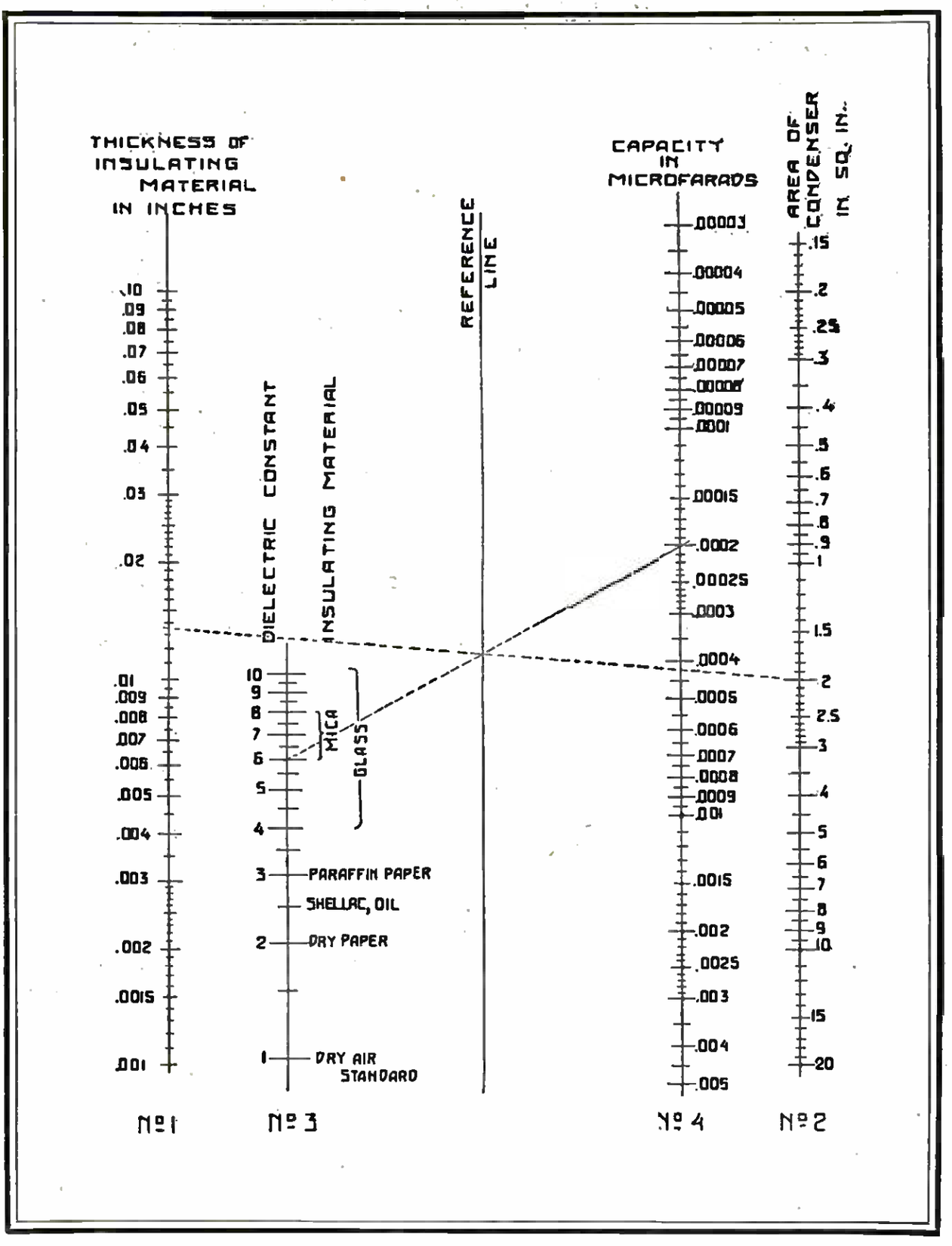
where

A = the area of the plates in square inches
K = the dielectric constant of the insulating material (given below)
T = the thickness of the insulating material, in inches

and

C = the capacity of the condenser in mfds.

The dielectric constants for various materials are:



USE A COMMON RULE ON THIS CHART FOR FINDING OUT THE CAPACITY OF YOUR CONDENSER

FIGURE 1: *To obtain a condenser of a certain capacity, connect the value of capacity on scale No. 4 with the dielectric constant for the kind of insulating material you wish to use, on Scale No. 3, with a straight line. Then connect the thickness of the insulating material you want to use (on scale No. 1) with the point where the first line crosses the reference line, and carry this last line over to scale No. 2. This will give you the correct area for the conducting plates.*

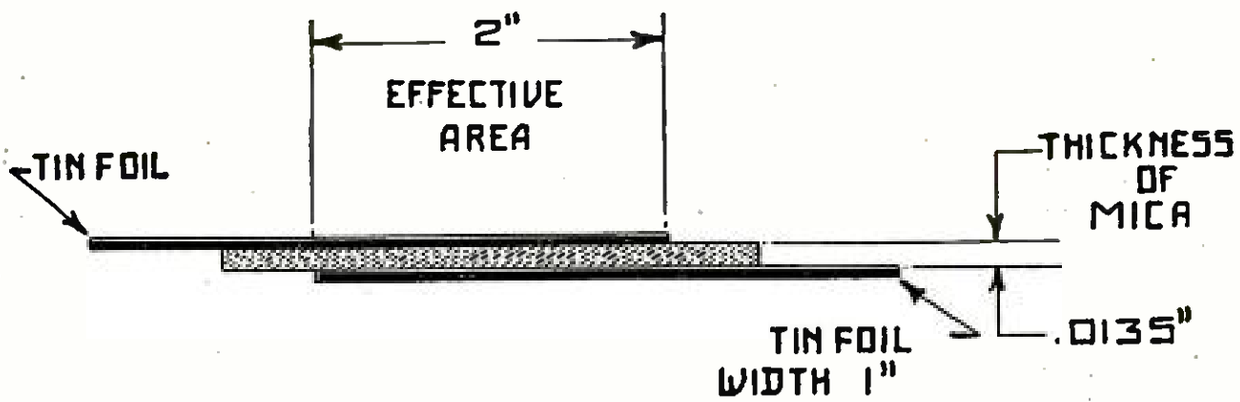


FIGURE 2

This diagram shows how to determine the different dimensions that are necessary to know in using the chart shown in Figure 1, for designing a condenser. Notice that the effective area of the plates is the overlapping area.

Material	*Constant (K.)*
Air (standard)	1
Paper	1.5-2
Paper (Paraffin)	3
Shellac	2.5-3.5
Oil	2.5
Mica	6-8
Glass	4-10

To enable the radio man to determine the capacity of a condenser which is already built, or to determine the size of a condenser which he intends to build that shall have a certain predetermined capacity, the chart in Figure 1 has been prepared, which incorporates the formula given above.

To use the chart to determine the capacity of a condenser, let us consider the example:

A condenser constructed as shown in Figure 2, contains two sheets of tinfoil conductor, which have an effective (overlapping) area of (2 by 1)=2 inches. The thickness of the mica insulator sheet is .0135 inch. Connecting .0135 on scale No. 1, with 2 on scale No. 2, with a ruler, and then connecting the reference point (where this line crosses the reference line) with the dielectric constant for mica (about 6) on scale No. 3 we find the continuation of this line crosses the scale No. 4 at .0002 mfd. which is the capacity of the condenser.

To determine the area of a condenser which will have a certain capacity, the process is reversed.

Example:

To construct a condenser with a capacity of .0002 mfd., using a mica dielectric of .0135 inch thickness, we proceed in the following manner:

Connect, on scale No. 4, the capacity desired (.0002) with the dielectric constant (6) on scale No. 3. Now connect the point of intersection (of this line with the reference line) with the thickness of the dielectric to be used (.0135) and extend this line over to scale 2, which will give the effective (overlapping) area of the plates to be used.

This chart will certainly be a time-saver for the amateur and will give him assurance that he is getting the most out of his experimental circuits by the use of the proper-sized condensers.

Preserve These Hoffman Charts for Reference!

They will save you time and insure accuracy when you build your set. Previous charts have told how to calculate wavelength of antenna circuits, series circuits and circuits in multiple, and how to calculate coil design for obtaining any value of inductance. Following articles will include charts for calculating the characteristics of the antenna, charts for the design of loop antennas, and charts for the design of C. W. transformers.

Traffic Cops *of* the Ether

How "Daddy" Cadmus Checks Up the Good and the Bad Boys of Radio

The task of keeping tab on wavelengths used by transmitting stations and of running down offenders on one hand and of helping amateurs to tune up their sets and to get a license on the other is taking up more and more time of Uncle Sam's radio inspectors. This article tells how one of them facilitates his duties with his ingenious "radio chariot."

By HENRY M. NEELY

UNCLE SAM is a kind and indulgent relative to all the good little boys in radio. But all of the little boys in radio are not good little boys—and Uncle Sam has to keep a watchful eye on the bad ones to see that they do not interfere with the pleasure of the good ones.

It was hard enough in the past to do this when there were only a few amateur sending stations and when they interfered with other amateurs who were usually skilful enough to tune them out. But with millions of beginners hooking up all sorts of inefficient sets to receive the modern broadcast programs and with the beginners even more inefficient than their sets, the amateur with the transmitting station has to comply strictly with all of the laws that Uncle Sam has made or else the inspector in his district begins to get complaints from the neighbors. Then there is trouble for somebody.

The radio inspectors all over the coun-

try are getting wrinkled and gray-haired as these complaints come pouring in. Oddly enough, most of these men are old "hard boiled hams" themselves and they agree with the amateur that the fuzzy growl or high-pitched shriek of the dot and dash code is the sweetest music in the world. But they are officials sworn to uphold the law and their personal sympathies have nothing to do with the case. If they find that an amateur against whom complaints have been lodged is exceeding his legal wavelength or is stepping on the gas too hard in the matter of power input or has not even a flirting acquaintance with that charming mystery of radio known as "Logarithmic Decrement," they have to walk in on him, pull back their coat lapel, show their badge and say gruffly, "Will you come quietly or shall I put the bracelets on?"

It remained for the inspector in the Third District to combine his hobby with his duty and thus reduce his worries by about 101½ per cent. Lieut. R. Y. Cadmus, popularly known as "Daddy" Cadmus, lives in Baltimore and has headquarters in the Custom House there. He is the radio daddy of all the good little boys who pound a mean fist from the District of Columbia to Trenton, New Jersey and all over the eastern half of Pennsylvania. The automobile is Cadmus' hobby; checking up on the shortcomings of his numerous radio children is his official duty.

With the rapid growth of amateur stations, he found it a tremendous job to investigate all of the complaints made by the enthusiast of the oatmeal box radiophone against amateur transmitters, because it was necessary to set up a perfectly calibrated receiving set within hearing distance of each station under suspicion. And it is no easy job to shove a wavemeter up against a strange aerial and take your oath as to the accuracy of the result!

Instruments of this kind are heavy and cumbersome to carry around anyhow; the mere problem of transportation is enough to make the average radio inspector quit his job.

So Daddy Cadmus combined his automobiling hobby with his calibrating duty and installed a complete testing station aboard his motor car. This is not a toy by any means, nor is it one of those affairs that are driven around the streets for advertising purposes and that have to be repaired every night to undo the damage done by the jolting of the car during the day.

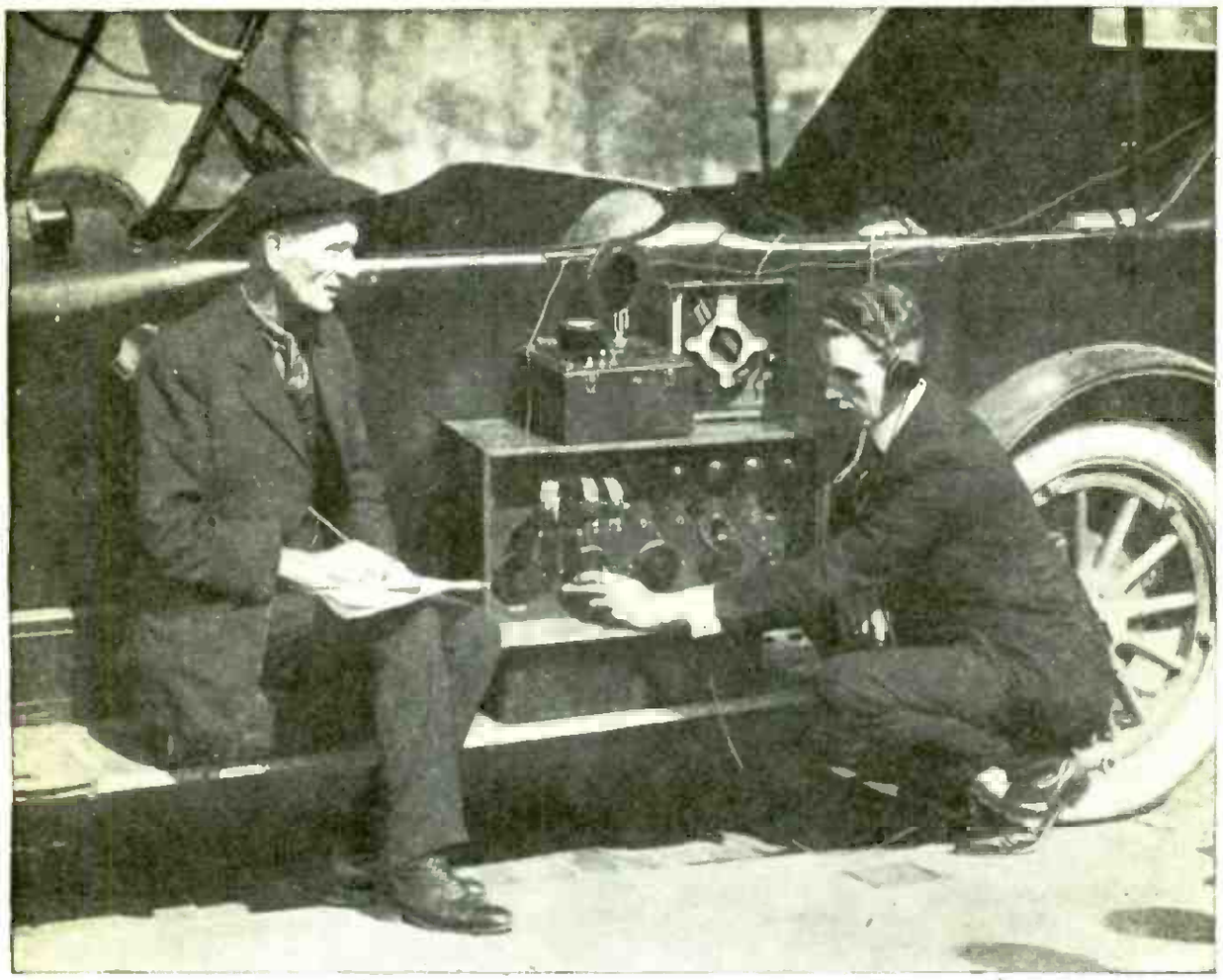
This station on wheels is built like a battleship so far as concerns what engineers call its "factor of safety." It has a miniature four-wire aerial strung between a steel mast on the front and another steel mast on the back, and these masts themselves are supported and braced by specially fitted steel arms that would almost do for bumpers if Daddy Cadmus should choose to try to push a freight car off the track.

On the back seat of the car is mounted a receiving set with a detector and two stages of audio frequency amplification, using the well-known three honeycomb coil circuit for tuning with variable condensers in each circuit.

When he first made this set Daddy Cadmus took it out in the country outside of Baltimore and experimented with it just to see whether it would be possible to get long wavelengths on such a short aerial. He was gratified to find that the big transatlantic stations came in like a ton of bricks on 20,000 meters with the use of 1,500-turn coils.

He then plugged in on the little baby outfits and found that he could get the amateurs; in this way he knew that he had a set that was good for his purpose. It was then merely a matter of placing a wavemeter in resonance and from then on he could read off the wavelengths of any station with a margin of accuracy that was astonishingly minute.

As soon as he had proved the success of his experiment he and his assistant, L. E. Richwien, of Baltimore (who in



HUNTING OVERGROWN WAVELENGTHS

By means of this portable apparatus, Inspector R. Y. Cadmus and his assistant, L. E. Richwien (3XT) traveled about in the Third District and in a little over two weeks checked up as many stations as would normally occupy their time for ten times that period.

his unofficial moments signs off "QTC nil nw OM 73 CUL GN de 3XT"), started on an inspection tour to see how much ground they could cover. There are not many so called "efficiency experts" in business houses who can point to such a saving of time.

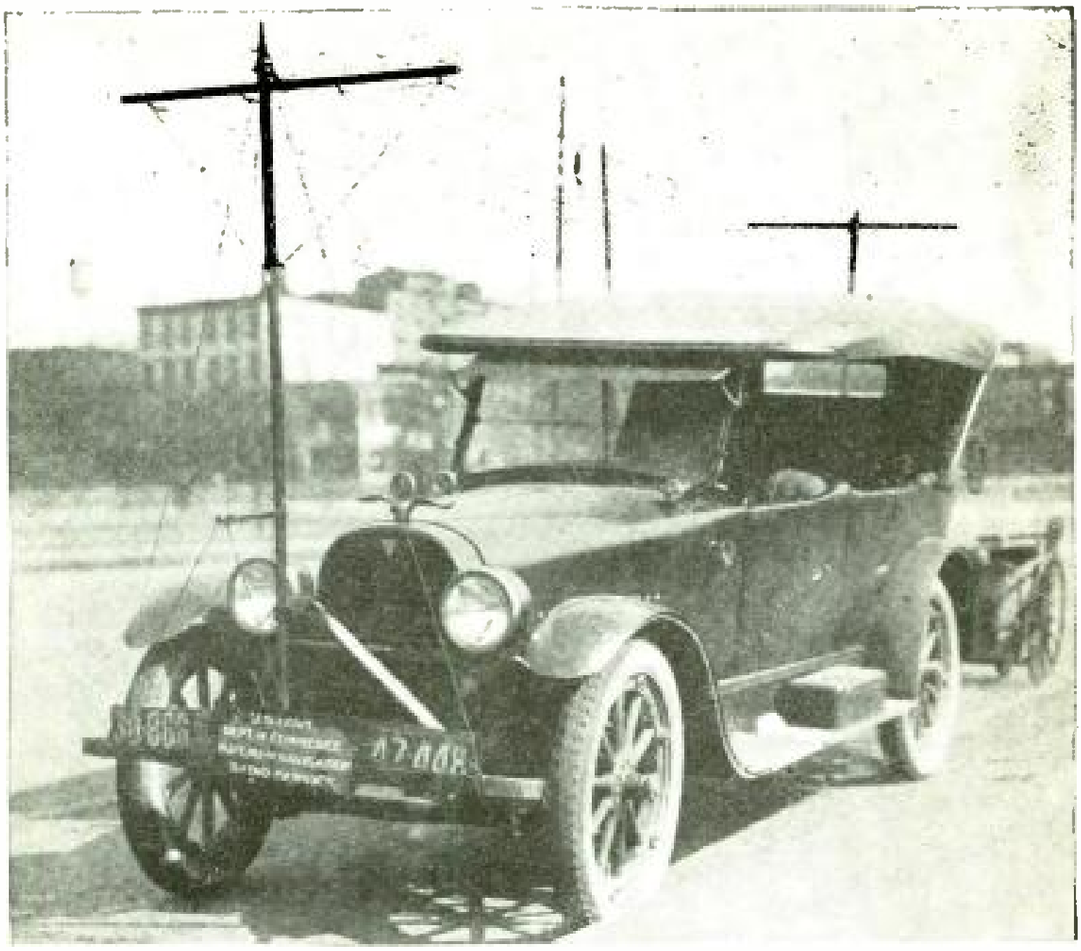
With this traveling station, Daddy Cadmus and Richwien checked up, in a little over two weeks, as many stations as they had been able to check up in between five and six months without it.

Cadmus admits that he did not observe union hours on this expedition. The two men spent their days flying from one station to another, personally inspecting each bit of apparatus; and they spent their nights at some advantageous locality outside of different cities listening in on all of the DX work and all of the plain key pounding going on in the ether about them.

First Richwien would put the receiving set and the wave meter on the running board and wear the phones while Daddy Cadmus stole a few hours' sleep on the back seat; then Daddy Cadmus would relieve him and Richwien would take the inspector's place among the blankets. In seventeen days these two men managed to spend three nights of sleep in their own beds at home.

Who wants to be a radio inspector now?

Although it has nothing to do with this traveling check-up station, Daddy Cadmus had some things to say about radio in general when I saw him on this trip.



THE RADIO SLEUTH ON THE TRAIL

With this essentially serviceable antenna system, the Inspector is enabled to pick up signals from transmitting stations ranging from the greatest transatlantic giants to the smallest of the amateur pygmies.

"Nobody can realize," he said, "the condition of chaos in an inspector's office with the present radio bill still pending before Congress. Every license that we issue now is for three months only and is marked *provisional* because nobody knows what Congress is going to do in the matter of technical requirements for transmitting stations and we cannot give a regular two-year license until the details are determined upon. Consequently we have been giving licenses good for only three months. This would not be so bad if we were permitted at the end of that time merely to write the word *Extended* across the face of the license. But we are not. We must forward new application blanks to each station and each station must go through all of the detail of filling out a complete description of its set, in duplicate, while we have to go all through once more the process of entering and filing and taking the oath and stamping and everything connected with the issuing of a new license. This applies not only to the amateur stations but to the broadcasting stations as well, so you can imagine the kind of job we have. In my district alone there are three clerks who have to work overtime every day on nothing but this matter of licenses.

"The past few months, remarkably enough, have shown a decrease of something like 40 per cent in the number of amateur transmitting stations that have applied for licenses, either new ones or renewals. This might seem to indicate that the interest in radio is dying out but my investigations show that the very contrary condition is the cause of it.

"Prior to a year ago, Sonny could lock

himself up in his own room and spend the whole night in perfect bliss 'chewing the fat' with his fellow hams within hearing distance of his spark gap. Father was probably away at the club and Mother was in the kitchen washing the dinner dishes and Sister was probably fox-trotting around the parlor with a dude in a high collar just home from college.

"But is Sonny allowed to have any such joyous evenings by himself these days? He is not.

"As soon as the good radio weather came in in the fall, Father stayed home from the club and Mother let the dinner dishes go until next morning and Sister brought the dude upstairs and introduced him to the family and the whole crowd took Sonny's favorite chairs in Sonny's room and insisted on Sonny tuning in on the nearest 360-meter broadcasting station and putting it on the loudspeaker. By the time the concert was over it was time for Sonny and everybody else to go to bed.

"Then they heard about improvements that could be put on these receiving sets and they had to have radio frequency and audio frequency amplification and the money that Sonny might have put in a new motor generator or a 500-cycle rotary gap went for apparatus that would make enough noise so that "Uncle," two blocks away, could hear the howling of the oscillating bulbs even if he could not make out any of the music.

"After about six months of this, Sonny simply shuts down his set in disgust because Father and Mother and Sister and the high-collared dude have all learned to twist the knobs, and Sonny is lucky if he is allowed in the room at all. Consequently when his transmitting license expires it is not worth while for him to apply for a renewal. All of the apparatus in his old set has gotten rusty or is falling apart and the money that he might have used to repair it has been spent on the family receiving set."

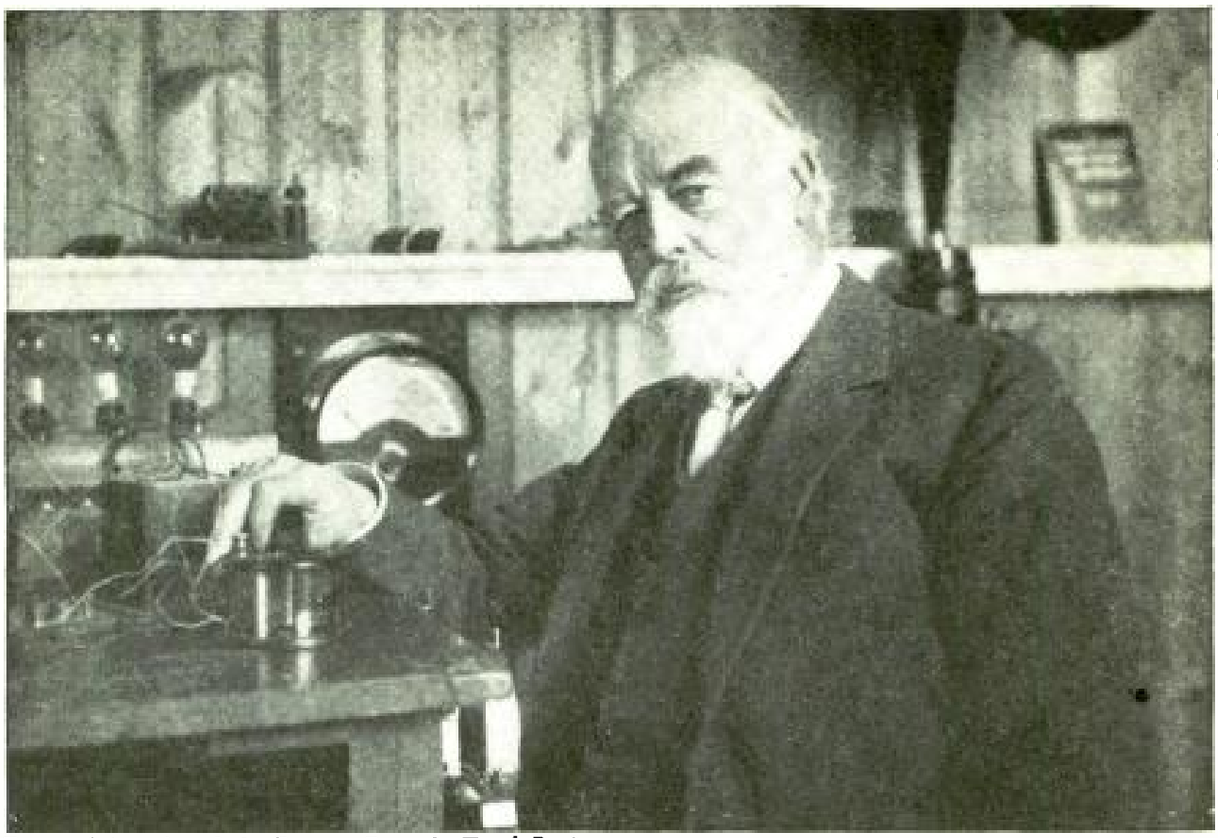
That does not sound as if Daddy Cadmus' idea of a perfect evening was listening to a broadcast concert, does it? Well it is not.

Daddy Cadmus is a "hard-boiled ham" himself and there is no music in the world to him quite so sweet as a good, clean fist, shooting code at something like 25 to 30 words a minute on a 500-cycle note.

Maybe that is an old-fashioned view to take of radio but there are a lot of us old timers, fast dwindling into a pathetic minority, who still feel that way about it.

How to Use Your Radio Set on Your Vacation

IN *the next number of* POPULAR RADIO *Mr. William F. Crosby will tell in specific and helpful detail just how to rig up your receiver in your camp by the water or in the woods, and how to install it on your motor car. The author is one of the most experienced men in the country on installations of this kind, and his article will be fully illustrated not only with numerous hook-up diagrams but also with photographs of actual—and successful—vacation sets in practical use.*



From a photograph made for POPULAR RADIO by Hoppé, London

A SCIENTIST WHO DEMONSTRATES HIS THEORIES BY PRACTICAL EXPERIMENT

The importance of coils in both receiving and transmitting sets can hardly be overestimated. In this article the distinguished English scientist, Sir Oliver Lodge, gives the results of his laboratory investigations that are of incalculable value to the radio amateur.

HOW TO GET THE MAXIMUM INDUCTANCE IN YOUR COILS

Third of a Series of Articles Written for POPULAR RADIO by—

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

THE conditions under which a coil can have maximum self-induction (inductance) for a given length of wire seem to have been laid down by the great mathematician Gauss, in or about 1865, but in what form that can have been then done I do not know. Anyhow, Clerk Maxwell, in his great treatise published in 1873 gives a number of complete formulas for inductance, and clearly specifies the condition for its maximum. He evidently paid great attention to the subject of mutual and self-inductance, probably in connection with his determination of the absolute value of the ohm (or "British Association Unit," as it used to be called then).

The first condition is that the winding should be as compact as possible, so as to bring every part of the wire as close as possible to every other part, so that as many as possible of the lines of force, due to each, may thread the others. That will be achieved by making the cross section of the winding on the coil either round or square, not oval or oblong. That much is obvious, because that is the most compact shape: but it is not at all

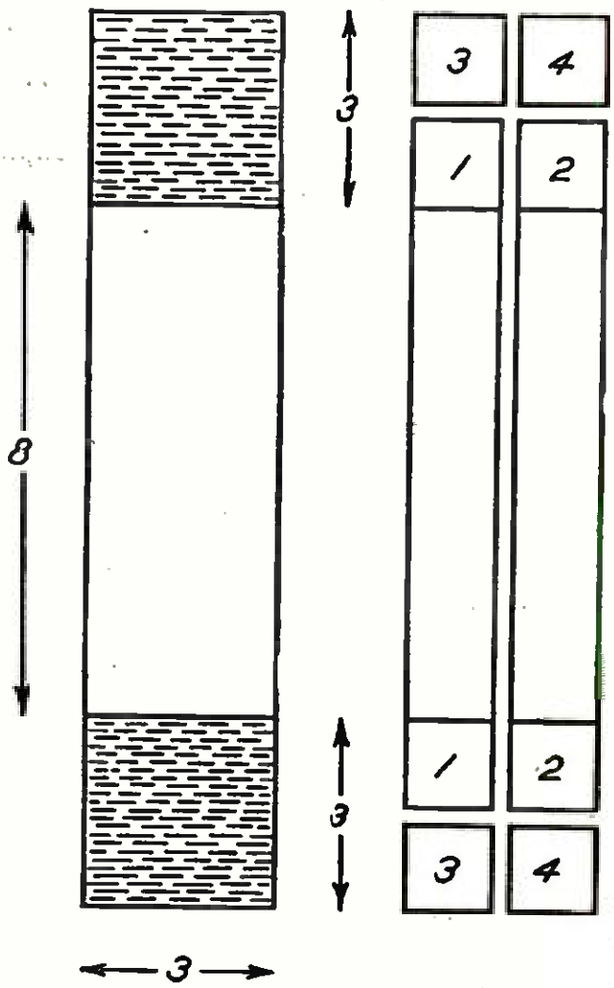
obvious how big the diameter of the coil should be in proportion to the size of the channel which contains the winding. That is what has to be worked out mathematically.

Although the working out may be considered complex, the result can be stated with great ease. Taking the channel for the wire as square, the outside diameter of the coil must bear, to the inside diameter, the ratio 47/27, which for all practical purposes is the same as 7/4, or 1¾. Hence the shape of the coil which gives maximum self-induction is as drawn to scale in the diagram (Figure 1), the breadth and depth of the winding being 3, the internal diameter 8, and the external diameter 14. For the present, we may take that as granted; and in this shape, no matter whether the turns are packed close together or not, the coils employed in radio ought to be wound (though they seldom are). That is the best and most efficient shape; and by adhering to this shape—other things being equal—the deleterious capacity and resistance in the coil are reduced to a minimum.

It need not be supposed that the shape must be very *precisely* adhered to. It is a common property of maximums and minimums that a slight fluctuation on either side makes but a small difference. This shape is the ideal to aim at, but some variation is allowable.

For instance, suppose (having made one coil), we want to put another alongside of it, and in series with it; the inductance will be immensely increased by an amount which is quite well known if the positions are given. But the shape will no longer be the best. Still, the difference is not very important; and something like the best shape can be restored by having four coils instead of two, and putting them in pairs side by side, with one pair big enough to fit over the other, as indicated in the diagram (Figure 1). Numbering the four coils 1, 2, 3, 4, it will be best to connect them together in that order, so that the extremities of the wire, at which the greatest difference of potential will occur, are as far separated from each other as possible. The connection 1, 2, 4/3, or 1, 3, 4, 2, is slightly less desirable.

The effect of putting one coil outside of another, instead of side by side, is that the mean radius of the whole winding is increased somewhat: otherwise the expression for the inductance is the same in the two cases. It is as broad as it is long, so to speak. Or rather, whether the length exceeds the breadth, or the breadth exceeds the length, makes no difference. That is not obvious, but so it



THE BEST SHAPE FOR COILS

FIGURE 1—*At the left is shown the dimensions for a single coil; at the right is shown the arrangement of a number of coils that can be connected in series, and that will still keep the best shape for inductance. For maximum results and to insure the lowest distributed capacity they should be connected as they are numbered: 1, 2, 3, 4.*

A THREE-LAYER COIL

This coil is tapped so that various inductance values may be used to facilitate changes in wavelengths ranging from 150 meters up to 3,000 meters. It will be noticed that this coil complies rather closely with the maximum inductance conditions so far as its shape is concerned.

A FIGURE-EIGHT COIL

This special type of coil has the wires run in the form of a figure eight. It is usually used in cases when some form of looscly coupled coil is suitable. The coupling between two such coils may be varied by simply revolving one of them upon its axis throughout a revolution of ninety degrees.

A HONEYCOMB COIL

This coil, which is widely used here in America, adheres closely to the ideal for maximum inductance. With this type of apparatus it is easy to obtain fairly close coupling by placing two coils side by side. The coupling is varied merely by drawing the coils farther apart.

comes out from the formula, which is symmetrical as regards length and breadth of cross section.

The advantage of a combination of coils, like this, is that it enables the wavelength to be easily changed; that is to say, it enables a coil to be selected which shall give approximately the order of wavelength required, fine adjustments being done by means of supplementary variable condensers, or by a separate variable inductance, or both. But we will not trouble about these tuning details, which are quite well known and understood.

Although I have emphasized the value of a maximum inductance shape, such considerations must not be allowed to override practical convenience; and, instead of packing coils into a square section, it is usually much more convenient

A TRANSMITTING HELIX

This type of coil is made of edgewise-wound copper strip instead of wire. The coil is held in shape by means of insulating spacer-rods which are slotted to fit the copper strip. The main advantage of this form of coil for transmitting lies in the large conductive surface area which is offered to the passing currents.

A BANK-WOUND COIL

In this coil the litzendracht wire is wound around a sort of circular ladder. This formation eliminates a large amount of useless insulating material from within the magnetic field of the winding, and cuts down the "hysterisis" losses in the insulation.

ANOTHER FORM OF MULTIPLE-LAYER COIL

Each layer of the winding of this coil is separated from the next consecutive layer by a snake-like layer of wire which is interposed between the main layers. All of the wire in the coil is connected in the circuit, however, which makes this coil exceptionally efficient.

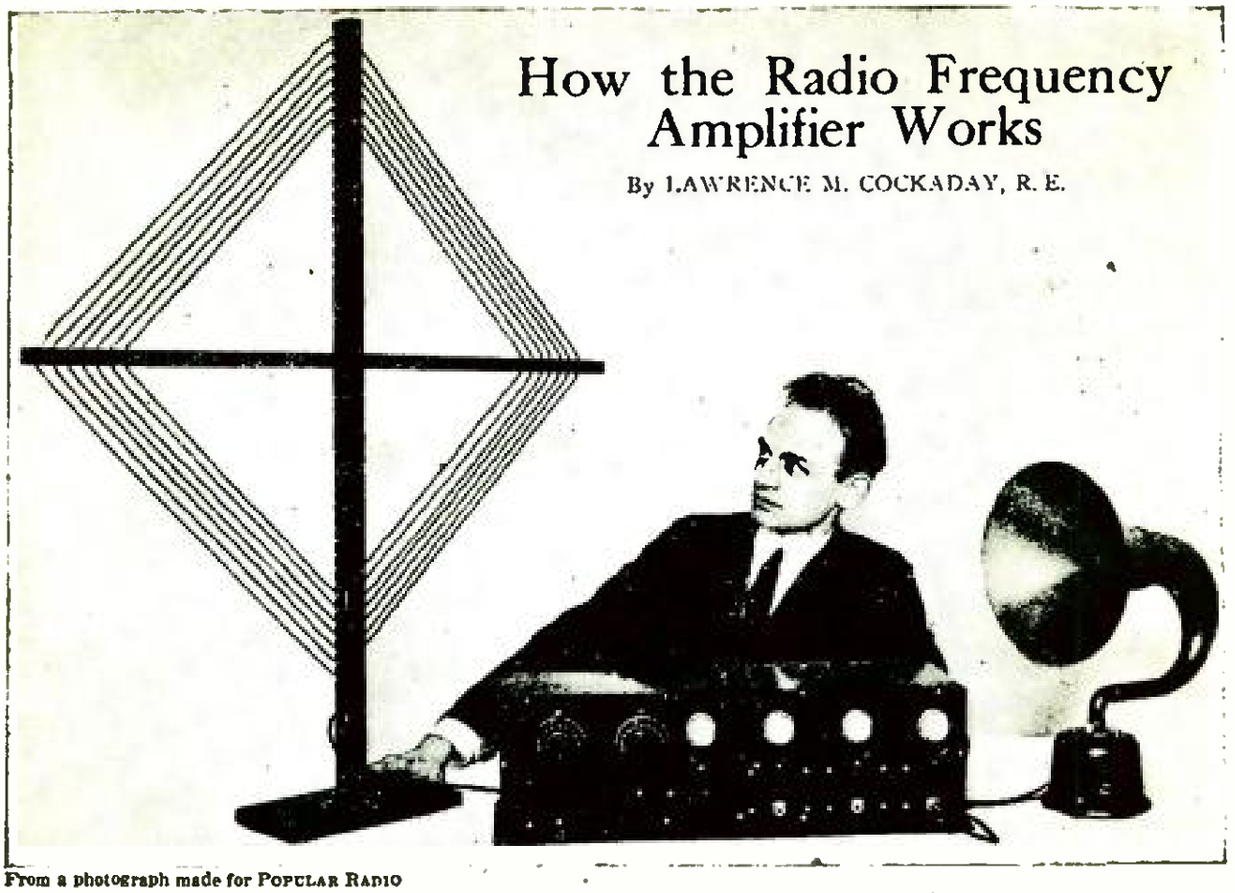
to arrange them either side by side, or one outside the other. That is to say, to arrange them so as to form either a cylinder or a disc. And again, such an arrangement *has* an advantage; for, though the inductance will be less than it might be with a given length of wire, the terminals are thereby kept far apart, and the capacity is therefore also diminished. Hence I do not propose to consider any arrangement except one or other of these plans for the construction of multiple coils.

When we are dealing with the single coil, however, there is no question but that the best shape is as stated before, that is to say, one with an external diameter of 14, and an internal diameter of 8.

Further details about this we will consider in a succeeding article.

How the Radio Frequency Amplifier Works

By LAWRENCE M. COCKADAY, R. E.



From a photograph made for POPULAR RADIO

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—No. 9

A beginner's first vacuum tube set usually includes simply a tuner and one vacuum tube as a detector. When he has mastered this set, his next thoughts are directed toward methods for amplifying the received signals; at this point it is always a question in his mind whether to use radio or audio frequency amplification. This article (see also "How the Audio Frequency Amplifier Works" in POPULAR RADIO *for February, 1923) tells not only how the two methods work but also their particular uses and advantages.*

IN the last article of this series we stated that cascade amplification of radio signals could be divided into two classes, as follows:

First, audio frequency amplification.

Second, radio frequency amplification.

Audio frequency amplification is cascade amplification of the rectified impulses which are flowing in the plate circuit of the detector tube. These impulses are of an audible frequency and the successive stages of amplification are coupled together with "audio frequency amplifying transformers," which step up the voltage of the audio frequency impulses and supply them to the grid circuit of the next tube.

Radio frequency amplification is cascade amplification of the impulses of radio frequency current received from the antenna circuit of a receiver before they have been rectified by the detector tube. The successive stages are coupled together with radio frequency transformers.

In the article "How the Audio Frequency Amplifier Works" in the February issue of this magazine, we studied the functioning of this type of apparatus fairly thoroughly; those readers who have read this article should understand its fundamentals clearly.

Before we take up the subject of how the radio frequency amplifier works, however, let us learn of one of the disadvantages of audio frequency amplification.

The detector tube receives radio fre-

quency oscillations and turns them into pulses of direct current. But *the impulses must be of a certain strength before the detector will respond to them.*

Let us consider the case of a receiving set that employs a vacuum tube detector and two stages of audio frequency amplification. The set is installed in a city. Signals from stations located in the city were detected and received with such volume as to be unbearable. This is because the detector delivered a fairly large impulse to the amplifiers and they further strengthened them to an enormous value. Signals from stations, say 500 miles away, were only just audible with the detector alone, but when the amplifiers were used they were comfortably audible; the amplifiers took the feeble current from the detector and strengthened it. Signals from across the other side of the country, however, were too weak to be detected by the detector tube and so the amplifiers were supplied with no current; thus no signal was heard.

This difficulty of the audio amplifier may be summed up in the following statement.

The audio frequency amplifier will not function on a signal unless the signal is of sufficient strength to operate the detector tube and thus supply an audio impulse to the amplifier. This is true no matter how many stages of amplification are used. Audio frequency amplification has its use, however, as it is the most efficient method for getting a loud signal when the initial signal is strong enough to operate the detector tube.

Radio frequency, on the other hand, has just the opposite characteristics; by its use, weak distant signals are amplified, but they cannot be increased by this method to a value strong enough to operate a loudspeaker satisfactorily. Radio frequency amplification strengthens the feeble oscillations received from the antenna circuit until they are strong enough to be detected by the vacuum tube detector.

In other words radio frequency amplification takes place *before* the signals are rectified by the detector and audio frequency amplification takes place *after* they are so rectified.

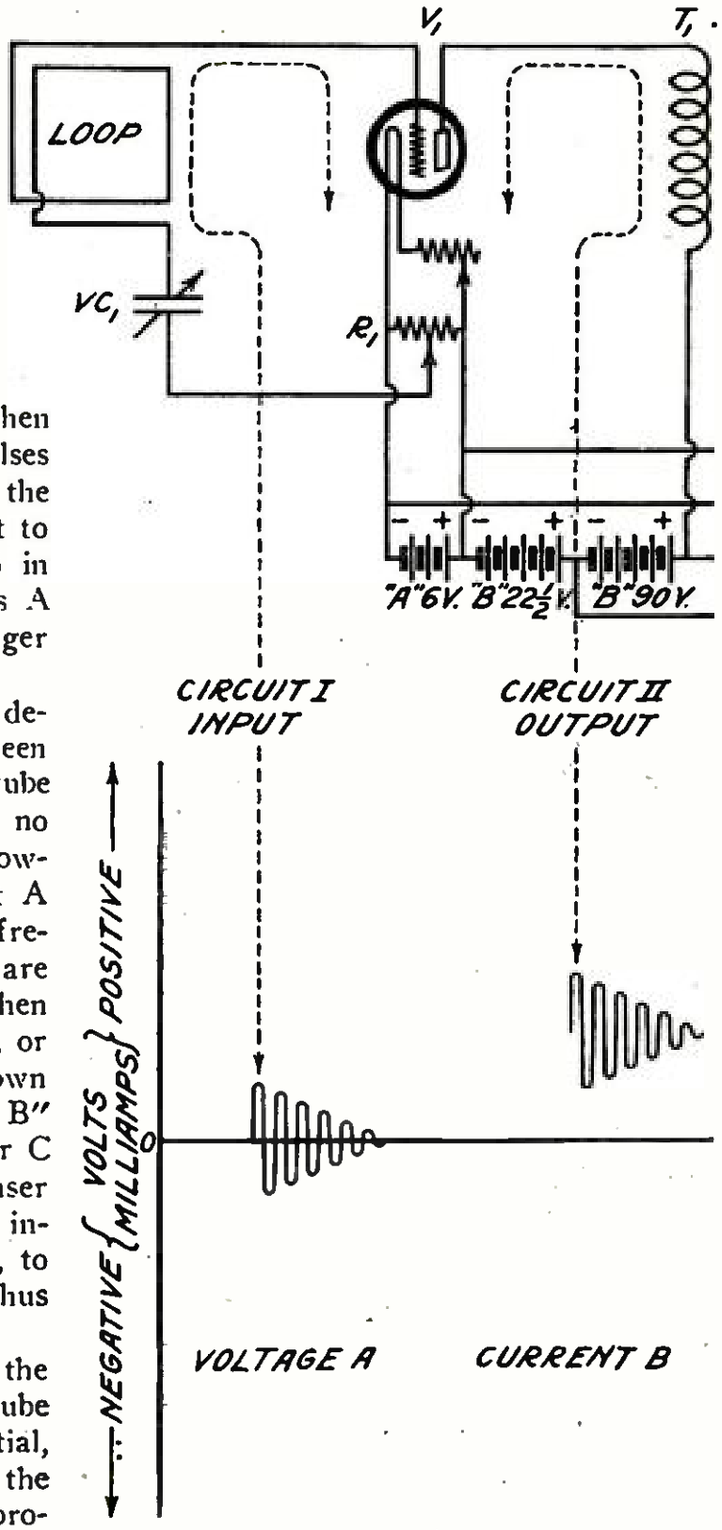
So much for the general explanation. Let us now see how the radio amplifier works.

In the diagram (Figure 1) is shown a conventional circuit with two stages of radio frequency amplification, and a vacuum tube detector, that employs a loop antenna. The tuning elements consist of the loop inductance and the variable condenser VC. The first stage of amplification consists of the tube V1; this is coupled to the second stage tube V2 by means of the radio frequency amplifying transformer T1. The second stage is coupled to the detector tube V3 by means of a second transformer T2, which is started by a condenser VC_2, and which supplies the amplified radio frequency impulses to the detector tube for rectification.

A weak impulse (much too feeble to operate a detector tube, let us say) is received by the loop and tuned by the condenser VCI. This high frequency impulse flows through the input circuit I and impresses a tiny voltage wave A on the grid of the amplifier tube V1. The relay action of the tube reproduces this wave form in its plate circuit II and causes a current B to flow through the primary winding of the transformer T1. (This type of transformer is unlike the audio frequency transformer in that it has an air core and readily passes high frequency currents through its windings, whereas the audio transformer has an iron core and passes only low frequency currents.) The voltage of the impulses is stepped up by the transformer T1, and supplied by its secondary winding to the grid of the tube V2 in circuit No. III. This voltage is shown at A′; by comparison with A it will be seen that it has been increased considerably. The tube V2 then responds to this voltage A′ and a current wave B′ flows in its plate circuit IV, through the primary winding

FIGURE 1

This diagram and chart show how the successive stages of amplification increase the minute voltages and currents of radio frequency energy until even the weakest signals are reinforced enough to be detected by the vacuum tube detector. This amplification is done BEFORE *the signals are detected.*



of the transformer T2. Comparison of B and B' will show a great increase in the current value. The transformer T2 then steps up the voltage of the impulses and impresses a voltage A" on the grid condenser GC which passes it to the grid of the detector tube V3 in circuit No. V. Compare Voltages A and A". A" is very much stronger than A.

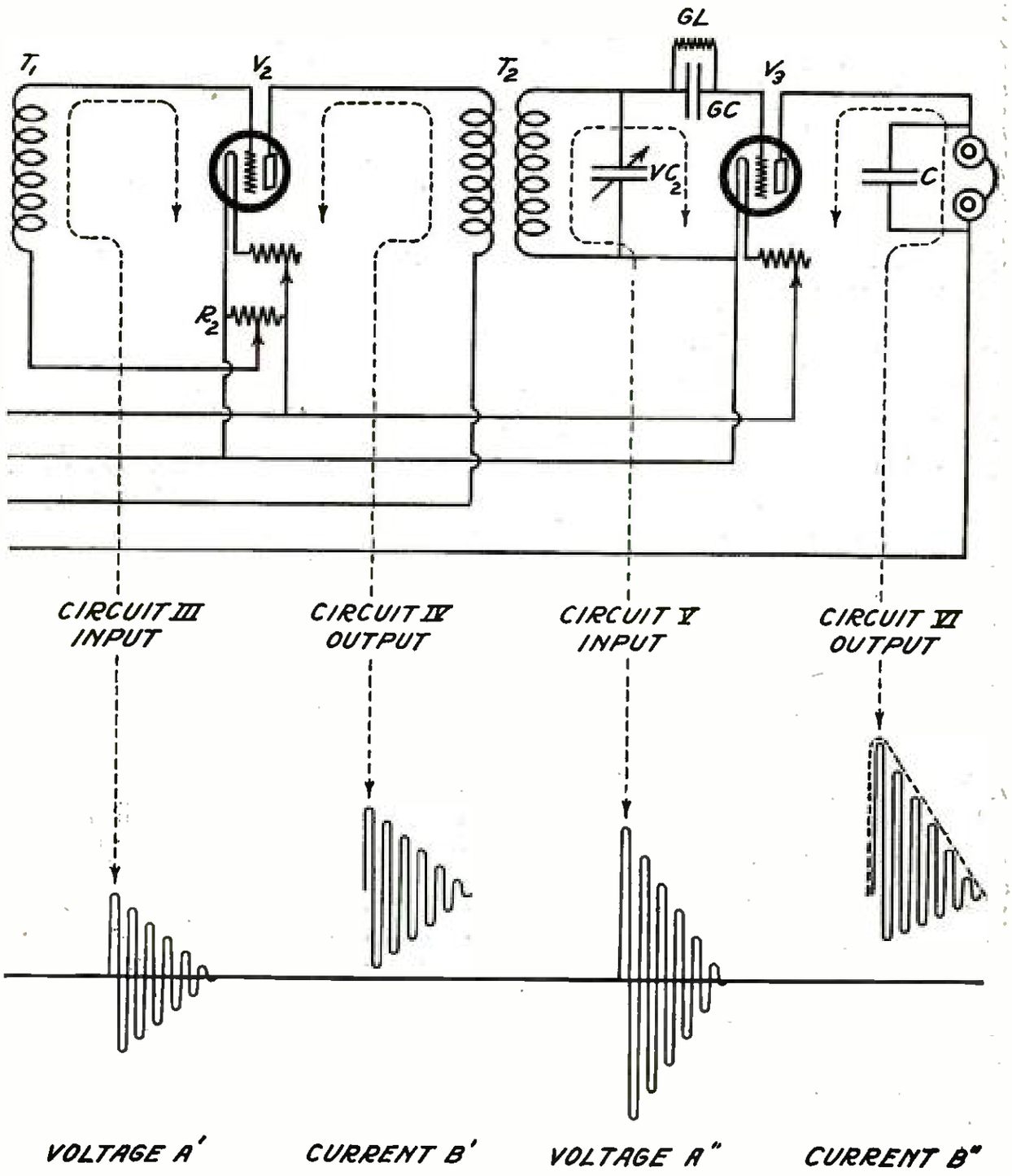
If A had been supplied to the detector tube direct, it would have been too weak to be detected by the tube V3 and there would have been no response in the plate circuit VI. However, the weak impulses shown at A have been amplified by the radio frequency amplifier until they are strengthened as shown at A", when the tube V3 is able to detect them, or in other words, rectify them as shown at B" in circuit VI. This current B" flows through the bypass condenser C and the voltages on the condenser cause a low frequency current, as indicated by the dotted lines in B", to flow through the telephones T thus producing audible sounds.

It must be borne in mind that the impulses on the grid of each tube oscillate about its free grid potential, and to secure maximum results the potentiometers R1 and R2 are provided as means for adjusting this free grid potential with respect to the filament.

By means of radio frequency amplification, then, distant signals may be easily heard without the use of audio frequency amplifiers, that could never be heard with any number of stages of audio frequency amplification if radio frequency amplification were *not* used to strengthen them.

This same sensitivity of the radio frequency amplifier makes it suitable for use with the loop antenna, which collects only an extremely small amount of energy, where the audio frequency amplifier *alone* would fail.

The use of radio frequency amplifica-

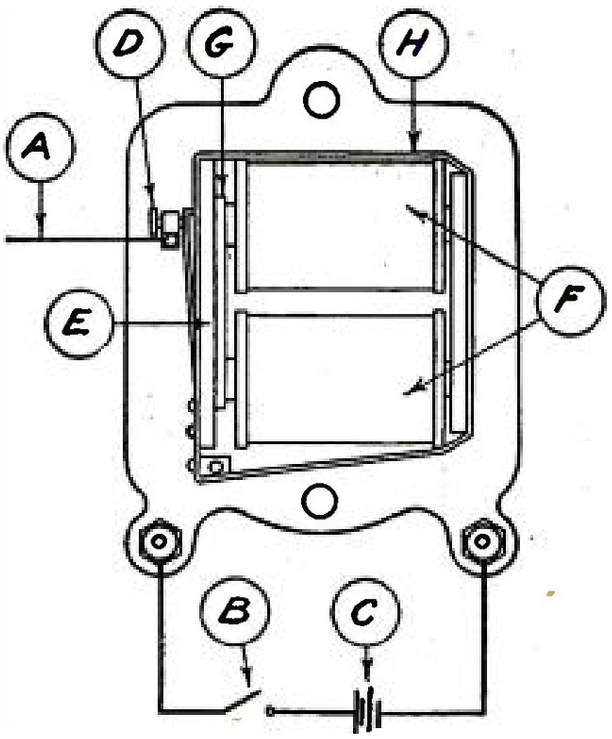


tion with a loop antenna for building up the strength of the feeble impulses so that the detector tubes can detect them, combined with the use of the audio frequency amplifier to increase these audible impulses to sufficient strength to operate a loudspeaker, makes an ideal set for listening to broadcasting. And not the least of its virtues is the fact that it may be assembled complete in a case similar to that of a phonograph, with batteries, tubes, loop and all; no outside connections are necessary.

In summing up, the use of audio frequency amplification is limited to signals which are strong enough to be detected, when this method will increase the volume tremendously. The use of radio frequency amplification is for increasing the strength of feeble impulses that are not strong enough for a detector to pick up alone.

THE PARTS OF THE BUZZER TEST ARE—

A is the wire that should be connected to the ground wire of the receiving set; B is a simple push button switch; C is a couple of dry batteries; D is the adjusting set screw; E is the armature; F shows the magnets; G is a small piece of cardboard, and H is a rubber band.



How to Make a Simple Buzzer Test at Home

By RICHARD LORD

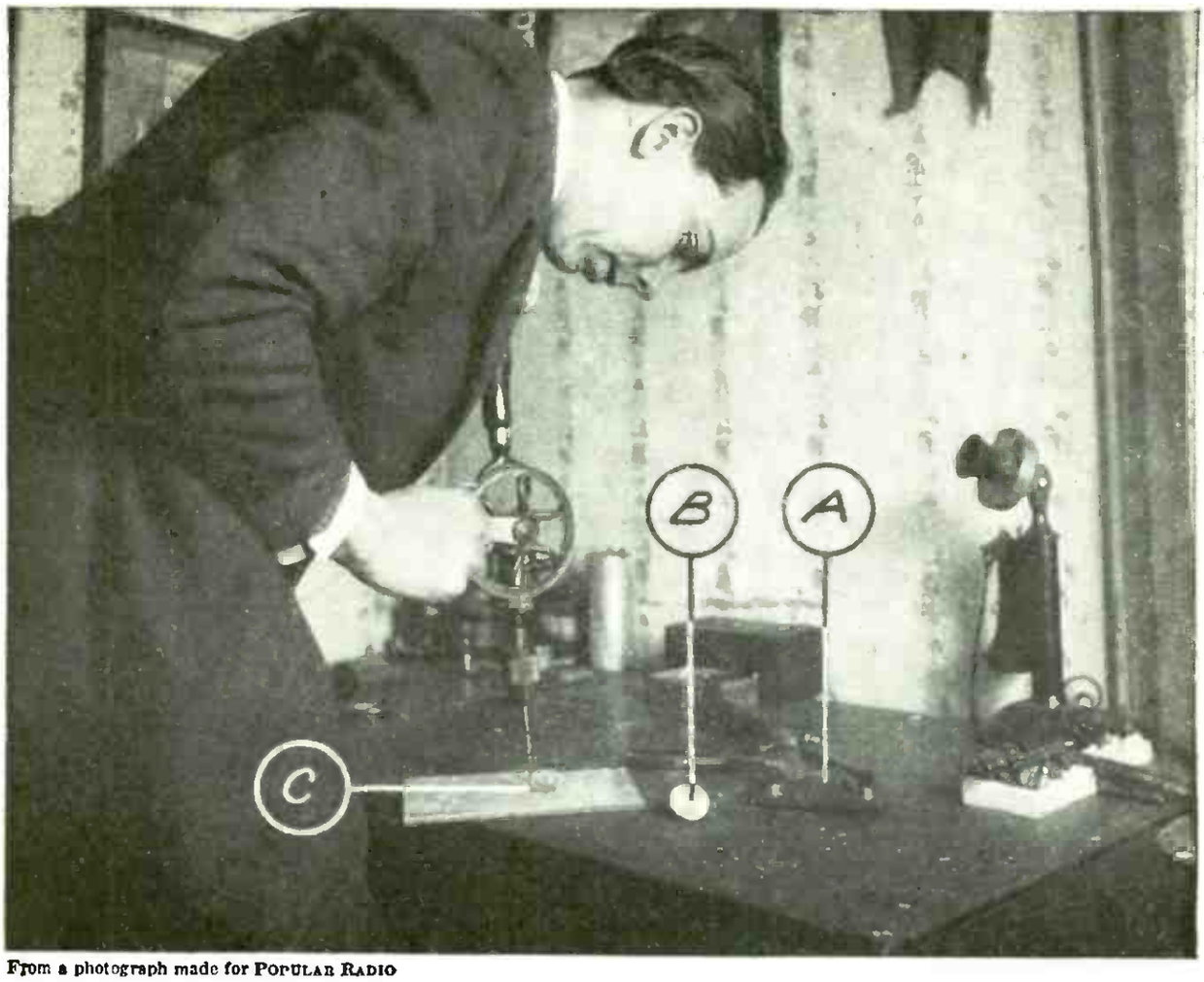
THE amateur who has had trouble with his crystal detector will welcome this word of practical advice from an experienced New Jersey fan; it tells how the trouble can be eliminated:

Aside from the fact that the buzzer test aids the amateur considerably in locating sensitive spots on a crystal, it is a real help in preventing the fading out of signals; merely by pressing the test buzzer switch the signals may be brought back to their former strength. One theory offered in explanation of this phenomenon is that a slight film of oxidation forms between the cat-whisker and the crystal, thereby reducing the strength of the signal. The pulsations of current from the test buzzer seem to break down this film and to permit better contact.

For the dyed-in-the-wool fan who must have the best of everything, there is on the market a high frequency buzzer which gives an especially clear, even, and pleasing note in the phones. However, the cost of this buzzer is beyond the reach of some of us; for these an ordinary buzzer can be made to serve admirably. A piece of cardboard or folded paper placed between the heavy iron armature and the contact spring (as shown in the diagram on this page) produces a fairly high and even tone. A rubber band placed as indicated in the diagram will also be found advantageous in obtaining a high note. After the buzzer is obtained it is connected in series with some kind of a switch, and one or two dry cells. One of the most convenient switches, in the writer's estimation, is nothing more than a simple electric push button.

An examination of the buzzer discloses a little adjustable screw, which makes contact with the vibrating armature. To this one end of a wire is fastened; the other end is connected to the ground wire of the receiving set. In some types of loose-coupled sets it will be found that this type of connection will not give satisfactory results; if such is the case, connect the latter end of the wire directly to one side of the detector, rather than to the ground lead. This connection will invariably work.

It is advisable to place the buzzer in a small box, so as to eliminate mechanical noises as far as possible. Fill the box half full of absorbent cotton and place the buzzer on this cotton. Then fill the box entirely full of cotton and put the cover on, leaving, of course, the leads projecting out. This box may then be suspended from under the table; it will be found practically impossible to hear the buzzer while in operation.



From a photograph made for POPULAR RADIO

This detector with a light spring adjustment, which uses either galena or iron pyrites, consists of (A) the base and adjusting arm, (B) the cup which holds the crystal, and (C) the upright upon which the cup is mounted.

How to Make a Light-Contact Detector

By LEROY WESTERN

EVERY true experimenter in radio at some time or other has used a crystal detector, for as a beginner he started out with a crystal receiving set. Those who are now starting out on their radio experiments will be interested in the detector here described; the time spent in its construction will be fully compensated for by the ease with which it may be adjusted.

The first consideration is the crystal. There are many kinds which can be used in connection with this detector, such as galena, iron pyrites (ferron) and silicon, to mention but a few. Galena is probably the best known and the most frequently used, but a little experimenting will show the amateur that some of the others are just as good, certain ones in some ways better. For instance, sensitive specimens of iron pyrites, while considerably more difficult to find than sensitive galena, give equal results and retain their sensitiveness for a long period of time. This crystal is generally used with a stiff phosphor bronze spring, the end of which is pointed.

In the construction of the detector first select a base of hard wood, or better still, hard rubber or bakelite, 4 inches long by 2½ inches wide. Drill four holes in this base, as shown in the diagram. Get a brass ball ¼ inch in diameter; drill a hole through the center of it which

will make a snug fit for a ⅛-inch brass rod. Next procure a piece of ⅛-inch brass rod 2 inches long, and thread each end for half an inch. Screw onto one end of this rod a suitable knob and pass the other end through the brass ball. Screw two nuts on the threaded end and fasten a coil spring of phosphor-bronze wire between them as shown. A standard for holding the ball is then made of brass in the form of a square U as indicated.

Now make another standard from a brass strip ⅛ inch thick by ½ inch wide in the form of an L to support the detector cup.

For the detector cup obtain a brass cup, 1¾ inches in diameter, either with or without a mounting screw. If the cup has no mounting screw it will be necessary to drill a hole in the center of the cup and pass the screw through it. A quantity of soft metal for mounting the crystal may be made by dissolving as much tin foil as possible in one ounce of mercury. Knead the mass together thoroughly and heat. When it becomes molten, pour it into the cup and press several crystals of various kinds into its surface.

It is important not to heat the metal any more than is necessary to melt it, as otherwise injury to the crystals may result.

Several pieces of various kinds of mineral may be mounted in the detector cup and their various receiving qualities thoroughly tested against each other. A phosphor-bronze wire spring will serve for most types of crystal, but a gold wire is superior as its point will not easily oxidize.

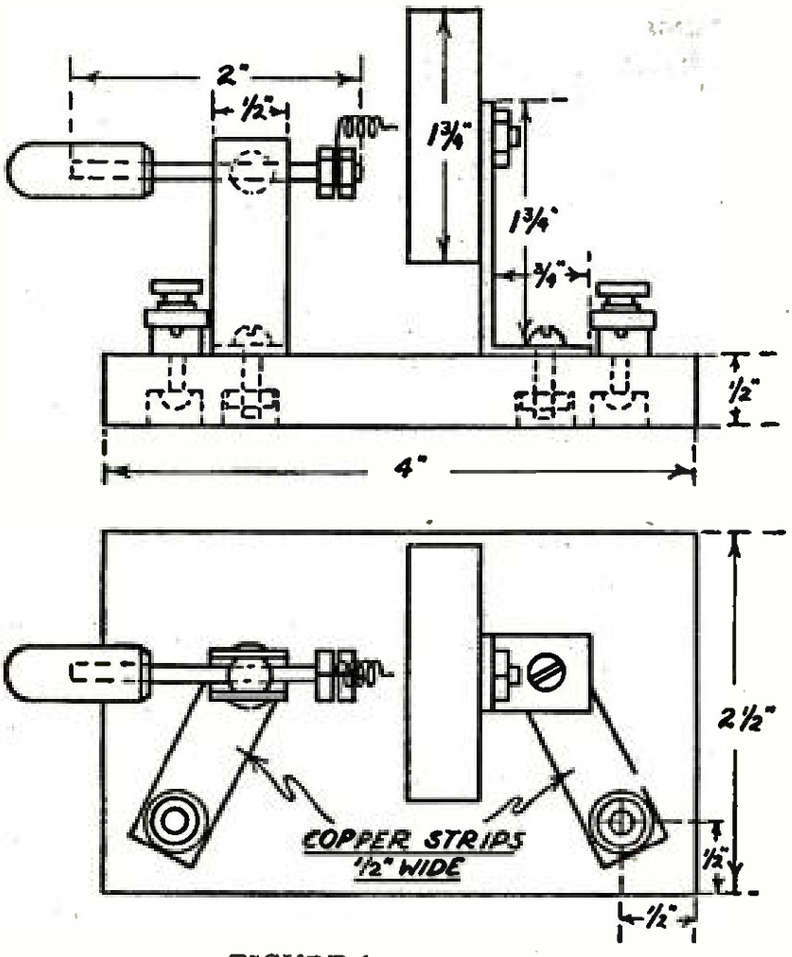


FIGURE 1

This diagram gives the side view (at top) and the top view (at bottom), together with the dimensions of parts of the detector.

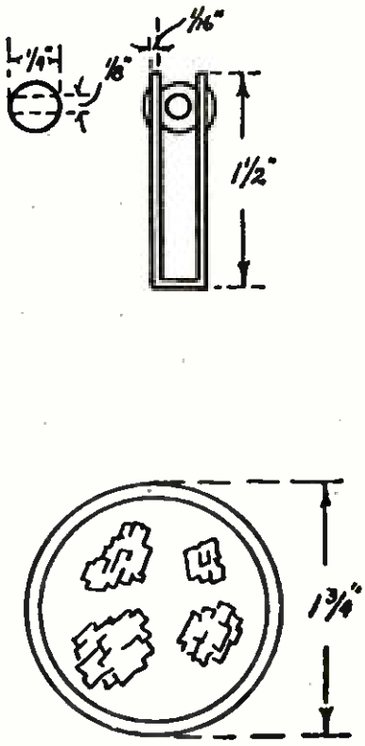


FIGURE 2

This diagram shows the dimensions for the universal joint of the adjustment arm (at top) and the manner of mounting the crystals (at bottom).

¶ I consider this Four-Circuit Tuner the most important contribution to the equipment of the radio amateur since the invention of the Super-Regenerative Set.

—EDITOR

From a photograph made for POPULAR RADIO

The set as it appears in actual use—small enough to keep in a bureau drawer. The demonstrator is the inventor, Laurence M. Cockaday (2XK).

HOW TO BUILD THE NEW

FOUR-CIRCUIT TUNER

A new and unusual development in vacuum tube control circuits that is exceedingly selective, simple to operate, highly sensitive (it has a verified C. W. range of 3,200 miles and a telephone range of 2,400 miles)—and that CAN BE BUILT FOR LESS THAN $40.00!

BY THE TECHNICAL EDITOR

THE ideal receiving set should have the following five qualifications if it is to meet the needs of the discriminating radio amateur:

A—absolute elimination of interference;

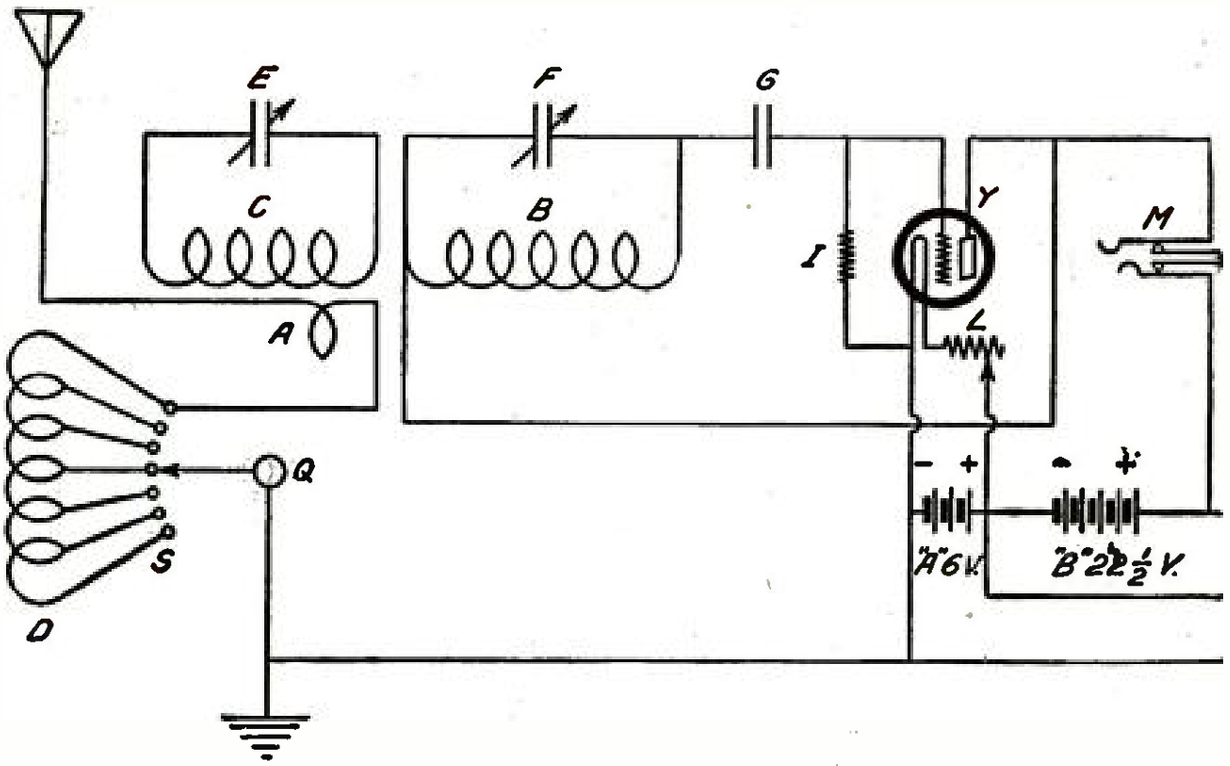
B—unlimited distance range;

C—ease of tuning;

D—truthful reproduction;

E—low cost.

A, B, and C are dependent upon the method of tuning used and the system of



detection. D and E depend more closely upon the type of amplification that is used.

In designing this set we have had these goals in view.

First, therefore, we have determined to use extremely loose coupling to insure the quality A; looser, in fact, than used in any other type of receiver. The step-up voltage ratio of the receiving transformer is 65 to 1. This insures an extremely high grid voltage even from weak signals.

Second, to insure a maximum distance range, and at the same time secure simplicity of tuning, and to hold the cost of construction to a minimum, we have decided to use the regenerative method of amplification as the closest approach to the ideal yet disclosed.

The main shortcomings of the standard regenerative circuit are well known; they may be summarized as follows:

a. A change in wavelength makes necessary a change in the regenerative control to keep the regeneration at a maximum.
b. It is extremely difficult to keep the circuits "stable," so that they will stay at the maximum amplification point. This is due to the fact that changes in the constants in the antenna circuit react on the grid circuit and throw the circuits in and out of resonance so that they oscillate for a few seconds and then cease, causing signals to come in strong for a while and then to die out, and also causing squealing at intervals.

Third, therefore, we have chosen a more simple method for controlling regeneration; it consists of an inductively-coupled stabilizer circuit whose function it is to vary the effective A. C. resistance of the grid circuit of our tuner. This circuit is electrically isolated from all the other circuits in the receiver, but it is placed directly within the magnetic field surrounding the grid coil. It consists of a low-resistance coil shunted by a variable condenser which when it is rotated varies the reaction between the grid circuit and its own circuit.

It is well known that the vacuum tube in a circuit will produce sustained oscillations when the negative resistance of the system equals the positive resistance of the system. The standard regenerator accomplishes this result by varying the negative resistance upward to the correct value.

This new circuit we have evolved, however, accomplishes the result by varying the positive resistance, downward, to the correct value. In the new method

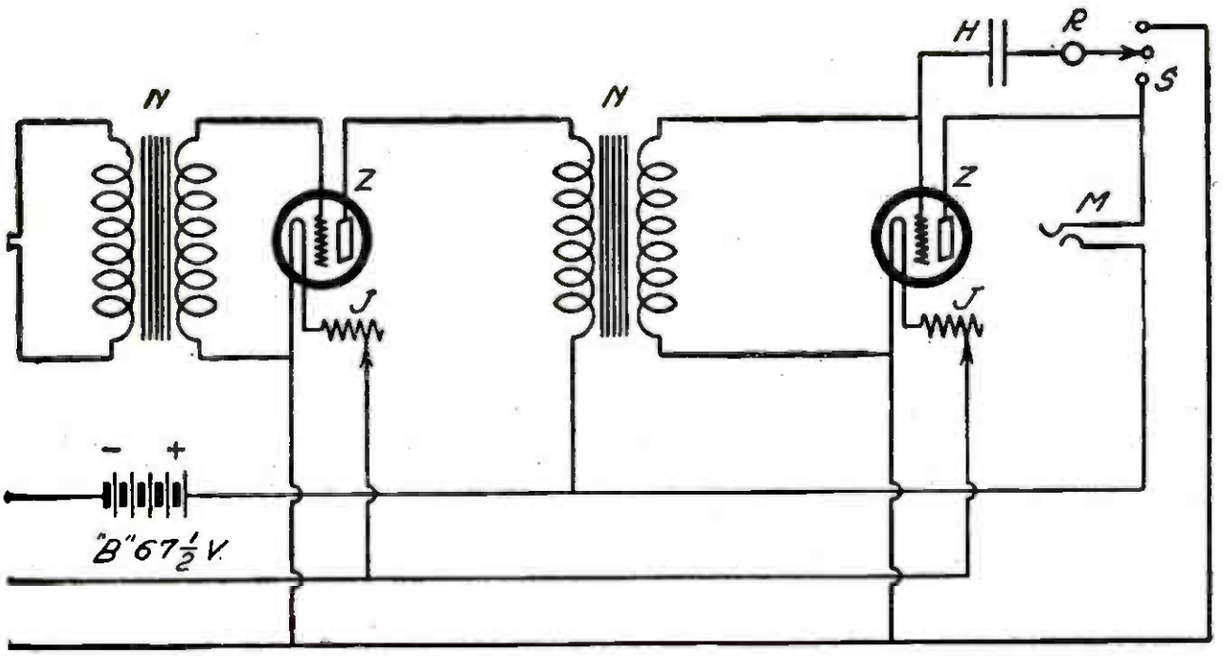
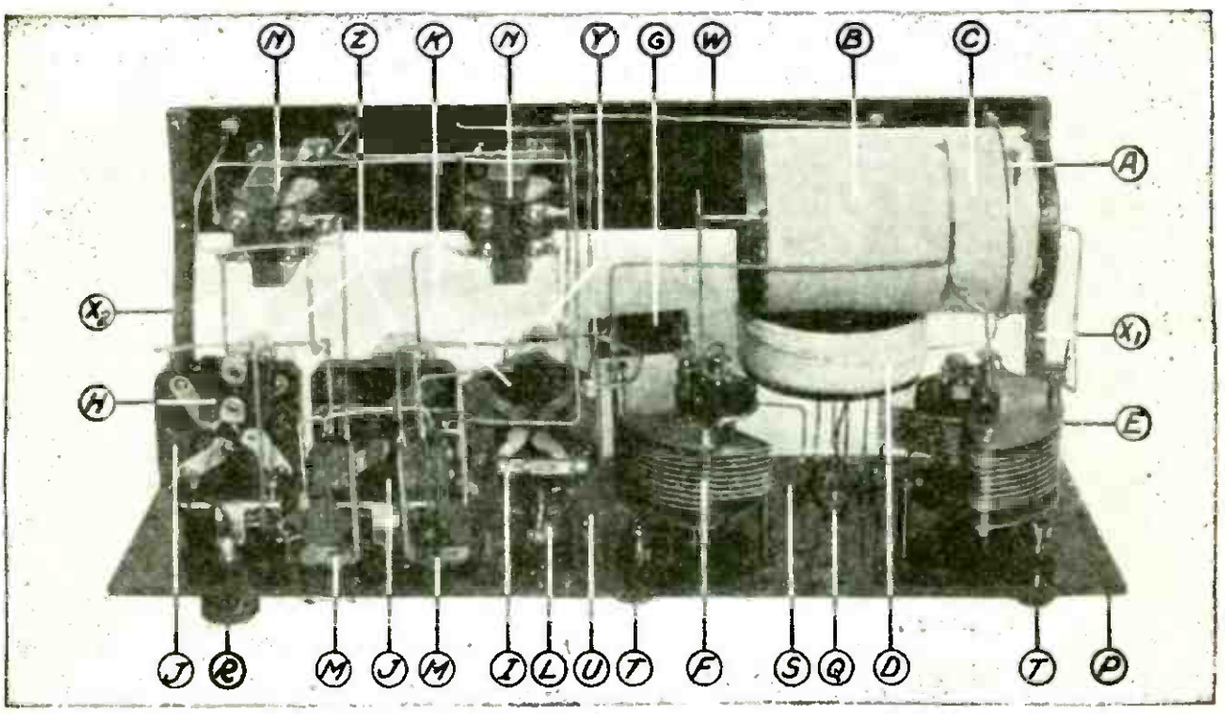


DIAGRAM OF THE FOUR-CIRCUIT TUNER

FIGURE 1: *Here are shown the exact electrical connections for the apparatus used in the new circuit; the parts are designated by the same letters that appear in the text.*



AN INSIDE VIEW OF THE RECEIVER

FIGURE 2: *This picture gives the prospective builder of the Four-Circuit Tuner a clear idea of how the instruments should be arranged in the proper positions. Notice that all of the inductances and transformers are placed well to the rear of the set, so that body capacity is eliminated while the set is being tuned. The mechanical drawings on the following pages give in greater detail the proper spacings and positions of the instruments.*

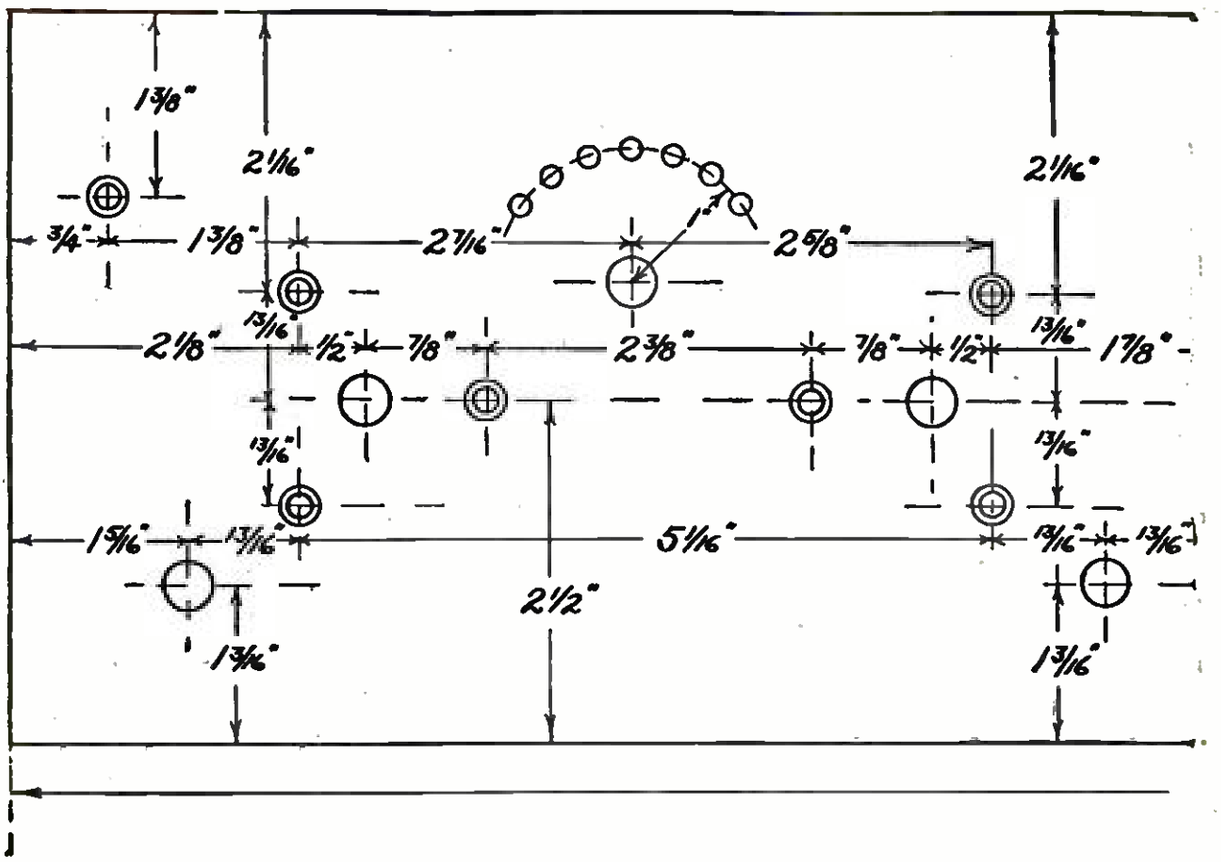


FIGURE 3
(above)

This diagram gives the exact dimensions for the main panel P; it also gives the drilling details for the holes for mounting the instruments.

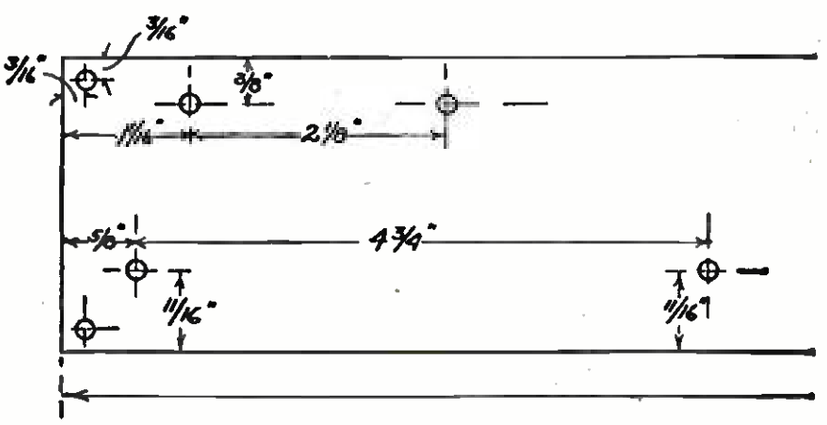
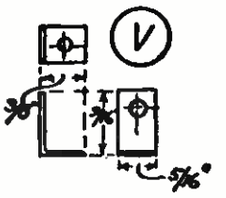
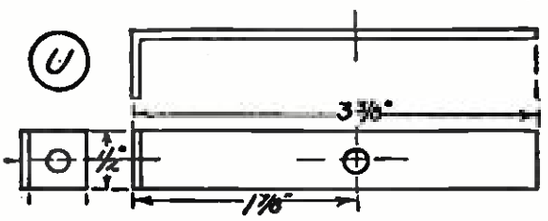
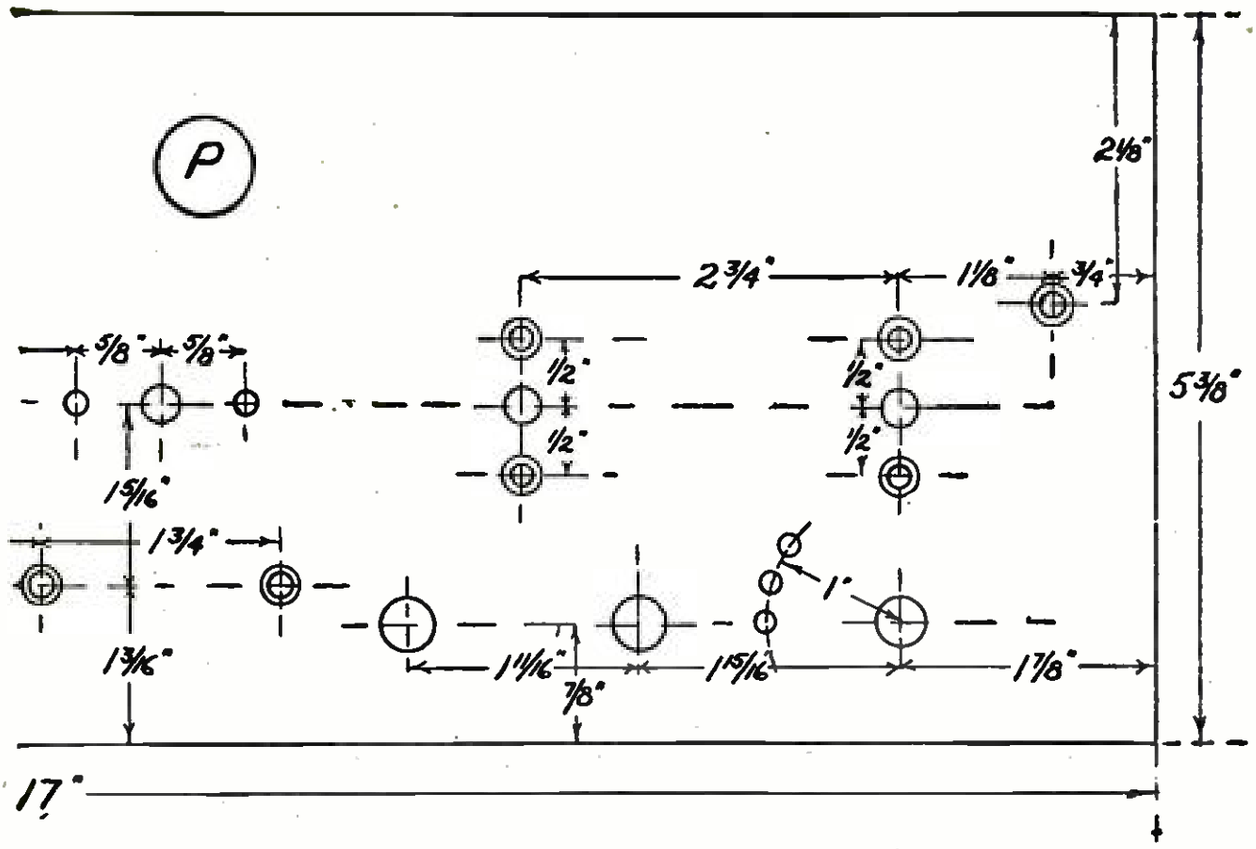


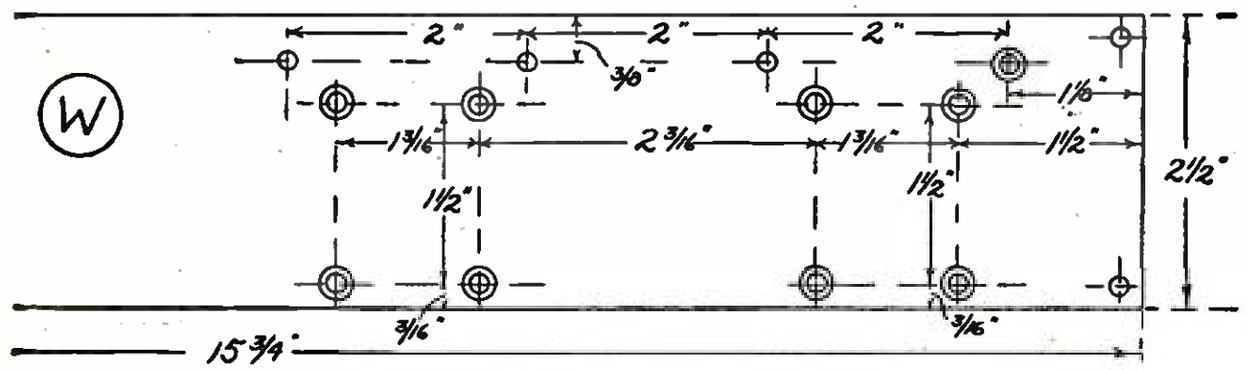
FIGURE 4
(at right)

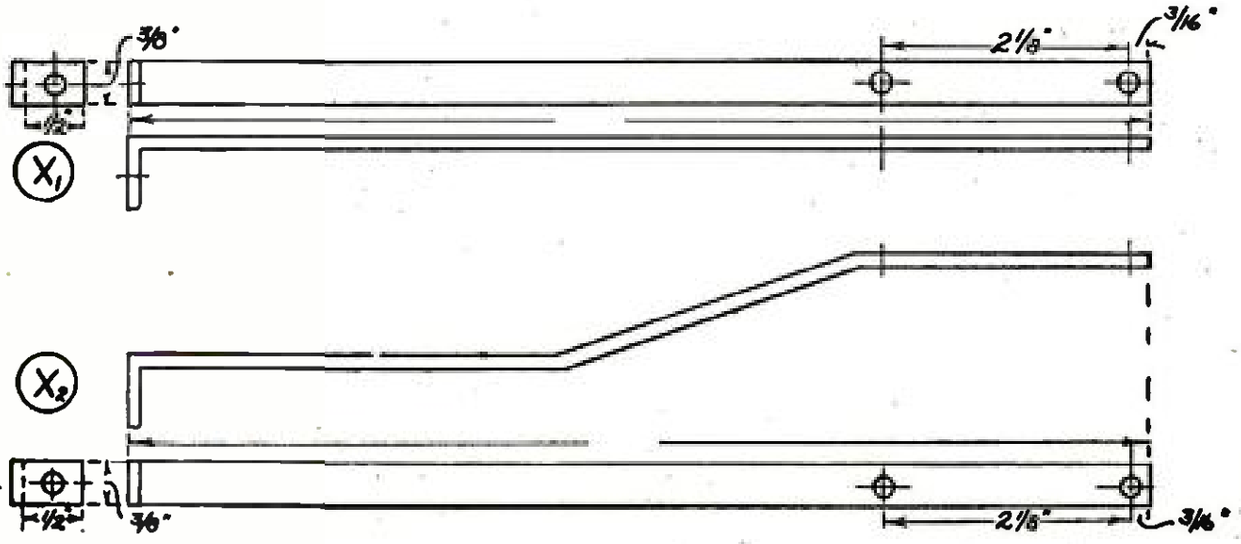
Here are shown the exact dimensions of the shelf panel and of the brass and phosphor-bronze brackets that are used for supporting the various parts of the set.

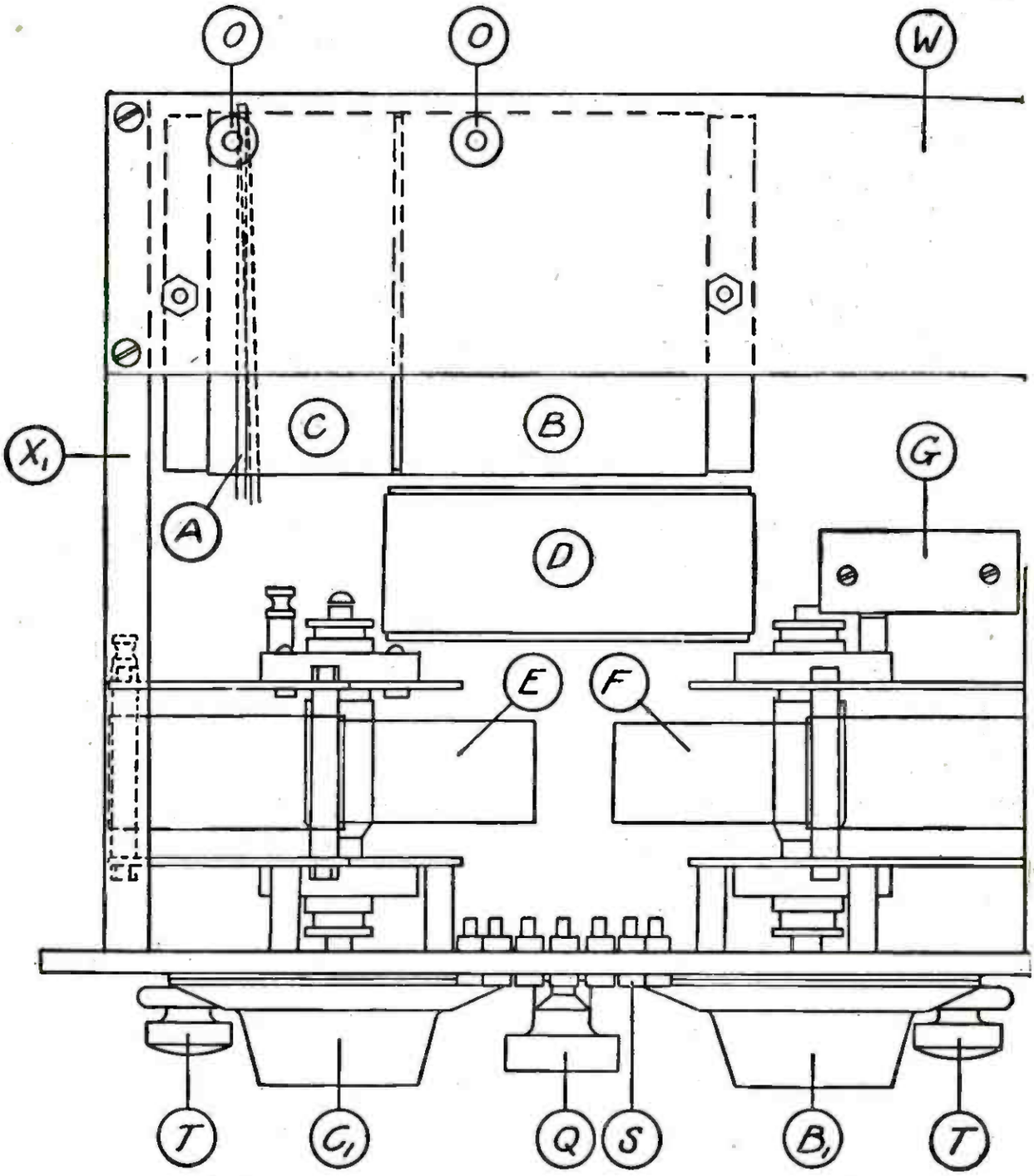





P
2 1/8"
2 3/4"
1 1/8"
3/4"
5/8"
5/8"
1/2"
1/2"
1/2"
1/2"
5 3/8"
1 5/16"
1 3/4"
1"
1 3/16"
1 1/16"
7/8"
1 15/16"
1 7/8"
17"


W
2"
2"
2"
3/8"
1 1/8"
1 3/16"
2 3/16"
1 3/16"
1 1/2"
1 1/2"
1 1/2"
2 1/2"
3/16"
3/16"
15 3/4"


3/8"
1/2"
X1
2 1/8"
3/16"
X2
1/2"
3/8"
2 1/8"
3/16"

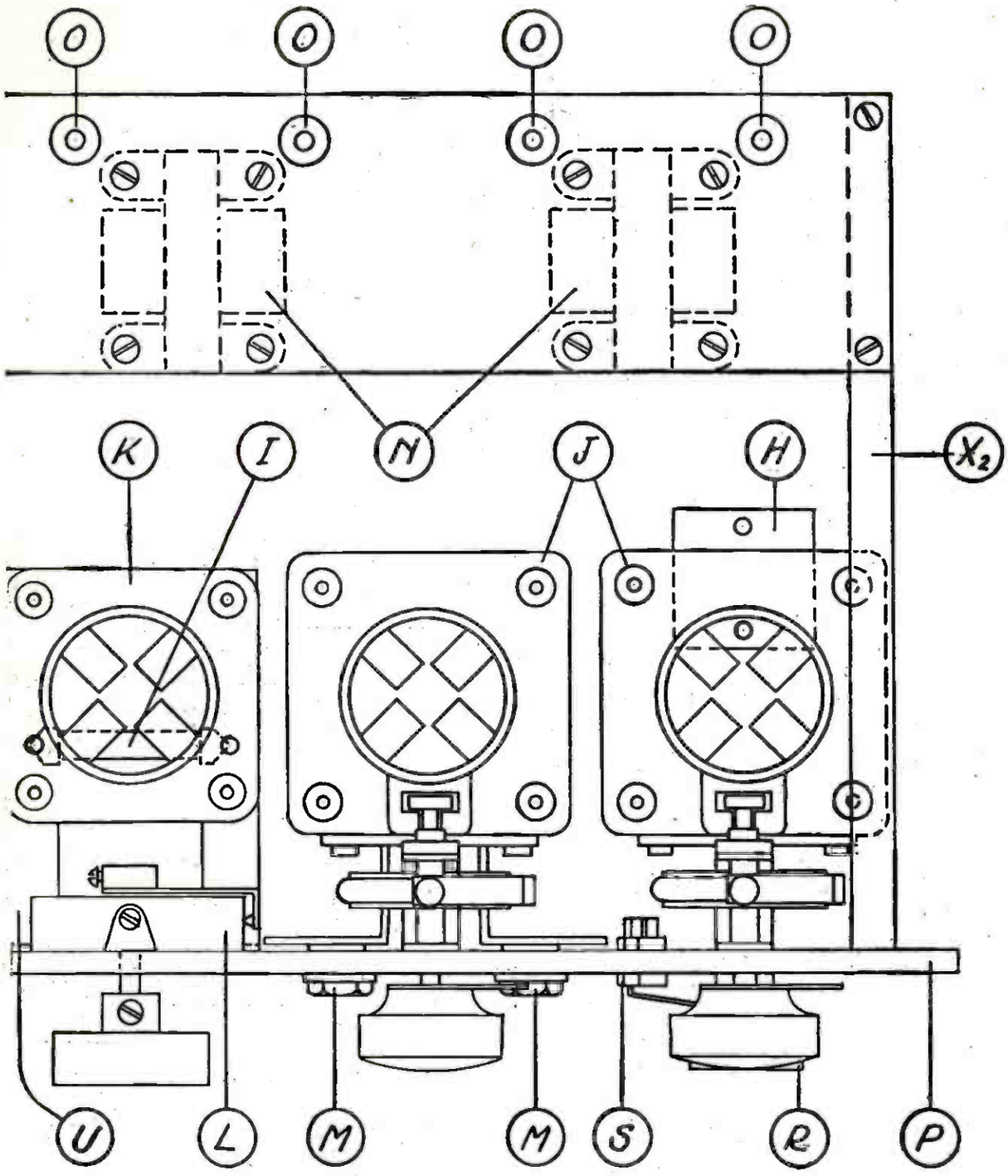


A WORKING DRAWING FOR ASSEMBLING THE SET

FIGURE 5: *A view of the set from above, showing the exact positions for the coils, condensers, transformers, tube sockets, switches, rheostats, and control dials. If the two panels used in the set are made as shown in Figures 3 and 4, the instruments will fit (as shown here) in a compact and efficient layout.*

no variometers, variocouplers, feedback coils, or tuned plate circuits are necessary. No variations of coupling are necessary, and the regeneration can be *set* and it will *stay put* over the entire wavelength range.

Another advantage of the system is that the constants of the antenna system make little or no difference on the other circuits; in other words, the set can be tuned on one antenna of totally different characteristics from another antenna and the two antennas switched with the signal still remaining tuned in. When receiving C. W. signals, the hands may be placed on the bare antenna wire without

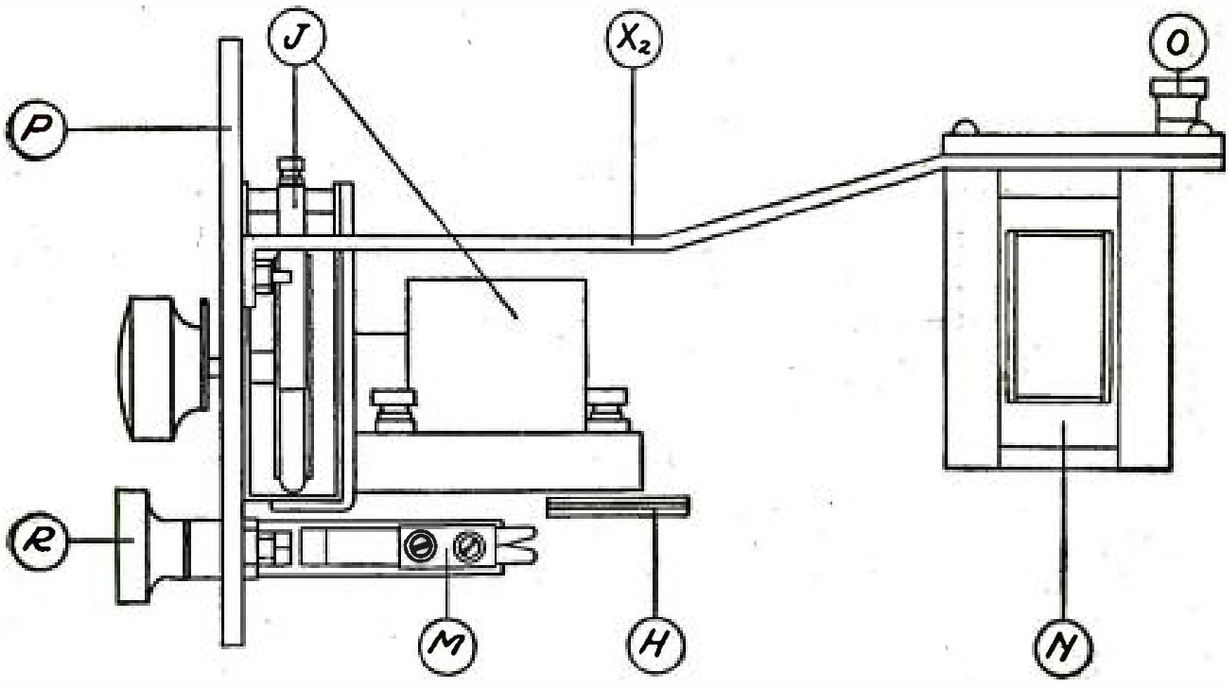


detuning the signal; in fact, the hands may be placed across the antenna and ground terminals. The antenna may be taken off or the ground lead taken away with signals still remaining tuned in but slightly weaker.

Fourth, to insure truthful reproduction we have added to the two-stage audio frequency amplifier a control for eliminating tube noises and for clearing up music and voice signals. This device makes music sound just as if it were being played in the room where it is received.

The set has, during the last few months, on all kinds and types of antennas, picked up about three quarters of all the broadcasting stations in the United States on a loudspeaker, and amateur stations in all the nine districts of this country and amateurs in other countries of this continent and in Europe.

The set as here described is not sensitive to body capacity and does not have to be externally shielded.



SIDE VIEW OF THE SET—FROM THE RIGHT

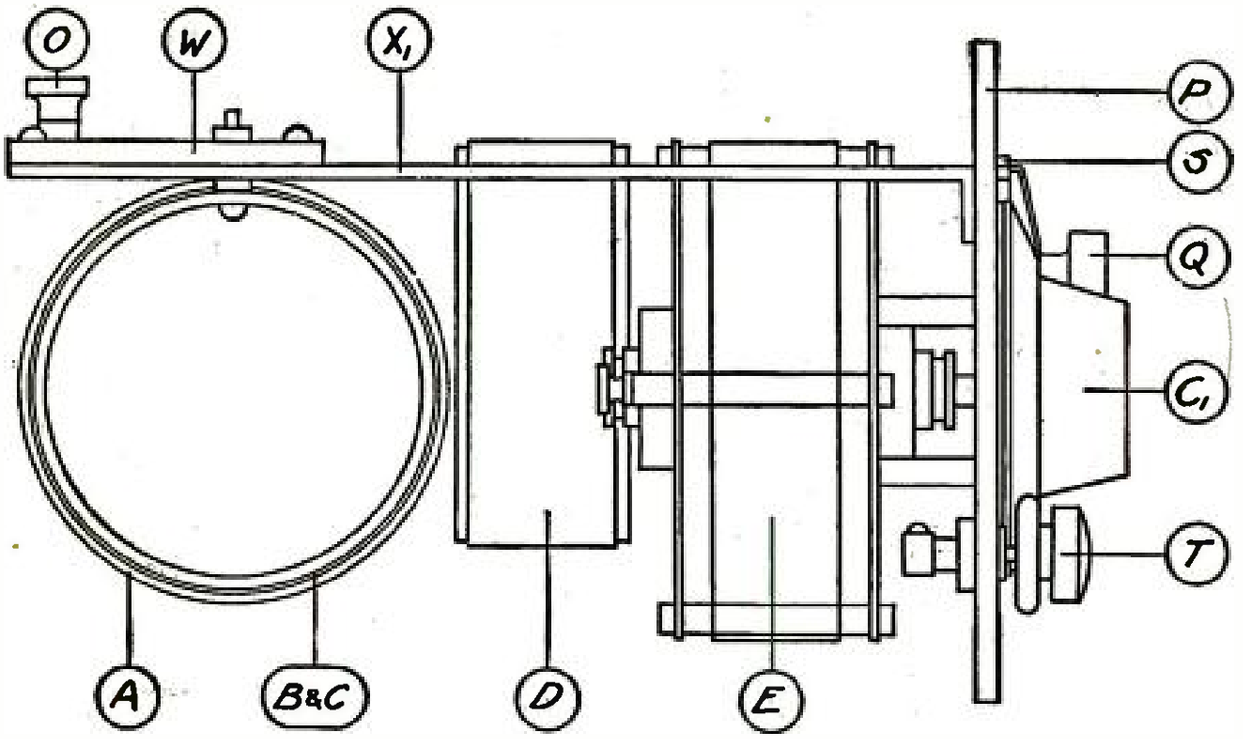
FIGURE 6: *This diagram shows how the rheostats, tube sockets and jacks are fastened to the main panel, and how the amplifying transformers are hung from the shelf panel in the rear. The condenser H is hung directly under the last socket and is supported by the connecting wires.*

The electrical circuit diagram is shown in Figure 1.

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

A—primary winding, consisting of a single turn of tinned copper bus-wire, 1/16 inch square;
B—secondary winding, consisting of 65 turns of No. 18 S. C. C. copper wire;
C—reaction-stabilizer winding, consisting of 34 turns of No. 18 S.C.C. copper wire; (Coils A, B and C are wound on a composition tube, the dimensions of which are shown in Figure 8.)
D—antenna tuning-coil, consisting of 43 turns of No. 18 S.C.C. copper wire, double bank-wound, on composition tube; (See Figure 8.)
B1 and C1—Tait 3½-inch knobs and dials;
E and F—Se-Ar-De variable condensers, 17 plates, approx. .00035 mfd.;
G—Dubilier micadon fixed condenser, .00025 mfd.;
H—Dubilier micadon fixed condenser, .002 mfd.;
I—tubular grid leak, 1 or 2 megohms.;
J—Se-Ar-De combination sockets and rheostats;
K—De Forest socket;
L—Jenkins vernier rheostat;
M—Pacent or Federal jacks, one double-circuit and one single-circuit;
N—Jefferson amplifying transformers, small type;
O—Fada binding posts;
P—composition panel;
Q and R—Haydon-Fenton switch lever and knob;
S—switch points;
T—Haydon-Fenton vernier controls;
U—brackets for mounting the De Forest socket;
V—phosphor-bronze spring contacts for mounting the grid leak;
W—composition shelf panel;
X and X2—brass brackets for mounting shelf panel;
Y—detector tube, preferably a UV-201, or C-301 or a De Forest tube;
Z—amplifier tubes, preferably two C-301a's or two UV-201a's;
one cabinet, dimensions as shown in Figure 9;
connecting wire, 1/16-inch square tinned copper bus-wire;
screws and nuts to fit.



SIDE VIEW OF THE SET—FROM THE LEFT

FIGURE 7: *In this diagram is shown the method of attaching the tuning condensers to the main panel, and of attaching the coils A, B and C to the shelf panel. The antenna tuning coil D is suspended between the other coils and the condensers.*

How to Construct the Set

After procuring all the instruments for building the receiver, the amateur should set about preparing the panel P (shown in Figures 2, 3, 5, 6, and 7).

First of all, the panel should be cut to the correct size (5⅜ by 17 inches); then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 3.

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

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

Next, the condensers, E and F, should be fastened to the panel in their respective places, as shown in Figures 2, 5, and 7, and the dials B1 and C1 should be affixed as shown. These dials are fitted with a chuck which centers and holds fast to the shafts of the condenser without the use of set screws. This insures even running of the dials when they are revolved and eliminates wobbling.

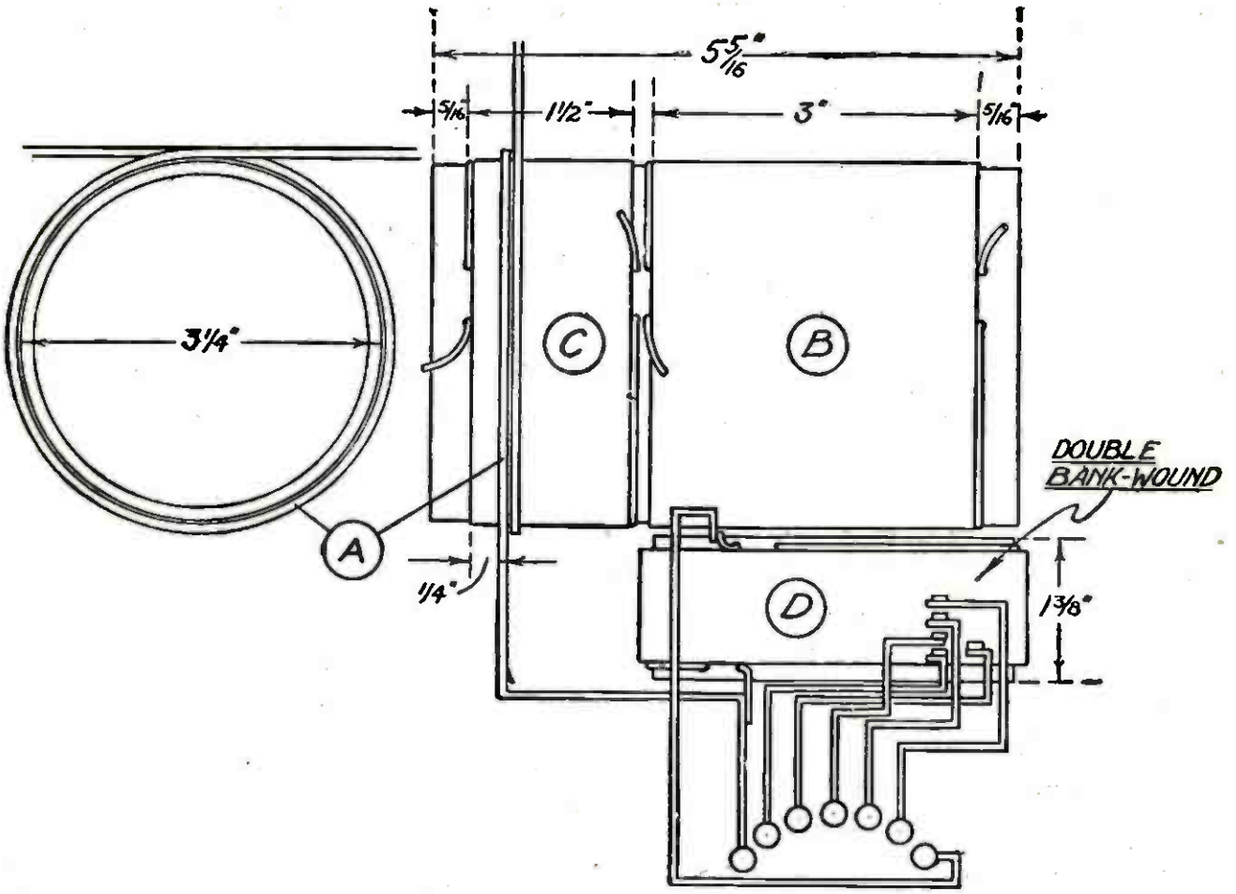
The two combination sockets and rheostats J, should be mounted on the panel (two screws to each instrument) as shown in Figures 5 and 6.

The detector vernier rheostat L should also be mounted in its proper place by means of two screws (see Figure 5). The detector socket K will require two brass brackets U, for attachment to the panel, and these should be of the dimensions given in Figure 4. The two grid leak phosphor-bronze springs V (shown in Figure 4) are mounted on these brackets, underneath the socket. Two holes will have to be drilled in the socket, one on each side (as shown in Figures 2 and 5) for fastening with brass nuts and bolts to the brackets U. The grid leak springs are held by the same bolts.

The three rheostat knobs should now be connected to the shafts of the rheostats protruding from the front of the panel.

Place the switch points S in the proper holes drilled for them and fasten with small nuts on the rear of the panel as shown in Figures 2, 3, and 5. Insert the two switch levers Q and R and make fast in the proper manner with the nuts furnished with the apparatus.

Mount the two jacks M, the double-circuit jack at the left and the single-circuit jack at the right, as shown in Figures 2, 5, and 6.



HOW TO MAKE THE COILS

FIGURE 8: *Here are shown the dimensions for the coils and the method for connecting the single turn of wire A to the coil D and to the taps S. The positions of these coils in relation to each other should be observed strictly.*

It will be noted that the two jacks should be mounted "back to back," as the space is limited. (There is really no benefit derived from using a jack in the first stage because the same results can be obtained by burning the two amplifier tubes at a low filament temperature and thus getting the same results as from one stage. This will save the tubes as they will last longer, burning dimly, than one that burns brightly.)

The last job on the main panel is to mount the two vernier controls T, for the condensers E and F (see Figures 5 and 7). These are necessary on account of the sharpness of tuning in this set.

Next, cut and drill the shelf panel W, as shown in Figure 4 and prepare the two mounting brackets X1 and X2, shown in the same diagram. These are fastened to the shelf panel and also to the main panel P, as shown in Figures 5, 6, and 7. The straight bracket is used at the left side of the set. The irregular shaped bracket X2 is used at the right side of the set, and the reason for using it is to allow space for all makes of tubes to fit into the last socket.

Now mount the two transformers N on the shelf W, using four screws to each transformer, as shown in Figures 2, 5, and 6.

The six binding posts O should be mounted in a straight line at the rear of the shelf and fastened underneath with nuts, in the regular manner.

In preparing the tuning elements great care should be exercised, for in the *exact* following of the instructions here given lies the success that can be had with the completed set.

First, cut the 3¼-inch tube to the right length, as shown in Figure 8. (If you have trouble in getting this size, use 3½-inch tubing; it will raise the wavelength only slightly.)

Start winding the coil C, finishing with 34 turns of No. 18 S.C.C. copper wire. Right next to this wind on the 65 turns of the same kind of wire for coil B. Then fasten the tube with the two coils wound on it to the shelf W with two screws and nuts (see Figure 5), and insert a washer between the shelf and the tube, as shown in Figure 7. This will leave a little space for the single turn A, which can be put on when the wiring is being done.

The antenna tuning coil, is a double-bank-wound coil on a tube the same diameter. The taps are taken off, one at the beginning of the coil, then one at the third turn, one at the 7th, 13th, 21st, 31st, and one at the end, the 43d turn.

In bank winding, the tube is shellaced with a light coat and while it is still wet, two turns are wound upon it.

Then the next turn is run up on top of the two turns that are already completed and a whole turn is put on.

When this turn is completed the wire is turned down on the tube again and another turn completed; the next turn is run up alongside the first top turn, then down, then up, and so on. In the set described the coil D was held in place by the stiff bus wiring, but it may be fastened to the shelf by a straight piece of brass and two screws and nuts (brass).

The two condensers G and H may be attached in the proper places when the wiring is being done, as they are held in place by the wiring.

How to Wire the Set

The design of this set is such that the grid circuit wiring of each of the three tubes may be made extremely short and isolated from the other circuits. In fact, all the tuning circuits and leads are arranged so that short connections may be used. As this is the case the set may be wired with bus-bar, with little loss in efficiency.

A tinned copper square wire is recommended. It should be about 1/16 inch square. All connections should first be shaped so that they will fit, and then soldered in place.

The binding posts along the back of the shelf W (design in Figure 5) are to be connected in the following manner:

First on left, antenna;
Second from left, ground;
First on right, amplifier "B," positive;
Second from right, detector "B," positive tap;
Third from right, "B," negative, and "A," positive;
Fourth from right, "A," negative.

It will be noticed in diagram (Figure 1) that the ground and the "A," negative, are connected together.

Start wiring the filament circuit, being sure to include the rheostats in the correct side of the filaments as shown in Figure 1. *This is important.*

Wire up the antenna circuit, including the placing of the single turn A, of the bus-wire, around the inductance in position shown in Figure 8 and connect to coil D and the taps S. One end of the loop A goes to the antenna post and the other goes to the first tap S and the beginning of coil D as shown. The switch lever Q is connected to the ground post.

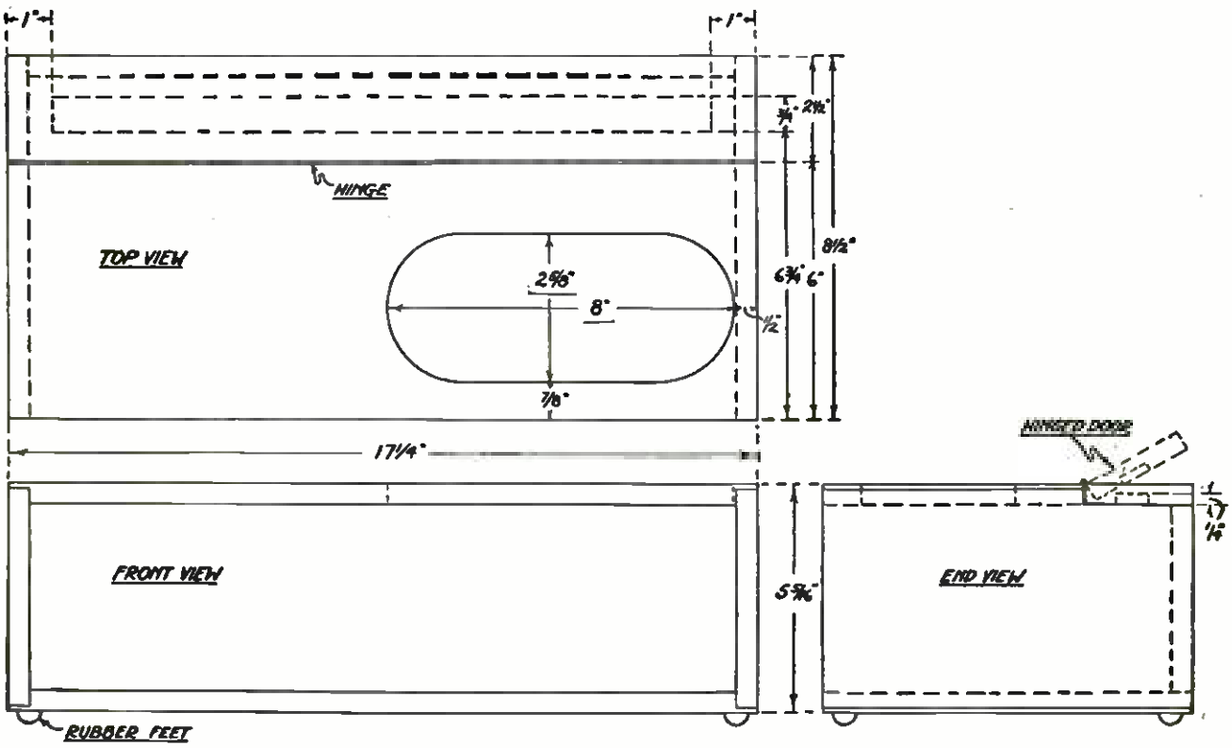
Now wire the two leads from coil C, to the terminals of the condenser E.

Then start with the secondary wiring (coil B, condenser F, condenser G, and the grid leak I) and connect exactly as shown in the diagram Figure 1.

Wire the plate circuit of the detector tube, including the jack, the primary of the first amplifying transformer and ending up at the detector "B," positive, binding post.

Next, finish up the first stage of amplification, and then continue with the second stage.

The last job to complete is to connect the condenser H to the switch lever R and the



HOW TO BUILD THE CABINET

FIGURE 9: *This working drawing of the cabinet, which contains all the necessary dimensions, may be turned over to a cabinet maker, who will be able to construct it of some hardwood—such as mahogany or oak. The hinge used is a section of piano hinge and may be finished in nickel.*

grid of the last tube, and also connect up the two end-taps S, as shown in Figure 1. This is the tone control of the amplifier and will give the operator three separate adjustments.

After you have finished the job, sit down with some friend and check over the wiring once or twice before using the set. This will save yourself a lot of trouble in case you have made a mistake.

Operating Data

When using the set, the following hints will be of practical value:

The set may be used with any antenna that is about 100 feet long—the longer the better. It also works well with a multi-strand antenna.

By lifting up the little hinged door at the top and back of the cabinet, the connections may be made in the following order, to the antenna, ground and batteries, commencing at the left (looking at it from the front):

First post, the antenna;

Second post, the ground;

Third post, the "A" negative;

Fourth post, the "A" positive and the "B" negative;

Fifth post, the "B" positive tap for the detector, 22½ volts;

Sixth post, the "B" positive for the amplifiers.

Close the lid.

All antenna tuning is done with the switch lever Q. All secondary tuning is done with the dial B1 and the vernier control T for that dial. Regeneration is controlled by the dial C1 and the vernier T for that dial.

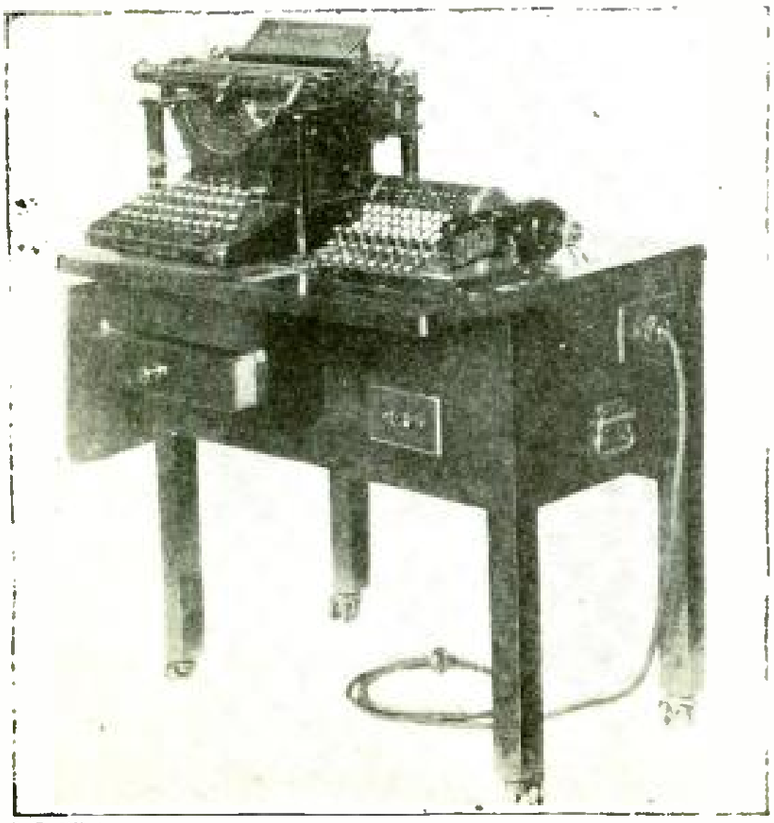
Place the detector tube Y in the socket, and place the telephone plug in the first jack and turn up the filament rheostat all the way. Then turn it back so that the filament is left at three-quarters brilliancy.

Now take the plug out of the first jack and put it into the second. Insert the two amplifier tubes Z, and just touch the rheostats to the first wire on the rheostat. Do not turn them up any farther. This is the way they are supposed to operate; they should not be turned up higher.

Set the dial C1 at 100, with the condenser "all in," and tune with the dial B1, until you pick up a signal. Then revolve the switch lever Q until the best tap is found. Turn up the rheostat L until the tube starts to oscillate and then turn it down slightly below this point. All further adjustments should be made with the two dials B1 and C1. The lower the value at which C1 is set the more the set will oscillate so that the regeneration can be easily controlled by the combined action of the two dials B1 and C1. You will soon get the knack.

Amateur C. W. signals should be tuned with the dial C1 somewhere between 0 and 80. All phone stations will be found to come in better with this dial somewhere between 60 and 100.

On dial B1, the amateurs tune between 0 and 15, and the broadcasting stations between 20 and 65. The antenna taps at the left will be best for amateur work, and the middle taps or the right taps for the broadcasting; it all depends on the size of the antenna, but you will soon learn the best taps to use with a little practice.



S. R. Winters

A NEW RADIO-OPERATED CODING AND DE-CODING DEVICE

This new apparatus, known as the Hebern electric code, is used like an ordinary typewriter; words are spelled out on it in any language and the machine itself does the coding. This is accomplished by means of rotating discs which are set on a key letter both at the transmitting and at the receiving end. These discs "scramble up" the message into five-letter groups and the different letters in the original message are replaced by other letters in combinations which number up to 40,303,146,321,064,147,046,400,000 distinct and different combinations. It has been estimated that it would take the whole staff of the Government's code experts at least 100 years to decode one message or even one word of one message sent out by this instrument, without the aid of the receiving machines.

HOW TO BUILD YOUR OWN

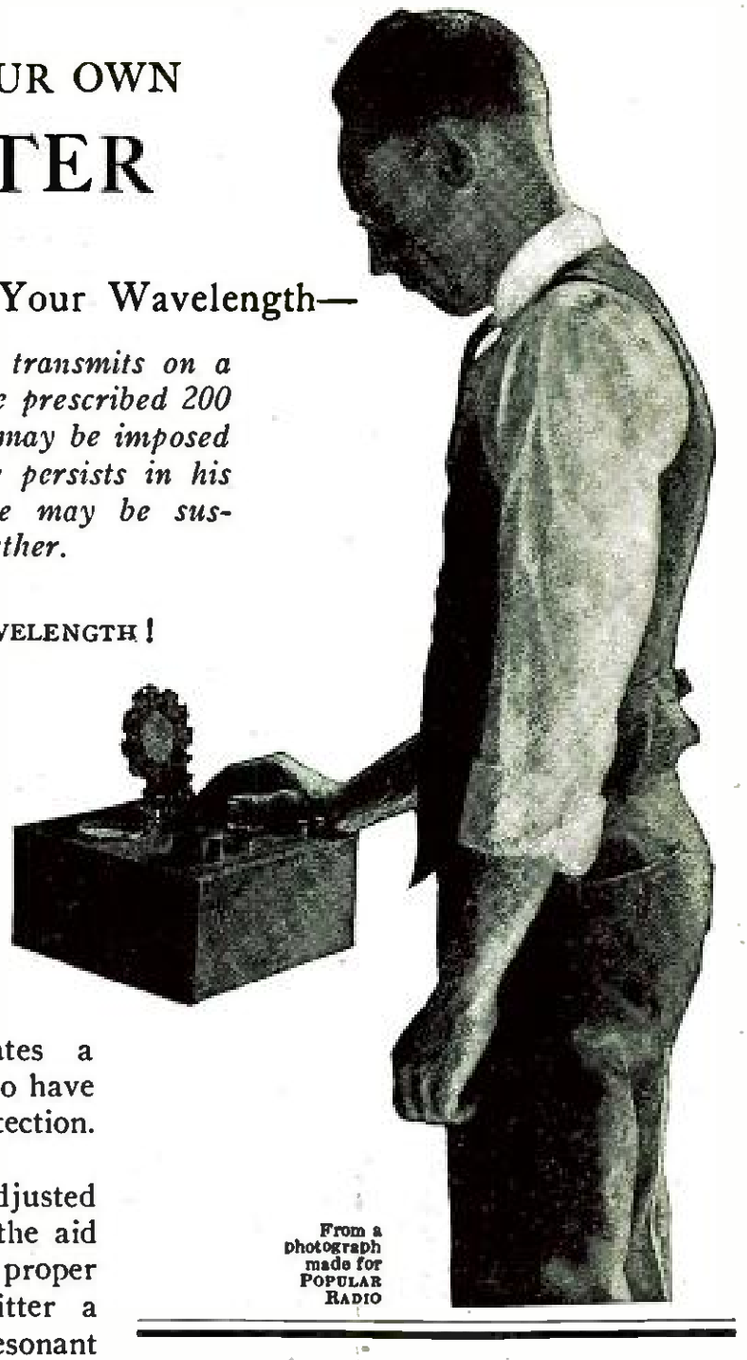
WAVEMETER

The Penalty for Exceeding Your Wavelength—

For the amateur who transmits on a wavelength exceeding the prescribed 200 meters, a fine of $25.00 may be imposed for each offense. If he persists in his transgression, his license may be suspended or revoked altogether.

WATCH YOUR WAVELENGTH!

By W. K. THOMAS



From a photograph made for POPULAR RADIO

EVERY amateur who operates a transmitting apparatus ought to have a wavemeter—for his own protection. Yet few amateurs own one.

No transmitting set can be adjusted properly for wavelength without the aid of an accurate wavemeter. In the proper adjustment of a spark transmitter a wavemeter is indispensable, as a resonant condition between the closed and open circuits is far more essential for maximum efficiency than "antenna current."

In obtaining resonance in a tube transmitter the amateur is usually guided by the use of various voltmeters, ammeters and milliammeters. But reliance should not be placed upon guesswork in determining the length of the emitted wave. Our Government through the Department of Commerce has complete jurisdiction over radio communication and has designated the operating wavelengths of various classes of stations, and these wavelengths must be adhered to strictly in transmitting. The amateur who uses a wavelength greater than that to which he is entitled is in danger of forfeiting his license.

The amateur who wants to build his own wavemeter—and the task is not difficult—will find the following instructions of practical value. The apparatus here described is really efficient; for amateur purposes, indeed, it may well take its place alongside the justly famous Kolster decremeter.

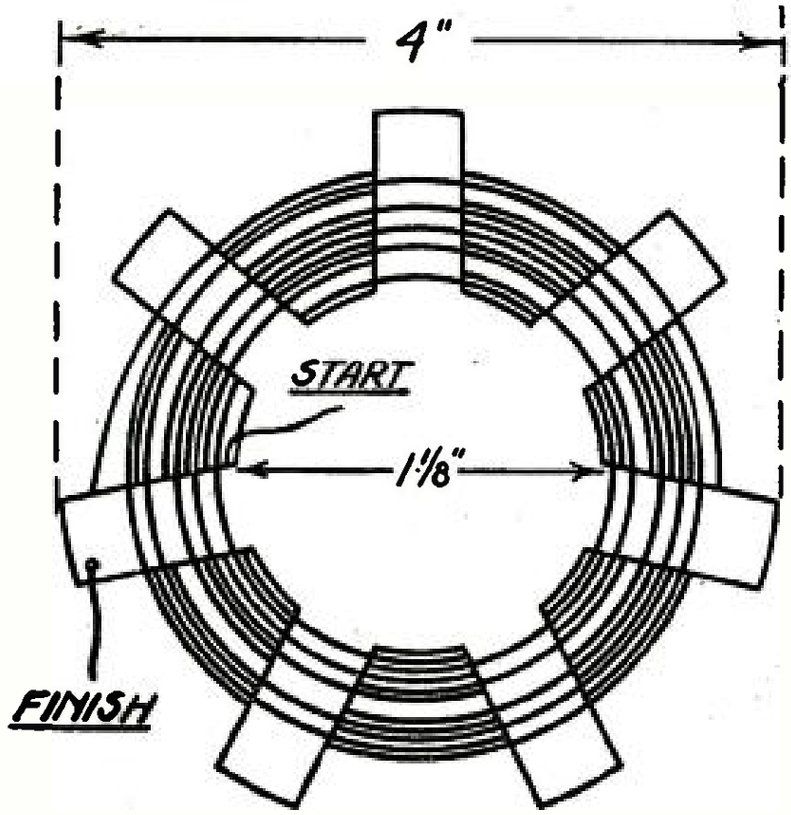


FIGURE 1

How to make the coils. Coil 1 has 20 turns on it, and coil 2 has 42 turns. This is the only difference.

The specifications call for the following material:

- 1 pc. bakelite 3/16 by 8½ by 8½ inches
- 1 Weston thermo-galvanometer No. 425
- 1 1½ volt flashlight cell
- 1 Century buzzer
- 1 rotary switch lever
- 2 contact points
- 1 variable condenser .001 mfd. with dial
- 2 binding posts
- 1 suitable oak or mahogany case

The schematic drawing (Figure 2) shows the electrical connections; the dotted lines represent wires which should be of No. 14 solid-copper wire covered with cambric tubing.

In Figure 6 is shown a circuit diagram, and in Figure 3 a drilling plan of the panel. Across the binding

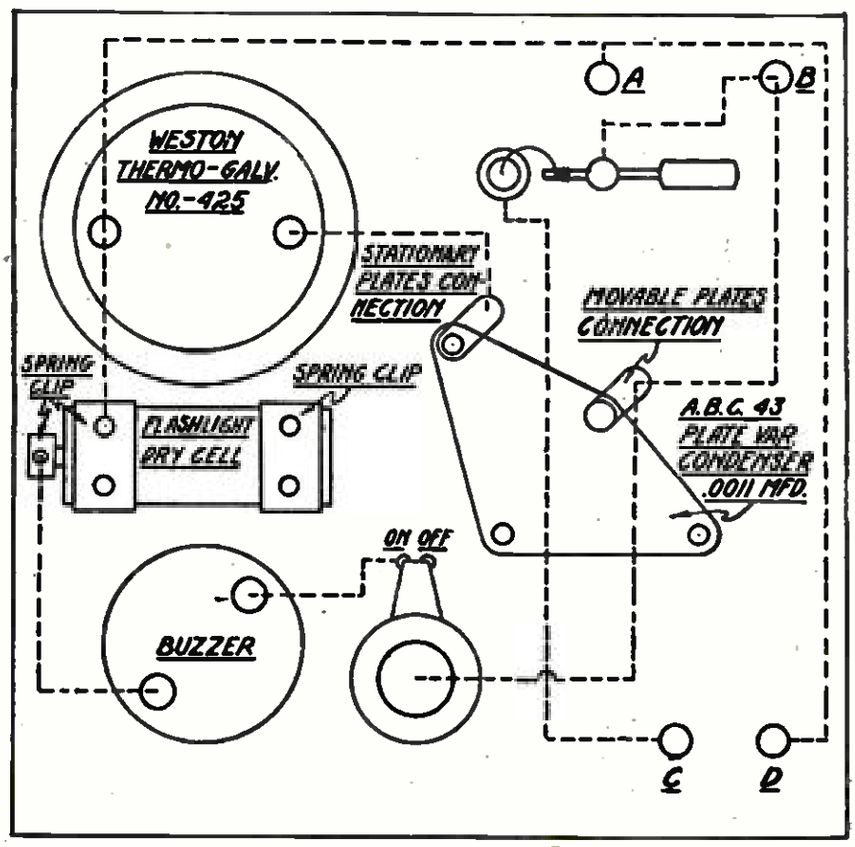


FIGURE 2

Figure 2 shows a schematic drawing of the instrument layout with the circuit connections indicated by dotted lines.

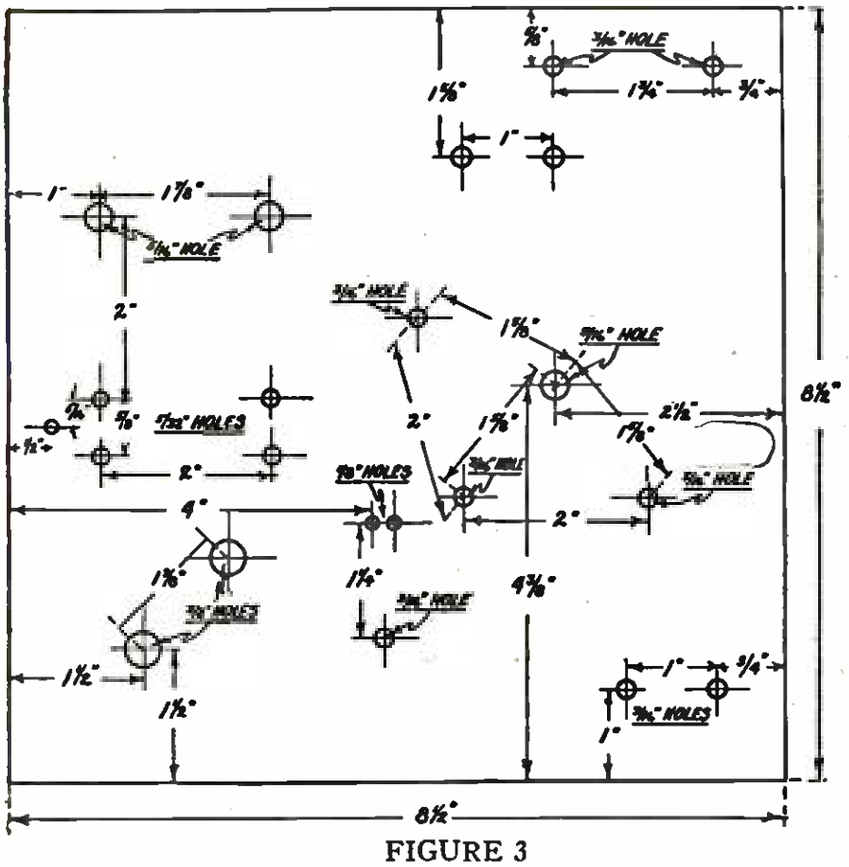


FIGURE 3

Where to drill the holes in the panel. Follow this diagram and know exactly what size the holes should be and exactly where they should be drilled.

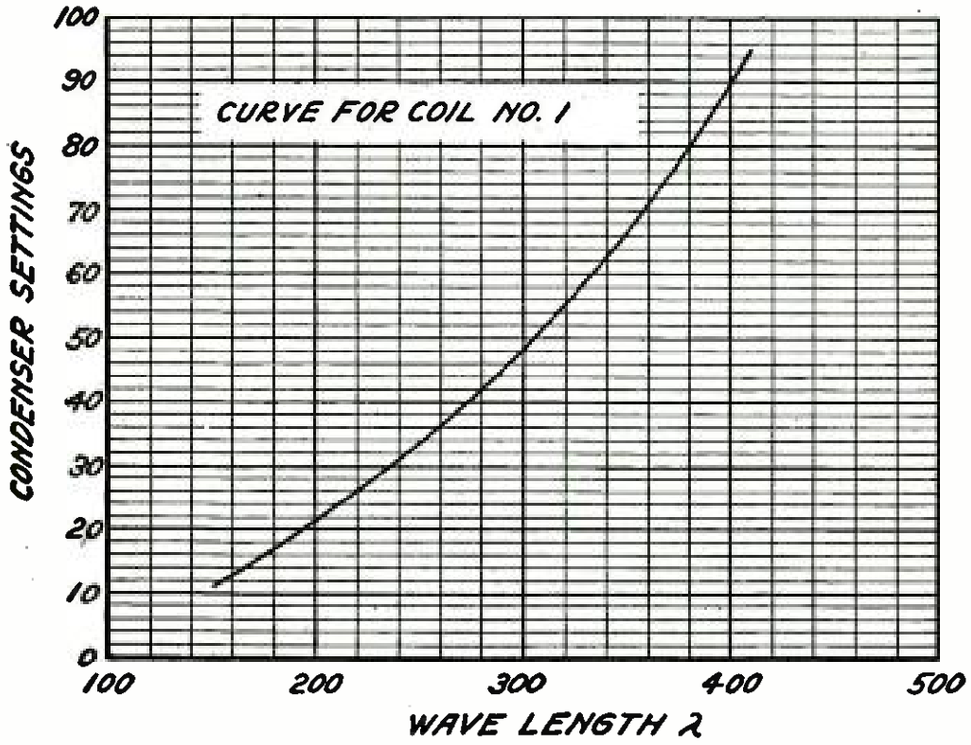


FIGURE 4

The wavelength chart for coil number 1. Run along the horizontal line, which corresponds to the number on the dial of the condenser in the wavemeter for a given setting, until you strike the curve; then run down the vertical line to the bottom of the chart to find the wavelength. Thus for a setting of 21 on the condenser we find a wavelength of 200 meters, on which amateurs transmit.

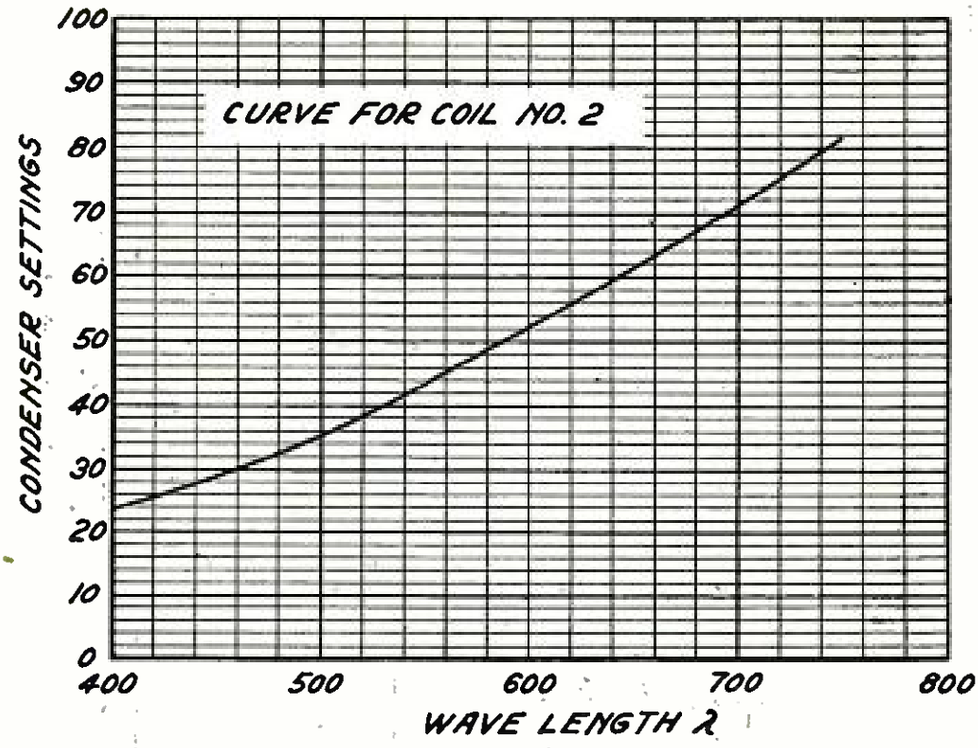


FIGURE 5

The wavelength chart for coil 2. This chart is used in the same manner as the chart shown in Figure 4. It will be noticed that coil 1 has a wavelength range of 150 to 400 meters and that coil 2 has a range of 400 to 740 meters.

posts A and B (Figures 2 and 6) are shunted the windings of the wavemeter coil which complete the circuit through either the meter or buzzer.

To calibrate a receiving set, place the wavemeter near the antenna lead-in wire, insert the desired coil across the binding posts A and B and place the rotary switch in the "on" position, closing the battery circuit through the buzzer and coil. Set the dial of the receiving set at zero and vary the position of the condenser dial on the wavemeter until the maximum sound is received in the head set that is connected to the receiving set.

Continue this process, taking readings of the wavemeter dial when the receiving dial is set at zero, 5, 10, 15, 20 and on.

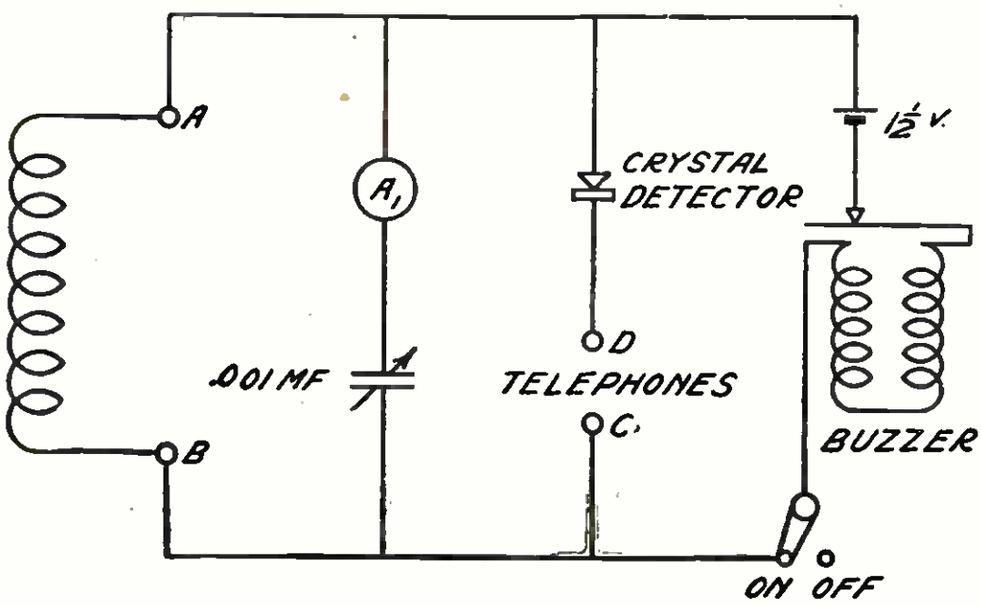
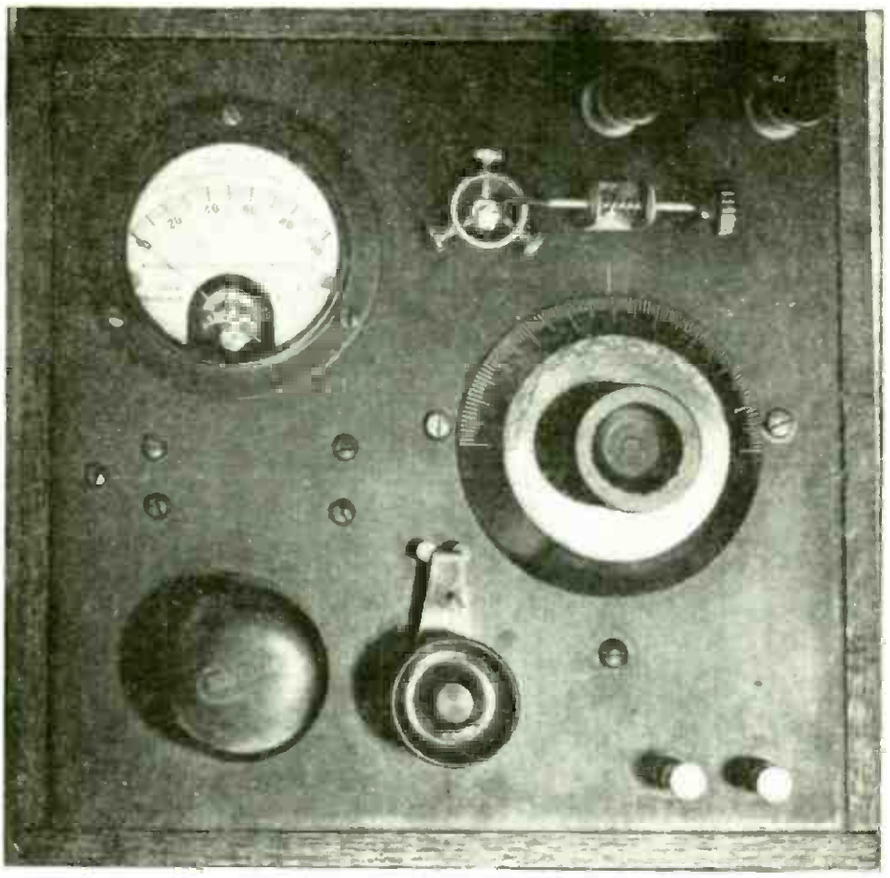


FIGURE 6

This circuit diagram shows the electrical hook-up for the apparatus. Either coil 1 or coil 2 may be used across the binding posts in accordance with the wavelength range to be covered.



A PANEL VIEW OF THE COMPLETED WAVEMETER

With this apparatus the amateur may check up on two important points—the wavelength of the signals that he is transmitting and the wavelength of the signals that he is receiving. No radio installation is complete without this important measuring instrument.

Then by reference to the curve (shown in Figures 4 and 5) you can ascertain the exact wavelength of each of the various settings of the dial on the receiving set.

Once you have obtained the values at different points, you may plot a new curve for your particular receiver; thereafter you need merely to refer to this curve to learn at a glance the exact wavelength of an incoming signal.

This meter, it will be noticed, is also equipped with two extra binding posts to accommodate a pair of telephones to be used in conjunction with the crystal detector as shown in the circuit diagram in figure 6 and in the photograph at the top of this page.

To tune a transmitting set, the only change necessary on the wavemeter is to move the rotary switch to the "off" position; when the transmitter is in operation, bring the wavemeter near the apparatus and move the wavemeter dial until the maximum deflection of the thermo-galvanometer is noted. By reference to the curve you can immediately ascertain the exact wavelength of your transmitter.

Care should be exercised not to place the wavemeter too near the transmitter, as the thermo-galvanometer shown is very sensitive; the full scale deflection is equivalent to only 115 milliamperes. A thermo-couple milliammeter of 0-100 scale will also be suitable for this purpose.

For construction of the coils across A and B, see Figure 1. If every detail is followed closely in making the coils, the curves shown in Figures 4 and 5 are accurate within a small percentage.

The instrument described will be a guarantee that you do not exceed the wavelength allotted to you.

Shaw Photo, Boston

WILL THERE BE BUYING AND SELLING IN THE SKY?

Sooner or later the question must be settled as to whether or not vendors of merchandise, insurance and real estate will be admitted to the realms of radio for exploiting their wares. Mr. Lee, the famous author and advertising expert, here brings up some pertinent observations on this timely topic.

Marketing Mattresses in the Ether

POPULAR RADIO does not believe that advertising matter should be intruded upon general broadcast programs, any more than it should be intruded upon motion-picture programs or the text columns of newspapers and magazines. Possibly a special waveband will some day be assigned exclusively to advertising; in which case the venture will succeed or fail in proportion as the paid publicity agents instruct or amuse us—as this article points out.

By GERALD STANLEY LEE

ADVERTISING men themselves, acting in combination with Mr. Hoover, have decided, I believe, that heaven is no place for them. They have decided that they should not be tolerated in the sky; they cannot even bear the thought of tolerating one another there!

This reveals a shrinking and a modesty on the part of advertising men that the American people have not previously been led to expect, and most of us cannot help wondering a little just now how long this shrinking of theirs is really going to be kept up.

When I first began to think of it I felt that this modesty was at least a good advertisement for advertising, that it was a good thing so long as it lasted and that it should be kept up. But on further thought I do not believe that the present feeling on the part of ad men will be kept up forever or that there is any permanent or unremovable reason why it should.

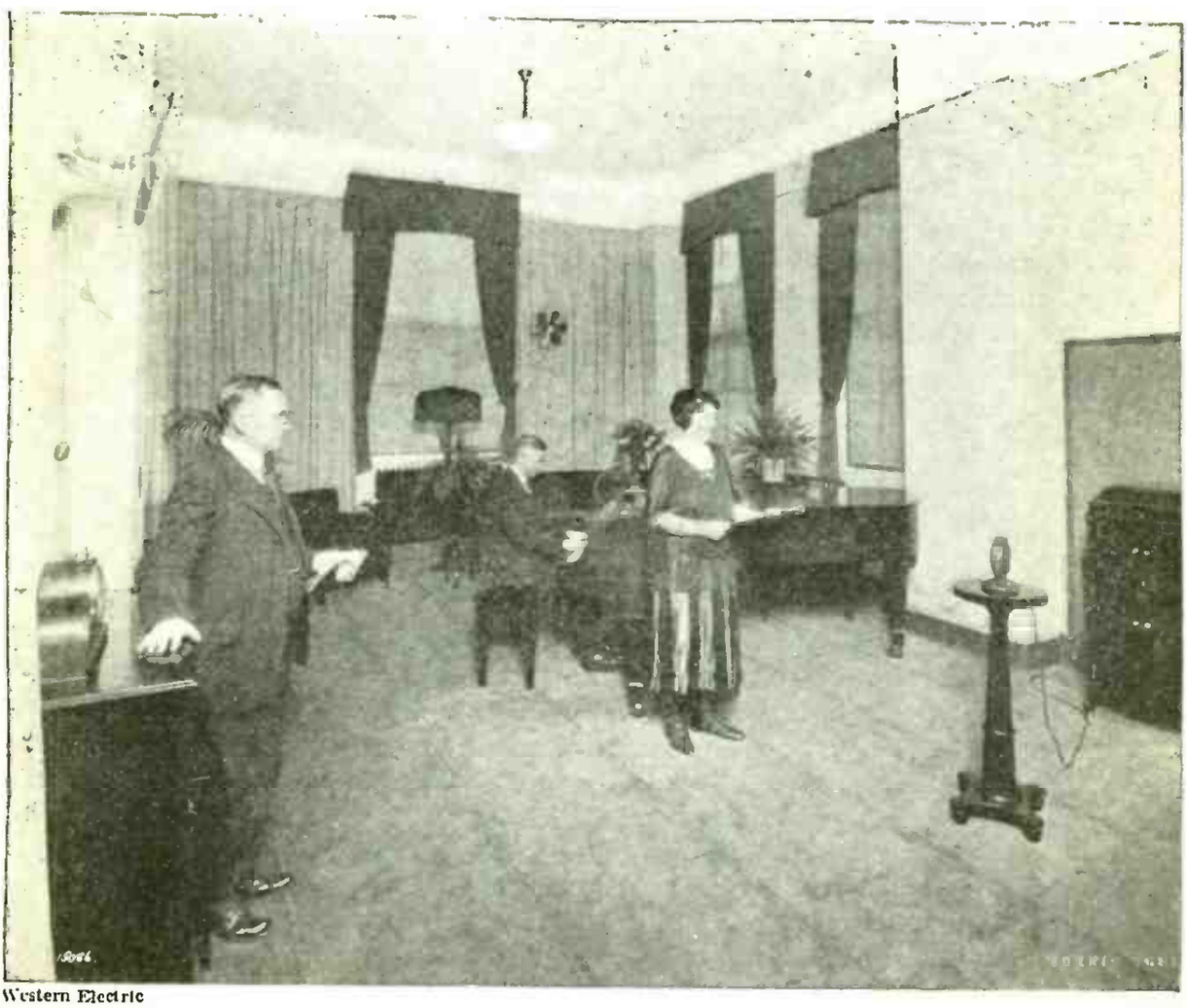
The reason given thus far for fencing off the big "vacant lot of space" above us and saying that no advertising men are to be allowed in it—the reason for saying that of course toothbrushes, mattresses, bathtubs, chewing gums and catsups and the other things must all keep out and that the air up over America must be reserved merely for breathing, soaring and other more unworldly and more spiritual interests and entertainments—is based on the idea that toothbrushes, mattresses, bathtubs, chewing gums and catsups will not behave themselves in the sky as they should.

Looking at the facts as to what advertising men would probably do with the sky if they were allowed to wander around in it nights, most people would have to admit what would happen. The air all about us from the rim of the earth up to the bottom floor of heaven would be one vast pandemonium of shouting and grabbing at people's pocketbooks.

This idea of what radio advertising would be like if let in on us suddenly is not one I quarrel with, so long as I keep looking at the facts about advertising as they are.

But when I look at the facts about advertising not as they are but as they might be, and as I believe advertising men are going to make them, I feel differently.

All that advertising men need to be is sensationally good, incomparably more



Western Electric

PRESS AGENTS MAY HIRE THIS STATION FOR 10 MINUTES FOR $100

The justly famous WEAF station in New York is for rent—at a specified price. It is maintained by the American Telephone and Telegraph Company as an experiment to determine whether or not there is a market for a toll-station of this kind.

entertaining than the present education and the present entertainment that flourishes around up in the air; and the time will soon be at hand when people will feel that advertising men, at least some advertising men in this country, can honestly earn their right to the air—their right to butt in as a matter of course on jazz and on "The Man in the Moon."

Competition works in the air as well as anywhere else. An advertisement is not intrinsically an affront, not if it really draws; and when the Dear Public, as I have seen it do, sucks on an ad like a lollypop, even Mr. Hoover is not going to have the heart to stop it.

The time is coming when, if the best ad men do their part, the sign up across the heavens that has been tacked up now,

NO AD MEN ALLOWED ON THESE PREMISES

will have Mr. Hoover stealing out in the dark some night and reaching up between the stars to take it down.

It will be taken down at least for certain ad men. The principle will be established that if men are exceptions they will be treated as exceptions.

The minute the real Bud Fishers, Charlie Chaplins and Babe Ruths of the air once appear in the interstices of space and begin clearing their throats there, if they are more amusing, more instructive and enjoyable about a soap than other people are about the League of Nations, everybody will buzz to them to go ahead. They will be given the very floor of heaven.

People are not going to stop listening to a man who makes them want to listen, merely because he is paid a high price for being the kind of man who can make people want to listen. Making them want to listen is the thing. People will like it and they will like his being paid for it.

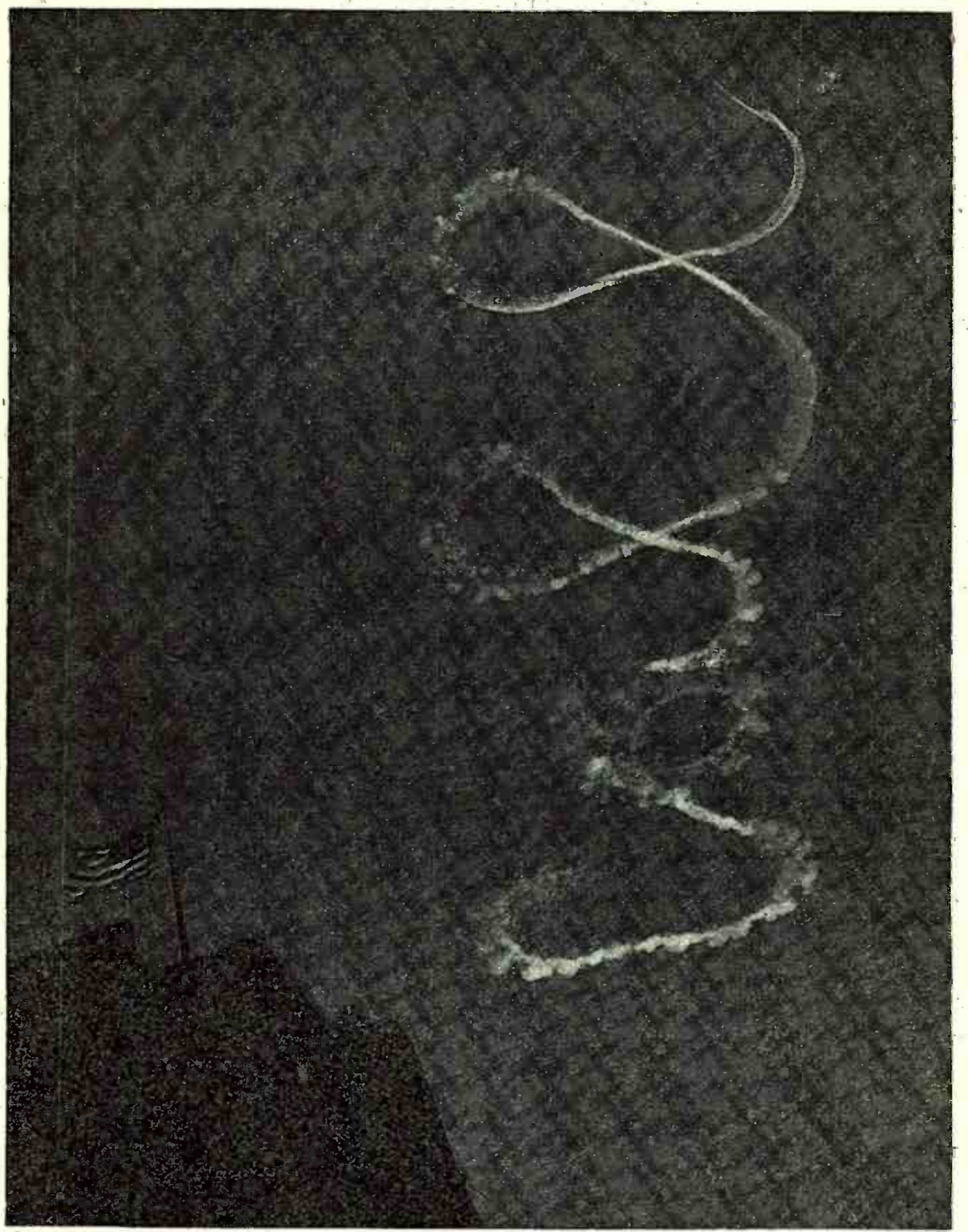
It has seemed to me for some time, as some of my readers know, that advertising—the art of touching men's imaginations so that they know something about themselves that they never knew before or that they never even wanted to know before—is one of the great professions. As the profession is interpreted by men who might yet be got to practice it, it calls for a kind of gift and a degree of gift which makes a man who has it and who determines men's lives with it fit to be listened to anywhere and listened to on almost any subject.

The invention of the radio telephone and the inauguration of broadcasting, instead of being made the occasion of a national snub to advertising men which they feel they must meekly bear, should be and I believe is going to be recognized and taken advantage of by many as the profession's great opportunity.

If the advertising men of America had wanted to pick out or arrange a picturesque and dramatic crisis for their profession in this country, if they had wanted to arrange a kind of gunpowder plot of publicity—a blaze of limelight in which to prove that advertising must be recognized as one of the greatest and the most honorable of the professions—they could not have done a better thing than to get themselves sensationally shut out of heaven, as they now are, and then with everybody looking on and everybody listening, begin doing things and saying things that will make people want them invited back again.

Perhaps the best way to make a start would be for The National Association of Advertising men to plan out and get under way what might be called a national tournament of advertising, a series of prize tests, and proceed to present to the American people in the quickest possible time advertisements that the American people would want broadcast.

A great profession is confronted with a loud, plain challenge from the people. It has a chance to look itself over and sort itself out. People are already interested in our national advertising men. They would be especially interested in seeing which are the ones that can get



THE "WRITING" ON THE FLOOR OF HEAVEN

The use of radio for controlling the airplanes that have indulged in the spectacular sky-writing of advertising slogans in London and New York has become more than mere theory; recent experiments in England indicate that planes guided by living pilots may soon be replaced by planes controlled by radio from ground stations. The "writing" is done by means of smoke from special devices that eject 250,000 cubic feet a second; the letters are about a mile high. The above photograph was made while Captain Cyril Turner was sky-writing the telephone number "Call Van 7100," about 10,000 feet above New York.

invited into the sky and which will be kept out.

Instead of saying sweetly and modestly, with a whole nation looking on, that they agree that the men who belong to the advertising profession cannot compete with other human interests and activities in earning the right to be allowed in our new annex on the world, our best advertising men, I believe, are going to accept the challenge.

The main principle which should be employed in determining the question of advertising in the air is the great democratic and spiritual principle that people should never be treated as if they were alike.

The idea that all men are created free and equal is not an idea anybody really believes as it is usually interpreted. It is a mere Fourth of July incantation. Nobody who accomplishes anything or lets anything be accomplished through him ever acts as if it were so. Every man in America gets up every morning and goes to bed every night proposing to be treated as if he were somebody in particular. Advertising men, like the rest of us, expect to suffer the penalties of being individuals.

The very essence of democracy, the juice and gusto of the whole idea, lies in the fact that we in this country do not believe that society is put up in big, soggy, undigested lumps of people. We dissolve these lumps into real human beings and treat them as they really are. The idea that all the men in any group or in any profession should be lumped together and treated in the same way by the government and by the laws of the people may be convenient, but it is superficial and lazy and in the long run expensive and drains the creative resources and finer powers of a nation like ours.

The only thorough, honest, economic, ethical manner of dealing with crowds or masses of men is never to give them privileges as if they were all alike. They are not all alike and they all feel and know that they are not alike; in their hearts they don't want to be alike and they hate to be treated as if they were. It is an anæmic, overworked and tired thing for our government to deal with advertising men as a group. If the government does not want to devote its brains to picking out some advertising men who are good enough for broadcasting, the National Advertising Association can establish publicity tournaments or adopt other means to determine exceptional men and to have them dealt with as a great nation wants them to be.

One of the biggest shoves forward that our civilization, our buying and selling civilization, is going to have, will come when our inventors perfect talking back in the sky. The first minute people can clap and boo in the sky, can make a man blush or stutter when he gets up to talk in it, millions of us who have been waiting to get even with some ad men in this country—ad men who have been hitching at our elbows and hollering in our ears half our lives—millions of us are going to have a heavenly time.

Incidentally, the advertising profession is going to get its reckonings and take its soundings. It is going to front itself and confront the people with facts that nobody can explain away. We shall spell out the names in the sky of the men whose advertisements grip. Publicity in America at last, instead of being a kind of splendid national guesswork, will proceed to establish itself as both a science and an art.

In the meantime, until our inventors perfect some suitable inexpensive device for sky back-talk or at least for taking a rising vote in the air, the best arrangement for determining which of our ad men should be let in to the sky would seem to be a vote by mail. We shall have to fall back on some such preliminary test placed before the public, as the National Advertising Association or some like organization may, for the glory of the profession, devise and set up.

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.*

The Senate Fails 3,000,000 Radio Fans

THE failure of the Senate to pass the White radio bill was a grave disappointment to the great army of radio fans as well as to the radio industry. To meet the emergency which has thus been created, the Secretary of Commerce, Herbert Hoover, re-convened the Radio Telephony Conference Committee of last year, with the purpose of working out a practical plan of action to tide over the period until Congress assembles again. What this Committee did—(it is in session as this number of POPULAR RADIO goes to press)—will be told in the June issue of this magazine by Mr. Paul Godley.

* * *

A New and Improved Vacuum Tube

AMATEURS who have advanced beyond the crystal-detector stage of development will be interested to know of the recent arrival of a brother of the UV-201 tube, popularly known as the "radiotron." Here is a brief description of it:

A new and improved radiotron, type UV-201-A, superior in many respects to the UV-201 tube and designed to supersede the latter, has recently been announced. While in outward appearance the new tube resembles its predecessor (with the exception of a slight discoloring of the bulb) the new tube incorporates several distinctive features. For instance, it contains a new and improved filament that requires only one-quarter of an ampere (.25) at five volts across the terminals of the filament; with this current the filament emission averages about five times that of the UV-201 tube. The filament, however, when burning at normal brilliancy, has a temperature materially less than that of the UV-201 tube.

The tube has an exceedingly high vacuum, is quiet in operation and produces no inherent tube noises. The high vacuum assures uniform characteristics. It is particularly adapted to radio frequency amplification.

In its operation as a detector, radio frequency or audio frequency amplifier, the results obtained are exceptionally independent of filament adjustment. Critical adjustments of grid leak or grid condenser are not required.

The new tube may be used in any equipment which at present uses the ordinary tube and will give improved results. No adaptor is necessary when the standard four-prong socket is used.

If the filament is supplied by a 6-volt battery, the resistance of the filament rheostat should be at least 4 ohms, preferably 6 ohms.

* * *

Theatrical "Try-Outs" by Wholesale

HERE is a novel application of radio to the work of the singers and instrumentalists of the stage:

The musician and actor sell their goods largely by sample. Before the theatre manager engages singers or instrumentalists, he wants to see or hear them. For which reason a great deal of the performer's time between engagements is spent in appearing before managers for private tests. This is particularly true in the new field of musical opportunity opened up in moving picture theatres, for where there are only a few

cities in the United States far enough advanced musically to support grand opera, even for a short season each winter, even small towns now have their picture palaces and good operatic music is heard in them fifty-two weeks a year.

In Baltimore recently, a couple of young singers who have been successful in putting on "twenty-minute operas" in moving picture theatres, made a successful trial of radio as their booking agent. Justin Lawrie, tenor, and Fernando Guarneri, baritone, make their own condensed arrangements of famous operas. Moving picture opera is pretty strenuous work, involving four or five performances a day, including Sundays and holidays, and often the doubling up in more than one part of the program. Taking one's samples around in between times and singing for managers with a view to booking future time, is just so much more work.

Lawrie and Guarneri find that it can be done better by radio. Scheduled to "appear" recently on a Baltimore broadcasting program, they wrote moving picture musical directors and theatre managers within a radius of several hundred miles around Baltimore, enclosed programs from the theatre where they were then giving twenty-minute operas, and asked that their radio performance be listened to as a sample of their work. Several engagements were secured in this way, and they expect to use radio regularly in future bookings. For the singer, instrumentalist, quartet, chorus and orchestra, radio seems to be an improvement in booking because it enables the performer to show his samples to more than one prospective purchaser at the same time. It is estimated that there are now at least three thousand moving picture theatres throughout the country in which such artists seek and find engagements. If they use radio to secure booking in paid engagements, it may help to solve the problem, "Who is to pay the radio performer?"

JAMES H. COLLINS

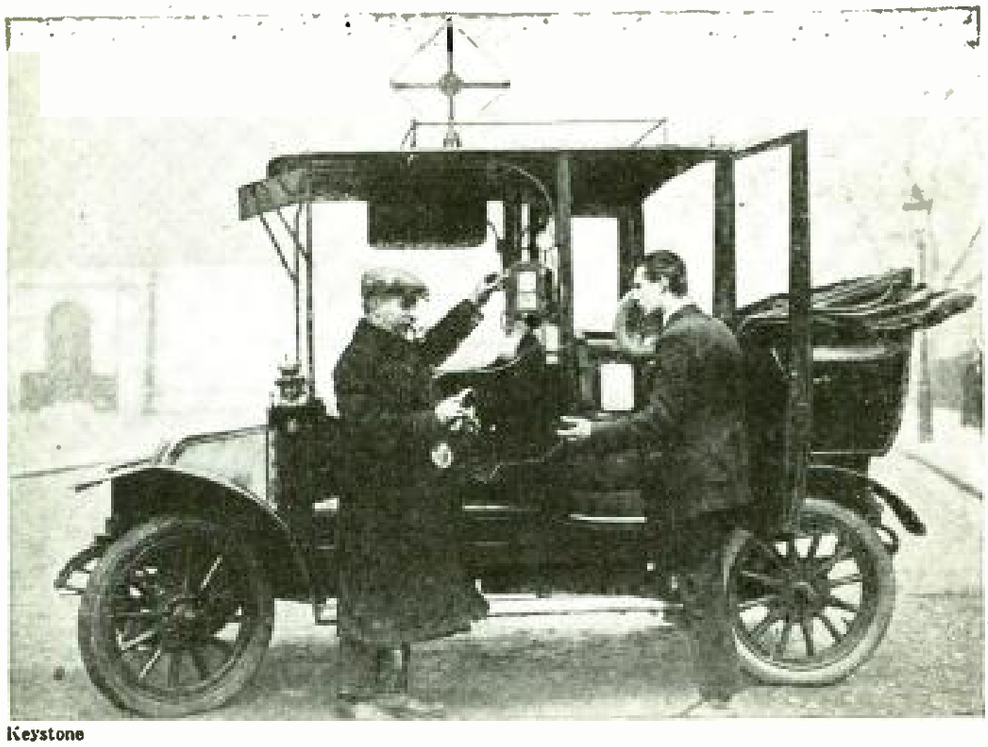
* * *

A Testing Battery for 11 Cents

IF you own—or can borrow—a silver dime, and can find a drop of ordinary vinegar about the kitchen, you can create a miniature electric battery that is quite good enough for testing your headphones. This tells how to do it:

Take a dime and a one-cent piece and place them 1/16 of an inch apart. Then place a drop of common vinegar between the coins, and take care that the vinegar touches *both* coins. Nitric or sulphuric acid can also be used to a good advantage. Lastly, take the phone terminals and move them on the coins, for a contact must be made on both terminals. If you hear a faint scratching sound in the receivers you will know that your phones are working.

WALTER A. WACHHOLTZ



Keystone

RADIO ENTERTAINMENT—WHILE THE METER CLICKS

An ingenious London taxi-driver not only lures his trade by means of a receiving set installed in his car, but often collects additional fares while his patrons remain seated until the conclusion of an interesting program.

South Sea Love Songs in New England

TO listen in upon the actual folk-music of the world, played and sung by native musicians in their native lands, is one of the startling possibilities suggested by the rapid development of radio apparatus. Indeed, this possibility is already being realized, as Mr. Dunlap points out:

Radio followers who have had the pleasure of listening in to the melodies of New England from station WBZ in Springfield, Mass., Southern medleys from WSB in Atlanta, Ga., and Western songs from WOC in Davenport, Iowa, may increase their concert range by tuning in to the 400-meter wavelength of PWX in Havana, Cuba, which is now broadcasting in the evening, Cuban songs and tropical dance music. Experimental tests have been heard as far north as New Jersey; as the grade of radio reception is improving, it is expected that the radio waves of Cuba will be heard throughout the entire United States.

The installation of a broadcasting station on the island of Cuba indicates that the music of radio is gradually going to travel from continent to continent, first by advancing from island to island, as did the ships of Columbus. Radiophone broadcasting of concerts and other forms of entertainment is still in its elementary stage. Just as the baby learns to walk by stepping from one chair to another, so the music of radio will advance around the world from island to island before gaining sufficient strength to leap from continent to continent.

Many broadcasting stations have a power of 500 watts. Engineers predict that powerful water-cooled vacuum tubes now being developed will be capable of hurling 100,000 watts into space. Already the 500 watts of station WOR at Newark have carried the human voice across 3,000 miles of ocean to London, where listeners-in caught the voice and reported it by cable.

The performance of radio stations in transoceanic code reception at the present time casts a light on the future possibilities of radio telephony. An operator in the United States listening to Nauen, Germany, can, by slightly turning a dial, tune out the German messages and hear Bordeaux, France, or Honolulu. Radiophone listeners will soon find that by a simple tuning adjustment, they will be able to skip around the earth in the twinkle of an eye to enjoy the melodies of each country, rendered by the natives themselves.

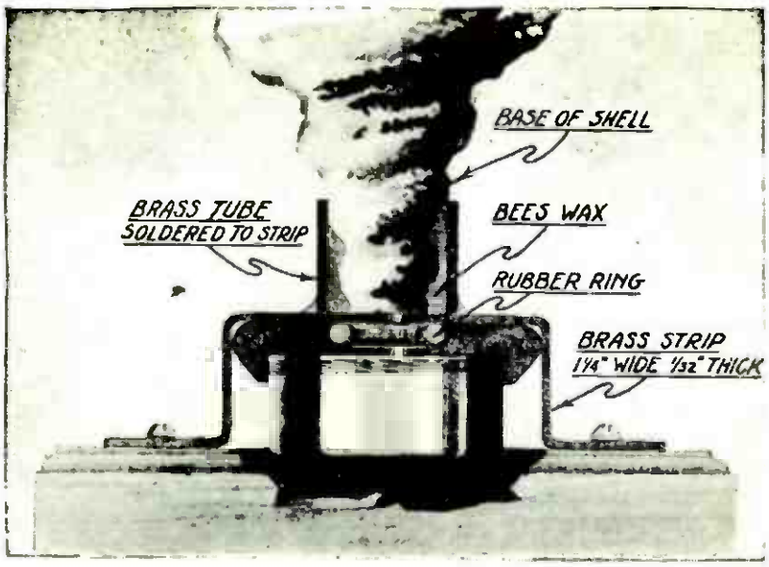
The radio concerts in the future will not be confined to the United States but every country in the world will represent the stage. Russian artists will be able to sing or play in Moscow and have their music heard just as clearly in New York as in the radio studio in Russia. One will be able to listen to the strains of American music played in Washington by a United States Navy band, or tune to the wavelength assigned to the British Isles and pick up the English folk songs broadcast from London, or French airs played in Paris. In a like manner will the songs of Spain and sunny Italy, the melodies of Norway, Hawaii and Japan be ever present on different wavelengths in the ether lanes.

ORRIN E. DUNLAP, JR.

© Keystone View Co.

A LITTLE "LIGHT" ENTERTAINMENT

By merely throwing her antenna wire over a metal street lamp and attaching the ground wire to a man-hole cover, this young London radio fan is demonstrating how obsolete has become the phrase "deaf as a post." This particular lamp-post is serving as an aerial for receiving programs from the Eiffel Tower in Paris.



HOW THE LOUDSPEAKER MADE FROM A SEA-SHELL IS ATTACHED TO THE EAR-PIECE

The telephone is set into the shallow hole in the wooden base, and the small rubber gasket is laid in position. The sea-shell, which has been previously secured to the brass tube and strip as described, is then placed in position and secured to the base by means of two wood-screws.

A Skeleton as a Loudspeaker

FROM England comes a practical idea for using a sea-shell as a part of the amateur's home-made set. Not only does this boney object of nature give excellent results but it combines low cost with real beauty:

The chief part of a loudspeaker is the telephone—for, whatever its name might imply, the ordinary loudspeaker is only a single receiver ear-piece with a horn of some sort mounted on it. It requires at least two tubes to obtain a reasonable volume of sound unless the amateur enjoys the questionable good fortune of being in close proximity to a transmitting station. A single high-resistance receiver would be suitable. The receiver shown in the photograph is a 3,000-ohm telephone.

The base is made of mahogany and a shallow hole turned in the middle to keep the body of the receiver in place. The horn, as will be seen from the photograph, is a large sea-shell. A piece of 1/32-inch brass strip, 1¼ inches wide, is bent to the shape given in the sketch. It just clears the ear-piece, and a soft rubber ring is clamped round the centre hole. A piece of 1¼-inch outside diameter brass tubing is soldered on top of the strip.

The horn was cemented in place with bees-wax. It was propped up in the right position and the hole at the bottom stopped up to prevent the wax entering. It was warmed up and molten wax poured round it and left to cool. This done, the result was a working instrument that was as handsome and practical as it was easy to make.

A tin or zinc horn would also serve. This could be made conical with the top slanting downward at about 50 degrees, and could be soldered straight onto the brass bridge-piece. No dimensions have been given in the drawing, as these will depend upon the size of the telephone receiver used. A good size of horn would be about 10 inches high and 4 inches in diameter.

NORMAN EDWARDS

How the Weather Does and Does Not Affect Radio

NEITHER wind nor rain have a bad effect upon radio transmission or reception; indeed, stormy weather is usually "good weather" from the point of view of the radio fan. Several common misconceptions on this subject are cleared up in the following contribution from an English correspondent:

What we commonly call good weather is not necessarily good weather for radio, and what we commonly call bad weather is not necessarily bad weather for radio. A dark, rainy day, for instance, is often an extremely good day for radio; indeed, it is during the stormy days of winter that most radio records are broken. The reason is that radio waves are entirely independent of air waves and of merely atmospheric disturbances.

Neither wind nor rain need have a bad effect on radio. The collection of moisture upon the insulators may cause a leakage of radio energy to the ground, but this is purely a mechanical fault that can be eliminated by the use of corrugated insulators. Radio waves do not constitute an electric current which flows down to the ground on the first convenient conductor. If a wind is so strong as to shake the antenna it may cause difficulty in tuning, but that is the only trouble a wind will give. The speed of the highest wind (one to two miles a minute) is so trifling compared to the speed of radio waves (186,000 miles a second) that even if an air wind could affect radio waves, the effect would not be appreciable.

There are three reasons why the conditions are not quite as favorable to radio work in summer as in winter:

First, the increased foliage of the trees brings about an increased absorption of radio energy, and this permits less of it to reach the actual antennas. Each tree acts virtually as an antenna, and the district becomes too "crowded" for good radio work.

Second, the brighter solar light in summer ionizes the atmosphere and causes a "dampening" of radio energy.

Third, there is more interference due to static in summer than in winter.

But even so, radio work can be carried on with success in summer. It is foolish to conclude that weather conditions at any time of the year can seriously interfere with radio. Last winter steamers off the coast of Colombia picked up American broadcasting from stations sometimes as far as 2,000 miles away! And the weather conditions in the tropics are infinitely more unfavorable all the year round than they are in the United States in summer!

Don't be discouraged about "summer radio." Take a set along with you on your vacation.

JOHN BULMER

A "HOME-MADE" OUTDOOR ANTENNA

By driving a nail into its top and bottom and making connections in the way that is shown above, any tree may be converted into an antenna that will actually work. And this antenna is the one kind that will be more efficient in summer than in winter, for the very foliage that is regarded as an "unfavorable" radio condition will make it absorb more energy.

* * *

How to Make a Spider-Web Coil from a Phonograph Record

HERE is a time- and money-saving hint from a practical-minded reader who made the spider-web coil that was described in detail in the October issue of POPULAR RADIO:

In the construction of this coil I discarded the composition sheet specified and I took an ordinary ten-cent phonograph record instead. I let this soak in hot water; then I made the cuttings that were required. (When the record is soft, this cutting can be made without cracking the record.) I then used it as the form on which to wind the coil. A phonograph record, as a form, has these three advantages: it insulates well; it is cheap and it is easily handled. A coil wound on it has a neat and workmanlike appearance.

WALTER H. SANDT

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 cooperate 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: Would a variable condenser help me any if it were used instead of the ordinary fixed condenser in the grid circuit of the vacuum tube detector? My set seems to be hard to keep from oscillating and although I can hear distant stations, reception is accompanied with a loud whistling sound.

E. JAMES EDSON

ANSWER: The variable condenser will enable you to tune out this whistling, due to oscillation, but it will add one more control to the set. However, as this will be necessary only in the case of tuning in the far-distant stations, you may leave this condenser set at a fixed value most of the time.

* * *

QUESTION: I am a beginner and would like to know a good hook-up for a crystal detector and a loose coupler.

J. B. EMERSON

ANSWER: You will find the circuit you require in Figure 5, page 212 of the November issue of POPULAR RADIO.

* * *

QUESTION: The diagram Figure 4, page 60, of the January issue of POPULAR RADIO, illustrates a circuit that shows three stages of radio frequency amplification, detector and two stages of audio frequency amplification. The coupling arrangement between the radio frequency amplifiers and the detector is a three-coil honeycomb mounting with suitable coils. I want to use this circuit, but I would like to eliminate the tickler coil L3, and use a variocoupler for the coils L1 and L2.

S. B. CROZIER

ANSWER: This modification should work well. If you have a variocoupler which has a tapped primary winding, you may also eliminate the condenser C3 and improve tuning.

QUESTION: Please give me the hook-up and particulars of the Flewelling super-regenerative circuit. I would like to know if it will work on an antenna and on a loop.

R. B. FOSTER

ANSWER: In the diagram (Figure I) you will find the circuit. The parts for the set are the following:

L1—honeycomb coil, L-50
L2—honeycomb coil, L-75 (a variocoupler may be used instead of coils L1 and L2.)
VC—variable condenser, .0005 mfd.
GC—grid condenser, .00025 mfd.
GL—grid leak, variable, 1 to 2 megohms
C1, C2, C3—mica fixed condensers, .006 mfd.
R1—low resistance, variable .25 to .75 megohms
R—filament rheostat 5 ohms
Tel.—telephones or loudspeaker
"A" and "B" batteries to suit tubes used.

Any type of hard tube may be used, including the 1½-volt filament tubes. All tuning is done in the same manner as is usual with the ordinary regenerative set. The variable grid leak GL plays a large part in tuning in and clearing up the signals. It will be best to experiment with the "B" battery voltage until the best voltage to use is found. This will vary between 22½ to 100 volts for the loudest results.

The set may be used with an antenna and ground if they are connected across the two wires marked XX on the diagram. The set may be used with either the antenna or the ground alone if it is connected to the upper wire X. If a loop is used it should be connected across XX. The set will function satisfactorily, however, up to distances of 50 miles without any antenna or ground of any kind.

A high pitched whistle will be heard in the telephones during reception, but this can be regulated and considerably reduced by adjusting the grid leak GL.

* * *

QUESTION: Does wind affect radio waves? I have noticed that during a heavy windstorm it is difficult to tune in, and keep tuned in, signals from broadcasting stations, especially the more distant ones. I have a single circuit regenerative receiver with two audio amplifier tubes attached to it.

F. R. SMYTHE

ANSWER: Wind does not affect the radio waves. They travel at the speed of light (186,000 miles a second) and the mile and a half a second of even a 90-mile hurricane would not have much effect against this great speed. Besides, the wind is a wind of *air*, and the radio waves pass through *space* and not through the air as a medium, so that there is no conflict between the two. What you are experiencing is a detuning of your single circuit receiver by the changes in capacity as your antenna swings in the wind. As it swings, the relative capacity varies, for the capacity of the antenna is inversely proportional to the distance between the antenna and the ground. In the type of receiving set that you are using, the antenna capacity plays an important part in the tuning and it is this that causes your signals to swing in and out.

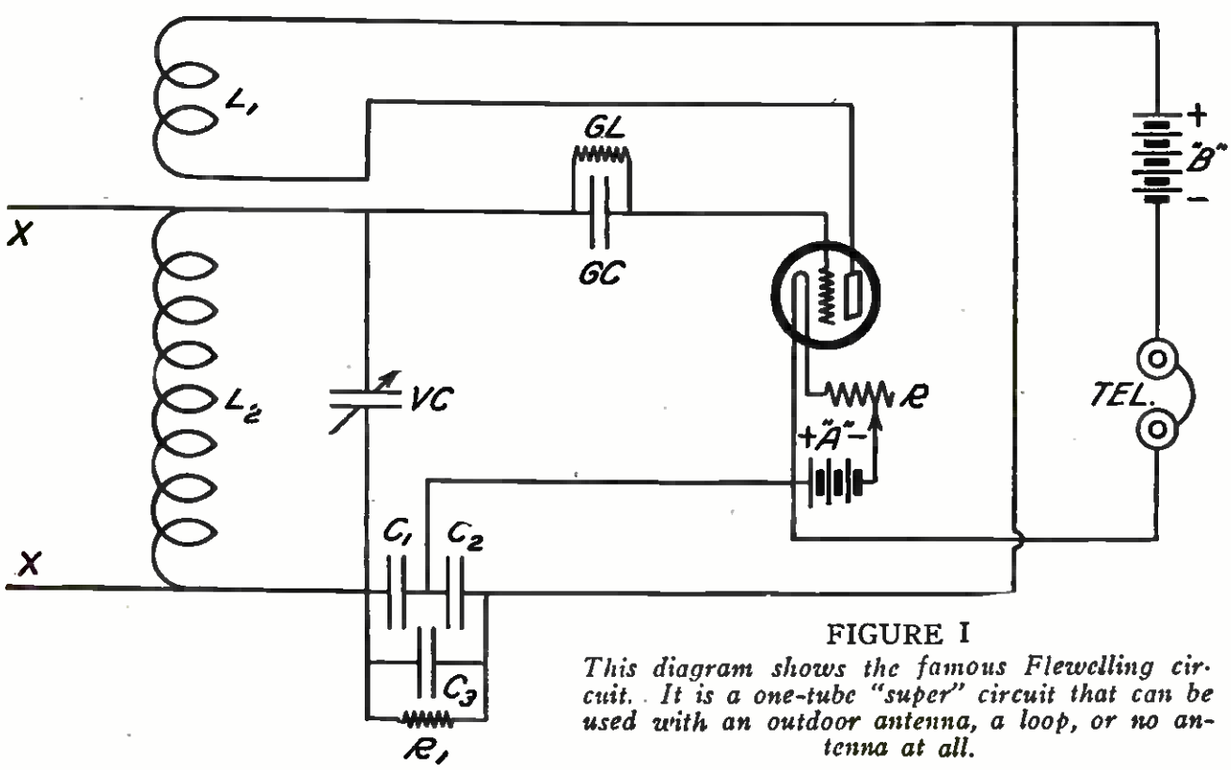
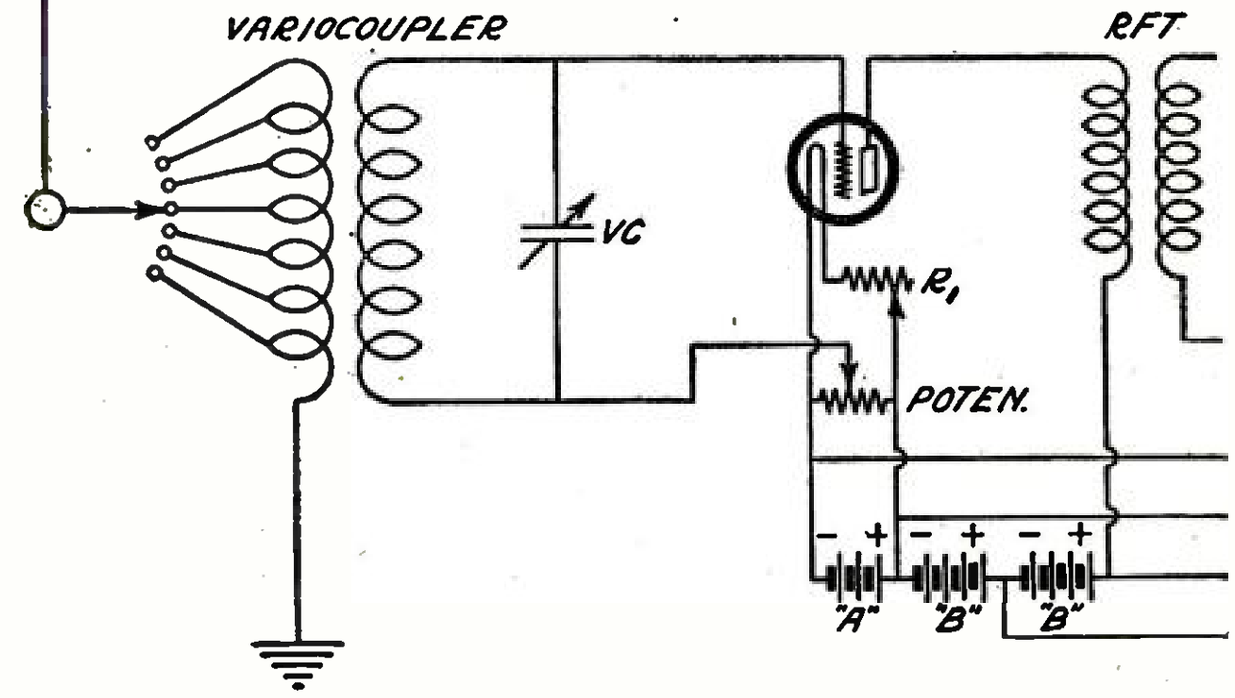


FIGURE I

This diagram shows the famous Flewelling circuit. It is a one-tube "super" circuit that can be used with an outdoor antenna, a loop, or no antenna at all.

FIGURE 2

A hook-up for two stages of radio frequency amplification used with a crystal detector. By means of the two potentiometer stabilizers the circuit may be made extremely sensitive to DX signals.



QUESTION: I have bought the following apparatus and would like to get a circuit for two stages of radio frequency amplification with a tube detector:

2 Cunningham C-301 vacuum tubes.

1 Cunningham C-300 vacuum tube (for detector).

1 variable condenser, 43 plate.

1 Atwater-Kent variocoupler.

1 Dubilier grid leak and condenser combination.

1 pair of Brandes headphones.

2 Murad radio frequency transformers (for first and second stages).

Is there anything else I will need to have?

ROSCOE B. NETTE

ANSWER: The hook-up for your apparatus will be found in Figure 2. You will need also three filament rheostats, two potentiometers (200 to 300 ohms), three tube sockets, "A" and "B" batteries, and one fixed telephone condenser. If properly connected this set will bring in distant signals, but if you use a loudspeaker you should add to it two stages of audio frequency amplification.

* * *

QUESTION: I would like to get a diagram that shows how to hook up a standard regenerative circuit that uses a variocoupler, two variometers and a series condenser in the antenna circuit, with two stages of audio frequency amplification. I want to use jacks in each stage so that I can use the set with the detector alone, or with either one stage or two stages of amplification.

ARTHUR NILSON

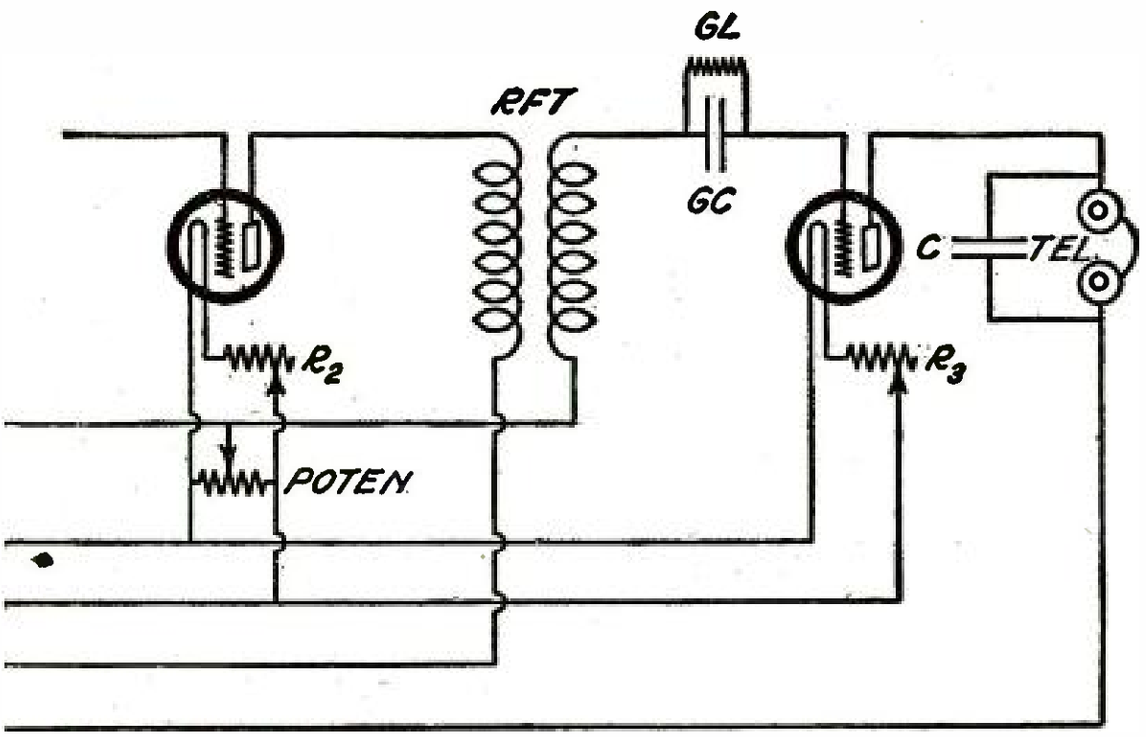
ANSWER: You will find this circuit given on page 210, Figure 3, in the November (1922) issue of POPULAR RADIO. This circuit has met with great favor among radio men; if you use the list of instruments given on the same page as the diagram, you will have good results in long-distance reception.

* * *

QUESTION: Will a potentiometer help me in regulating the "B" battery potential on my detector tube? How many ohms should it have? How should it be connected?

LAWRENCE VRELAND

ANSWER: This will be a good addition to your receiving set. It should be one of at least 200 ohms and should be connected directly across the "A" battery with its pointer connected to the negative terminal of the "B" battery. By rotating the lever arm a variation of six volts can be made in the potential of the "B" battery.



QUESTION: I have the following radio parts:

1 variocoupler
1 variometer
1 variable condenser, .001 mfd.
1 variable condenser, .0001 (vernier)
1 grid leak, 2 megs.
1 grid condenser, .00025 mfd.
1 telephone condenser
2 potentiometers, each 200 ohms

Will you give me a good regenerative hook-up for them?

T. E. REDMOND

ANSWER: The hook-up for connecting your instruments is shown in Figure 3. The two potentiometers are shown as P1 and P2, the grid leak and condenser as GL and GC, the large and small variable condensers as VC1 and VC2, and the variometer and telephone condenser as VAR, and C, respectively.

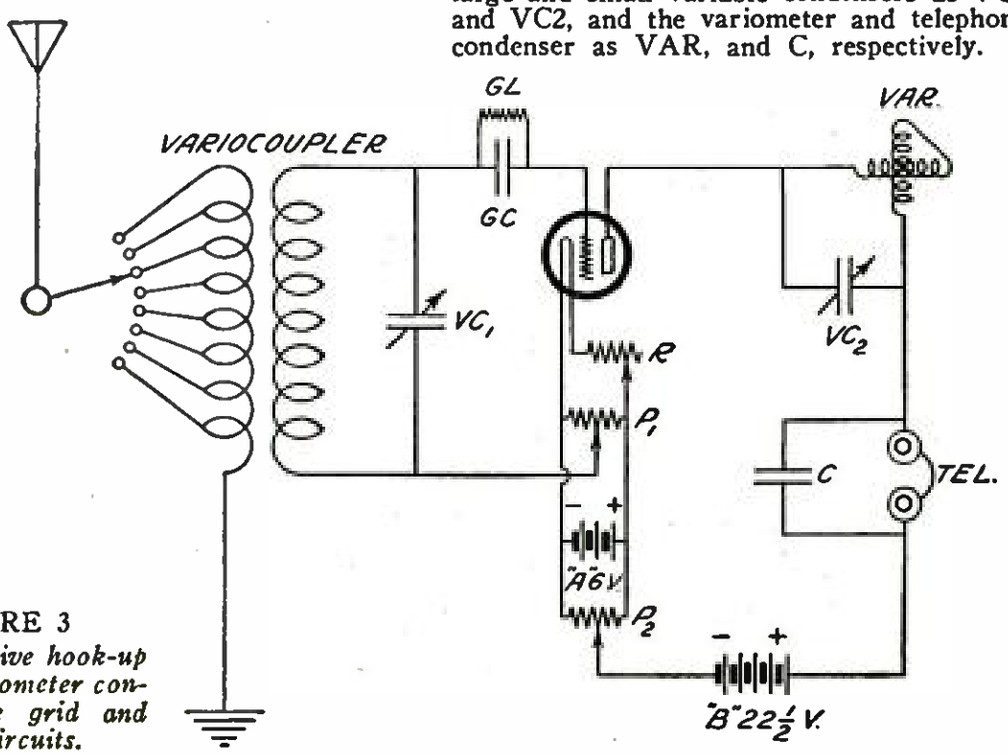
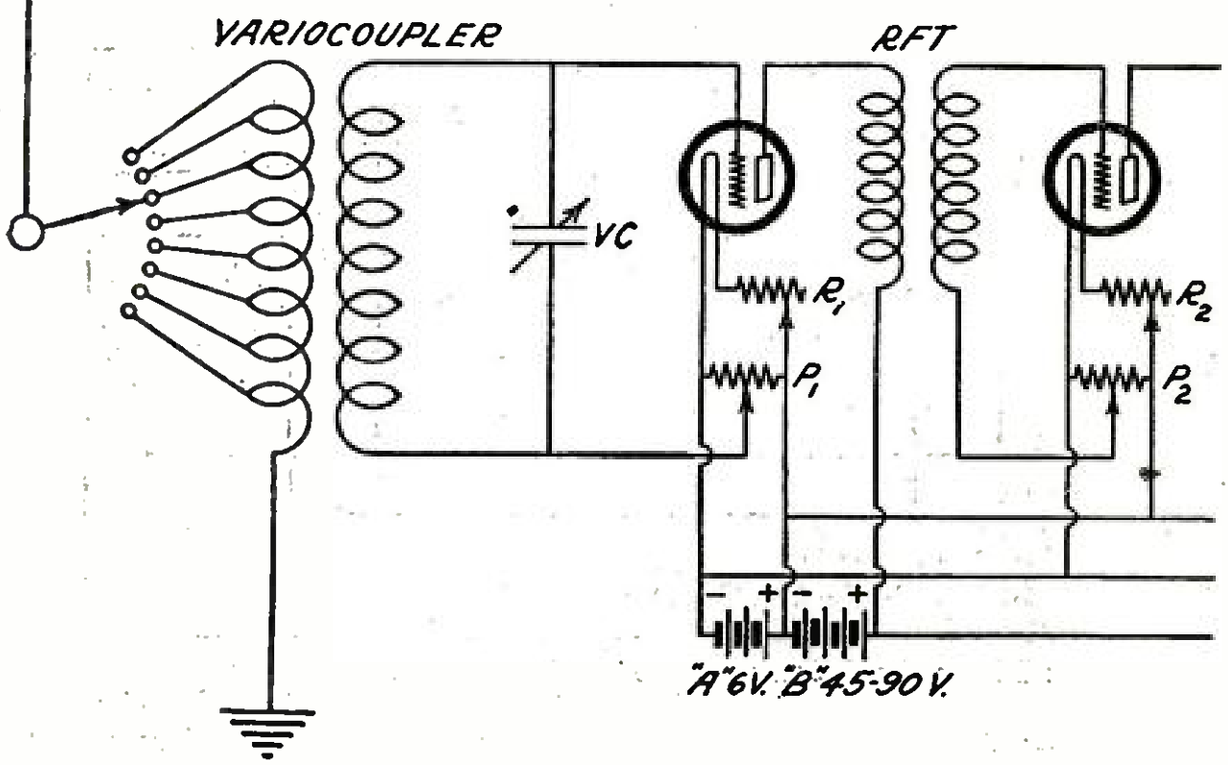


FIGURE 3
A regenerative hook-up with potentiometer control of the grid and plate circuits.

FIGURE

A four-tube set which consists of two stages of radio and two of audio frequency amplification used with a crystal detector.



QUESTION: Please give me a diagram for two stages of radio frequency amplification, crystal detector and two stages of audio frequency amplification. I would like to use a crystal detector, as it would cut down the number of tubes I have to use. I have some crystals that are sensitive over their whole surface and believe they would work if I had the proper circuit

SAM NEWBERRY

ANSWER: The hook-up you need is shown in Figure 4. The radio frequency transformers are designated as RFT, and the audio frequency transformers as AFT. Two potentiometers, P1 and P2 will be required. and these should have a resistance of 200 ohms each. The filament rheostats R1, R2, R3 and R4 are of five or six ohms each. The telephone condenser C should be of approximately .001 mfd. capacity.

* * *

QUESTION: What is the difference between a regenerative set and a non-regenerative set? How can a regenerative set be constructed out of a non-regenerative set?

C. PEARSON

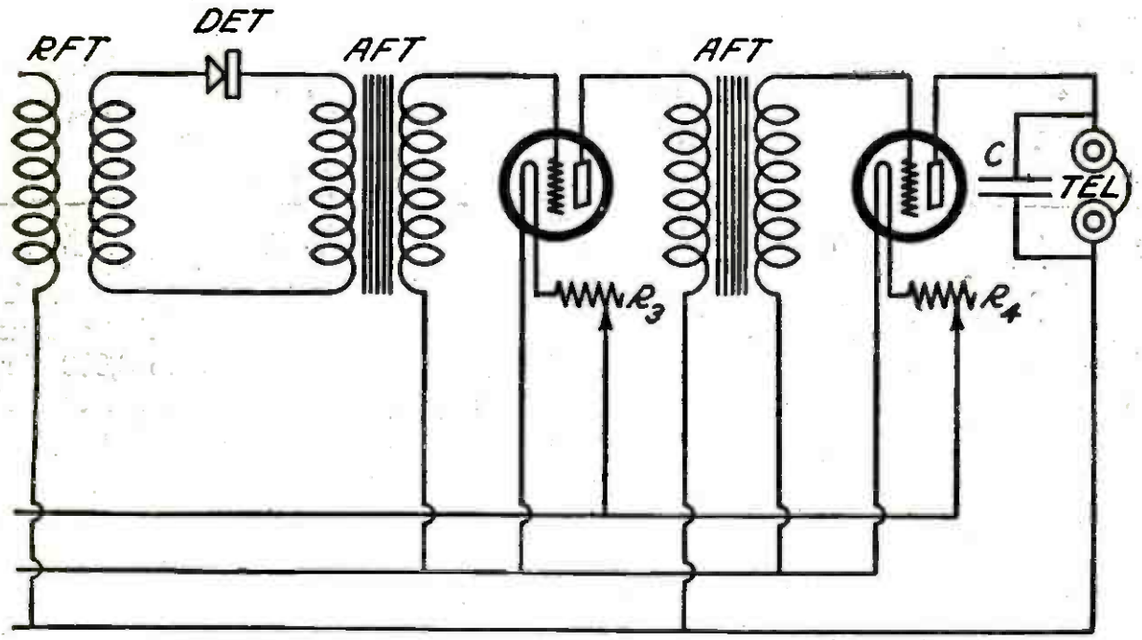
ANSWER: A regenerative set is one in which part of the received and amplified energy is fed back into the input circuit of the vacuum tube and regenerated or reamplified by passing again through the vacuum tube. In a non-regenerative receiver this is not so, the signals entering the input circuit only once. To make a regenerative receiver out of a non-regenerative receiver, insert a variometer in the plate circuit of the detector vacuum tube, so that the plate circuit may be tuned to approximately the same wavelength as the input circuit. Then part of the energy flowing in the plate circuit will be fed back into the input circuit, and the amount of this feedback may be controlled by turning the knob attached to the variometer.

* * *

QUESTION: On page 119 of the June issue of POPULAR RADIO you show a type of antenna called a loop antenna. I would like to know the dimensions of such an antenna.

W. H. MORRIS

ANSWER: We would advise you to build a square type loop. It should have a length of 3 feet to a side. For listening to broadcasting on 360 meters you should wind it with at least 15 turns of solid copper wire, bare or insulated, spaced ¼ inch between turns. Tuning will be accomplished by connecting a variable condenser across the loop.



QUESTION: Is it better to use the small or the large type of "B" batteries?

E. S. T.

ANSWER: If you have a single-tube set the ampere-hour capacity of the small type will be sufficient. If you use more than one tube with amplifiers it would be advisable to use the larger type, especially if you use more than 45 volts on one plate of the amplifier tubes.

* * *

QUESTION: I have a crystal detector set that consists of a variocoupler, a variable condenser, a crystal detector, a telephone condenser and a pair of telephones. Kindly show me how to add a variometer and a vacuum tube to it so that it will be regenerative. I would also like to keep the crystal so that I can switch to either crystal or vacuum tube.

ELINOR ROBINSON

ANSWER: The circuit shown in Figure 5 will give the results you require. You will, of course, require an "A" battery of six volts for the filament of the tube, and a "B" battery of 22½ volts for the plate. The switch shown in the diagram should be closed when using crystal and open when using the vacuum tube. When the crystal is being used, the filament of the vacuum tube should not be lit.

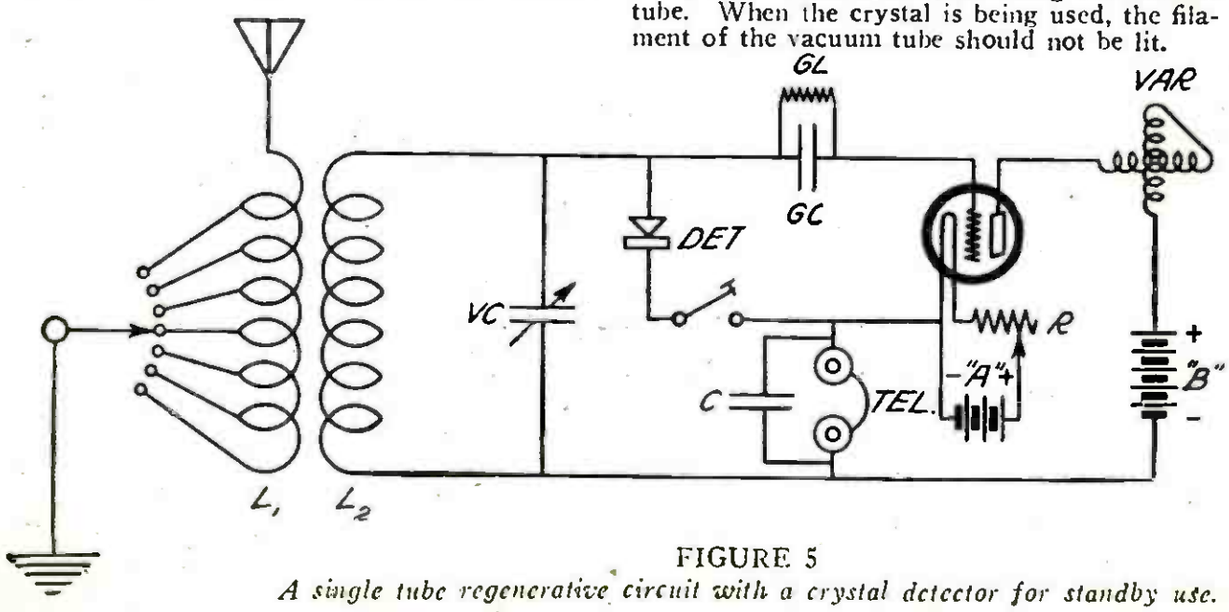


FIGURE 5

A single tube regenerative circuit with a crystal detector for standby use.

If you see a diagram and read a description of a radio set in a book and decide to build such a set, be sure to follow out every detail of construction. You may be sure that the design of the set has been carefully worked out and that the set has been tested before the description has been put into print.

Many novices try out a hook-up and build a set but use parts other than specified; when they get inferior results they blame it on the set. As a matter of fact they themselves are usually at fault. If you decide to follow instructions for this purpose, follow them down to the last detail; even then, if your success is not as great as you had hoped for, you may be sure that you have overlooked some detail which may have been all-important.

* * *

The ordinary telephone ear-piece is not suitable for use in a radio receiving set because its resistance is too low. To be most efficient a receiver should have a total resistance (impedance) equal to the circuit which is feeding it current. The resistance of the telephones that are used in radio vary from 2,000 to 8,000 ohms. The average resistance in the majority of makes is 3,000 ohms.

* * *

The lead-in for a radio installation should not be run at any great length through the interior of a building, as this will weaken the received energy on account of absorption by the building structure.

* * *

While listening-in to broadcasting, do not allow the detector in a regenerative-circuit receiver to oscillate. You can easily determine if it is oscillating by the high-pitched, whistling sound in your head telephones.

If a set is allowed to oscillate it will send out into space, *via* the antenna, a small quantity of radio energy that will cause the same sort of whistling noise

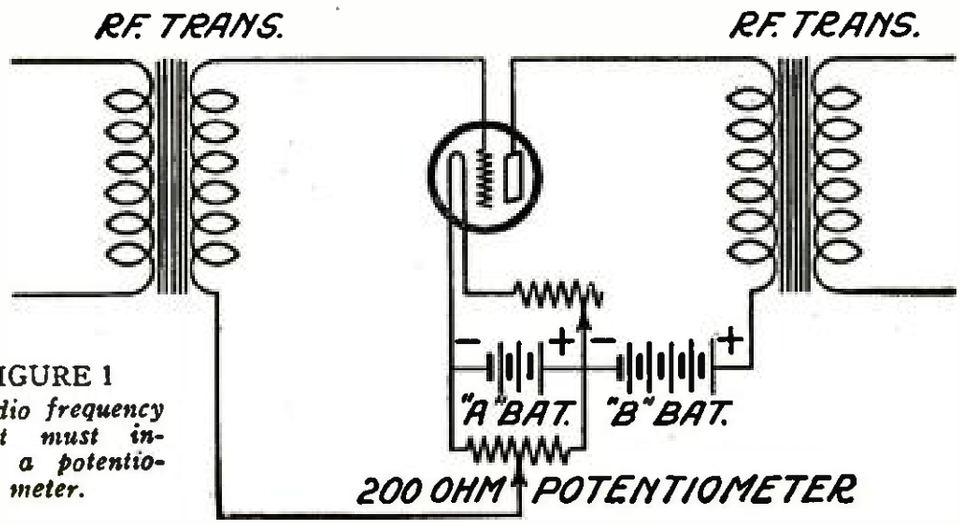


FIGURE 1
A radio frequency circuit must include a potentiometer.

in your neighbors' sets that you hear in your own telephones. There is no excuse, for anybody who knows this fact, for causing this radiation from regenerative receivers, as it will always be evident to the person who operates the receiver whether or not his set is oscillating.

* * *

WHEN experimenting with the radio frequency amplifier, the amateur should keep in mind the fact that the vacuum tube is a potentially operated device; that is, it is caused to function by the voltage applied to the grid. The grid should therefore be kept at a correct potential so that any incoming voltages that are impressed upon it make the greatest response in the plate circuit. This is most easily done by the use of a potentiometer shunted across the "A" battery. The adjustable pointer of the potentiometer allows this critical voltage to be applied to the grid with ease. A picture of a potentiometer is shown on this page, and the method of connecting it to the radio frequency amplifier is shown in Figure 1. Without this, the amplifier will be sure to function inefficiently.

* * *

WHEN the amateur builds his tickler feed-back circuit receiver he sometimes has trouble getting the set to oscillate. This trouble may be easily overcome by reversing the terminals of the tickler coil, as this is the fault most usually made. To find out which way to connect the tickler coil, tune in a signal the best you can; then reverse the terminals and retune the same signal. The comparison between the two strengths of the signals will give you the answer.

* * *

GOOD reception does not mean noise. A man may have a set that can be heard all over the neighborhood, but what good is mere volume of sound if it is incomprehensible? The two prime requisites of a good receiver are:

That it should tune sharply to eliminate interference.

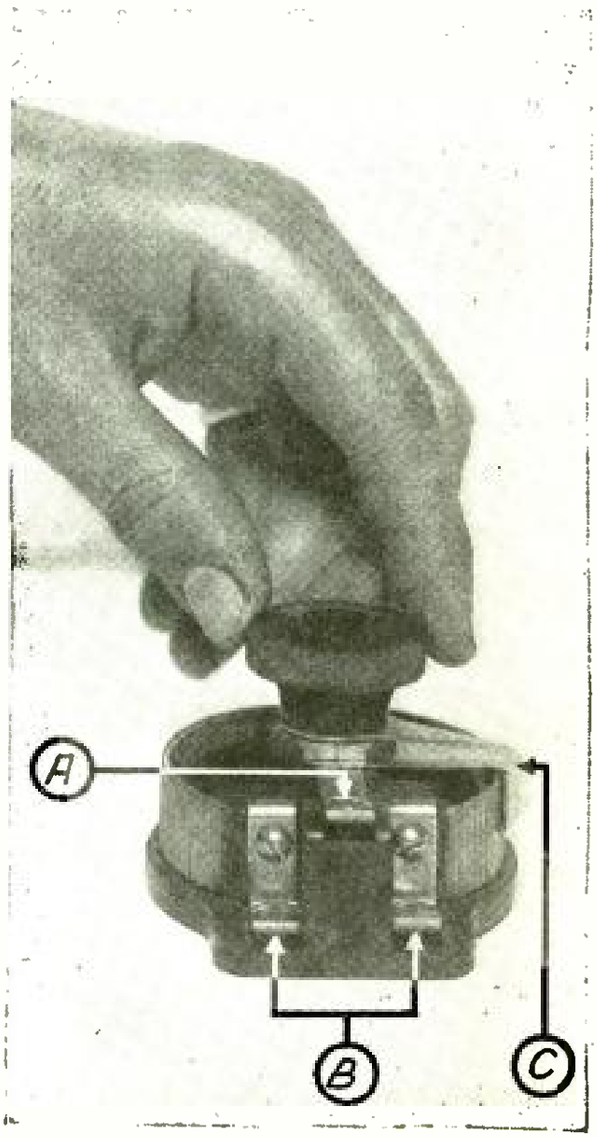
That it should reproduce signals with clarity and truthfulness.

A set that tunes in a signal and can be heard with comfort in a room with a loudspeaker and that can be clearly understood, is valuable, whereas a set that produces strident discords is useless.

When you buy your set, make sure that it will tune sharply and give a clear signal.

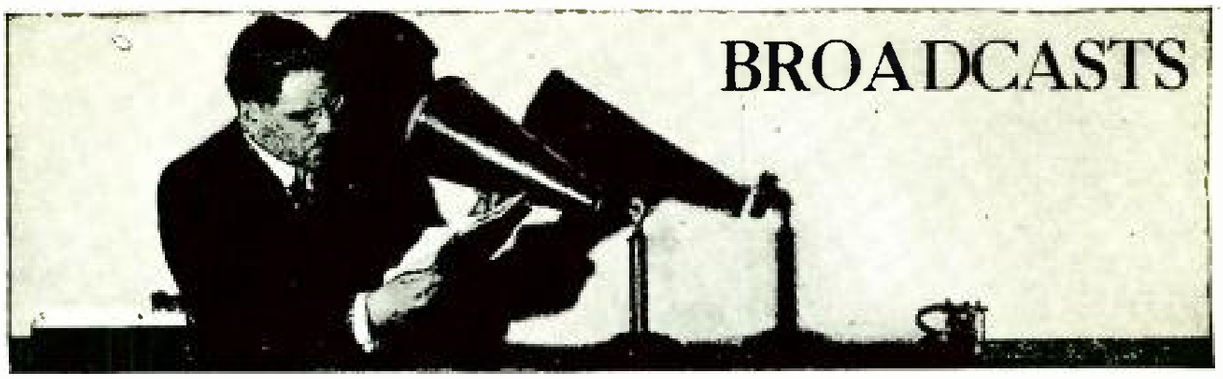
* * *

REMEMBER that the positive terminal of your "B" battery goes to the plate of the vacuum tube.



HOW TO CONNECT THE POTENTIOMETER

The terminal A (attached to the lever C) is connected in the grid circuit. The two terminals B are connected across the "A" battery.



BROADCASTS

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

Will We Get Radio Signals from the Spirit World?

THE possibility of establishing contact with the world of the dead by means of radio continues to absorb the interest of the spiritualists. Sir Arthur Conan Doyle has recently delved into the subject and announced the following conclusions:

"Wireless takes us into an etheric region, and it is our provisional belief that psychic life is also on an etheric level and expressed in etheric terms. Therefore, I think there is great hope that wireless, possibly on a far longer wavelength, 30,000 meters say, may give us wonderful results. Several important experiments are progressing along this line."

* * *

The First Press Photograph Is Sent by Radio

THE invention of C. Francis Jenkins for transmitting and receiving pictures by radio (described in the April number of POPULAR RADIO) was given its most impressive practical test on March 3, when a photograph of President Harding was sent from the Naval Radio Station, NOF, in Washington, D. C., and was received at the station of the *Evening Bulletin* in Philadelphia. The picture was transmitted on a wavelength of 1,150 meters.

* * *

Amateur Sentinels in the Ether

IN order to co-operate with Uncle Sam in protecting radio, amateurs of the American Radio Relay League propose to appoint observing stations which will listen in and will log all interference that they hear. The information that they collect will be of help to the government in its determination to get after that peculiarly annoying radio nuisance —the station that insists upon "parking" on the wrong wavelength.

* * *

1,000 Voices Are Broadcast at Once

A RECORD of largest volume of human voices ever broadcast at one time was recently established when station WGY successfully transmitted the singing of the Albany Community Chorus, which is made up of 1,000 men and women.

A College Education at Home—by Radio

STILL another college is testing the possibilities of radio as a means of getting education to the public. The faculty of Marietta College in Ohio, has decided to broadcast a full set of its courses and to give regular credit toward a degree for courses taken in this way. It will be necessary for the radio student to register in the usual way, but aside from that he need not go from his own house.

* * *

Radio Enters a Stockholders' Meeting

THE first use of radio for reporting the proceedings of an important business meeting was made in Chicago on February 27, when the annual gathering of the stockholders of the Commonwealth Edison Company was broadcast for the benefit of the 25,000 owners and 600,000 customers of the concern. One stockholder who listened in on a small crystal set expressed surprise at the ease with which a $20,000,000 increase in capitalization was voted!

* * *

Radio on the Trail of a Dead Language

SCIENTISTS engaged in the study of Mayan, the prehistoric language of Mexico, found unexpected help in the new radio instrument, the pallophotophone, that makes photograph film records of sound. Dr. William Gates, Director of the National Museum of Guatemala, found an Indian who spoke Quiche, which is a direct offshoot of Mayan. He took him to Washington, where he made kymagraph tracings of his voice. Then he discovered that the pallophotophone could catch vibrations which the kymagraph could not possibly record. The Indian has gone back to his mountain home, but the records of his speech are still being studied. Already the scientists have discovered that Quiche is a tone language, akin to Chinese.

* * *

Radio Makes Song Birds Sing

ONE of the most remarkable concerts ever given occurred recently when the Detroit station WWJ put six canaries in front of its transmitter and made them sing—and sing on schedule time, at that! A microphone was placed in front of the cages, which were not

moved from the accustomed positions. When the program was scheduled to begin a few notes were sounded on the piano, and the tiny artists at once burst into melody.

"We have a canary," wrote in one fan, "that did not know it could sing until WWJ began. He looked into the loudspeaker, twisted his head from side to side, and then started out."

* * *

Radio Warnings from the Jack Frost Country

THREE radio weather stations are to be set up in the MacKenzie Valley this summer by the Canadian Government. The MacKenzie Valley, Siberia, and Greenland are the three great cold centers of the world. One of the difficulties in predicting weather in the past has been the virtual impossibility of obtaining more or less simultaneous weather information from all sections of the earth, particularly from these three frigid areas.

* * *

John Bull Picks Up Yankee Jazz on an Indoor Loop Aerial

LISTENING for signals from American stations is an all-night job in England. Yet during the last few months station WGY in Schenectady has been flooded with letters from English fans who have picked up its broadcast programs. Perhaps the most remarkable instance of long-distance reception of this station is furnished by Captain Round, who heard the American station on a two-foot loop aerial. The Englishmen who listen for American stations have to be real enthusiasts; WGY's program, for example, starts at 7:45 in the evening—12:45 in the morning in London!

* * *

Radio Required on Airships

THE Commissioner of Air Traffic of Denmark has recently made a ruling that all airplanes operating in passenger service must carry radio apparatus as part of their equipment for emergency. This ruling extends the general custom of requiring ships to be so provided as a means of saving life.

* * *

Commands from an Invisible Drillmaster

THE feature of the U. S. Naval Academy's gymnkhana at Annapolis this year was a drill conducted by commands issued *via* radio. The midshipmen who made up the drill team wore the Ku Klux costume, but in each conical helmet was installed a small receiving set. While the spectators could hear no sound, the midshipmen went through their paces in their usual perfect unison.

* * *

A Combination Letter-and-Radiogram

THE postman and the radio operator now work together in a new system of communication that combines postal and radio service between France and her colonies. A letter may now be sent by mail to a radio station, transmitted to a receiving station in the colony, and from there sent by mail again to its destination—at a cost of only the postage at both ends plus two-thirds of the regular radio charge.

* * *

A Radio Wave That Rings a Bell

GERMAN scientists, experimenting with the tendency of radio waves to follow telegraph and telephone wires, announce an invention that enables a transmitting station to call by means of a bell some individual receiving station or group of stations. It is not inconceivable that "answering the radiophone bell" will be included among the duties of the housemaid.

* * *

Uncle Sam's Mail by Radio

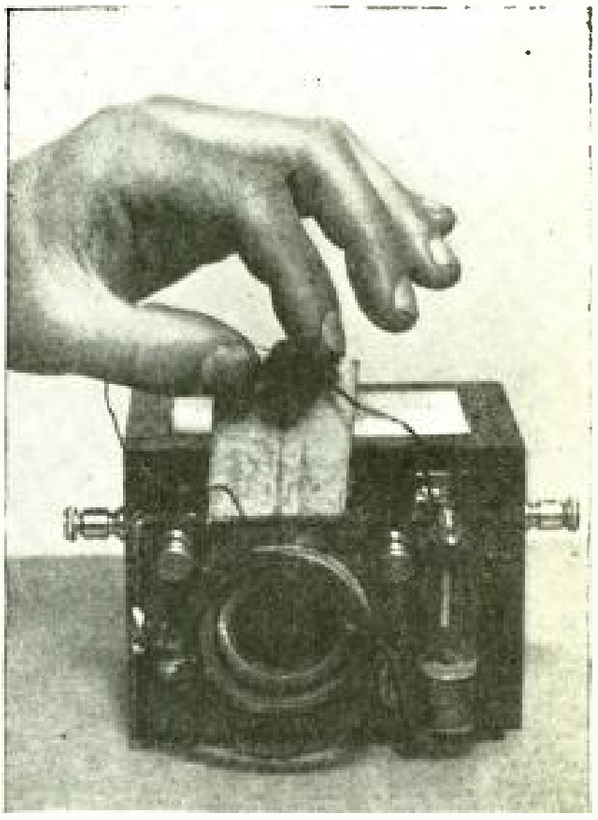
SIXTEEN radio stations are now in operation by the U. S. Post Office Department to aid the Air Mail-Service.

* * *

Gaston Blocks Fritz in the Ether

THE ancient grudge between France and Germany, having recently been settled on land, sea and in the air, is now being fought out in the ether. When a broadcasting station near Berlin recently started to send out news about the Ruhr situation, the Eiffel Tower station in Paris sent out such a long-continued howl as to prompt a Dutch newspaper to observe naïvely that "it must have been done purposely!"

* * *



ONE OF THE SMALLEST TUBE SETS IN THE WORLD

Some idea of its compactness is gained from the fact that the peanut tube is held in place by its grid condenser and the filament rheostat is concentric to the tuning inductance. It was made by a New York amateur, Frederic W. Proctor.

"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.

HE USES THE FORBIDDEN THIRD STAGE OF AUDIO FREQUENCY

THE often forbidden third stage of audio frequency in connection with one stage of radio frequency amplification is used by Carl C. Raymond of New York to pick up Davenport, Iowa. He reports that he is not bothered with interference from the powerful stations of WEAF, New York, and WJZ, Newark, N. J.

Two variometers, one in the grid circuit and one in the plate circuit, are used with a highly selective variocoupler. A variable condenser is used in the antenna circuit. The aerial used is 40 feet high and 160 feet long, with two wires. It points in the direction of Davenport, which accounts in a large measure for its success in picking up that station and tuning out the others.

* * *

REMARKABLE RANGE OF A CRYSTAL SET

STANLEY M. HADLEY, who lives in the country near Danville, Ind., says he can hear New York and Atlanta, Ga., on cold nights with almost nothing but a crystal and "a little perseverence." The only item in his set which he considers worth mentioning is his loose coupler, which he carefully soldered and mounted on hard rubber. He also hears Kansas City, Mo., Schenectady, N. Y., as well as nearer stations.

* * *

THIS FAN PREFERS HONEYCOMB COILS

A PERFECTLY good two-variometer set was scrapped to make room for honeycomb coils by Arthur F. Dearborn of Elizabeth, N. J., with surprising results. His record with the variometers was a faint whisper from PWX at Havana; now he hears from St. Louis, Mo., Chicago, Ill., and Davenport, Iowa, with one tube.

Even with a variocoupler helping the variometers, they were not improved to any considerable extent, he insists. He is now using three honeycomb coils: primary, 25 turns; secondary, 35; tickler, 75. A 43-plate condenser is used across the primary and a 23-plate across the secondary. His aerial consists of one wire 110 feet long, strung 35 feet above the ground.

* * *

A TIN ROOF DOES NOT HANDICAP THIS SET

ONE dry-cell tube brings KYW, Chicago, to R. N. Trueman, of Brooklyn, N. Y., in spite of a tin roof and a long lead-in. He uses a variocoupler and one variometer.

His antenna is a single wire about fifty feet high at one end, but it runs down almost to the ground in order to gain its length of 110 feet. For almost half its length it runs six feet from the tin roof. The lead-in runs for forty feet inside the building, held about an inch from the walls by means of glass insulators.

Chicago is heard distinctly, he says, although his instruments are mounted temporarily on a board, and are not shielded from the capacity effects of his hands. Nearer stations are received loud and clear, although the powerful stations of New York and Newark, N. J., are somewhat hard to tune out.

* * *

HE VISITS 13 STATES *VIA* ETHER

A RECORD of hearing 42 stations in thirteen states during his first two months of listening-in is reported by James A. White, of Cincinnati, O. He uses one storage battery tube and no amplification. His list includes WJZ, Newark, N. J., WGM, Atlanta, Ga.; WLK, Minneapolis, Minn.; WBAP, Fort Worth, Tex., and WNAC, Boston, Mass.

White uses a single-circuit regenerative hook-up with an aerial 120 feet long, strung at an average height of 40 feet above the ground.

HALF A CONTINENT ON A SINGLE TUBE

A TOTAL of 66 stations heard with one tube is the modest report of L. S. Hoskins of Rome, N. Y., who made the "Real DX Regenerative Receiver" designed by Laurence M. Cockaday for POPULAR RADIO and described in the January, 1923, number.

"I have never been stumped yet," writes Hoskins. "I can find something any time of the day. Whenever I find a good program, I put it on my loudspeaker through my other two tubes, rather than hunt for distant stations. Before I made the regenerative set I had heard only 13 stations. The rest of the 66 I caught in three weeks with my new machine."

His station log includes:

WAAF	Chicago
WAAK	Milwaukee, Wis.
WAAM	Newark, N. J.
WAAY	Youngstown, Ohio
WBAK	Harrisburg, Pa.
WBAN	Paterson, N. J.
WBAP	Ft. Worth, Texas
WBS	Newark, N. J.
WBT	Charlotte, N. C.
WBZ	Springfield, Mass.
CFCF	Montreal, Canada
CFCA	Toronto, Canada
WCAB	Newburg, N. Y.
WCAE	Pittsburgh, Pa.
WCAU	Philadelphia, Pa.
WCK	St. Louis, Mo.
WCX	Detroit, Mich.
WDAF	Kansas City, Mo.
WDAJ	Atlanta, Ga.
WDAL	Jacksonville, Fla.
WDAP	Chicago
WEAF	New York City
WFAF	Poughkeepsie, N. Y.
WFAG	Waterford, N. Y.
WFI	Philadelphia, Pa.
WGI	Medford Hillside, Mass.
WGL	Philadelphia, Pa.
WGM	Atlanta, Ga.
WGR	Buffalo, N. Y.
KOP	Detroit, Mich.
KSD	St. Louis, Mo.
KYW	Chicago
WLAG	Minneapolis, Minn.
WLAK	Bellows Falls, Vt.
WLK	Indianapolis, Ind.
WLW	Cincinnati, Ohio
WMAQ	Chicago, Ill.
WNAC	Boston, Mass.
WNAT	Philadelphia, Pa.
NOF	Anacostia, D. C.
WOC	Davenport, Iowa
WOH	Indianapolis, Ind.
WOO	Philadelphia, Pa.
WOQ	Kansas City, Mo.
WOR	Newark, N. J.
PWX	Havana, Cuba
WQAA	Parkersburg, Pa.
WRP	Camden, N. J.
WRW	Tarrytown, N. Y.
WSB	Atlanta, Ga.
WWJ	Detroit, Mich.
WGY	Schenectady, N. Y.
WHAS	Louisville, Ky.
WHB	Kansas City, Mo.
WHK	Cleveland, Ohio
WHN	Ridgewood, L. I.
WHAZ	Troy, N. Y.
WHAM	Rochester, N. Y.
WIAL	Norwood, Ohio
WIAO	Milwaukee, Wis.
WIP	Philadelphia, Pa.
WJAS	Pittsburgh, Pa.
WJAX	Cleveland, Ohio
WJZ	Newark, N. J.
WKAP	Cranston, R. I.
KDKA	East Pittsburgh, Pa.

WHY HE USES AN ANTENNA CONDENSER

THE chief reason that he hears PWX, Havana, Cuba, six times in one month is the use of a variable condenser in his antenna circuit, writes Henry O. Miller, of Philadelphia, Pa.

He has a one-tube regenerative hook-up which does not require a condenser in the antenna circuit, but *with it* he is able to tune out other stations broadcasting on nearly the same wavelengths at the same time. He also hears WDAP, Chicago, and WOC, Davenport, Ia.

* * *

PINE TREES AS AERIAL TOWERS

WITH only one tube Oscar E. Johnson, of Indianapolis, Ind., is able to pick up fifteen to twenty stations almost any night. He uses a small inductance coil shunted by a variable condenser in his plate circuit.

Two pine trees about 100 feet high support his antenna. They are 130 feet apart and stand on the top of a small hill. Two wires are strung between them, with insulators spaced six feet from the nearest branches, and the lead-in is fastened to one end.

* * *

REMARKABLE RESULTS FROM A CRYSTAL SET

USING electric light wires for an aerial and a vacuum tube with his crystal in a reflex circuit, Joseph M. Ambrose hears Chicago in Louisville, Ky. Experimenters seldom go to so much trouble to use a crystal, but Ambrose thinks his set is as good as the ordinary three-tube receiving set.

* * *

HE SPANS THE CONTINENT WITH A LOUDSPEAKER

BROADCAST music from San Francisco comes in clear on the loudspeaker of R. N. Borden, of Pittsburgh, Pa. He uses a regenerative hook-up with two stages of audio frequency and two stages of radio frequency amplification. His aerial is made of two strands of wire 35 feet high and 90 feet long.

* * *

ADVANTAGES OF A SINGLE CIRCUIT

MYRON SELFRIDGE, of Atlanta, Ga., hears practically all of the New York stations with a single circuit tuner, one tube, and a two-wire antenna, 45 feet long.

* * *

RECEIVING LONG-DISTANCE ON A DOOR

UNABLE to erect an antenna on his roof, John A. Spear has made an efficient loop aerial on a door of a clothes closet. He opens or closes the door so that the aerial will point toward the station he wishes to hear, and with two stages of radio frequency amplification he brings New York stations into his Chicago room almost loud enough to operate a loudspeaker.

The aerial is made of 75 feet of the ordinary seven-strand antenna wire for sale at most radio stores, and is held about an inch from the door by porcelain insulators. His set is grounded on a steam radiator.

FROM NEW HAMPSHIRE TO CALIFORNIA ON A DETECTOR TUBE

A DETECTOR tube alone, in a single circuit, can reach from Newfields, N. H., to Los Angeles, Calif., according to Russell Sheehy. He made his set himself, and during the last six months he has heard 144 stations in 38 states, Cuba, Porto Rico and Canada. His record shows 16 stations in New York, 15 in Pennsylvania, eight in Texas and seven in Ohio (and it might be added) one in his own state, New Hampshire.

* * *

A ROCKING-CHAIR TOUR TO SEVENTEEN CITIES

DAVID R. NEWMAN of Hoboken, N. J., submits his distance record for one evening of rocking-chair traveling, and sets down the time when he arrived at 17 different cities, using one dry-cell tube and a crystal detector in a reflex circuit. His list is:

7:18	WDAP	Chicago
7:21	WJZ	Newark, N. J.
7:33	WDAL	Jacksonville, Fla.
7:39	WFI	Philadelphia, Pa.
7:52	WEAF	New York City
7:57	WOC	Davenport, Ia.
8:07	WCAE	Pittsburgh, Pa.
8:18	WSB	Atlanta, Ga.
8:22	WHN	Ridgewood, N. Y.
8:30	WWJ	Detroit, Mich.
8:39	WHAS	Louisville, Ky.
8:52	WGY	Schenectady, N. Y.
8:54	CFCA	Toronto, Canada
8:57	WGR	Buffalo, N. Y.
9:08	WJAX	Cleveland, O.
9:17	WCK	St. Louis, Mo.
9:21	WOQ	Kansas City, Mo.

Newman used an outdoor antenna made of two strands, 120 feet long, at an average height of 35 feet from the ground.

* * *

LONG DISTANCE ON A CRYSTAL SET

LONG distance work with a crystal set is reported by James A. Jefferson, of South Bend, Ind., who listens in on WJZ, Newark, N. J., and WEAF, New York, almost every clear night. He hears WSB, Atlanta, Ga.; WGY, Schenectady, N. Y.; KDKA, Pittsburgh, Pa.; WWJ, Detroit, Mich.; WOC, Davenport, Ia., and WHB, Kansas City, Mo.

Jefferson is fortunate to have a tower for his antenna, and no landlord to kick about it. The tower is 70 feet high, and his two-wire antenna runs a distance of 125 feet to the roof of his home, which is 40 feet high. In his fifth month of "radio fanning" he is still proud of his loose coupler which he made from directions printed in POPULAR RADIO, and he sees no reason for using more expensive apparatus.

* * *

THIRTY IN TWO NIGHTS

THIRTY stations in two nights is the record of A. H. Bosworth, of Los Angeles, Calif., who uses a regenerative circuit with two stages of amplification. In addition to practically all of the larger stations of the western coast he hears WGM, Atlanta, Ga.; WIP, Philadelphia, Pa.; WBAP., Fort Worth, Tex.; KDYY, Denver, Colo., and a station in Salt Lake City, Utah.

He was satisfied with less than a dozen stations and thought his set was working well when by accident he learned that tuning is a gentle art. Concerning tuning, he says:

"I had heard that a movement of a hundredth of an inch or less would sometimes tune a station in and out, but had no idea that my own set was so sensitive until experience forced this upon me. Since then, I have acquired a more gentle touch and a great respect for the man who can really tune his set."

* * *

A LONG-DISTANCE BED

NEXT to the magic carpet comes the enchanted bedsprings as a means of traveling through the air from one city to another. Several have told of their exploits with this new antenna, notably A. R. Goldberg, of New York, who, in the third story of a seven-story apartment house, hears Pittsburgh, Pa., with but one tube.

A range of two or three hundred miles is not infrequent with such a combination, as it is often quite as good as an indoor loop or one of the plugs made to fit in a light socket.

* * *

TWO STAGES OF AMPLIFICATION COVER THE UNITED STATES

Two stages of audio frequency amplification have covered the United States for L. M. Stephenson, of Phoenix, Ariz., when used with a regenerative hook-up of the two-variometer type. A variable condenser is used across the secondary coil of the variocoupler with another in the antenna circuit, and these are highly praised by Stephenson for their help in delicately tuning-in distant stations. An outstanding feature of the set is the large number of combinations which can be used for tuning to any particular station. When one station interferes, it is almost always possible to shift the dials to new positions, where the interference diappears.

Among the stations he has heard are WEAF, New York, WSB, Atlanta, Ga., KYW, Chicago, KFAF, Denver, KZN, Salt Lake City, KFDB, San Francisco, and KYG, Portland, Ore.

* * *

HE INCREASED HIS RANGE WITH A WOODEN VARIOMETER SHAFT

THE operator who gets down to the fine points of tuning is constantly hunting for "stray capacity," such as that caused when the human body comes close to a receiving set, and Walter E. Jacket, of San Francisco, has happily discovered the drawback of a metal variometer shaft.

He first mounted his variometer four inches behind the panel of his set, to keep it farther away from his hand while he was tuning. This helped a little, but to make a good job he cut out a piece of the metal shaft and inserted a small rod of wood. His range was increased from 200 to 2,000 miles. He used to hear only local stations, but now he hears Chicago stations, as well as practically all of the stations on the Western coast.

"WORKRITE"

180° SUPER VARIOCOUPLER

$3.50

One of these WorkRite 180° Super Variocouplers made from moulded Bakelite and two WorkRite Super Variometers made from mahogany make up the "WorkRite Tuner Team"—the most selective circuit possible.

A year ago the price of these instruments was $6.00 each. Due to our enormous production you can now buy them for $3.50 each. Order a set today. And remember that

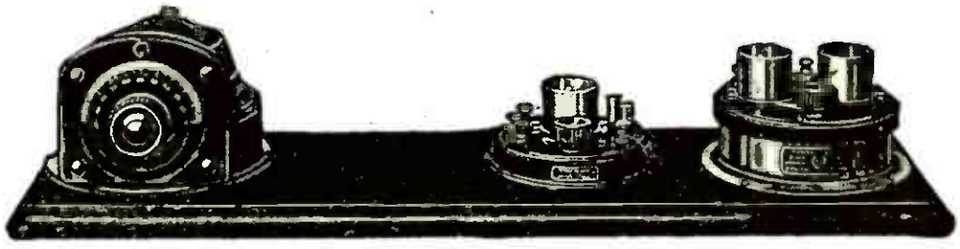
WORKRITE RADIO PARTS WORKRITE

THE WORKRITE MANUFACTURING CO.

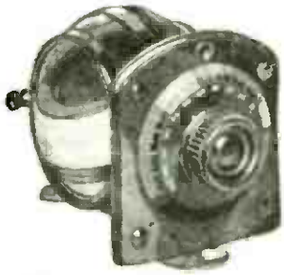
(Branch Office, 2204 Michigan Ave., Chicago) 5509 Euclid Avenue, Cleveland, Ohio

ATWATER KENT

Receiving Sets and Parts



Complete Set, consisting of Coupled Circuit Tuner, Detector Unit and 2-stage Amplifier

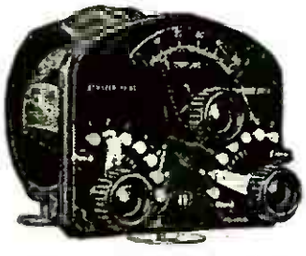


Mounted Variometer

Type 11 Tuner

TAKE the world with you this summer wherever you go. On your automobile and yachting trips, to your camp, or your cottage at the shore or in the mountains. An ATWATER KENT radio set will bring you music, reports, time signals, baseball scores—the world's news.

Atwater Kent products sell on appearance.



Mounted Variocoupler

Detector Unit

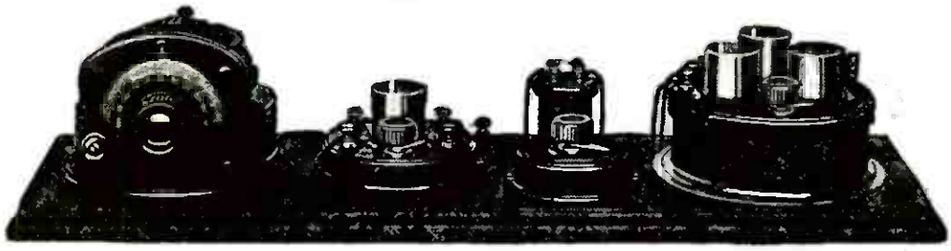
1-stage Amplifier

ATWATER KENT MANUFACTURING COMPANY

4933 STENTON AVE. *Radio Dept.* PHILADELPHIA, PA.

ATWATER KENT

Receiving Sets and Parts



Complete Set, consisting of Type 11 Tuner, one stage of Radio Frequency Amplification, and Detector 2-stage Audio Frequency Amplifier

ATWATER KENT sets and parts are ideal for summer use due to their compact and rugged construction and the fact that they are moisture-proof. They are made mostly of condensite with all metal parts thoroughly water-proofed.

You will find ATWATER KENT radio equipment ideal for summer use.

They stay sold on quality of performance.

R. F. Transformer

Standard Vac. Tube Unit

2-stage Amplifier. A similar unit is furnished in a Detector 1-stage Amplifier

Detector 2-stage Amplifier

Potentiometer
Also made for panel mtg.

ATWATER KENT MANUFACTURING COMPANY

4933 STENTON AVE. *Radio Dept.* PHILADELPHIA, PA.

BUILD YOUR OWN RADIO OUTFIT

HIGH QUALITY GOODS AT LOW PRICES

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

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.

BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS

D812—43 plate .001 Mfd. $1.73
D813—21 plate .0005 Mfd. 1.43
D814—11 plate .00025 Mfd. 1.32
D815—3 plate Vernier 98c

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

D824—23 plate .0005 Mfd. Price $2.89
D826—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	D301	$0.39	D320	$0.89
35	175- 450	D302	.42	D322	0.96
50	240- 720	D303	.49	D323	1.04
75	330- 910	D304	.54	D324	1.08
100	500- 1450	D305	.58	D325	1.13
150	600- 2000	D306	.63	D326	1.17
200	900- 2500	D307	.72	D327	1.26
250	1200- 3500	D308	.78	D328	1.35
300	1500- 4500	D309	.82	D329	1.36
400	2000- 5000	D310	.97	D330	1.57
500	2800- 6100	D311	1.12	D331	1.63
600	4000-10000	D312	1.27	D332	1.78
750	5000-12000	D313	1.43	D333	1.93
1000	7900-15000	D314	1.70	D334	2.28
1250	9750-19500	D315	1.92	D335	2.49
1500	14500-26500	D316	2.18	D336	2.65

COIL MOUNTINGS

D340 Three coil mounting $3.95
D341 Two coil mounting 2.95

High grade fine looking mountings. 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. D732 Each..... 59c

VACUUM TUBES

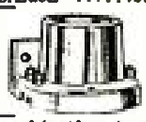
Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.

D105 Detector. Each..... $4.45
D110 Amplifier VV200 or C300 Each..... 5.95
D112 Amplifier VV201A or C301A Each 5.95
D115 5 Watt Transmitter..... 7.70
D107 WD 11 1½ volt..... 5.95
D109 WD 11 adapter. Each ... 48c

VACUUM TUBE SOCKETS

Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections. Right angled contact springs D140 For Standard Base Tubes. Each 39c
D108 For WD 11 Tubes. Each 49c

PORCELAIN BASE AND TUBE



D144 Crosley for either panel or table mounting for Standard Base... 38c

High Grade combination type for panel or table mounting. Metal tube. Highly insulated base. For Standard Base Tubes D146 Each 45c

GRID CONDENSER

D162 Mounting holes spaced to fit lugs of above leak Cap. .00025 MF..... 14c
D163 Same as 162 but higher grade. Enclosed in metal case..... 39c

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed.
D100 Each..... 19c

VARIOMETER

D410—Completely assembled, price $2.69

Perfect in design and construction. Accurate wood forms. Correct inductive ratios. Solid baked windings, positive contacts. Highest efficiency.

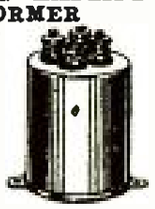
D411—Not assembled but all parts complete, except wire, including winding form $1.48

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.

D415 Price, completely assembled $2.45
D416 Not assembled, but all parts complete. Price, except wire $1.18
D417 Rotor ball only. Each..... 29c
D408 Bakelite Stator tube only. Each 35c

RADIO FREQUENCY AMPLIFYING TRANSFORMER



D995 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.

D234 10 to 1 Mounted. Each..... $3.48
D235 10 to 1 Unmounted. Each.... 2.05
D236 3 to 1 Mounted. Each..... 3.40
D237 3 to 1 Unmounted. Each.... 2.85

FILAMENT CONTROL RHEOSTATS

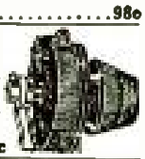
Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
D130 Each..... 45c

Best grade. High heat resisting base. Diam. 2⅛ in. cap. 1½ amp. Resist. 6 ohms. 1¼ in. Knob with pointer.
D132 Each..... 45c

POTENTIOMETER

Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 140 ohms.
D133 Each..... 98c

VERNIER RHEOSTAT



Gives exceedingly fine control of a battery current. A necessity for best receiving results.
D135 Each..... 78c

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.

D180 Signal Corps type. small size. 15 cells. 22½ volts. Each. 95c.

D184 Variable Large Navy size. 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each..... $1.80

D188 Combination Tapped 45 volts. 30 cells. 6½x4x8 battery. Tapped to give 45. 22½. 21. 19½. 18. and 16½ volts. Handles both detector and amplifier tubes. Each $3.55

DETECTOR CRYSTALS CAREFULLY TESTED

D736 Galena. Arlington tested, per piece 19c
D738 Silicon, Arlington tested. per piece 19c
D735 Tested. Galena, per piece..... 9c
D737 Tested, Silicon, per piece..... 9c

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

BARAWIK STANDARD PARTS

TO SAVE MONEY WHEN YOU BUY FROM US

SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

...D BARE COPPER WIRE

...bare copper wire for aerials, leads ...iring instruments.

Solid Bare Copper Wire, size 14
D240—100 ft. coil 49c
D242—500 ft. coil $2.35

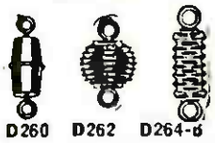
Solid Bare Copper Wire, size 12
D244—100 ft. coil 67c
D245—500 ft. coil $3.05

STRANDED ANTENNA WIRE

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

D248—100 ft. coil 72c
D249—500 ft. coil $3.20

ANTENNA INSULATORS



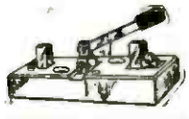
D260 D262 D264-6

D260 Size 1x3¼. Two for.....17c
D262 Size 2⅛x3¼. Two for.....55c
D264 Size 1½x4. Two for.....69c
D266 Size 1½x10½. Two for $1.28

OUTDOOR LIGHTNING ARRESTER

D980 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 blades. Can be used as antenna switches.

D385 Single Pole Single Throw. Each 20c
D383 Single Pole Double Throw. Each 32c
D384 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.

D380—1" Radius
D381—1¼" Radius } Each
D382—1½" Radius } 19c

SWITCH LEVER STOP

Brass, polished nickel finish.
D386—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.

D900 2¼" Diam. for 3-16" shaft. Ea..19c
D901 2¼" Diam. for ¼" shaft. Ea....19c
D904 3" Diam. for 3-16" shaft. Ea.....25c
D905 3" Diam. for ¼" shaft. Ea.....25c
D906 3½" Diam for 3-16" shaft. Ea...35c
D907 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
D390 Open circuit. Each.....43c
D391 Closed circuit. Each...49c
D392 Two circuit. Each.....60c
D393 Single-cir. fila. control..69c
D394 Two cir. fila. control..85c

D395 Plug. Large space with set screws for attaching cord. Each.....49c

COMPETITOR JACK AND PLUG

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

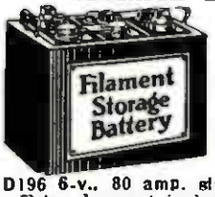
D387 Open Circuit Jack. Each.....27c
D388 Two Circuit Jack. Each.....35c
D389 Standard Plug. Each.....35c

BINDING POSTS

D370-2 D376-8

Brass, polished nickel finish. Washer and 6-32", screw extending ⅝".....
D370 Large size—barrel and knob ¾" long, dozen 85c
D372 Smaller size—barrel and knob 9-16" long, dozen 70c
D374 Large size with composition knob, dozen 50c
D376 Large size with hole for phone tip or wire, dozen.....80c
D378 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.
D194 6-v., 40 amp. size. Each..$10.00
D196 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"	D420	$2.48
6x10½"	5½"	10"	7"	D422	2.75
6x14"	5½"	13½"	7"	D424	3.30
7x14"	6½"	13½"	7"	D423	3.60
7x18"	6½"	17½"	7"	D426	3.90
7x21"	5½"	20½"	7"	D425	4.20
9x14"	8½"	13½"	10"	D428	3.70
12x14"	11½"	13½"	10"	D430	4.40
12x21"	11½"	20½"	10"	D432	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	⅛" thick Art. No.	Price	3-16" thick Art. No.	Price	¼" thick Art. No.	Price
6x7	D450	$0.50	D460	$0.75	D470	$0.98
6x10½	D451	.75	D461	1.18	D470	1.47
6x14	D452	1.05	D462	1.55	D472	2.05
7x14	D458	1.20	D468	2.60	D478	2.40
7x18	D453	1.55	D463	2.30	D473	3.10
7x21	D457	1.78	D467	2.65	D477	3.60
9x14	D454	1.60	D464	2.30	D474	3.10
12x14	D455	2.10	D465	3.10	D475	4.15
12x21	D456	3.15	D466	4.65	D476	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.
D201 For 6 volt battery.....$13.95

BARAWIK QUALITY HEADSETS

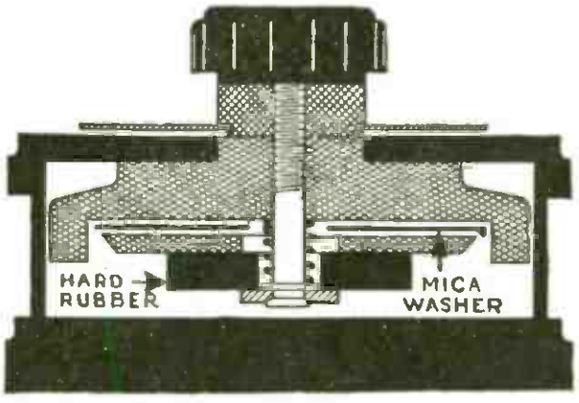
These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellent with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are brass in fine polished nickel finish. Polished black ear pieces. Fabric covered 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.
D770—2000 ohm.....$3.75

OTHER STANDARD BRAND HEADSETS

D751 Murdock 56, 2000 ohm.....$4.20
D752 Murdock 56, 3000 ohm..... 4.95
D764 Frost, 2000 ohm..... 4.20
D766 Frost, 3000 ohm..... 4.85
D756 Red Head, 3000 ohm..... 5.85
D758 Western Electric, 2200 ohm.. 9.50
D754 Baldwin Type C with universal jack plug $12.00
D755 Baldwin Type C unit..... 5.50
D768 Brandes, 2000 ohm..... 6.95

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

CONNECTICUT RADIO



Finer adjustments

Better selectivity

Greater signal strength

Simple as the symbol that stands for it

The Secret of Its Efficiency

It is a well-known fact that losses in radio condensers take place in the solid insulating material used in their construction.

And it is equally true that a condenser increases in efficiency of signal reproduction as its losses decrease.

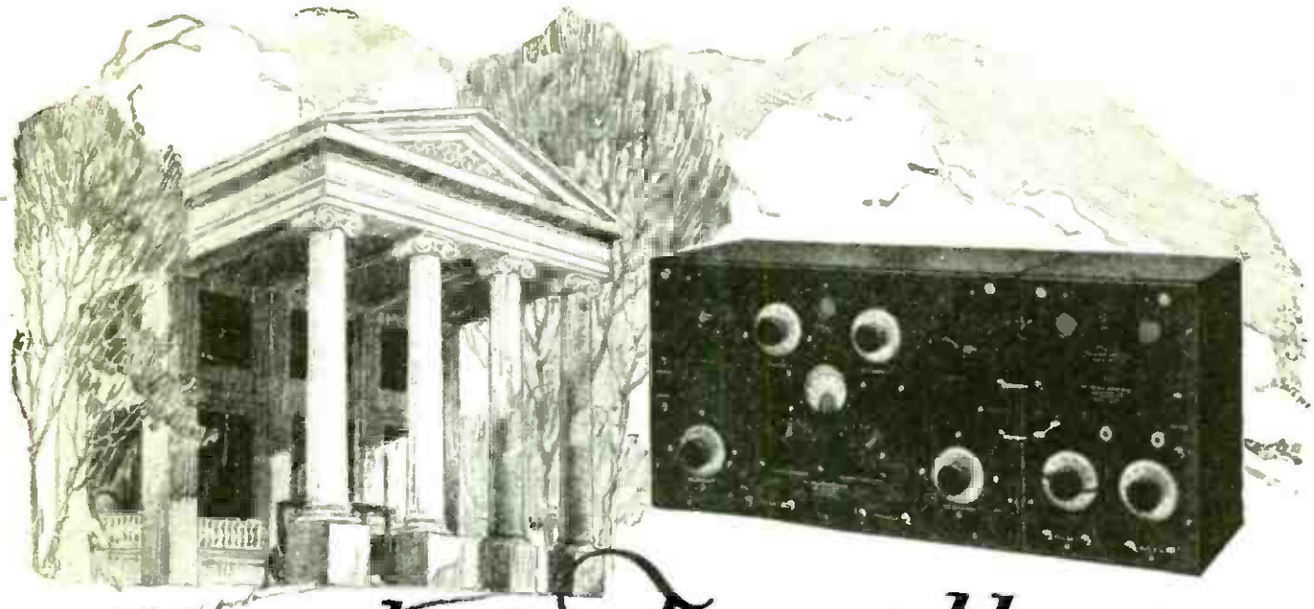
The CONNECTICUT Variable Condenser not only employs the two best insulating materials known—mica and hard rubber—but the smallest possible amount of each. This, then, is the reason for its extremely low resistance—0.2 ohm—as well also the secret of its high efficiency at short wave lengths.

Descriptive bulletin 100-F upon request

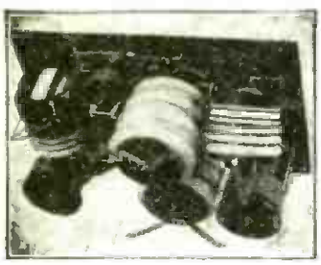
Panel type, J-108, $5.00

Portable type, J-107, $6.00

CONNECTICUT TELEPHONE & ELECTRIC COMPANY
MERIDEN RADIO DIVISION **CONNECTICUT**



In the Finest Homes



That the Kennedy "Universal" set is a wonderful example of mechanical excellence is shown by this interior view. It can be made to detect, regenerate or oscillate over its entire range of 200 to 25,000 meters.

All Kennedy Regenerative Receivers are licensed under Armstrong U. S. Patent No. 1,113,149.

IT IS but natural that Kennedy Receiving Sets are found in the finest homes. The same appreciation of artistry that is responsible for beautiful home surroundings sees in a Kennedy a fitting example of craftsmanship that belongs with the finest.

Again—the clarity of reception, freedom from extraneous noises, and greater elimination of interference made possible by a Kennedy appeals to the true lover of music and the finer things of life. The long range places the music of the continent within your reach.

And last—the owner of a Kennedy knows that others will admire it. Its possession reflects good taste and judgment.

Arrange with your local dealer for demonstration, or write us direct for descriptive literature.

THE COLIN B. KENNEDY COMPANY

SAINT LOUIS SAN FRANCISCO

KENNEDY

The Royalty  *of Radio*

In Philadelphia, Where Radio Enthusiasm Tops the Country, the Biggest Selling Receiver Is the S-P-2!

Distributors for

Lyradion Sales & Eng. Co.
Sleeper Radio Corp.
Jewett Mfg. Corp.
A. B. C.
Pacent Elec. Co.
Schieber & Jensen
Elec. Prod. Mfg.
Penn Radio
Atwater Kent
Homecharger
Radisco
Electrose
Mitchell-Rand
Callophone
Amer. Radio & Research Corp.
Baldwin Radio
Dubilier

WHOLESALE ONLY

The S-P-2 is truly the SUPERIOR RECEIVING SET on the market today and has been proven far and away in a class by itself, excelling any regenerative receiver now offered costing $125.00 to $180.00.

THE LIST PRICE IS BUT $85.00 WITH AN ADDITIONAL CHARGE OF $15.00 FOR THE ADAPTER.

The S-P-2 is a complete Receiver of radio-telephone and radio-telegraph signals over a wavelength range of from 180 to 650 meters, using three tubes, viz.: detector, one stage of radio frequency amplification and one stage of audio frequency amplification.

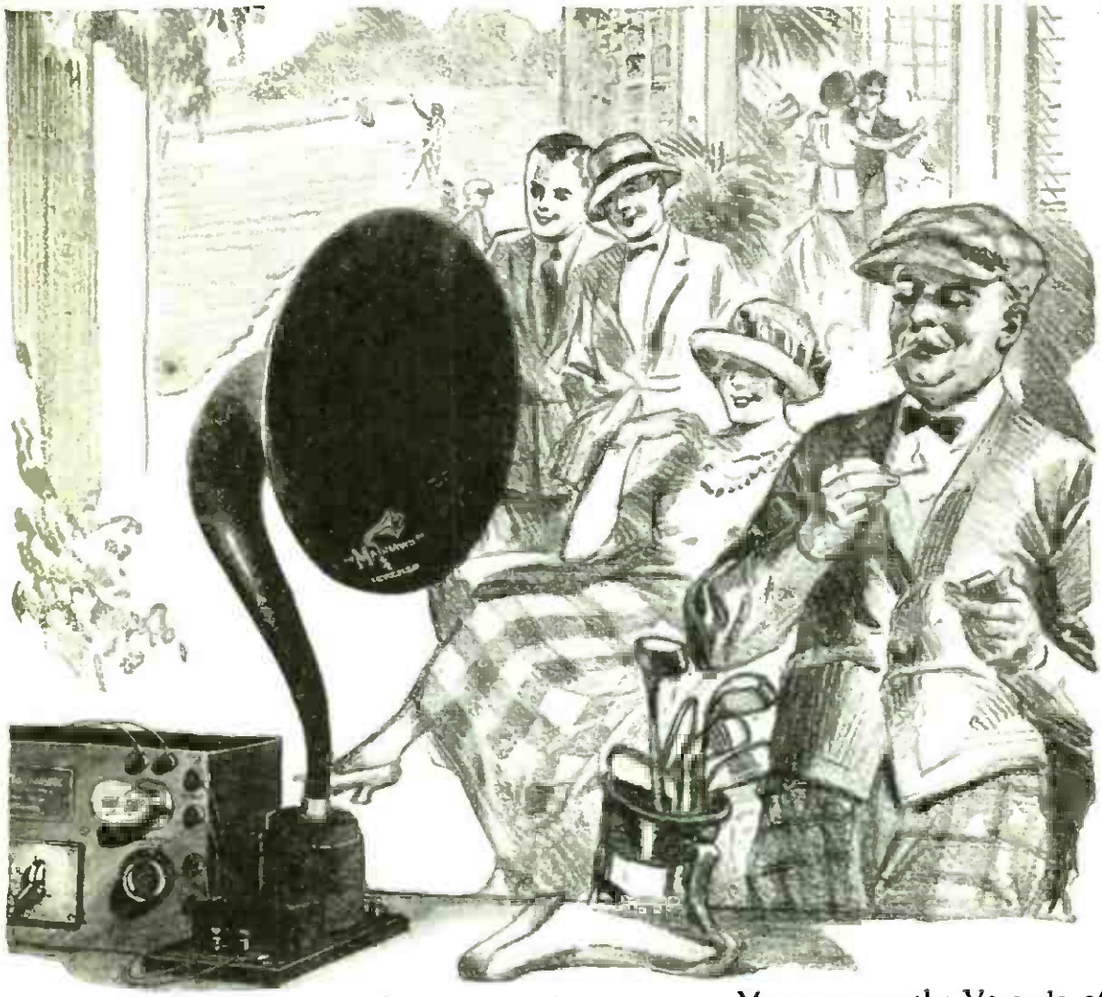
An Adapter representing an additional stage of audio frequency amplification added to the S-P-2 Receiver AS SIMPLY AS INSERTING A TUBE INTO A SOCKET. Without necessitating the change of a single binding post, wire or batteries or headphones! The S-P-2 Adapter is a basic patent and is thoroughly covered.

The S-P-2 COMPLETE with ADAPTER

Write for Big, New Catalogue No. 102A Price 20c

PITTSBURGH RADIO SUPPLY HOUSE

963 *Liberty Ave. Pittsburgh, Pa.* BELL TELEPHONE GRANT 3632



Magnavox on the Veranda of the Country Club

WHERE radio apparatus, like a professional entertainer, must meet the test of satisfying really discriminating people, a Magnavox Reproducer and Power Amplifier (as shown above) are certain to be installed.

Combination R-3 Reproducer and 2-stage Power Amplifier **$90.00.**

R-2 Magnavox Reproducer with 18-inch horn: the utmost in amplifying power. **$60.00.**

R-3 Magnavox Reproducer with 14-inch horn - - - - - - **$35.00.**

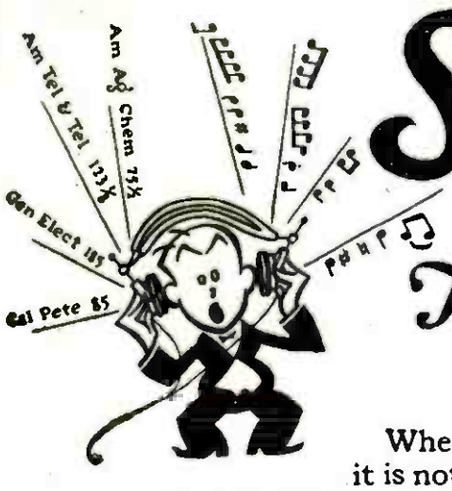
Model C Magnavox Power Amplifier
AC-2-C 2-stage - - **$55.00.**
AC-3-C 3-stage - - **75.00.**

Magnavox Products can be had of good dealers everywhere. Write for booklet.

The Magnavox Co., Oakland, California
New York Office: 370 Seventh Avenue

MAGNAVOX PRODUCTS

No Radio Receiving Set is complete without them



Soprano Solos *by* The Stock Exchange

When you try to tune in with a single circuit receiver, it is not surprising that songs should suddenly turn into market quotations and bedtime stories into weather reports.

For with several hundred powerful broadcasting stations all operating on one narrow wave band, it takes real selectivity and sensitivity to get a satisfactory radio programme.

Get a Paragon three-circuit receiver. Then you will have the pleasure and satisfaction of obtaining the station you want when you want it. Clear, complete programmes without interruption or disturbance.

Ask some experienced amateur what he knows about

PARAGON

Reg. U. S. Pat. Off.

RADIO PRODUCTS

The amateur will tell you that the Paragon three-circuit receiver, because of its great superior selectivity and sensitivity, can pick and choose between broadcasting stations of about the same signal strength with less than one per cent differential.

This means that 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, without interruption and jamming. 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.

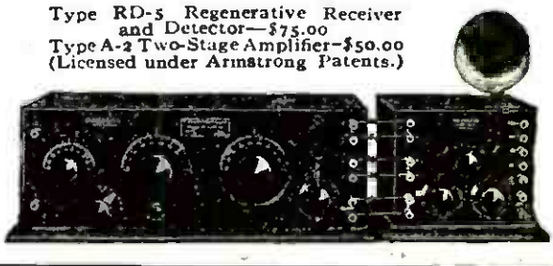
An illustrated Catalog of Paragon Radio Products Is Yours For the Asking

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.

Also Manufacturers of PARAGON	
Radio Telephone Transmitters	Amplifier Transformers
V. T. Control Units	Control Dials
Rheostats	Amplifiers
Potentiometers	Receivers
V. T. Sockets	Switches
Detectors	Variometers

Type RD-5 Regenerative Receiver and Detector—$75.00
Type A-2 Two-Stage Amplifier—$50.00
(Licensed under Armstrong Patents.)



Exide
BATTERIES

Uniform current cuts out the noise

EVERY radio amateur knows how disastrous battery noises are to clear receiving. You can avoid this annoying interference by getting the battery that insures a steady flow of filament current. That battery is the Exide Radio Battery.

This specially designed radio battery does its work uncomplainingly, and never requires much attention. The rasping, snarling noises often caused by fluctuating current in ordinary batteries do not exist in the Exide Battery. It delivers uniform filament current for every type of vacuum tube. You can count on the Exide for dependable, long-lasting service.

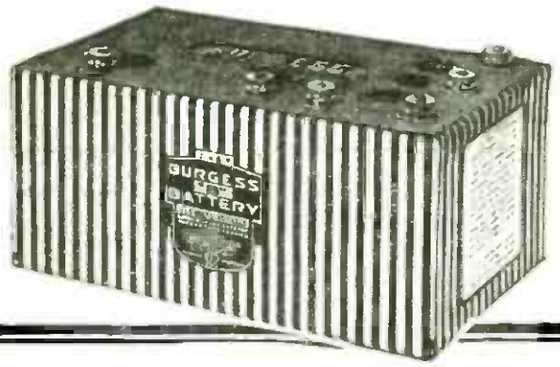
Exide Batteries are used in a majority of the government and commercial wireless stations and in every industry where a battery's response to the call of duty must not fail.

Any dealer in radio equipment will sell you an Exide Radio Battery, or you can get one at the nearest Exide Service Station.

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia, Pa.

Service Stations Everywhere

Branches in Seventeen Cities



BURGESS
RADIO BATTERIES

Are the accepted standard for radio circuits. Leading manufacturers recommend Burgess Batteries and they are specified by radio engineers. Being designed and built by radio engineers brings a guarantee of satisfactory service to you.

BURGESS "B" BATTERIES

Burgess "B" Batteries can be furnished in several types or styles and in varying capacities. Drop in to your dealer's store today. Select the Burgess "B" best fitted to the requirements of your set and invest confidently, knowing that in the judgment of thousands of users the Burgess is the one best radio battery.

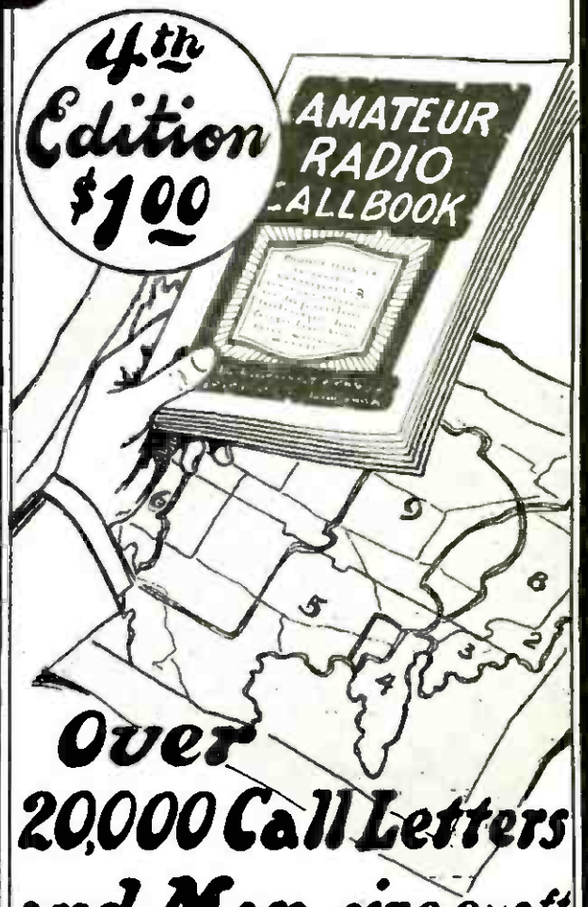
BURGESS No. 6 BATTERIES

Are recommended and have proven highly satisfactory for use in "A" or filament circuits where the 1½ volt vacuum tubes are used.

BURGESS BATTERY COMPANY
Engineers Manufacturers
Dry Batteries
Flashlight Radio Ignition Telephone
General Sales Office:
Harris Trust Bldg., Chicago
Laboratories and Works:
Madison, Wisconsin
Branches:
New York Boston Washington St. Paul
Kansas City New Orleans
In Canada: BURGESS BATTERIES, Ltd.
Winnipeg Toronto Montreal

BURGESS
RADIO BATTERIES
"ASK ANY RADIO ENGINEER"

Just Out



Over 20,000 Call Letters and Map-size 2x3 ft

Indispensable to every radio owner. Contains up-to-date list of over 20,000 Amateur, Commercial, Army, Navy, Transoceanic High Powered, and Broadcasting Stations in the United States and Canada; International Morse Code and Convention Signals; the construction and operation of the Reinartz Tuner, Detector, and one-stage Amplifier; also an abundance of other useful information.

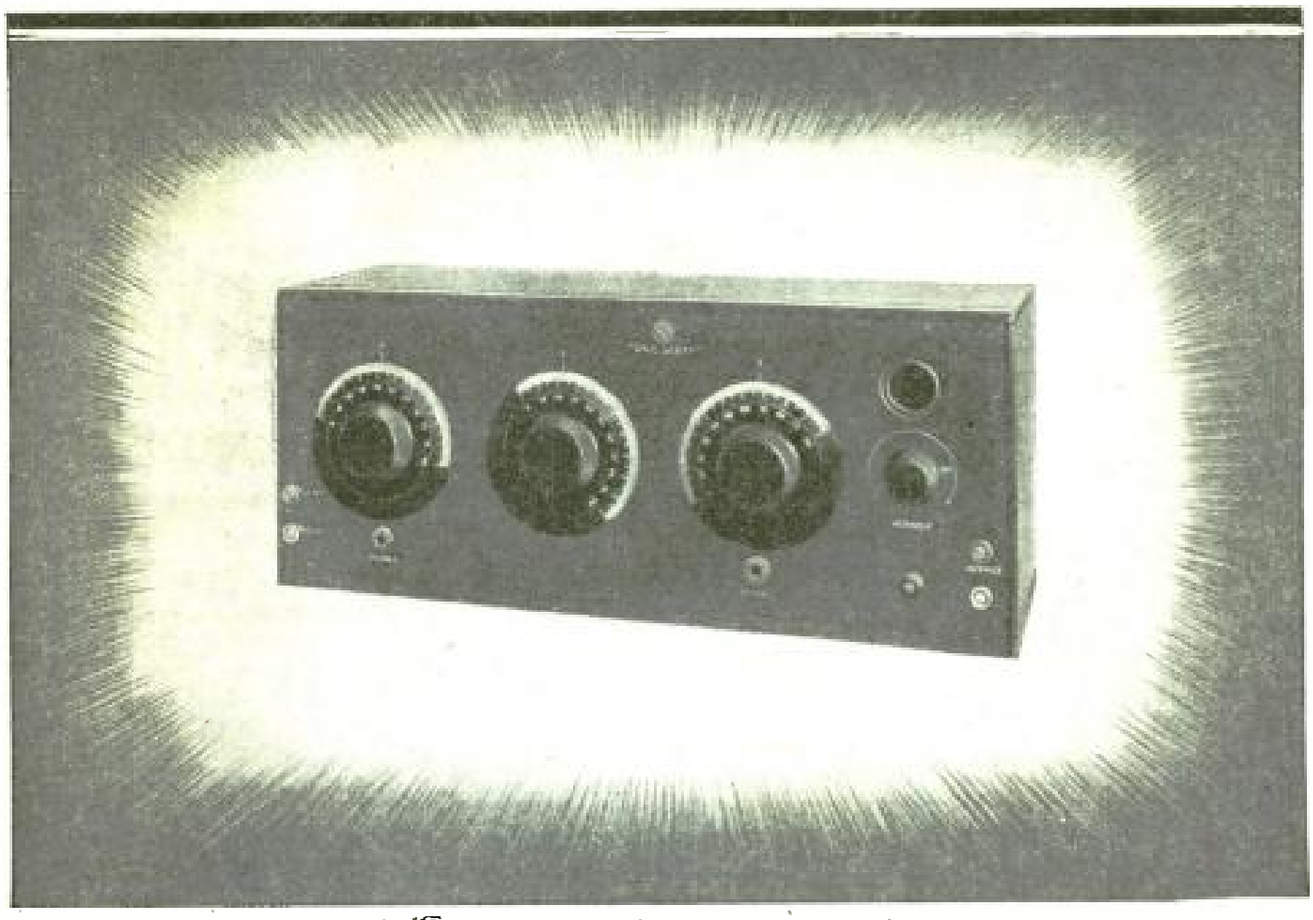
Included with the book is a splendid two-color map of the United States and Canada, 2x3 ft., showing radio district boundaries, standard time lines, geographical location of broadcasting stations, etc.

Buy the Book with the Blue Cover

The greatest dollar value on the radio market. At your dealers or direct by mail. Use check or money order. Do not send stamps.

Dealers: write for proposition

Radio Directory and Publishing Co.
45-J Vesey Street New York City



The famous FADA "ONE SIXTY" *with the* NEUTRODYNE *circuit*

Neutrodyne

is the name given to a marvelous new radio receiver circuit invented by Professor L. A. Hazeltine, of Stevens Institute of Technology, Hoboken, N. J., and used in the FADA "ONE-SIXTY" receiver.

Only four vacuum tubes are used. The selectivity is remarkable and yet the dials can be easily adjusted to receive distant stations.

The FADA "ONE-SIXTY" will receive broadcasted concerts from the Atlantic to the Pacific and with loud speaker intensity.

Denver, Colo., San Antonio, Tex., Havana, Cuba, and Los Angeles, Calif., are some of the far distant stations listened to from New York City, using only a small indoor antenna.

The FADA "ONE-SIXTY" is the ideal receiver — the cost $120.00

F. A. D. ANDREA, INC., 1581-D JEROME AVE., N. Y. CITY

The FADA "ONE SIXTY"

— WITH THE NEUTRODYNE CIRCUIT —

The PACENT New UNIVERSAL PLUG 50c.

Number Forty

The quality of this plug and its low price enable you to enjoy satisfactory plug connections on every piece of your radio equipment. Look for the PACENT Trade Mark and ask for PACENT New Universal Plug No. 40.

Materials that last
Simple, Sturdy Construction
Permanent Biting Contact
Perfect Insulation

The makers of the FIRST Radio Plug now offer the first Quality plug at a popular price. This plug meets perfectly every radio requirement.

Don't Improvise—"Pacentize"

Write for Descriptive Bulletin P-5

PACENT ELECTRIC COMPANY, Inc.

Executive Offices
22 Park Place
New York, N. Y.

Sales Offices
Chicago — Washington, D. C.
Philadelphia — Minneapolis
St. Louis — San Francisco

Members Radio Section, Associated Mfrs. of Electrical Supplies
Canadian and British Licensees: Colonial Radio, Ltd., Hamilton, Can.

Pacent
RADIO ESSENTIALS

Rich Resonance that Only WOOD Can Give

THEY call MUSIC MASTER the "Stradivarius Among Amplifiers." For its horn is WOOD, with that pure, mellow-sweet tonal quality of the human voice that wood alone can simulate. (Phonograph experts proved the principle before radio.)

A powerful amplifying unit in the art-metal base of MUSIC MASTER sends sounds up through a cast-aluminum "gooseneck"—cast aluminum, so it won't vibrate. This conveys true tones to the wooden horn, where they are beautifully enriched, humanized and given to the audience as they are actually sung, played or spoken.

There is only one MUSIC MASTER. Get it and you won't *regret* it! Hundreds of orders are pouring in daily. Demand actually exceeds supply, so get your order in NOW! Comes complete, ready to attach in place of head 'phones. No extras to buy. Hear MUSIC MASTER at your dealer's today. COMPARE it with any other amplifier, regardless of price! Literature on request.

14-inch Amplifier complete, $30

21-inch Amplifier complete, $35

Ask about the GERACO Phonograph Attachment which makes an efficient radio loud-speaker of your Victrola or Columbia. Only $10.

GENERAL RADIO CORPORATION

Makers and Distributors of High-Grade Radio Apparatus

CHICAGO — PHILADELPHIA *624-628 Market St.* — PITTSBURGH

JOBBERS—DEALERS

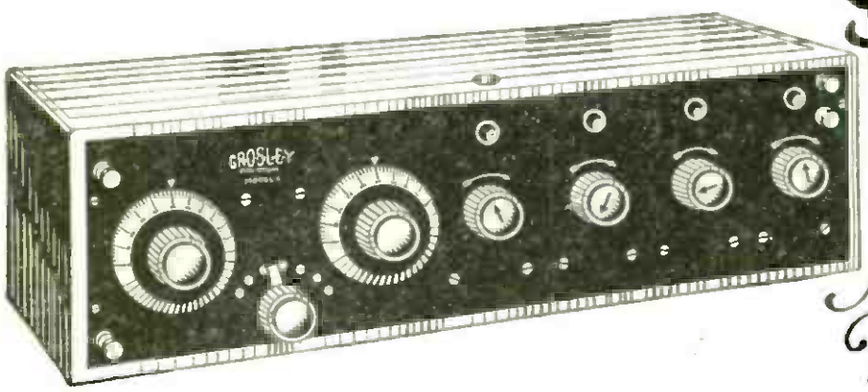
A MUSIC MASTER will be sent to you with full privilege of return.

GERACO
PROVEN RADIO PRODUCTS

Write for full description of the GERACO line, and prices.

CROSLEY *Model* X

$55



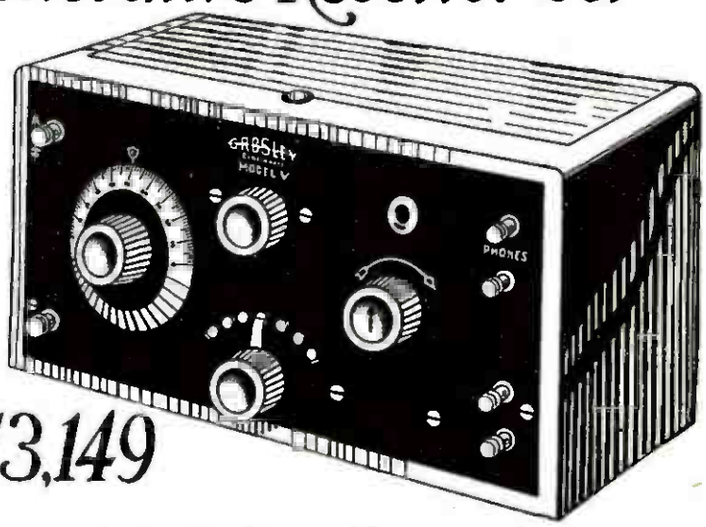
A 4 tube Radio Frequency Set

THE HIT OF THE RADIO WORLD
FOR SALE by Good Dealers Everywhere
Catalog on request to Dealer or Consumer

CROSLEY MANUFACTURING COMPANY
516 ALFRED STREET CINCINNATI, OHIO

CROSLEY *Model* Vc

$20 *Regenerative Receiver Set*



Licensed under Armstrong U.S. Patent No. 1,113,149

The trade name "Crosley" is used by permission of the Crosley Manufacturing Company.
Write for FREE Catalog!

THE PRECISION EQUIPMENT CO.
Powel Crosley Jr. President
516 GILBERT AVENUE CINCINNATI, OHIO

The Loud-Speaker With the Natural Tone

The Bristol "Audiophone" will bring into your presence the actual "tonal personality" of the speaker, the singer or the player. You will hear them as they are — not disguised by mechanical distortion. The "Audiophone" is a true sound reproducer, retaining all the fine gradations of tone quality, volume and feeling which distinguish the original performance of the artist. You forget the instrument, in your enjoyment of the entertainment it brings to all your household and the guests who may join you.

BRISTOL
TRADE MARK
AUDIOPHONE
Reg. U. S. Pat. Office
LOUD-SPEAKER

MOST SIMPLE AND EFFICIENT
Construction Covered by Basic Patents

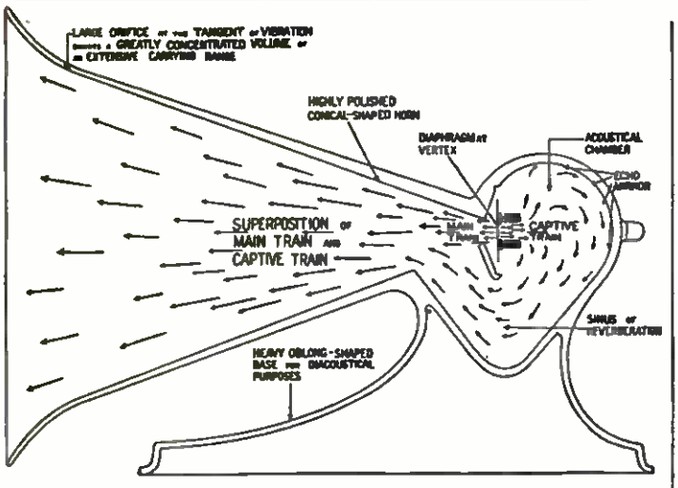
Years of research in sound reproduction, in the laboratories of an established engineering concern, have made the "Audiophone" what it is—have given it its round, full tone, its ample carrying power, its distinctive freedom from blurring and distortion. It needs no separate storage battery for magnetizing current, and can be used with any two or three stage power amplifiers.

"AUDIOPHONE SR." Complete, 15-inch bell, $32.50
"AUDIOPHONE JR." Complete, 13-inch bell, $22.50

A new Bristol single stage power amplifier for use with the usual two stage amplifier can be furnished, which will greatly increase the range of the Audiophone where desirable. Price $25.00.

Ask your dealer to demonstrate the "Audiophone." If he hasn't it, write us—we will see that you are supplied.

THE BRISTOL COMPANY
WATERBURY **CONNECTICUT**



ECHO-TONE

GIVES FINER NEEDLE TONE TO THE RADIO PHONE

An acoustical chamber, an echo mirror and a sinus of reverberation, has made **Echo Tone** more than a ***horn,*** it is an acoustical instrument.

Convince Yourself of Its Faithful Service

If there is no Echo-Tone dealer near you, send a check or money order for $35.00 direct to us. Upon receipt of the money, we will immediately express an Echo-Tone to you. Try it out on your own set. If it does not prove entirely satisfactory to yourself and family, replace it in its wooden box and give it to the expressman consigned to us. Simply mail us the express receipt, not even necessary to write us your reasons for returning it. As soon as we receive the receipt, we will refund your money, without even waiting until we receive the instrument. Remember, we pay express charges both ways, making it just as convenient as though you were buying in the same city.

QUALIFIED DEALERS WANTED

Introducing ECHO-TONE, thruout the country, we are sending a limited number to responsible dealers on a 10-day trial with the privilege of returning at our expense if it does not prove to be entirely satisfactory. Write at once if you wish to be the dealer to secure the demonstrating ECHO-TONE that has been allotted to your district.

Retail Price, $35.00

WILLIAMS RADIO COMPANY

Radio Tone Specialists

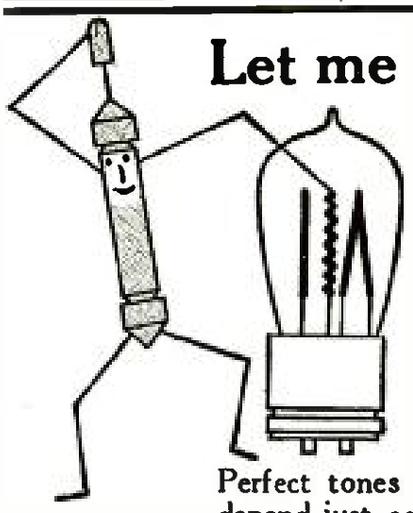
1438 Washington Blvd. Detroit, Mich.

Crystal Set .. $2.50

The Ritter Grand Crystal Set will tune up to 600 meters and receive all concerts within 25 to 50 miles. It is made of the best materials, stands six inches high and has a 100% rating from the Technical Department of "Popular Radio."

Free circular on how to erect your aerial sent upon request. We invite jobbers' and dealers' inquiries.

RITTER RADIO CORPORATION
232 Canal Street
New York City



Let me *regulate* Your Grid Leakage

No. 201A—Special. the only leak made for this size tube, 2 to 10 megohms

No. 101—Up to 5 megohms

No. 100—Up to 100.000 ohms

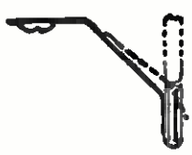
75c each

Perfect tones in the phones depend just as much on close grid leak regulation as on filament current control. That's why Mr. E. T. Flewelling recommends DURHAM Variables—the plunger permits exact regulation. Buy from your dealer.

Durham & Co., 1936 Market St., Philadelphia

DURHAM Variables High Resistance

Na-ald W.D. 11
No. 411



Na-ald De Luxe
No. 400

It's the contact that counts

The special phosphor bronze clips of the Na-ald W. D. 11 Socket maintain perfect contact regardless of any variation in tube prongs and bases.

Moulded from genuine Condensite, these sockets are made for use with the famous W. D. 11 tubes, operated by a single cell battery.

The Na-ald De Luxe V. T. Socket is of highest quality throughout. Its laminated phosphor bronze strips press firmly with a side wipe action on the contact pins, keeping surface clean and insuring perfect contact.

These sockets retail at 75c each

Send stamp for dial, small-space socket, condenser and R 4 transformer circulars

ALDEN MANUFACTURING CO.
Formerly Alden-Napier Co.
Dept. C 52 Willow Street
Springfield, Mass.

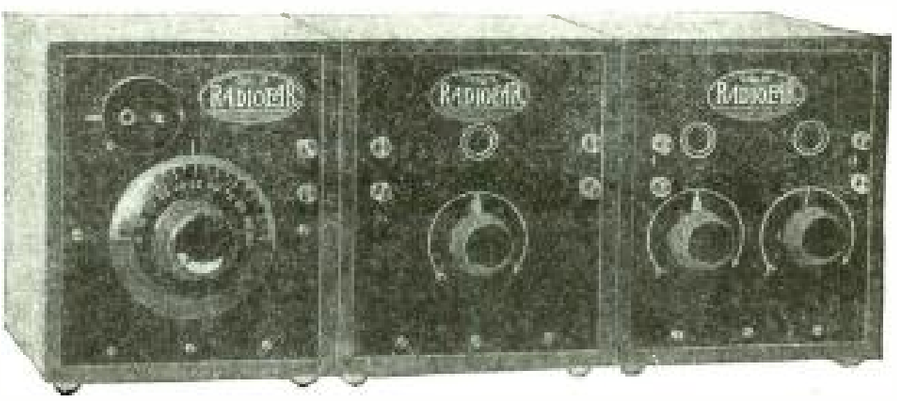
NA-ALD

Booklet with wiring design instructions for Hazeltine's Neutrotyno and the Flewelling Super-regenerative Circuits, and a number of standard circuits, packed with each socket.

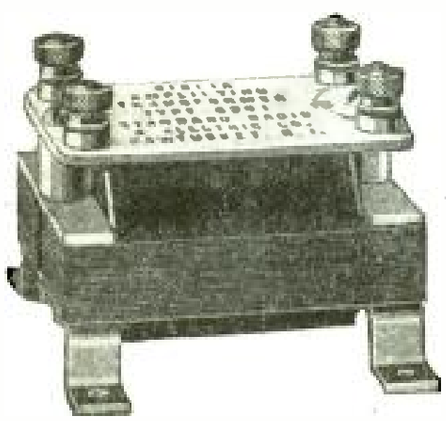
GIBLIN
RADIO APPARATUS

Every product manufactured by us is the result of the inventive genius of Thomas P. Giblin. For years this master inventor has concentrated on the development of wireless telegraphy and telephony. The three leaders illustrated here are perfect in design and construction, and their performance is guaranteed.

The "RADIOEAR" Vacuum Tube Receiving Set



This set includes the new Giblin receiver, detector and two-stage amplifier. The single-control tuner is easily and quickly tuned with full efficiency on any wave length. Local and distant stations can be heard with perfect clearness. The amplifier secures maximum volume without distortion. For the average radio enthusiast, this set will do all that could possibly be desired. Price, $50.00.



Audio-frequency Amplifying Transformer

This transformer has won the approval of radio enthusiasts from coast to coast. It is designed for use with standard amplifying tubes, and gives maximum amplification without noise or distortion. May be placed in any position without pre-magnetic coupling and squealing. Price mounted, $4.50; unmounted, $3.50.

Radio-frequency Amplifying Transformer

Features: Simplicity of operation; elimination of static and interference; loop reception of signals made possible regardless of the distance of transmitting station; maximum amplification; maximum resistance without the use of iron; maximum coupling between primary and secondary winding; minimum of distributed capacity. Price, $7.00.

If your dealer cannot supply you, order direct.

STANDARD RADIO & ELECTRIC CO.
PAWTUCKET, RHODE ISLAND

Announcing

THE NEW JENKINS VERNIER RHEOSTAT

CALLED THE UNITY VERNIER RHEOSTAT

An improvement on the Jenkins Rheostat, manufactured and sold by us heretofore.

The UNITY VERNIER RHEOSTAT has a BAKELITE base.

Genuine NICHROME RESISTANCE WIRE.

PATENTED adjustable screw fastens wire, thus eliminating all "loose wire" trouble.

PATENTED CUT OUT SWITCH with positive spring contact mounted directly in Rheostat, permits switching on or off with tuning unchanged.

PATENTED METHOD OF FASTENING resistance wire permits easy changing of wire to obtain a resistance suitable to any tube, or to replace if burnt out.

Suitable for use in the detector circuit of the four-circuit tuner.

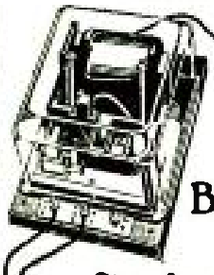
Price: $1.75. Add ten cents for postage. ***Hear a set that uses one.***

UNITY MANUFACTURING COMPANY, 224-232 N. HALSTED ST., CHICAGO
CONTRACT MANUFACTURERS

DEALERS AND JOBBERS WRITE FOR SAMPLES

WWJ | KDKA | WSB | KSD | WOC

Hear them all, all the time



Don't miss a program
Charge your A and B Batteries at home with a

Valley Battery Charger

Simple, safe, convenient. Cannot harm your batteries. Thousands of users would not be without it. At radio dealers—or write us.

Valley Electric Company

ST. LOUIS, MO.

WOI | WMC | WDAP | KDYX | PWX

Warren Radio Loop, cut away to show construction

Direction Finding

A New Radio Pleasure

LOCATE ships at sea, trace amateur stations to their hiding places, direct your receiving in the full path of broadcasting stations.

THE type B2537 or type BL2520 Warren Radio Loop, the most compact, efficient, attractive loop aerial, is all you need. Our new Bulletin I-102 explains the fascinating art of direction finding and gives hookups.

A Type for Every Set—at the Best Dealers

Type-A-787 (300-700 meters) 6 inches square—non-directional.....$10
Type-A-7286 (175-1000 meters) 6 inches square—non-directional...$12
Type-B-2537 (300-700 meters) 18 inches square—directional.....$20
Type-BL-2520 (200-18,000 meters) with honeycomb coil. 18 inches square—directional.....$25

Send for Bulletin I-102

V-DE-CO RADIO MFG. CO. Dept. FF. **Asbury Park, N. J.**

WHY NOT HEAR 'EM ALL?

The UNIVERNIER will make any instrument on your radio set "vernier" in its operation. Your outfit will be at least 100% more selective than before, and enable you to pick out with precision, stations that were entirely missed by usual adjustment.

By turning the UNIVERNIER as you would an ordinary knob, the speed of your instrument shaft is reduced nearly one-twelfth. By pressing toward the panel against light spring tension the UNIVERNIER will function as an ordinary knob. The UNIVERNIER takes the place of the common knob or dial, and is easily installed in a few minutes on ordinary variable condensers, variometers, tickler coils, variocouplers, potentiometers, and rheostats. It is the *logical* way to obtain genuine vernier adjustment.

Made in two sizes

No. 251 for ¼" shafts **No. 188 for 3/16" shafts**

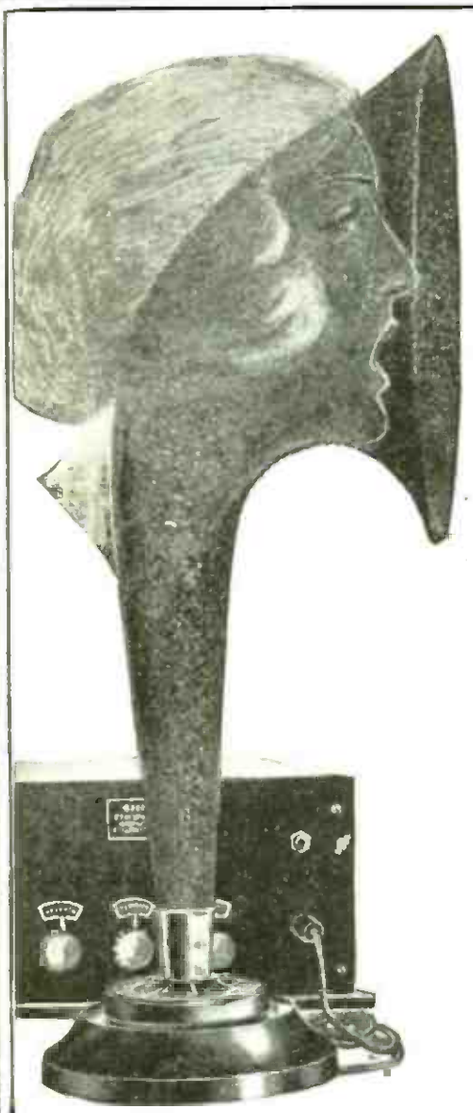
The UNIVERNIER $1.00
Special silver plated 360 scale for use with the UNIVERNIER.....$.25
Complete $1.25

At your dealers or postpaid on receipt of the above amount.

Discounts for jobbers and dealers.

WALBERT MANUFACTURING COMPANY, 933 Wrightwood Ave., Chicago, Ill.

P. S.—The UNIVERNIER will add to the appearance of any set.



A Real Musical Instrument

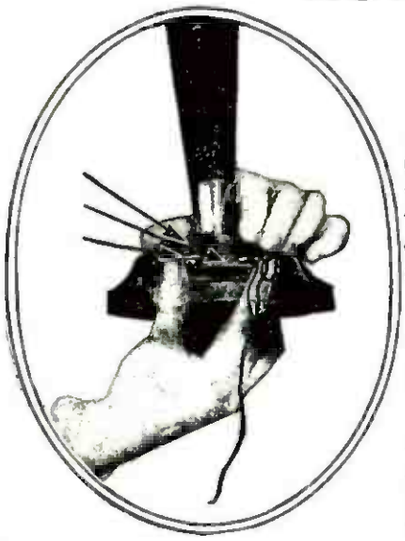
ACTUAL REPRODUCTION, of the artist's music, as broadcasted, is at last attained in the **Atlas Amplitone** Loud Speaker without blast or distortion. The artist's personality breathes again in the full, natural, vibrant tones of the Amplitone Re-PRODUCTION. Musical critics and radio fans, who have heard the Amplitone, agree that, at last, the musical superiority of even the finest phonographs has been surpassed. Embodies exclusive acoustic principles including the marvelous double diaphram.

Atlas AMPLITONE
LOUD SPEAKER

◆ ◆ ◆

NO loudspeaker is perfect, unless it can be adjusted to your own individual set. The **Atlas Amplitone** is adjustable to any set. Complete with connecting cord

$25



Amplitone Unit

The **Atlas Amplitone** Unit (without base or horn), with Grafonola Attachment, for use with your own horn or base or to convert any phonograph (except the Brunswick) into a loud speaker. With attachment

$13.50

Write for Amplitone Booklet

Write for illustrated booklet and the name of your nearest *Amplitone* dealer. No other loud-speaker can take the place of the *Amplitone*.

Multiple Electric Products Co., Inc.

7 Orange Street — Newark, N. J.

THE RADIO SET OF THE FUTURE

IT cannot be foretold what combination of units will be used, or the circuits that may be employed in the Receiver of tomorrow. It is obvious, however, that today's conventional set will soon be considered crude and antiquated.

Little prescience is required to realize that the panel of insulating material, with its shielded background, is doomed to obsolescence. The use of a great mass of expensive insulating material to provide for "live shafts" was merely a temporary expedient. Progressive practice has eliminated the electrical difficulties connected with live shafts and also obviated the necessity for massive insulation.

Carrying primary leads to the panel, and the drilling of numerous holes for a switch, will cease because of the waste such labor entails. To make the tap-switch an integral part of the instrument is the expedient thing to do.

Knobs add nothing to the appearance of a panel, and will in time become a relic of bygone days. The concave dial and bar control, giving ease of adjustment without cramping the hand, is far more sensible and attractive.

EISEMANN PARTS AND PANELS

Permit changing circuits and re-location of parts on panel, all units being interchangeable.

Make unnecessary the use of shielding—the metal panel itself accomplishing this purpose.

Eliminate mounting of tap-switches and soldering of primary leads.

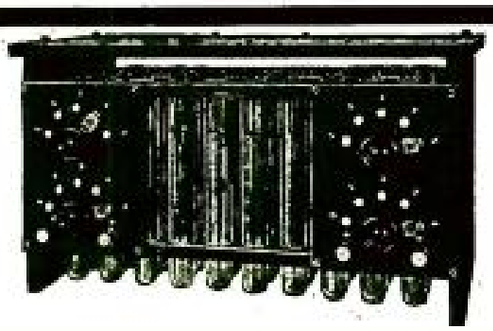
Give the many advantages of concave dials—a natural position of the hand in tuning, added attractiveness in appearance and ease in packing for transportation.

Write for descriptive literature.

EISEMANN MAGNETO CORPORATION
William N. Shaw, *President*
BROOKLYN, N. Y.

DETROIT CHICAGO

EISEMANN



KICO Radio Storage "B" Batteries for EFFICIENT Receiving

1. KICO "B" batteries allow single cell variations by means of switches mounted on panels. (The first in the market with this feature.)
2. Alkaline type.
3. Rechargeable from your 110-volt A. C. line in connection with the rectifier supplied.
4. One charge lasts from three to six months in the detector plate circuit.
5. Neat, efficient and compact.
6. Unlimited life.
7. Your money back if unsatisfied within a 90-day trial.

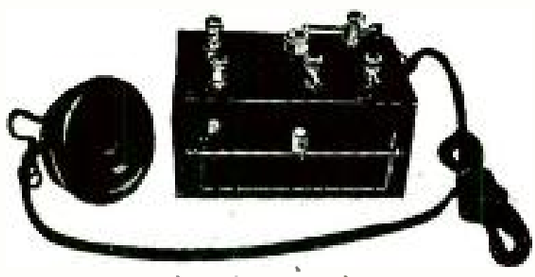
	(Plain)	(With Panels)
16 cell 22 volt	$6.50	.....
24 cell 32 volt	8.00	$12.00
36 cell 48 volt	10.00	14.00
50 cell 68 volt	12.00	17.00
78 cell 100 volt	16.00	21.00
108 cell 145 volt	21.00	26.00

"A" and "B" Battery Literature gladly furnished

KIMLEY ELECTRIC COMPANY
1357 FILLMORE AVENUE BUFFALO, N. Y.

"VB" RADIO CRYSTAL SET

Very Simple and Efficient



PRICE

Without phone or antenna . . **$1.25**
With single phone (1000 ohms) receiver and cord **$3.25**
With phone and antenna equipment **$3.75**

Satisfaction Guaranteed or Money Refunded

Sent prepaid to any address upon receipt of money order, or will send C. O. D. parcel post.

B. W. WHITEHURST
250 South Street Newark, N. J.

BRANSTON RADIO

Branston Lateral Wound Honeycomb Coils

Manufactured Under Deforest Patents

The finished product resulting from many years' experience in coil winding.
They are the most efficient and practical radio inductance ever designed. Sold unmounted or mounted with Branston Standard Mountings.

PRICE LIST

Turns	Unmounted	Mounted
L25	$ .50	$1.40
L35	.50	1.40
L50	.60	1.50
L75	.60	1.50
L100	.65	1.70
L150	.70	1.75
L200	.75	1.80
L250	.80	1.85
L300	.85	1.90
L400	.90	1.95
L500	1.00	2.20
L600	1.15	2.35
L750	1.35	2.60
L1000	1.60	2.85
L1250	2.00	3.30
L1500	2.50	3.85

3 Coil Bakelite Adjustable Mounting $5.00
2 Coil Adjustable Mounting..... 3.50
Single Coil Mounts..... 50c

Order through your dealer or write direct for complete catalog showing Branston "Standard" Radio Accessories.

CHAS. A. BRANSTON, Inc., 815 Main St.
BUFFALO, NEW YORK
In Canada, Chas. A. Branston, Limited, Toronto, Ontario

How to build the Reinartz Receiver

is told, complete with illustrations and diagrams, in the latest addition to the "Chi-Rad" Handbook-Catalog.

Our Handbook also includes:

1. Technical discussions of standard radio apparatus and equipment.

2. Radio definitions, wireless codes, wire tables, definitions, etc.

Pin this ad to your letter and mail it together with a dime for your copy of the Handbook.

Send for it, today!

Chicago Radio Apparatus Co.
415 S. Dearborn Street
Chicago

P. R.

Federal Is a Large User of Formica

THE FEDERAL TELEPHONE AND TELEGRAPH COMPANY of Buffalo is a large factor in the radio industry and has an excellent reputation for the quality of its product.

It is a very extensive user of Formica insulation not only in the complete sets which it produces but in the radio parts, variometers, variocouplers, headsets of which it is a large manufacturer.

A list of the users of Formica reads like a directory of the leading independent radio manufacturers. So many of the best informed radio men in America cannot be mistaken in their opinion that Formica is most uniform, the best looking, and the most efficient radio insulation.

Dealers and amateurs can safely follow these great concerns in selling or using Formica.

The Formica Insulation Company

4641 Spring Grove Avenue
Cincinnati, Ohio

SALES OFFICES

50 Church St., New York, N. Y.
422 First Ave., Pittsburgh, Pa.
1042 Granite Bldg., Rochester, N. Y.
415 Ohio Bldg., Toledo, Ohio
1210 Arch St., Philadelphia, Pa.
1819 Lyndale Ave., S. Minneapolis, Minn.
Sheldon Bldg., San Francisco, Cal.
Whitney Central Bldg., New Orleans
414 Finance Bldg., Cleveland, Ohio
9 S. Clinton St., Chicago, Ill.
313 Title Bldg., Baltimore, Md.
47 King St., Toronto, Ontario

FORMICA
Made from Anhydrous Redmanol Resins
SHEETS TUBES RODS

Red Seal SPARKER—steel clad

for every outing

Red Seal
Radio Sparker

Specially designed for operating W D-11 Tubes. Radio Sparkers give nearly three times longer service than a single dry cell. Made in 2-cell, 6-cell and 8-cell sizes for operating one to four W D-11 Tubes.

For economical operation specify **Radio Sparkers.**

This summer let the Red Seal Sparker—steel clad—supply dependable power for your outing needs. A fat, full spark for your motor boat ignition—a quick, sure start for your car—lighting up your camp lantern—Red Seal is always on the job, long lived, efficient.

For tractors, stationary engines, and so forth, farmers also find Sparkers—steel clad—stand all kinds of hard knocks.

The Red Seal Sparker—steel clad—is made in three sizes: 4 cells, 6 volts; 5 cells, 7½ volts; 6 cells, 9 volts.

Be sure to ask for it by name—Red Seal Sparker—steel clad.

MANHATTAN
ELECTRICAL SUPPLY CO., INC.

Makers of the famous Red Seal Dry Batteries, Sparkers and Manhattan Radio Products.

New York **Chicago** **St. Louis** **San Francisco**

Dependable Radio Sets and Service

Can always be had from local dealers who have been honored with the

M.R.C. FRANCHISE

For Three Reasons:

1. Franchise is granted only to merchants of standing and financial responsibility, with sufficient technical experience to render intelligent service.

2. "Michigan" Radio Sets are the finest examples of correct Regenerative radio engineering, expressed in superlatively good workmanship.

3. The Michigan Guarantee is as valid as a Bond. For back of it stands the strongest independent Radio manufacturing concern in the United States.

"SENIOR" SET

Michigan Regenerative Receiving Sets

are built under Armstrong License (U. S. Pat. 1,113,149 and letters patent No. 607,388). This means that they embody the latest development in Regeneration—the soul of radio.

Long Distance Wonder Workers

"JUNIOR" SET

The "Senior Set" includes both detector and amplification, and can be used with either headphones or loud speakers or both.

The "Junior Set", a detector unit only, is limited to headphone reception. It can however, be hooked up with the Michigan Amplifier unit for loudspeaker reception.

Send for the Michigan Circular, giving full information on both sets and parts, and telling of some of the long-distance triumphs of Michigan set owners.

MICHIGAN RADIO CORPORATION

21-31 OTTAWA ST. GRAND RAPIDS, MICHIGAN

1200 MILES
with a Crystal Set Using

A Needles, California, radio fan writes:

"Using M. P. M. Crystal, I picked up Los Angeles, San Francisco, Salt Lake, Denver and St. Louis. It is far superior to any crystal I have ever used."

Before discarding your Crystal Set for an expensive Tube outfit, give M. P. M. Crystal a trial!

¶ ***Beware of imitations!*** The genuine Million Point Mineral is sold only in separate crystals packed by our company in boxes bearing the trade-mark "M. P. M."

Send 25c and name of your Radio Dealer for a sample M. P. M. Crystal—concert-tested and guaranteed. 35c for mounted Crystal.

M. P. M. SALES COMPANY
Department PR
247 So. Central Ave. Los Angeles, Cal.

PRICES *SMASHED*

Each sale has created new friends and customers, with the result that we now announce drastic reductions in our quality lines. All goods prepaid. Send card for complete list. You'll be surprised. You'll tell your friends. A sample saving follows—

Complete Regenerative Vacuum Tube Set

(Knocked down. Approx. range 1000 miles.)

	Our price	Others
Panel 7" x 12"—Bakelite—drilled	$1.75	$2.50
Cabinet of 3 ply wood to fit above panel	1.50	2.50
Two 3" dials @ 35c each	.70	1.40
16 switch points with nut @ 1c each	.16	.48
4 switch stops with nut @ 1c each	.04	.12
8 nickel plated binding posts @ 3c each	.24	.48
2 switch levers @ 25c each	.50	.90
1 filament rheostat. Highest grade	.65	1.10
1 vario-coupler with 7 multiple, 7 single taps	2.25	4.00
1 23 plate variable condenser. Built right	1.95	3.50
1 tube socket—High grade	.45	.85
1 grid condenser and leak	.20	.35
1 phone condenser	.15	.30
1 support for tube socket	.15	.25
10 feet of shaghetti tubing @ 5c per foot	.50	.84
15 feet copper connecting wire	.15	.30
Blueprints showing details to assemble outfit	.10	.25
	$11.44	$20.12

Other articles taken at random from our list are:

Detector tubes—Cunningham—New. NOT rebuilt	$4.25	$5.00
Amplifying tubes—Cunningham—New. NOT rebuilt	5.50	6.50
Transformer—Audio frequency. United	2.95	4.50
Variometer—Hardwood Stators 4¾" square. Assembled Workrite type	2.45	4.00
Frost Fones .....2000 ohms	3.95	5.00
Dictograph .....3000 ohms	6.50	8.00
Stromberg Carlson..3000 ohms	5.95	7.50
Murdock .....3000 ohms	4.75	5.50
Holtzer Cabot ....2200 ohms	6.25	8.00
Manhattan .....2000 ohms	4.95	6.00
Manhattan .....3000 ohms	5.50	7.00
Two stage amplifier—Knocked down. Cabinet and drilled panel	12.95	23.50
Blueprints giving detail of two stage amplifier	.10	.25

Send for full list today or order from above. Goods sold subject to return for rebate or exchange. YOU SIMPLY MUST BE PLEASED.

RADIO PARTS MANUFACTURING CO.
Dept. "P" 2150 Montclair Detroit, Mich.

In Any or All Stages
of audio frequency amplification
The AMERTRAN

Price $7
Ask your electrical dealer, or sent carriage charges collect. (Wt. 1 lb.)

can and should be used. It is made in only one type and one ratio. Its flat-top amplification curve precludes the possibility of distortion on the part of the transformer when used in any or all stages. It will give the same clear-toned distortionless amplification with all tubes which are approximately alike in A. C. Impedance and Amplification Factor, such as

WD-11
UV-201 UV-201-A
C-301 C-301-A

Its amplification in one stage is 38.6; two stages 1490.

American Transformer Company
Designers and builders of radio transformers for over 20 years
175 Emmet St., Newark, N. J.

Determines RANGE of YOUR SET

$1 Complete

Determines DISTANCE of CALLS RECEIVED

$1 Complete

THE McNEARY
RADIO SCALOMETER
AND OFFICIAL RADIO MAP

After you recover from the thrill you get every time you tune in on an out-of-town station, the first thing you want to know is HOW FAR was that?

With the Scalometer mounted on the official map you read the distance directly on the tape—instantly and correctly.

SCALOMETER
An instrument of precision in a beautifully finished aluminum case.

RADIO MAP
Authoritative, up-to-the minute, showing broadcasting stations time zones, radio districts, cities and towns of the United States and Canada.

BROADCAST DIRECTORY
In handy booklet form with all broadcasting stations alphabetically arranged by call letters.

IF YOUR DEALER CANNOT SUPPLY YOU SEND ONE DOLLAR TO

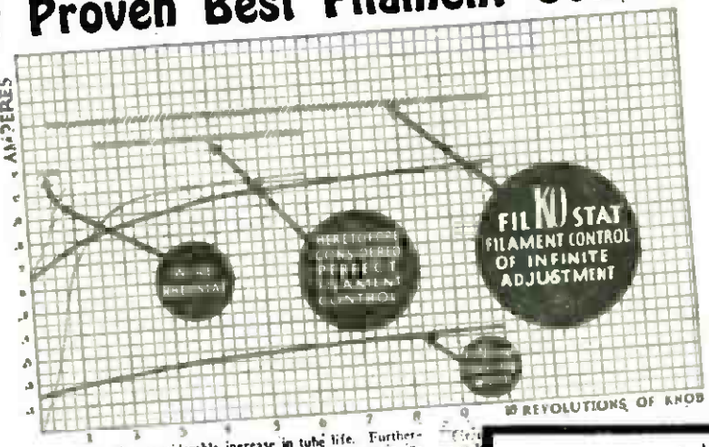
EMBLEM MANUFACTURING CORPORATION
255 MIDDLE CITY BLDG., PHILADELPHIA, PA.

Read this again!!

1830

April, 1923

Filkostat Proven Best Filament Control



Comparison of Fine Adjustment Control Range of Filkostat With Rheostats and Other Filament Controls Clearly Indicates Filkostat Superiority, as it Permits Perfect and Gradual Current Increase With Infinite Adjustments.

IN the Filkostat, a new filament control just perfected by S. R. Hipple, well known as an inventor of apparatus for the control of electric currents, there is at last presented an instrument which is distinctively designed to utilize the great tuning possibilities of the vacuum tube itself. Radio set builders, amateurs and manufacturers have been looking forward to the advent of just such a device. They have realized that all rheostats and other so-called filament regulators, are merely adaptations of pre-radio day devices, not capable of adjusting the infinitesimal graduations of filament HEAT which adjustments are essential to perfect tuning.

PERFECT TUBE CONTROL

The Filkostat permits perfect regulation of filament heat. Since the heat emitted varies as the square of the current, fine current regulation becomes extremely necessary to accomplish. This governs the flow of electrons. Proper control of the electronic flow in the tube permits the very finest tuning conceivable. The fine adjustment of the Filkostat starts slightly before the tube begins to function. With other filament controls, what minute adjustment there is, starts when the filament is almost at maximum heat. Between 1800 degrees—dull red glow—and 2050 degrees—white heat—the Filkostat control is so fine that increases of temperature of *fractions of a degree*, with corresponding variations of electronic flow from the filament to the plate, are obtainable.

considerable increase in tube life. Furthermore the extreme degree of fineness in increase and decrease of electronic flow by infinitesimal variations, makes the Filkostat control ideal.

The perfection of design including ample internal contact is the cause of this new instrument being non-microphonic, absolutely silent, and free from all noises.

IDEAL FOR WDII'S AND DX WORK

The lower curve on the graph above is eloquent testimony as to the Filkostat's adaptability to any dry cell tube. These tubes using only a fraction of an ampere demand an instrument that is so finely adjusted that this fractional current can be perfectly regulated. This the Filkostat accomplishes.

OTHER FILKOSTAT FEATURES

The Filkostat has a *definite off*. It is so designed that the filament extinguishes abruptly indicating that the A battery supply is completely disconnected.

At *Full On* the Filkostat resistance is practically zero.

The Filkostat consists of a hollow cylinder containing the special resistance material, placed between two large adjustable contacts controlled by turning the knob.

The Filkostat is to all purposes "fool proof." It is compact in form, takes very little space on the panel and so mountable that it can replace any other control without redrilling.

THE RESISTANCE ELEMENT is so finely divided that no further division is possible. There are no disks to break or chip.

The RESISTANCE remains CONSTANT at any position eliminating cuerent variations once set. Such variations are not apparent to the person tuning excepting in "fading out" of stations and noises. But in the laboratory, where such a test as, that shown on the above graph can be made by anyone, this feature and all the other points of superiority of the Filkostat are immediately apparent.

The filament kontrol of infinite adjustment

FIL-KO-STAT

CURRENT INCREASE PERFECT AND GRADUAL

LIKE THE RISING SUN

$2.00

—and here's why you need it!!

Designed For Vacuum Tube
adjustment and not just an old method adapted to it.

NOT a Rheostat
—but a REAL *Filament Control.*

Infinitesimal Control—of filament heat
and therefore of *electronic flow.*

Very Finest Tuning for DX
is realized with Fil-Ko-Stat.

Controls Fractional Currents
—making it ideal for use with any dry cell tube.

Fine Adjustment Starts
—where tube commences to function increasing the AREA OF FINE ADJUSTMENT CONTROL.

Definite Off—
an important feature indicating complete 'A' Battery disconnection.

Resistance Practically Zero
at "full on" there is practically no resistance in circuit.

No Disks To Break or Chip
Resistance Element is so finely divided further division impossible.

Absolutely Silent
The Fil-Ko-Stat is non-microphonic and operates free of all noises.

Fahnestock Clips
and solder contacts on connection posts.

Adjustable Mounting
—no re-drilling of panel necessary.

GUARANTEED

The FIL-KO-STAT is to all purposes "fool proof". Each instrument is packed with the maker's guarantee that it will be replaced if broken within one year.

Replace Old Style Current Controls with the NEW FIL-KO-STAT *a real Filament Control*

ON SALE AT RADIO DEALERS EVERYWHERE

Manufactured By

DX INSTRUMENT CO.

If your dealer has none in stock yet send $2.00 and his name direct to

SOLE INTERNATIONAL DISTRIBUTORS

RADIO STORES CORPORATION

Dept. P.R. 6 218-222 West 34th Street, New York

A Message to Radio Dealers and to Other Members of Popular Radio's Fast Growing Family

This issue of POPULAR RADIO which you hold in your hands is our First Anniversary Number. It was just one year ago that POPULAR RADIO, even then a healthy youngster, first saw the light of day.

Since the issue of May, 1922, the magazine has made a host of admiring friends. Our little family of subscribers has grown to number approximately ten thousand. Our newsstand friends total close to a hundred thousand.

In almost every city and village where radio sets are in operation POPULAR RADIO is giving its readers practical hints and suggestions on how to build their own sets, how to widen their range, how to make improved hook-ups—is bringing to the radio novice and amateur the most authoritative information that can be had.

You, as a reader and friend of POPULAR RADIO, can help us to make this magazine still more useful and valuable by calling it to the attention of new readers. On page 60 of this issue you will find an attractive list of premiums offered for new subscriptions. Read it carefully. We also offer liberal cash commissions for subscriptions. Why not write us and get full details regarding our agent's proposition? It will help you to make good money in your spare time, and it will help us, also, to give you in the months to come a still bigger, better magazine.

Simply address Dept. 51 and we will tell you how you can make from $3 to $5 a day and more. To radio dealers who write us on their business letterheads, we also have an interesting offer. Ask for it!

POPULAR RADIO, Inc.

9 EAST 40th STREET — Dept 51 — NEW YORK CITY

It's Only a Step For You Now to a Big Paying Radio Position

SURELY you have noticed how wireless is spreading over every part of the world. Every day you learn of some new field that is utilizing it—some new firm organized to push it forward. But do you realize that YOU can easily qualify for the wonderful opportunities that are opening? Do you know that you can quickly build up a complete knowledge of Wireless—and be ready any time you wish to for a fine Wireless position, either on land or on sea? Through our special method of home-study instruction a short period of your spare time can be turned into preparation for a worthwhile future in the fastest-growing field in America today—Wireless. No one is in a better position than you to cash in big on the wireless expansion that is sweeping over the world. You have the whole foundation, all ready to build upon. Our new easy method of instruction makes the rest pure fun—but fun that pays big.

Commercial wireless expansion is sweeping over the world like wildfire! Big opportunities are open—and every day get more numerous and attractive. You are in a fine position to cash in big on this growing field. Right at home in spare time you can easily build upon your present knowledge and quickly qualify. The coupon below will bring you an interesting free booklet—telling about the splendid opportunities open, and how you can share them. Mail coupon for booklet today!

New Method Makes It Easy to Qualify

Without obligation to yourself we would like to tell you more fully about the future wireless offers you. We would like to tell you about our Institute, which is officially recognized by the U. S. Government. The National Radio Institute was the original and is today the oldest and largest school in America teaching wireless by mail. The Government allows our graduates five to ten points credit when taking First Class Government License examinations. We have graduates in almost every part of the world who have quickly qualified through our special new method.

Both on sea and on land a fine future awaits the man who is qualified in wireless. No matter whether you wish to visit every nook and corner of the world or whether you prefer a land station, wireless awaits you.

This method not only includes a comprehensive course of instruction written exclusively for us by some of America's greatest wireless experts (members of our own staff), but also includes, Free, a wonderful new invention patented and controlled only by us. This device, called the Natrometer, teaches you in half the usual time how to send and receive with speed and accuracy. This Natrometer is superior to any other device of its kind. Without aerials or any outside device it sends you any one of 600 different messages at a speed which you can vary from 3 to 30 words per minute. It is portable; also very attractive in appearance. It is noiseless; and it sends in a natural manner, not like a mechanical device. You get the messages thru its phones at whatever speed you wish. And this is **only one** of the features which our new method brings you. Others are listed below. Read them and you will realize why our students quickly qualify and why they step into the fine wireless positions that are waiting!

10 Points That Make This School the Best

1. **New Easy Method of Instruction.**
2. **Wonderful Natrometer and 3 other instruments to give you practical instructions at home.**
3. **Government Credit and Recognition.**
4. **Our Location in Washington—Passing New Official Developments on to You.**
5. **Personal, Individual Attention of Great Experts.**
6. **Our Service in Obtaining You Employment.**
7. **Free Training in Wireless Telephony.**
8. **Unlimited Consultation and Advisory Service.**
9. **Free Post-Graduate Course in Our Washington Residence School If You Wish.**
10. **Low Tuition Cost and Easy Terms of Payment.**

Mail coupon today for our free illustrated booklet, "How to Learn Radio at Home." Without cost or obligation, we want to tell you more about this field, its big opportunities both on land and on sea, and just how our new method quickly qualifies you. No agent will call upon you. We just want to send you the facts. Mail coupon at once! National Radio Institute, Dept. 32-E, Washington, D. C.

Men—Boys 16 or Over—Should Mail Coupon Immediately

NATIONAL RADIO INSTITUTE
Dept. 32-E 1345 Pennsylvania Ave., N. W., Washington, D. C.

Please send me your free book "How to Learn Radio at Home," 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 Radiotrician. Also, tell me how your free employment service will help me to a position and particulars of your special short-time offer.

Name ..... Age .....

Address .....

City..... State.....

More Good News for POPULAR RADIO Readers!

A brand new list of premiums for you to select from. Bigger values than ever before. Get the parts you want for your set—and get them FREE—by taking a few subscriptions from your friends.

If you've never tried it, you don't know how easy it is to get subscriptions for POPULAR RADIO. Just show this copy to some of your friends. Let the magazine sell itself to them. Then send us their names, with $2 for each yearly subscription, and take your choice of any of the following radio parts. They'll come to you *free!*

Any One of These for 2 Subscriptions:

Dubilier Ducon

Dubilier Tubular Grid Leak (any standard size) with Grid Condenser .00025 mfd.

DeForest Vacuum Tube Socket with Bingo Rheostat

DeForest Potentiometer

Teleradio Lightning Arrestor with 50 feet of No. 14 r.c. lead-in wire and ground clamp

100 feet of stranded phosphor bronze aerial wire with 2 Electrose Insulators

Manhattan Combination Volt-Ammeter

Your Choice for Only 5 Subscriptions:

Jefferson Audio Frequency Transformer (new style)

23 Plate Teleradio Variable Condenser, unmounted, with Alden-Napier 3 inch Dial

Set of DeForest Honeycomb Coils (Mounted) No. 35, No. 50 and No. 75

Phono-Phane Fixed Crystal Detector

Bakelite Panel, size 7 x 24 inches

Big Values for 8 Subscriptions each:

Manhattan Genuine Bakelite Variocoupler

Manhattan Genuine Bakelite Variometer

Radiotron U. V. 200 and C. H. Vernier Rheostat

DeForest 3-Coil Honeycomb Mounting

R. C. A. Radio Frequency Transformer

U. V. 201 Vacuum Tube

Post Electric Soldering Iron

Manhattan Headset (3000 ohms)

Free with 10 Subscriptions each:

43 Plate United States Tool Vernier Type Variable Condenser

Brandes Phones

Atwater Kent Detector Unit, Complete with 22½-volt Ever Ready B. Battery

Moon Radio Horn

Atwater Kent Variocoupler

Atwater Kent Variometer

If you want some particular part that isn't listed here, write us and we'll tell you how many subscriptions you'll need to get it free. Renewals count just as much as new subscriptions. A two-year subscription for $4.00 counts the same as two one-year subscriptions.

Start today, and you'll have your required number of subscriptions in a jiffy!

POPULAR RADIO

Dept. 5 — 9 East 40th Street — New York City

Critical tuning with the Dubilier Ducon

THE Dubilier Ducon is the only device of its kind passed by the Laboratories of the National Board of Fire Underwriters. Several hundred thousand radio "listeners in" in America and Europe use it to do away with the cumbrous antenna and its lightning arrestors and switches.

With the Dubilier Ducon in a lamp socket, the tuning is so sharp that the slightest movement of the knobs is sufficient to suppress one of two stations on nearby wave lengths.

Hence the Dubilier Ducon not only makes it easy to enjoy radio by doing away with the antenna, but gives to the simplest set a selectivity in tuning attainable only in the most expensive and elaborately equipped apparatus.

DUBILIER CONDENSER AND RADIO CORP.
48-50 West Fourth Street, New York

Branch Offices

St. Louis, Mo., Syndicate Trust Bldg.
Atlanta, Ga., Forsyth Building
Los Angeles, Cal., 329 Union League Bldg.
Washington, D. C., Munsey Bldg.
Chicago, Ill., 33 So. Clinton St.
Pittsburgh, Pa., 704 Granite Bldg.
Huntington, W. Va., 1028 Fourth Avenue

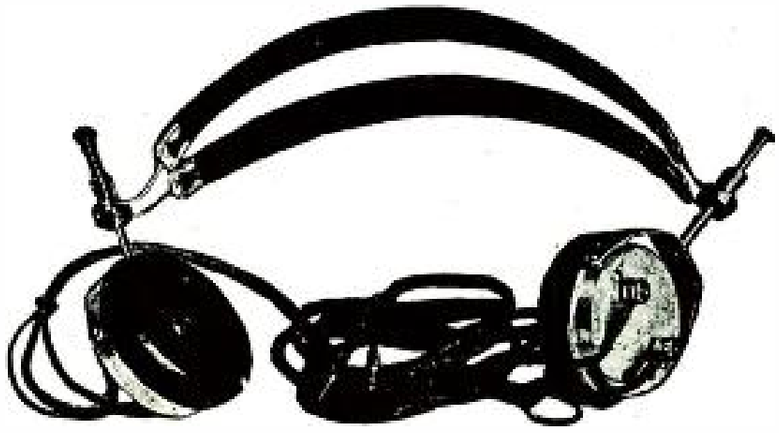
Distributed in Canada by

Canadian General Electric Company, Ltd., Toronto
England: Dubilier Condenser Co., Ltd., London
Germany: The Telefunken Co., Berlin
France: C. Capart, Paris

Retail price $1.50. At all good dealers. The Dubilier Ducon is used throughout the world

Teleradio

(TRADE-MARK)



SUPER SENSITIVE PHONES

USED IN EVERY STATE IN THE UNION

are the result of years of experience in the construction of delicate electrical apparatus.

They are designed and built on sound engineering principles. They are famous for their super sensitiveness, superior quality of tone, volume, and clearness—accurately reproducing either vocal or musical sounds with wonderful tonal qualities. *Equally satisfactory for local or long distance work.*

Growing popularity — INCREASING SALES prove it is the PERFORMANCE and SATISFACTION of TELERADIO *correctly balanced* Phones that really count.

TRY THEM AND BE CONVINCED

Type C, 2000 ohms, **$6.50**; Type B, 2200 ohms, **$7.50**; Type A, 3000 ohms, **$9.00.**

TELERADIO FILAMENT RHEOSTAT

Can be mounted on panel or table

Will carry 1½ amps without overheating and is wound to 6 ohms resistance

Price, **$1.00**

TELERADIO LIGHTNING ARRESTER

Electrical No. 5837

Approved by the National Board of Fire Underwriters

Price, **$1.00**

TELERADIO FILAMENT PROTECTOR

For detector and amplifying tubes

Complete, **60c**

Extra fuses, **10c** each

OTHER TELERADIO "HIGH QUALITY" PRODUCTS

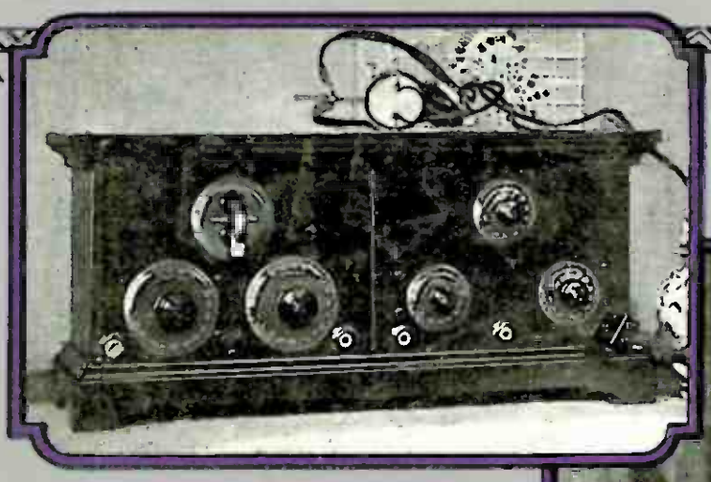
Variable Condensers, 3-11-23 and 43 plates, **$1.50, $2.50, $3.00** and **$4.00**, respectively. Tube Sockets, **60c**; Fixed Phone and Grid Condensers, **35c** each; Grid Leak Condensers, **50c** each.

If your dealer has not stocked TELERADIO PRODUCTS order direct and mention dealer's name. Jobbers: Write for our discounts. Dealers: Ask us about our "Dealer's Stock Order" proposition

TELERADIO ENGINEERING CORPORATION

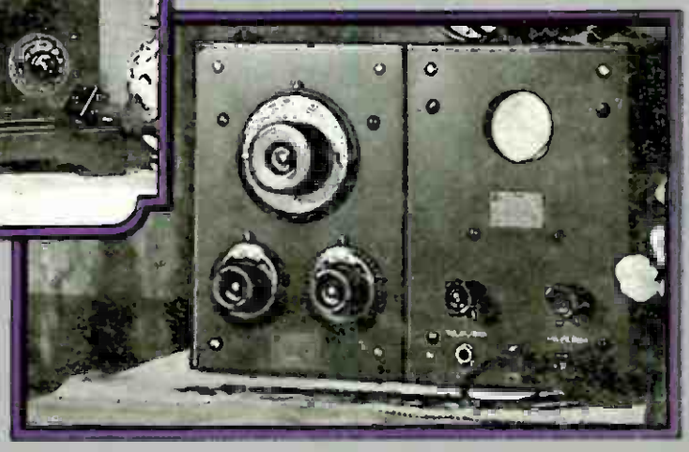
484-490 BROOME STREET, NEW YORK CITY

CHARLES FRANCIS PRESS, NEW YORK



Radiola RC

Three tube set—detector and two step amplifier. Solid mahogany, attractively finished.



Radiola V

Mahogany finished case, of rugged build. A three tube Radiola—detector and two steps of amplification.

A New Improvement Lowers the Cost!

Dry cells replace storage batteries. A new vacuum tube has made it possible. Radiola V and Radiola RC have been topping them all in popularity for dependability and long range—receiving over thrilling distances—up to 1,500 miles and more. Now both are converted to dry battery operation.

No more need for expensive storage battery and charger. A big saving! And a saving made greater by the new offer—a combination offer of receiver and accessories—complete at a price remarkably low.

"There's a **Radiola** *for every purse"*

at the nearest Radio or Electrical Store

Radiola

REG. U.S. PAT. OFF.

Radio Corporation of America

Sales Department
233 Broadway
New York

District Sales Offices
10 So. LaSalle Street
Chicago, Illinois

433 California Street
San Francisco, California

This symbol of quality is your protection

RCA

Radiola V *or* Radiola RC Complete $142.50

The New Way: Complete for dry battery operation, including three WD-12 Radiotron vacuum tubes; head telephones; "A" Battery consisting of three dry cells; "B" battery consisting of three 22½ volt units. $142.50.

The Old Way: The price of Radiola V or Radiola RC when equipped for storage battery operation, formerly came to $207.50.

Send for this Free Booklet—There are Radiolas from $25 to $350. Send for the booklet that describes them all.

RADIO CORPORATION OF AMERICA
Dept. 2067, 233 Broadway, New York

Please send me your free Radio Booklet.

Name.....

Street Address.....

City.....R. F. D.....

State.....