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APRIL 1923

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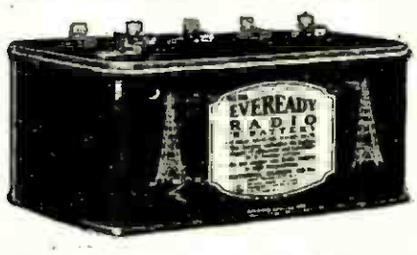

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POPULAR RADIO

EDITED *by* KENDALL BANNING

CONTENTS *for* APRIL, 1923

(Cover design by Frank B. Masters)

VOLUME III NUMBER 4

DEPARTMENTS

VOLUME III APRIL, 1923 NUMBER 4

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


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"What is whispered — in the ear is heard miles away." said Mencius.
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A Page with the Editor

With this issue Popular Radio authoritatively announces—as it might have unauthoritatively announced some months ago—that it has the "largest certified circulation of any radio magazine."

* * *

Popular Radio has not, up to this time, quoted circulation figures. It has never asked advertisers to accept statements that could not be verified and certified and otherwise established as indisputable facts. Circulation claims that cannot be proven are (to quote the Editor's honored professor of English) "both interesting and convincing—particularly neither."

* * *

"There is need at present for a suitable name for that particular type of broadcasting which is based on wired wireless principles," writes Major-General George O. Squier to the Editor. "Every day sees the necessity for a word which should express as clearly as possible the idea involved and distinguish it carefully from general broadcasting. I have noted that in your excellent journal recently the subject was referred to as narrowcasting. I do not particularly like this word; it is too long and the word 'narrow' implies something limited. Another word which has been suggested here is 'wirecast' or 'wirecasting.' Perhaps you or some of your readers could suggest a suitable term."

In accordance with the General's wishes, the polls are now open for suggestions. Write and tell us what term should be used.

* * *

The extending use of Popular Radio in the schools and colleges is perhaps the most convincing proof of the regard in which the magazine is held that the Editor could ask. Principal John H. Frizzell of the High School for Boys in Reading, Pa., for example, recently "experimented" with the magazine by having it come to the school so that he could know "whether or not it would be a good plan" to subscribe to it regularly.

Two months later he reported: "The experiment is a decided success. The magazines are worn out before the month is half up, and not from carelessness in handling, but from reading. The boys like it. It has gone 'over the top' with a bang."

* * *

The rapidly extending recognition given to the articles in Popular Radio by governmental authorities and scientists generally furnishes impressive evidence of the standing that this magazine enjoys. The *Radio Service Bulletin* (for example) issued by the Department of Commerce on January 2, lists no less than six articles in our January number alone as "among the more important papers of interest to the professional radio engineer which have recently appeared in technical periodicals."

Among the radio experts who have been called in by our Technical Editor to help handle the mass of questions from our readers is Russel P. May, widely known among navy men as the radio engineer who planned and designed ship, shore and aircraft installations for the Navy Department during the war. He is the inventor of the push-pull oscillator circuit, and was formerly an associate of Dr. De Forest in the development of the original Cascade amplifier; he also assisted in the development of Dr. De Forest's first high-frequency-spark telephone, the forerunner of the modern radio telephone.

Our readers may be assured that their problems have been worked out by a Man Who Knows.

* * *

"My boys think that there is no paper that compares with Popular Radio in helping them to make their wireless outfits. At the present time we have five separate sets in our house."

So writes Frank B. Gilbreth, the well-known industrial engineer and authority on scientific management. And he backs up his opinion with a check for another subscription.

* * *

The Editor's appeal to our readers to dispose of such of their radio parts as they no longer need to the hospitals for veterans has not been in vain. The latest call comes from U. S. Veterans Hospital No. 78, in North Little Rock, Arkansas. "Our aerial is already up," writes Nurse Pauline Peters. "Now we want a receiving set to entertain our boys."

What Good Sport among our readers will help out—at least to the extent of sending along some useful parts?

* * *

Each day brings additional evidence of the esteem in which Popular Radio is held abroad; so many eminent European scientists are now numbered among our contributors that the magazine is assuming an international character. "I can assure you that we have no wireless magazine in England equal to it," writes Mr. John Scott of Newcastle-upon-Tyne—and, properly enough, he encloses a subscription in proof of his conviction.

* * *

"The magazine with the silver cover" is literally being swept off the newsstands! The only way to be sure of getting your copy is to subscribe.

* * *

Last call for subscriptions at the present rate of $1.50 a year! Beginning March 20th the yearly subscription will be $2.00.

Kendall Banning

Editor, Popular Radio

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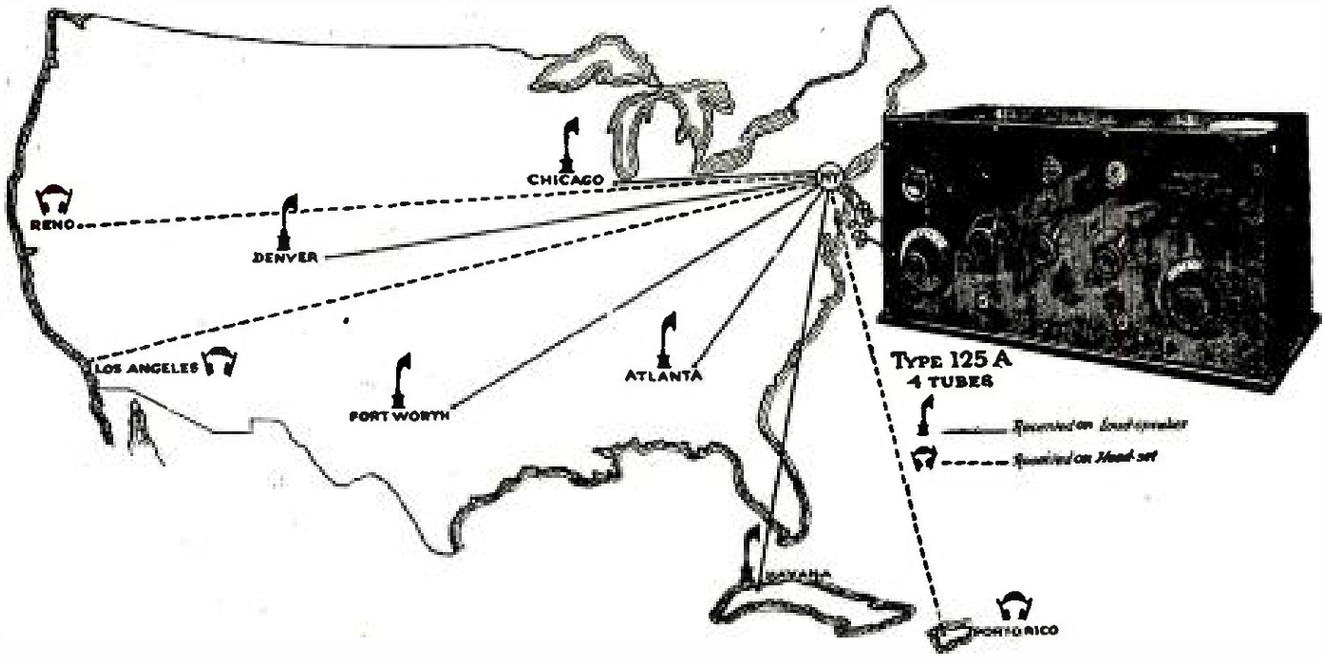

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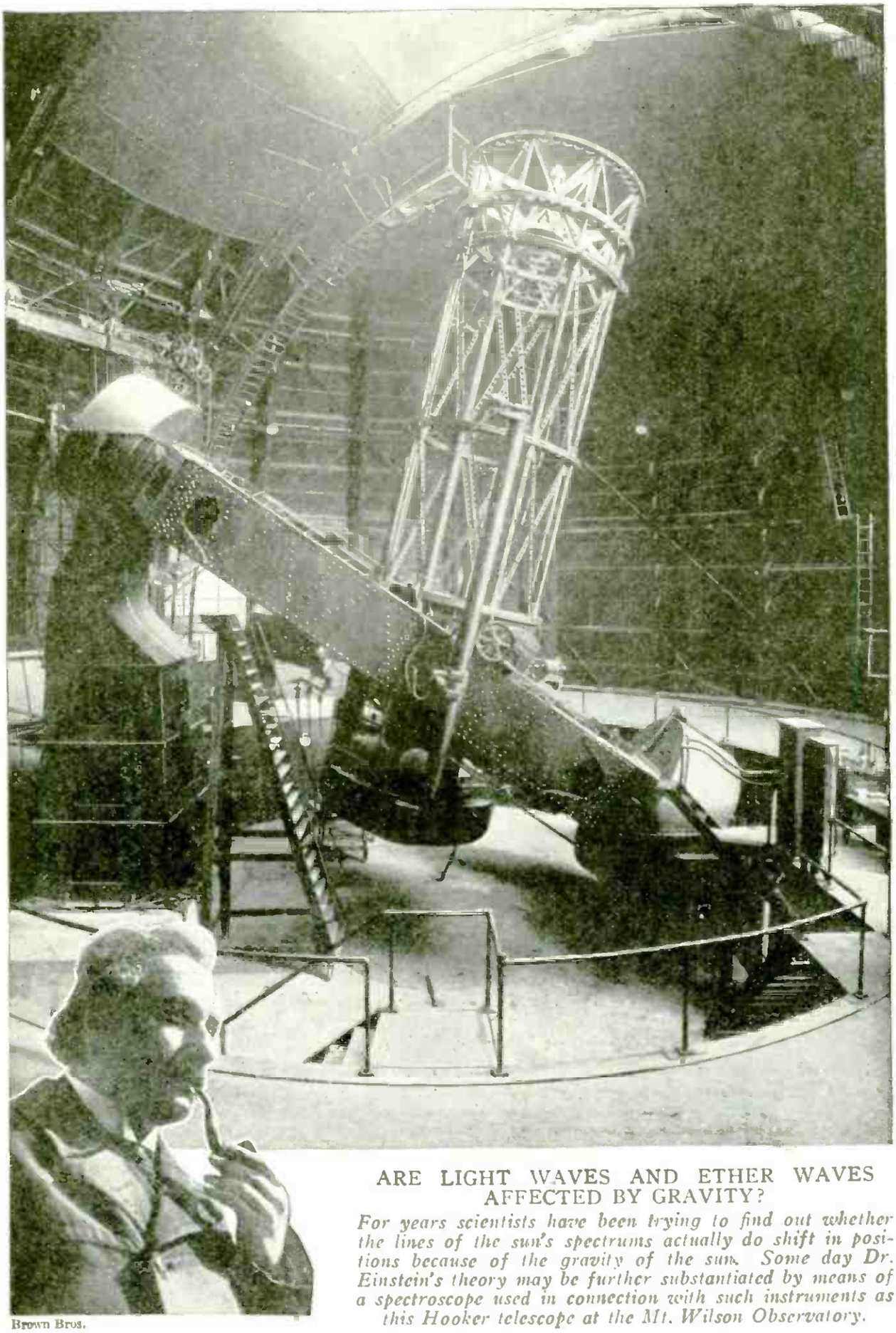
To the Editor of Popular Radio:

I have followed with more interest than you know your work to utilize radio broadcasting for the common happiness and education of the country. Your plan of action seems to me to be sound sense and a real vision of service. My congratulations to you. And here's our pledge to help you in every way we can.

John H. Bowman

Chancellor, University of Pittsburgh



Brown Bros.

ARE LIGHT WAVES AND ETHER WAVES AFFECTED BY GRAVITY?

For years scientists have been trying to find out whether the lines of the sun's spectrums actually do shift in positions because of the gravity of the sun. Some day Dr. Einstein's theory may be further substantiated by means of a spectroscope used in connection with such instruments as this Hooker telescope at the Mt. Wilson Observatory.

Popular Radio

VOLUME III APRIL, 1923 NUMBER 4

RADIO *and* RELATIVITY

An Explanation of Ether Waves in the Light of the Einstein Theory

FOREWORD

The now famous article, *There Are No Ether Waves,* by Dr. Charles P. Steinmetz (published in our issue for last July), precipitated an international discussion which is still keeping the scientists stirred up. As a result POPULAR RADIO has received so many inquiries concerning the exact relation of the Einstein theory to the problem of ether waves and radio that we asked Dr. Free to prepare this outline of the theory in terms that the lay reader can understand.—EDITOR.

BY E. E. FREE, Ph.D.

JUST why does the Einstein theory prove so difficult to understand?

I think it is because most of us begin to study the theory in a wrong way. We begin by trying to make a *picture* of what Einstein means.

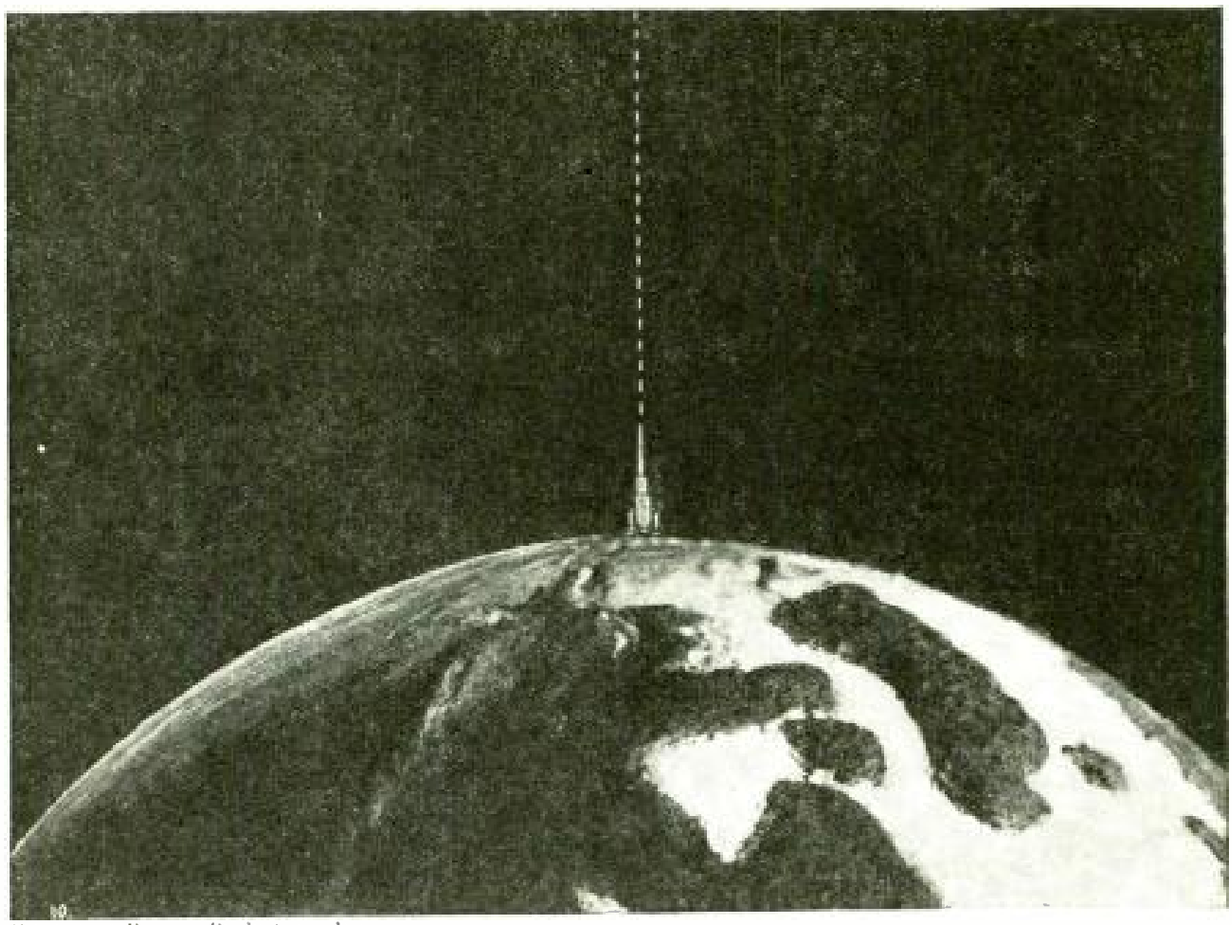
We have grown accustomed to this way of understanding things, by what we call "visualizing" them. For instance, we get an idea of the character of the solar system by making a mental picture of it, a picture of a lot of round balls for planets revolving about a larger ball for the sun.

We understand radio similarly, by pictures of waves in the ether or of electrons flying about inside the vacuum tube. Most of the science of physics consists of such mental pictures of things.

Now it is a law of the mind that all such pictures are built up out of experience, out of things which we have actually seen. We could have no mental picture of the solar system unless we had sometime seen round things like oranges or billiard balls, and had seen things in rotation about a center like the rubber balls that boys whirl on the end of strings.

The peculiar difficulty of understanding the Einstein theory is due mainly to the fact that we cannot apply to it this customary process of making mental pictures.

Imagine an artist so insistently devoted to the principles of cubist art as to have banished from his house everything that was round. Suppose that no balls or apples or round lamp globes were allowed, and that even the door knobs were square. And imagine a child



Courtesy of Premier Productions, Inc.

How the Course of a Cannon Ball Looks to a Person on Earth

To an observer on our globe and traveling with it the path of the projectile fired perpendicularly appears to be straight up and down.

brought up in this rectangular house; a child who had never been allowed to see a sphere, a child from whom all experience of roundness had been kept.

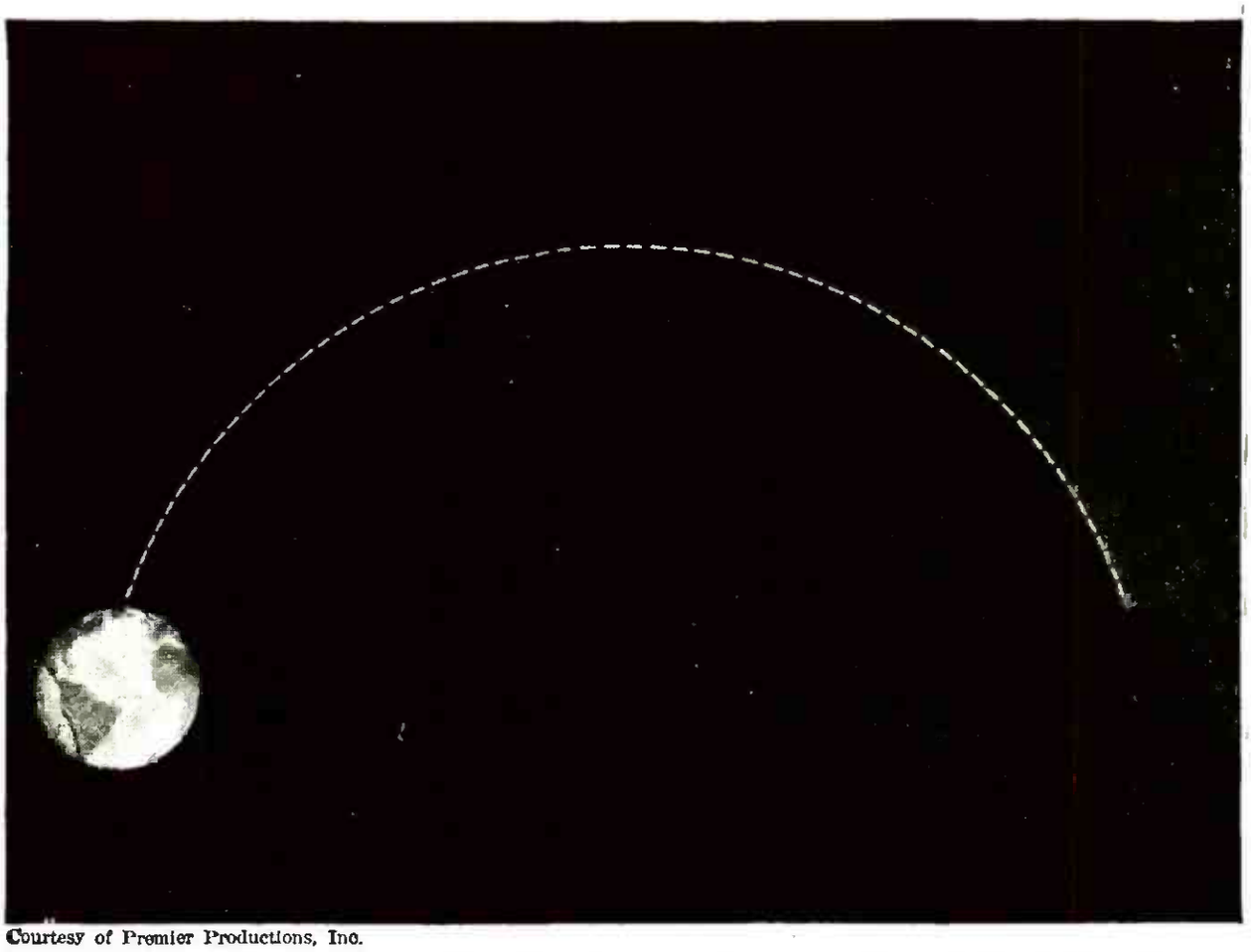
This child would not be able to understand the solar system as we do. He would not know what a round ball was nor what it was like. He could form no picture of the planets. The customary descriptions would be, for him, mere meaningless words.

So when we ordinary people approach the Einstein theory we are in exactly the mental situation of this cubist child. We have never seen the things that Einstein talks about or anything like them. So far as we know we can never see them. It is utterly impossible for us to make any kind of a picture of them; either a picture on paper or a model or an image in our mind's eye. **The theory cannot be visualized at all.**

Does this mean, then, that the understanding of the theory is impossible?

Not a bit of it. It means merely that we cannot understand it by trying to make pictures of it. But this way of understanding things, while the most common way, and for most people the easiest way, is not the only way. You have, for instance, a fairly good idea of honesty. You know it when you encounter it. You understand it at least as well, probably, as you understand the solar system. Yet you cannot make a picture of honesty. You cannot visualize it. It is quite possible, you perceive, to understand something which is not picturable.

And so the first thing that I ask you to do, before we even begin to talk about the Einstein theory is to give up trying to picture it. Simply try to *understand* it through the medium of words, just as



Courtesy of Premier Productions, Inc.

—and How the Same Thing Looks to a Person Located off in Space

But to an observer on another planet, the projectile's path appears to be curved; the missile returns to the earth, which in itself has traveled.

you would understand honesty or any other non-picturable idea.

I shall try to explain the theory in the English language. By expressing the ideas of the theory in mathematical symbols (which are, of course, no more than a special sort of language) the expert mathematicians use and work over and modify these ideas with a precision far greater than we can attain in ordinary words. You must bear this in mind; if you want to know *all* about the theory you must study it in its native language of mathematics. So in this description of the theory, I want you to remember:

First, that you are not to try to make mental pictures of it;

Second, that the proper language for all this is the symbols of mathematics.

The first form of the Einstein theory, published in 1905, was an attempt to explain an experiment which has since become famous as the Michelson-Morley experiment. This experiment was devised to detect the motion of the earth relative to the ether. The ether, you remember, was supposed to fill all space, even the space inside masses of matter. It was supposed that the earth passes through it and that it passes through the earth. This last is not so difficult a thing as one might think, for we know that matter is composed of very tiny particles which are relatively quite far apart. Matter has plenty of holes in it, although very small ones, and the ether was thought of as blowing freely through these holes.

A great wind of ether, men thought there was, blowing through all terrestrial matter as the earth swept along in its path around the sun. Michelson and Morley set out to measure this wind.

The ether is, of course, the medium

which carries light. Michelson and Morley set up two mirrors on a great slab of stone and arranged to measure with great accuracy the time required for light to pass back and forth between the two mirrors. This time would be a little different, they thought, when the light was passing parallel to the wind of ether than when it was passing across the wind. The stone slab which held the mirrors was movable. It could be turned so that the mirrors stood first from east to west and then from north to south. Michelson and Morley expected to find that light would pass a little faster in one of the two directions, just as the sound of a shout will travel faster with a gale than across it.

But they did *not* find this difference.

Very surprisingly, the time of passage of light between the two mirrors was always exactly the same, no matter in what direction the stone slab was turned.

This result puzzled the physicists greatly, and many people began to doubt the real existence of the wind of ether which everybody had previously assumed. That is, they began to doubt if space really was full of this something called ether through which the earth was supposed to be sweeping along.

Einstein began to doubt it in a rather special way. He began to doubt the reality of space itself!

The reason for doubting this I can express in no better way than by quoting the great French physicist, Poincaré. He writes:

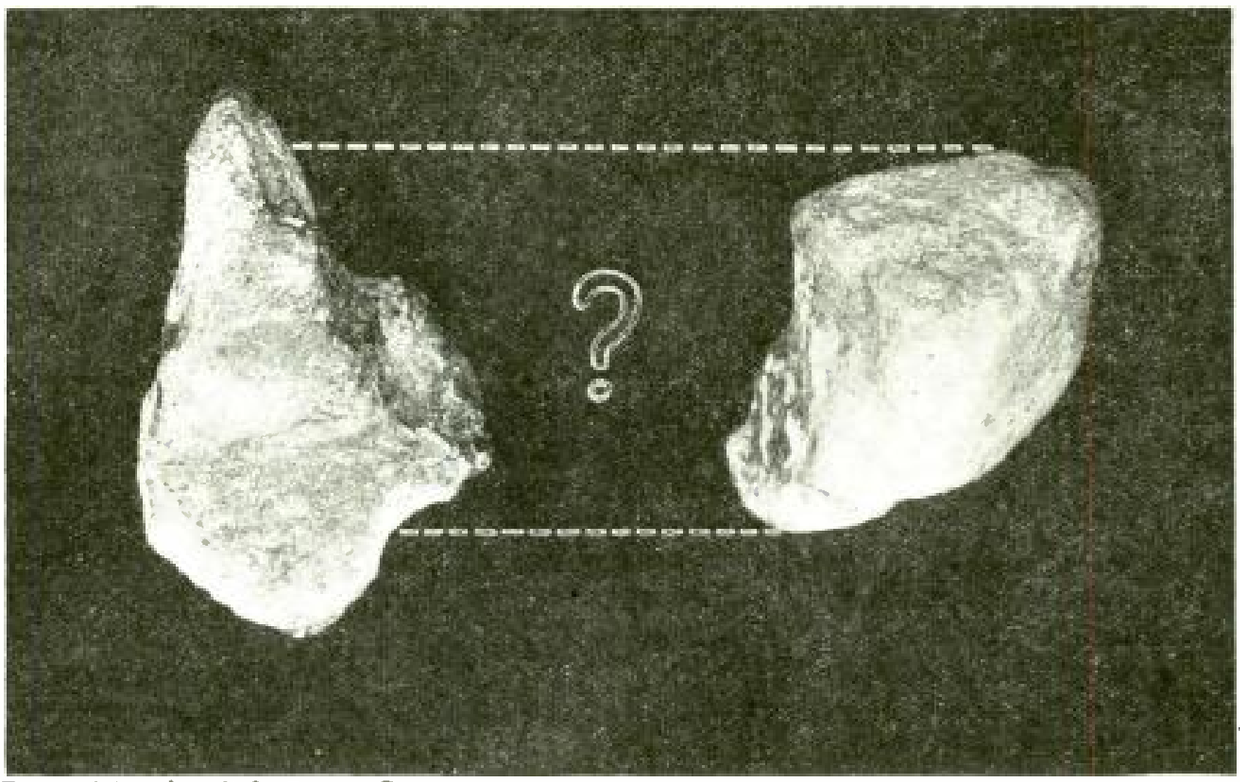
> I am at a particular spot in Paris—the Place de Panthéon, let us suppose—and I say, "I will come back here tomorrow." If anyone asks me whether I mean I will return to the same point in space. I am tempted to reply "yes." But I should be wrong, because between this moment and tomorrow the earth will have traveled, taking the Place de Panthéon with it, so that tomorrow the earth will be more than two million kilometers away from where it is now. And it would be useless attempting to use precise language, because these two million kilometers are part of the earth's journey around the sun, but the sun itself has moved in relation to the Milky Way, and the Milky Way, in turn, is doubtless moving with a speed which we cannot learn. Thus we are entirely ignorant, and always will be ignorant, as to how far the Place de Panthéon shifts in position in space in a single day. What I really meant to say was: "Tomorrow I shall again see the dome and façade of the Panthéon." If there were no Panthéon, there would be no meaning in my words, and space would disappear."

And this, says Einstein, is exactly what space does do. It disappears. Motion, displacement in space, has no meaning unless it be displacement relative to something else. A train cannot merely move ten miles. It moves ten miles *relative to the earth's surface,* or relative to some other predetermined point. All motion, says Einstein, is relative. That is why they call his theory the theory of "relativity."

Einstein began, you remember, with this doubt of the correctness of our notions of space, a doubt induced by the failure of the Michelson-Morley experiment to find evidence of the supposed wind of ether blowing through the matter of the earth. His next step was to see whether he could find anything to substitute for the idea of space, some other fundamental standpoint from which to build up a picture, or, as he said, a mathematical description, of the universe.

He tried the velocity of light. Michelson and Morley had found, you remember, that the velocity of light between their two mirrors was always the same regardless of the direction in which these mirrors stood. Other experimenters had tried other experiments and everyone had found that the velocity of light in a vacuum, that is when not retarded by matter, was always the same. So Einstein decided to *assume* that this was a general law; the law, namely, that the velocity of light in empty space is always the same, the speed of 186,326 miles a second, which we find experimentally that it has on earth.

Having assumed this and having expressed it in the language of mathematics, Einstein proceeded to deduce from it a set of mathematical expressions for the laws of motion of the planets and for



From a photograph made for POPULAR RADIO

ARE THERE TWO ROCKS HERE, OR ONLY ONE?

If time and space are eliminated, as the Einstein theorists point out as a possibility, only an "undulatory continuum" lies between two objects in space, and the two objects thus become merely a part of a great unit.

various other laws of physics. This gave him his first theory of relativity, the one now usually called the "Special Theory of Relativity." It is the one that was published in 1905.

It is important to realize just what Einstein had done. He had found men with a certain picture of the universe, expressed in the main, in mathematical laws of which Newton's laws of motion were typical. This picture and these laws were based upon an assumption, the assumption that things exist inside a kind of ether-filled box which men call space. Poincaré and a few others had already perceived that this assumption was not valid; that the idea of space was meaningless apart from the idea of matter, of things inside space to mark it off. The Michelson-Morley experiment was also against any such idea.

So Einstein said:

Let us throw this outworn assumption away. Let us dispense altogether with the idea of space and try to build up a new and better picture of the universe, a new and better set of physical laws for it. Let us start from a new assumption, one which we have better reason to believe valid.

The new assumption which he selected was the assumption that the speed of light is the same everywhere.

So far so good, but physicists began at once to ask themselves another question. Why stop here? they said; if the idea of space was mistaken, may not the idea of the constant speed of light be mistaken also? All that we actually know is that the speed of light is constant here on earth. Who can say what it may be somewhere else in the universe?

The Einstein theory of 1905 rested on only one assumption, but even that, the physicists said, was one too many. Could not a way be found to construct a mathematical description of the universe without making any assumptions whatsoever?

Einstein thought that such a way might

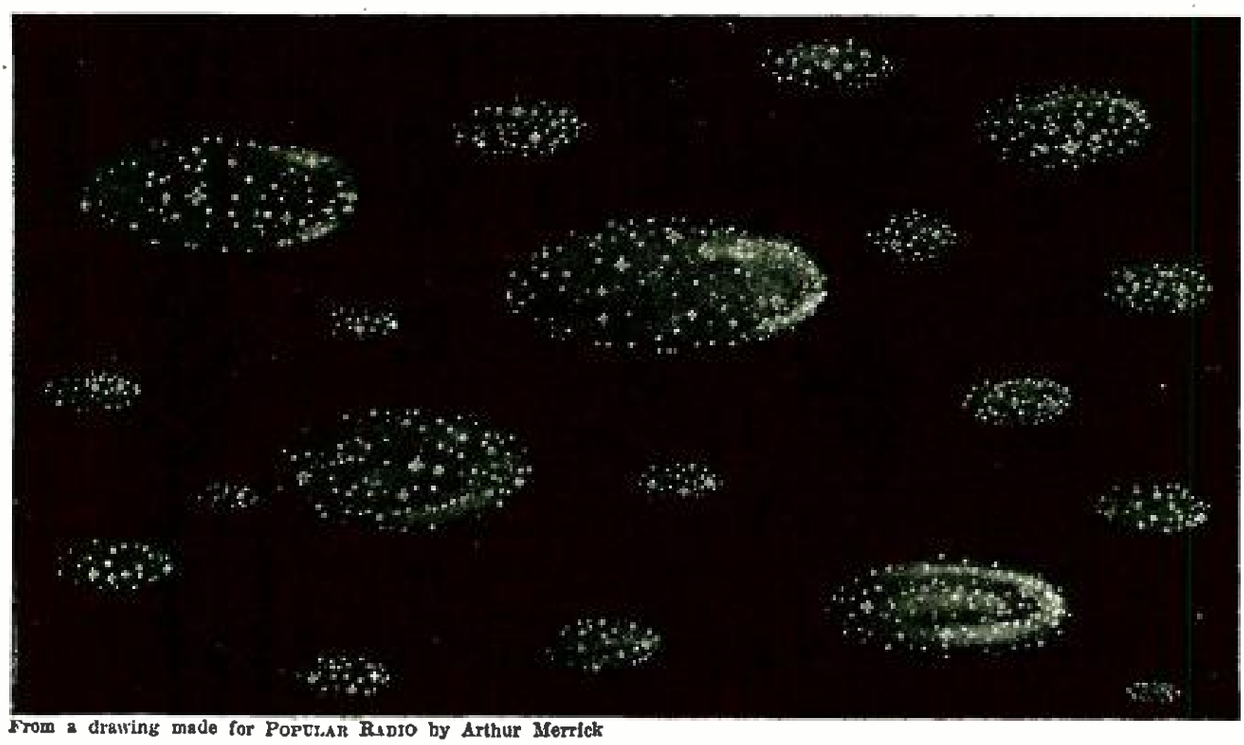
be found and he set himself to the problem. A partial solution appeared in 1911, the final theory in 1915. This is the theory now known as the "General Theory of Relativity."

It is, as I have warned you, purely mathematical. It begins by finding a mathematical expression for motion; an expression which makes use of no assumptions at all, neither the old-time assumption of space nor the assumption of constant light velocity nor any other assumption. From this expression for simple motion, Einstein constructs all over again the mathematical picture of the universe which he destroyed when he showed that the former pictures were based on fragile assumptions.

To the ordinary man, however, the most interesting features of the theory are its consequences. What does it help us to learn about the ultimate nature of things?

The consequences are derived mathematically. If you know the mathematical law of falling bodies you can calculate easily the time required for a stone to fall from the top of the Washington Monument to the ground. Similarly, if you know mathematical laws of the universe, worked out by Einstein and if you can handle the mathematics involved, you can deduce various things which must happen if the theory is true.

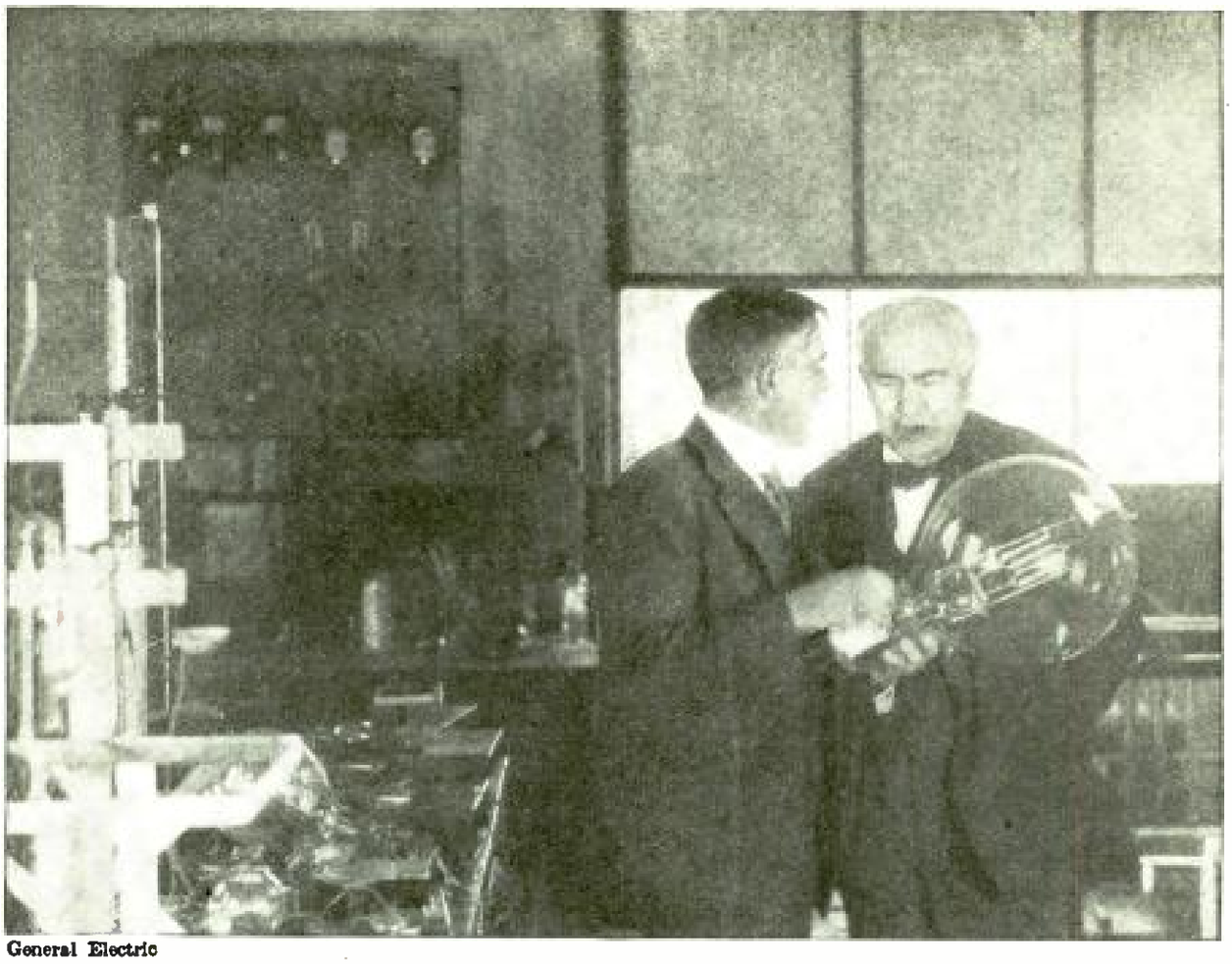
One of these deductions is the thing which first called public attention to the theory. It is the slight shift in the apparent position of stars during a solar eclipse. A ray of light coming from a star and passing very near to the sun does not pass by it, the Einstein theory says, in a perfectly straight line. Instead the light is bent a little so that the star will seem to be moved a trifle from its real position in the sky. When the sun is shining this cannot be observed. The sunlight drowns out the star altogether. But during an eclipse the stars near the sun can be seen and their positions can be photographed accurately.



From a drawing made for POPULAR RADIO by Arthur Merrick

IS OUR UNIVERSE BUT ONE OF MANY, EACH FOREVER UNKNOWN TO THE OTHERS?

If the Einstein theory is correct, rays of light may curve around the inside of the universe and return to where they started. Perhaps there are many universes, each forever unknown to the others, because there is no ether or other light-carrier in the space between them.



General Electric

HOW MUCH DOES THE LIGHT OF THIS LAMP WEIGH?

Dr. Irving Langmuir is here seen showing to Thomas A. Edison the largest electric lamp ever made; it uses an electrical power amounting to 30,000 watts. The weight of its brilliance, when calculated by the Einstein Theory, is so small that the lamp would have to burn 8,000,000 years to produce one ounce of light!

This was done at the time of the eclipse of May 29, 1919, and the predicted slight shift of the stars was found. It agreed with the mathematical deductions from the Einstein theory. The matter was tested again during the eclipse of last September but the results require long and complicated calculations and have not yet been announced.

Many other consequences can be deduced mathematically from the theory, but they are mainly of interest to the professional scientist. Greater general interest resides on the relativitist's picture of what lies behind science, in his picture of the inmost nature of things.

Since Dr. Einstein's publication of this final theory in 1915, it has been extended importantly by Dr. H. Weyl in Germany and by Professor A. S. Eddington in England. What I am about to say is based not only on Einstein but on these recent generalizations also.

Philosophers have always insisted that we really have no knowledge whatsoever of the inmost nature of things. We know the universe, the earth and the things around us only through our senses, only by means of what we can see and feel and hear. We exchange ideas with other people but such exchanges are also as dependent on our senses. We can communicate only by speech which we must hear or by written words which we must see.

A man born color blind sees the world in a different way from the rest of us. How do we know, say the philosophers, that all of us are not blind in some other way? It is quite possible, they insist,

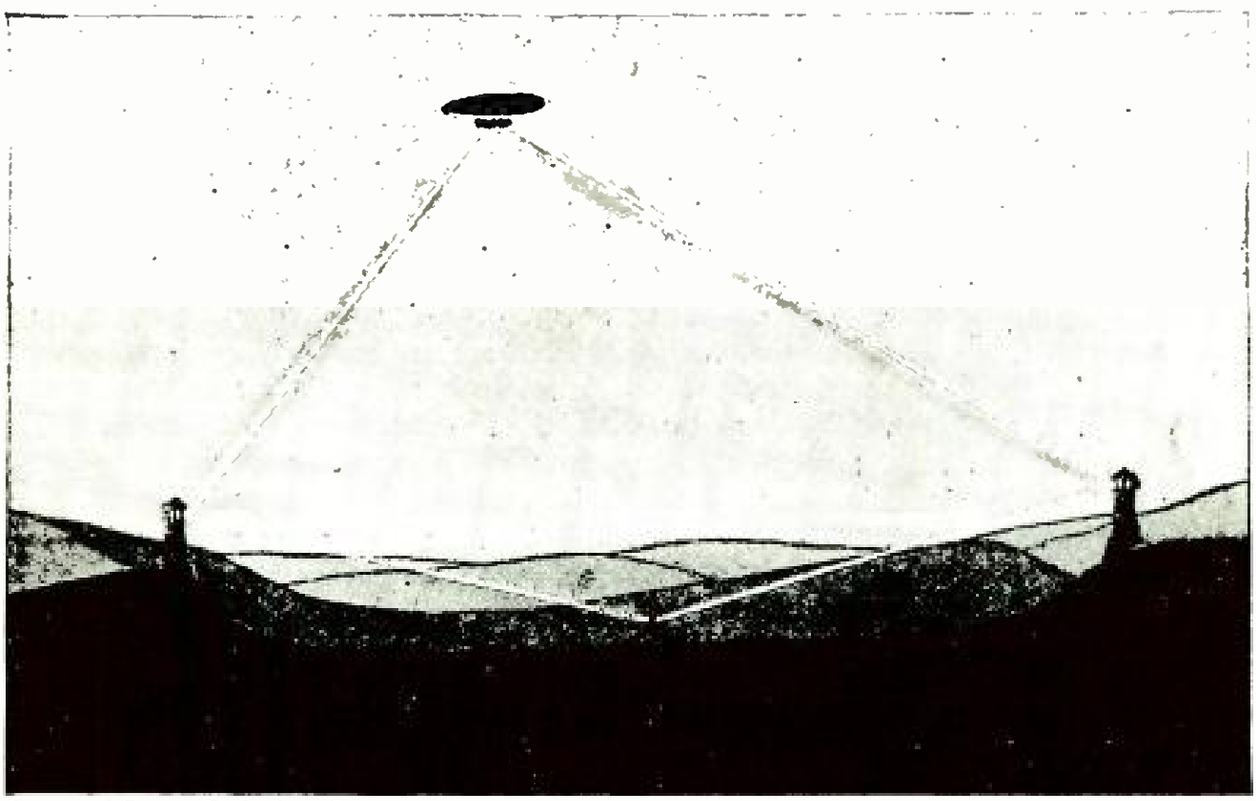
that all human senses are imperfect, that they give us a wrong idea of the real nature of things around us.

According to the theory of relativity this is just what happens. It is possible to deduce from the theory not only such things as the star shift but also certain characteristics of the ultimate nature of things. Such a deduction will be more reliable, the relativitists think, than are our impressions from what our senses tell us. The color-blind man can go through certain scientific tests and can find out thus about the nature of his infirmity. Therefore he knows that things are not really as they seem to him. Just so, say the relativitists; we can find out scientifically that things are not really what they seem to us to be. and we can find out, furthermore, something about what they really are like.

I have said that some deductions about this problem of the nature of things can be made mathematically from the Relativity Theory. The main one of these is the deduction that the real universe has the nature of a four-dimensional something which the relativists call a "continuum," meaning thereby no more than a something which exists everywhere and always; something which is continuous, therefore, both in what we call time and in what we call space.

You will find it easier to do this inferring about the nature of the continuum if you study carefully an illustration devised by Professor Eddington and famous among physicists as the "parable of a penny." I have changed a little the wording of the Professor's exposition.

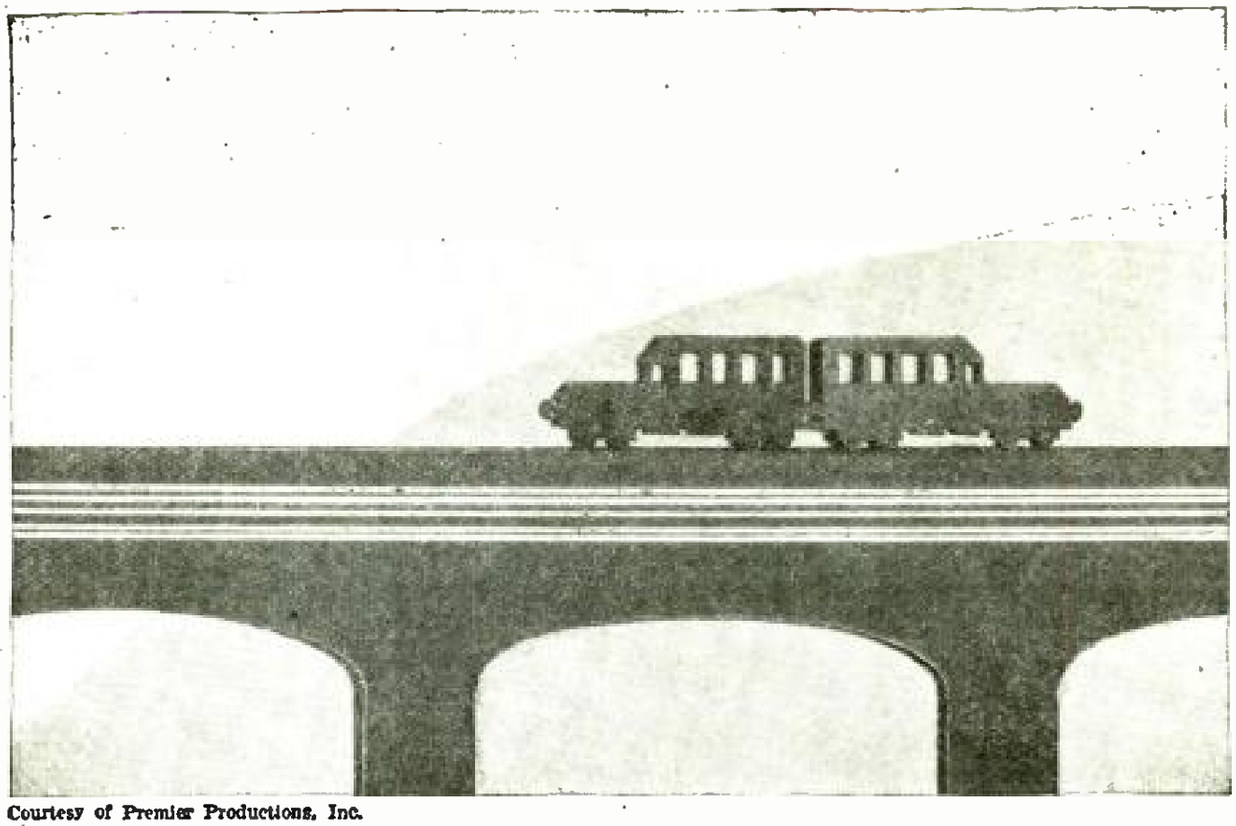
"I hold before me," he says, "a certain object, and see a picture of the head of Lincoln; another observer on the other side sees an ornamental design marked 'one cent'; a third observer to the right sees only a thin copper colored rectangle. Am I to say that the head



Courtesy of Premier Productions, Inc.

WHAT ARE THE INTERVALS BETWEEN FLASHES FROM A LIGHTHOUSE?

It is a fundamental conclusion of the Einstein theory that both time and position are purely relative; consequently this question would be answered differently by a man traveling overhead in an airship than by a man on the earth.



Courtesy of Premier Productions, Inc.

THE FAMOUS "RELATIVITY TRAIN" DEVISED BY DR. EINSTEIN

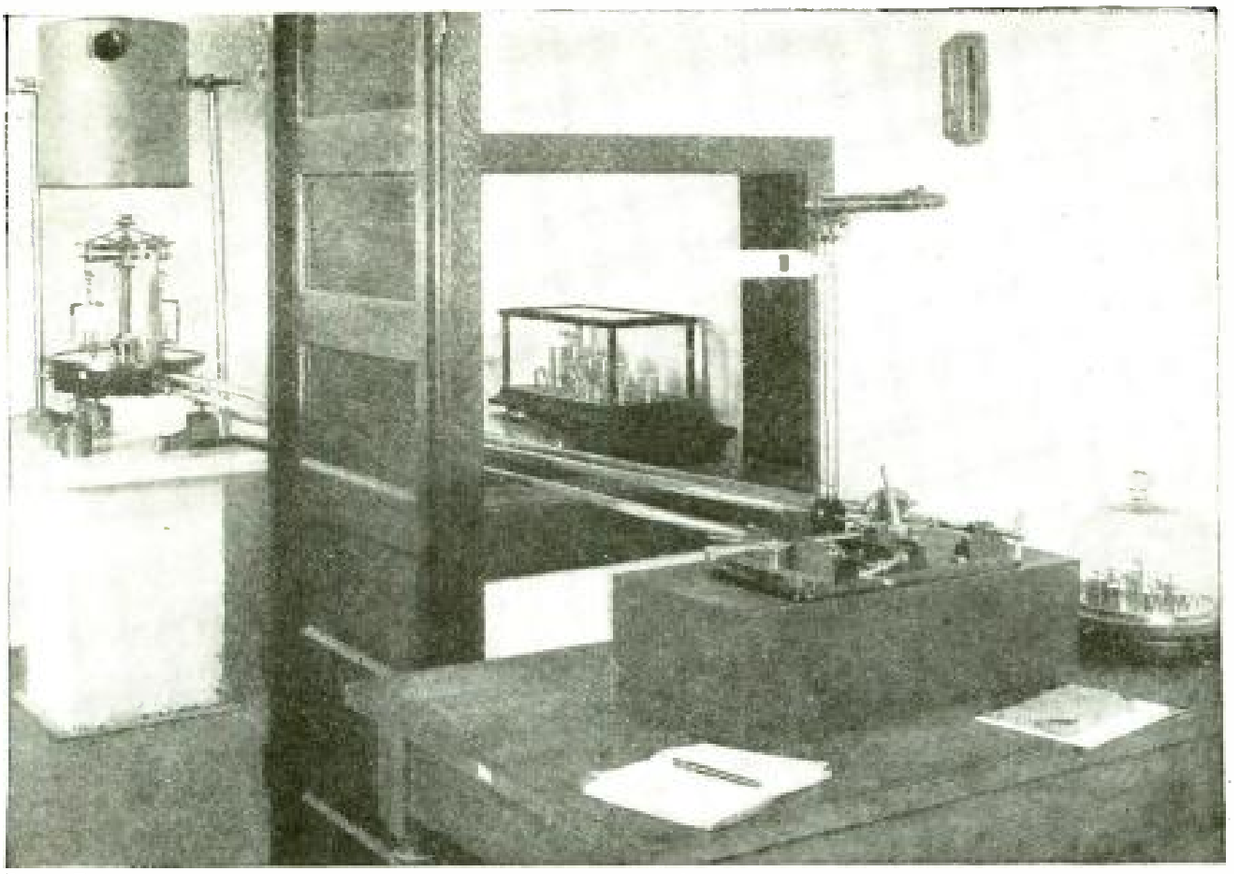
The famous scientist proved that an imaginary train would SEEM *to change in length at various speeds when measured with a beam of light. Even one of our earthly railroad trains would seem shorter if it could move fast enough. At a speed of 100,000 miles a second the train would seem to lose nearly half its length.*

of Lincoln is the real object and that the crude impressions of the other two observers are wrong? Not at all. All three appearances can be accounted for if we are all looking at a three dimension object—a penny—and no reasonable person can doubt that the penny is the corresponding physical reality."

"Similarly," he goes on, "an observer on earth might see and measure something, perhaps a group of stars, and might find it to be an oblong block. An observer on some other star, measuring the same object, might find it to be a cube. Shall we say that one observer is right and the other wrong? Not at all. It is much more reasonable to believe that the thing observed is really a four-dimension something and that both the oblong view of it and the cubical view of it are partial views; are three-dimension aspects of the real thing just as the three separate appearances of the penny were two-dimension aspects of something that had actually three dimensions."

A thorough mental grasp of this illustration will give you an easy key to the whole relativitist view of the universe. Reality is, they say, a four-dimension something which, because of some present limitation of our senses, we are able to perceive only from a series of three-dimension viewpoints. From one of these viewpoints we see things as matter; from another we see things as electricity; from a third we see things as the laws of gravitation. All of these are true, but all are partial, just as were the three separate views of the penny.

Imagine a man with one eye who had never seen a penny or anything like it. Show him the penny; turn it about for him, but do not let him touch it. Having only one eye he will not receive any visual impression of solidity. Everything will look flat. And being forbidden to touch the penny he will not be able to thus correct his impression of its flatness.



Brown Bros.

SOME DAY SOME SUCH MACHINE MAY MEASURE THE WEIGHT OF LIGHT

So delicate is this apparatus in the Bureau of Standards that it must be operated from an adjoining room to avoid the disturbing effects caused by the operator's body. Prof. Eddington of England calculates that the sunlight received each day by the earth weighs about 160 tons.

It will look to him like a changeable flat object, a sort of dissolving view. Only if he is clever or if he has previously seen similar objects which he was allowed to touch, will he be able to infer that the penny is really a solid three-dimension object, his perceptions of which were all one dimension short.

As regards the real nature of things, we are all of us, the relativitists say, in the position of the one-eyed man. Because of some incompleteness of our senses we can observe things only in three dimensions. We see things now from this aspect, now from that one. We never *see* them as they really are. Only slowly are we becoming clever enough to *infer* something about what they really are.

Now what does this mean for the problem which prompted the writing of this article, for the problem of whether or not ether and ether waves are real? Dr. Steinmetz says that there are no ether waves.* Sir Oliver Lodge dissents from this opinion.† What does Einstein say?

On the fifth of May, 1920, Einstein delivered at the University of Leiden a lecture on ether and the theory of relativity. He concluded with the following words, the somewhat free translation being my own:

> Bringing everything together we can say this: According to the General Theory of Relativity space itself is endowed with physical qualities; in this sense, therefore, an ether exists. According to the General Theory, space without ether is unthinkable; for in such a space there could be neither the propagation of light nor the possible exis-

*In POPULAR RADIO for July, 1922.
†In POPULAR RADIO for November, 1922.

tence of measuring rods and of clocks. It would be impossible, therefore, to have separation of things in space-time as these words are understood in physics. The ether must not be thought of, however, as endowed with the characteristic property of a ponderable medium, the property of possessing separate parts, the history of which can be followed through time. The property of being in motion or the property of being at rest are alike unthinkable as applied to the ether.

Does this mean that there is an ether or that there is none?

To me it means that the ether exists but that it has properties very different from those ascribed to the old-fashioned space-filling thing which Michelson and Morley tried to detect by their famous experiment.

In Einstein's view the "ether" and the four-dimensional "continuum" come, I think, to mean practically the same thing. This ether-continuum is the substratum of reality. It is the inmost nature of things. By very definition it is not perceivable by our senses or picturable by our mind. We can perceive only its various three-dimension aspects, only the several flat views of the penny. One of these aspects is space, another one is electromagnetic waves, another one is gravitation.

It is not that space is filled with ether; space *is* ether. Space is merely one aspect of the continuum and the continuum is the ether.

We must not say that there are ether waves or that there are not. The truth is that the things we call waves are merely one aspect of the continuum. They *are* ether. They are merely one view of the four-dimension etherial penny.

It is futile to deny that these ideas are difficult to grasp or that they fail of being fully satisfactory to the mind. On this view the ether-continuum appears to be something which must ever remain unknowable to us except by means of dry and lifeless mathematical abstractions. The mind revolts at thus abandoning the problem.

But is it really necessary to abandon it? Is there no hope of being able, some day, to know something directly about the ether-continuum, as though our color-blind man were to recover somehow his power of seeing hues? May we regard the ether problem as fit material for scientific study or must we give it up?

Let Sir Oliver Lodge answer these questions. He wrote in 1921:

Whether the properties of the ether can ever be formulated in terms of the same sort of dynamics as we have found so fruitful and effective in dealing with matter is at present an open question. Quite possibly a different dynamics may be needed, one perhaps of which we have as yet no conception; but let us not shut the door on discovery, assume that nothing of the sort can ever be arrived at, and think that pure mathematical abstractions, glorified and complicated sufficiently, can be an ultimate embodiment of physical laws or can adequately express the facts of Nature. . . .

We cannot be forever satisfied with a blindfold mathematical method of arriving at results. We can utilize the clues so given, and admire the ingenuity which has provided them. But that is not the end; it is only the beginning. The explanation is still to seek, and when we really know the properties of the ether we shall perceive why it is that things happen as they do.

How to Use Your Radio Set on Your Vacation Trip

In a near issue of POPULAR RADIO *one of the most experienced radio experts in the country will tell, in specific terms, how to set up your receiving set on your motor car, on your pleasure boat and in your camp—and how to avoid the difficulties that will confront the inexperienced fan who is not forewarned and forearmed against them.*

"Interference" *from* Receivers

How to Use Regeneration without Radiation

Many of us know that the howls that sometimes disturb our radio programs are caused by one of our neighbors whose regenerative set is acting like a miniature transmitter when he tunes and passes the wavelength on which we are listening. We hear his radiated energy interfering with our own reception. How to spare your neighbors this nuisance by adding one stage of radio frequency amplification to your set is told in this article by—

JOHN V. L. HOGAN

THE ordinary audion is so much more effective when used with a well-designed feed-back circuit than in a non-regenerative outfit that there are comparatively few grid-tube sets used in the latter fashion.

Regeneration has two points of especial utility:

First, it neutralizes a large part of the wasteful resistance in the ordinary aerial and in the receiver circuits (thus giving louder signals and better selectivity).

Second, it provides a convenient means for receiving continuous wave telegraphy or for picking up telephone carrier waves by employing the self-heterodyne method.

The first of these advantages is perhaps the more useful, especially when it is necessary to use rather poor aerials for receiving.

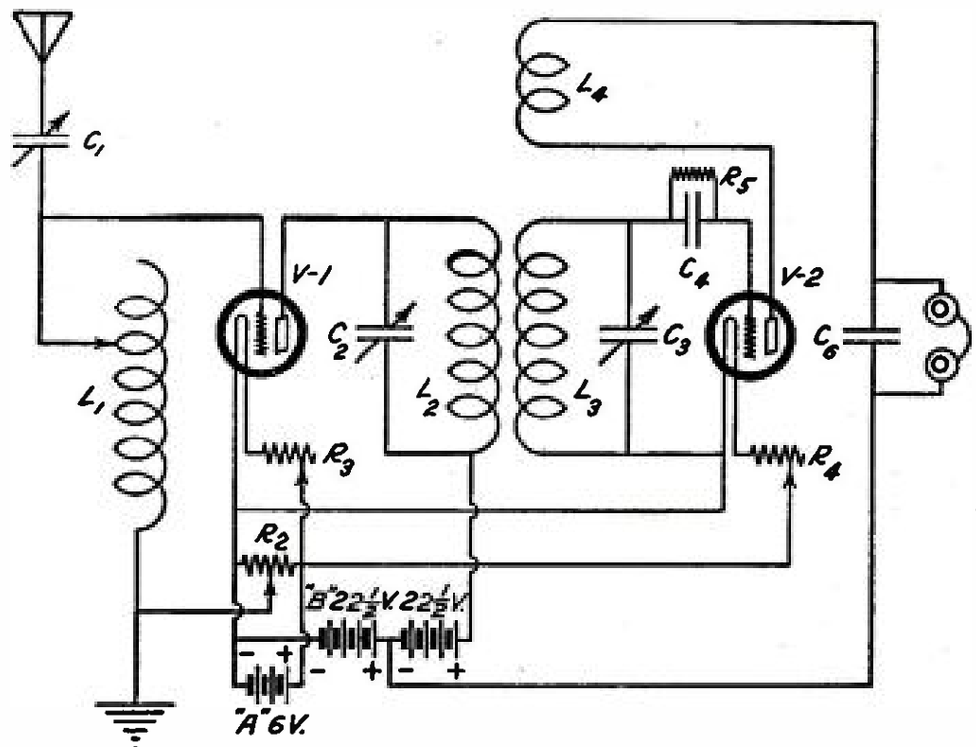
The second point represents a possibility that is of tremendous help to the individual user of a regenerator, but as it requires the set to be placed in the oscillating state, it may create a good deal of interference to reception by other listeners within a zone of several square miles.

This matter of interference caused by oscillating regenerators seems to be by no means as serious as it was some months ago. When radio novices were setting up feed-back circuits of all conceivable types and, in the absence of competent instruction, were allowing them to oscillate continuously and slightly off-tune from the broadcasting wave-

lengths, it was nearly impossible to receive a complete radiophone program. Of course these unskilled users themselves heard nothing but whistles, louder than the interfering tones they produced in their neighbors' outfits; largely as a result of this many of them have learned to use their receivers properly without allowing them to oscillate. Self interest has thus brought about a great public benefit.

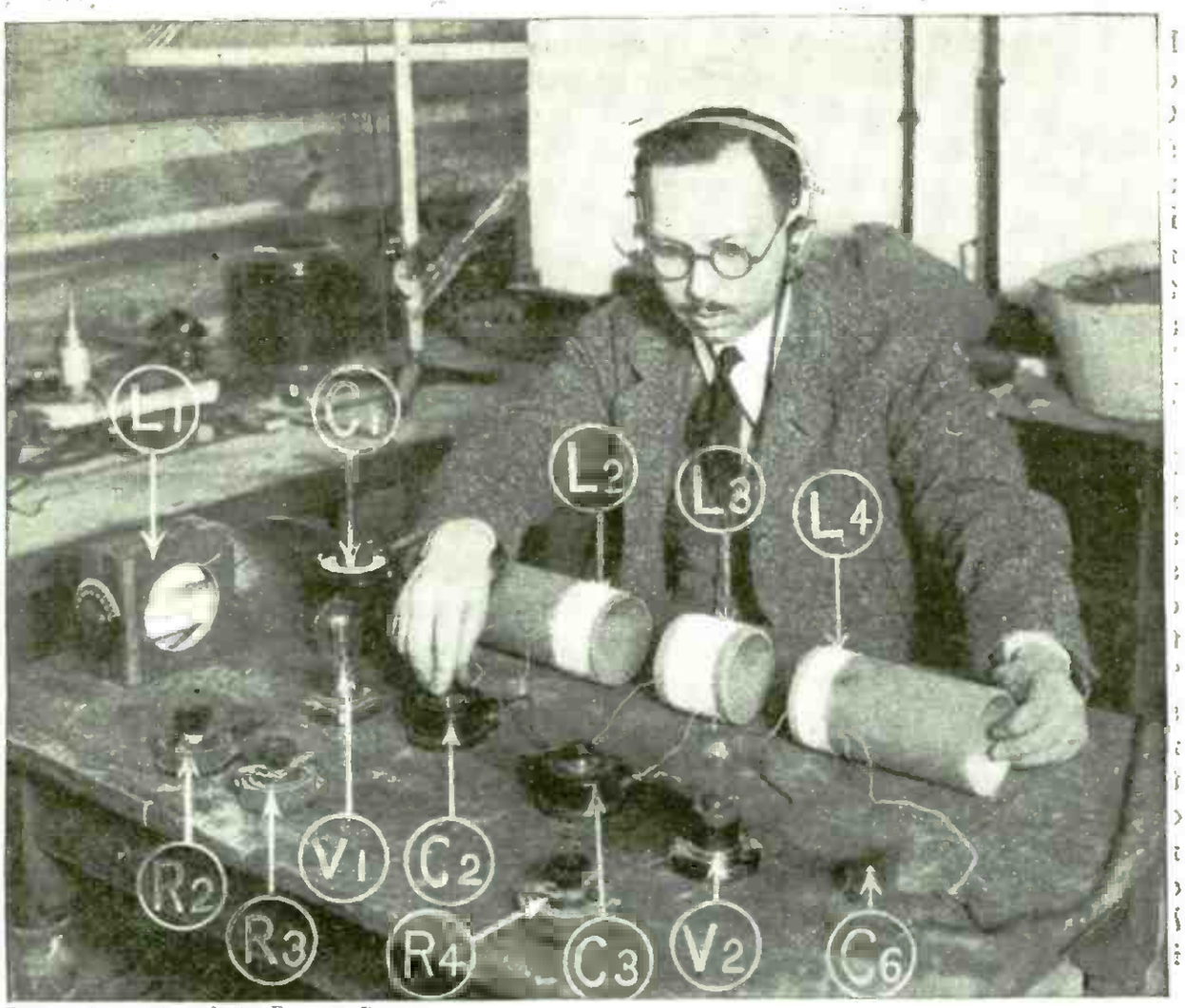
The ideal condition in which there will be no interference from regenerators has not yet been reached, however. Occasionally while listening to a broadcasting station one hears the swinging beat note or whistle which proves that someone in the vicinity is tuning his receiver by the "heterodyne search" plan. In the suburbs of New York such interference nowadays is often only momentary, but there is no need even for that. It is entirely feasible to pick up long distance radiophone signals by tuning one's receiver with the feedback set somewhat *below* the oscillating point, and if this is done it will cause no inconvenience to other listeners. Some otherwise good regenerators are so designed, however, that it is practically impossible to tune over even a rather small band of wavelengths without either readjusting the amount of feed-back or losing the benefits of regeneration. This is especially true of many of the plate-variometer outfits, in which helpful amplification can be had (for a single setting of the plate circuit inductor) only over a small wavelength range. Tuning beyond such limits results either in negligible regenerative amplification or in the production of oscillations that may greatly disturb nearby receivers.

There are several ways in which one may get most of the useful features of regeneration without causing the radiation of interfering waves from his receiving aerial. With these arrangements it is feasible to pick-up signals from distant stations by the heterodyne or beat-note method, and to increase signal intensity by regenerative amplification resulting, in part, from neutralization of circuit resistance. As they



A SIMPLE CIRCUIT THAT INCLUDES A REPEATER TUBE

FIGURE 1—*A circuit with one stage of tuned radio frequency amplification with regenerative detector. This is the "hook-up" of the set pictured on the page following.*



From a photograph made for POPULAR RADIO

THE AUTHOR ILLUSTRATES THE "HETERODYNE-SEARCH" PLAN OF TUNING

Mr. John V. L. Hogan is seen adjusting the wavelength of the plate circuit of the amplifier tube with his right hand, while controlling the regeneration in the detector circuit with his left hand. The "heterodyne-search" plan of tuning may be used with this set, without causing interference to other sets in the neighborhood.

depend, however, upon the use of a radio-frequency repeater between the antenna and the feed-back circuits they will not permit great reduction of aerial resistance; it is consequently desirable to use these circuits with an antenna which is itself of sufficiently good design to be an effective wave-absorbing system.

A simple circuit that includes such a repeater tube is shown in Figure 1. Here the antenna is connected to the ground through a tuning condenser of about 0.0005 microfarad maximum capacitance and an inductor of some 50 or 100 microhenries. Across this coil is connected the input circuit of the repeater tube, as shown; the grid potential can be controlled, from 0 to 6 volts positive of the negative filament lead, by means of the potentiometer. The output circuit of the repeater tube contains the tuned primary of a short-wave inductive coupler; the balance of the circuit is the conventional transformer feed-back or "tickler" arrangement. In making the installation the only point that requires special care is the choice of the proper constants for the coils and condensers that will enable the circuits to tune to the wavelengths it is desired to receive.

The operation of this circuit is a little more difficult than that of the ordinary single-circuit regenerator.

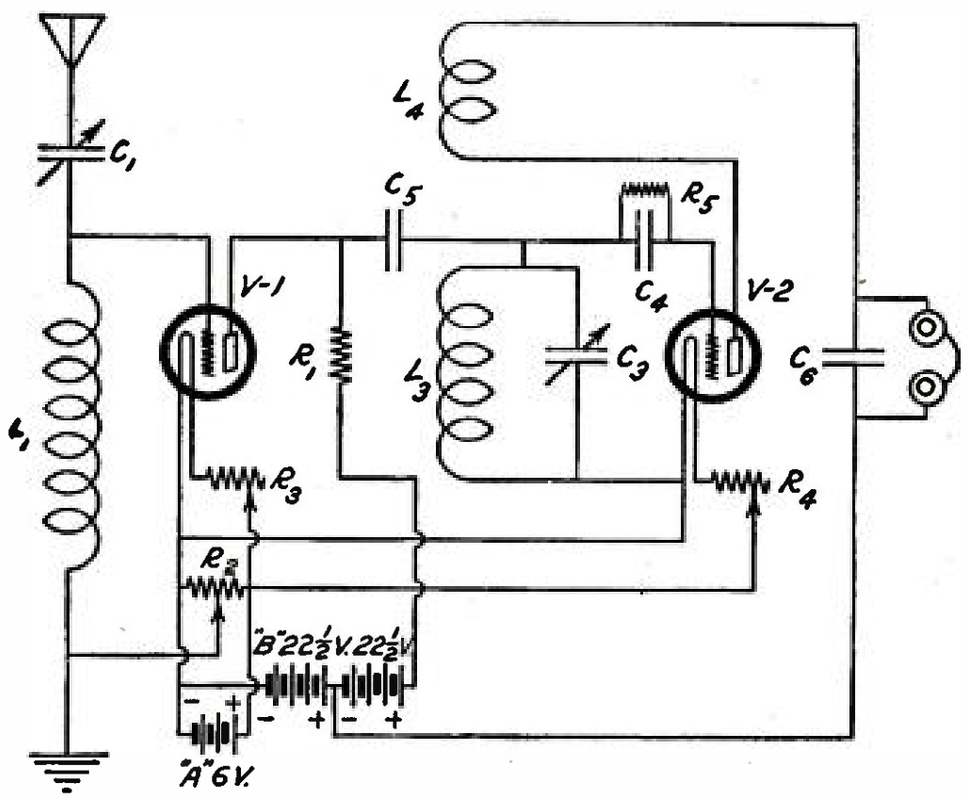
In the first place, there are two sets of circuits that can oscillate independently. The whole idea is to prevent the first tube (repeater) and the aerial from generating oscillations, and to confine this action to the second tube and its circuits.

In the second place, there are three tuned circuits (C_1-L_1; C_2-L_2; and C_3-L_3) and two couplings (L_2-L_3 and L_3-L_4) to adjust. But once the proper constants are chosen and the outfit is correctly set for reception of some particular wavelength, it will not be found difficult to tune to others.

Probably the best way to start using this receiver is to connect it up as shown, then to light only the detector tube, to set coil L_2 as far as possible from L_3 and to couple the aerial coil L_1 to secondary L_3. This makes the set a simple two-circuit regenerator with inductive feedback, and it may be tuned to a nearby broadcasting station in the ordinary way. Thus one can find fairly closely the best values for C_1, L_1, C_3, L_3 and L_4. Of course the final tuning should be done with quite weak coupling between L_1 and L_3, so that the inductance of each coil will not be too greatly influenced by the reaction of the other. There remains only the determination of proper values for L_2 and C_2, and the co-ordination of the adjustments throughout the set.

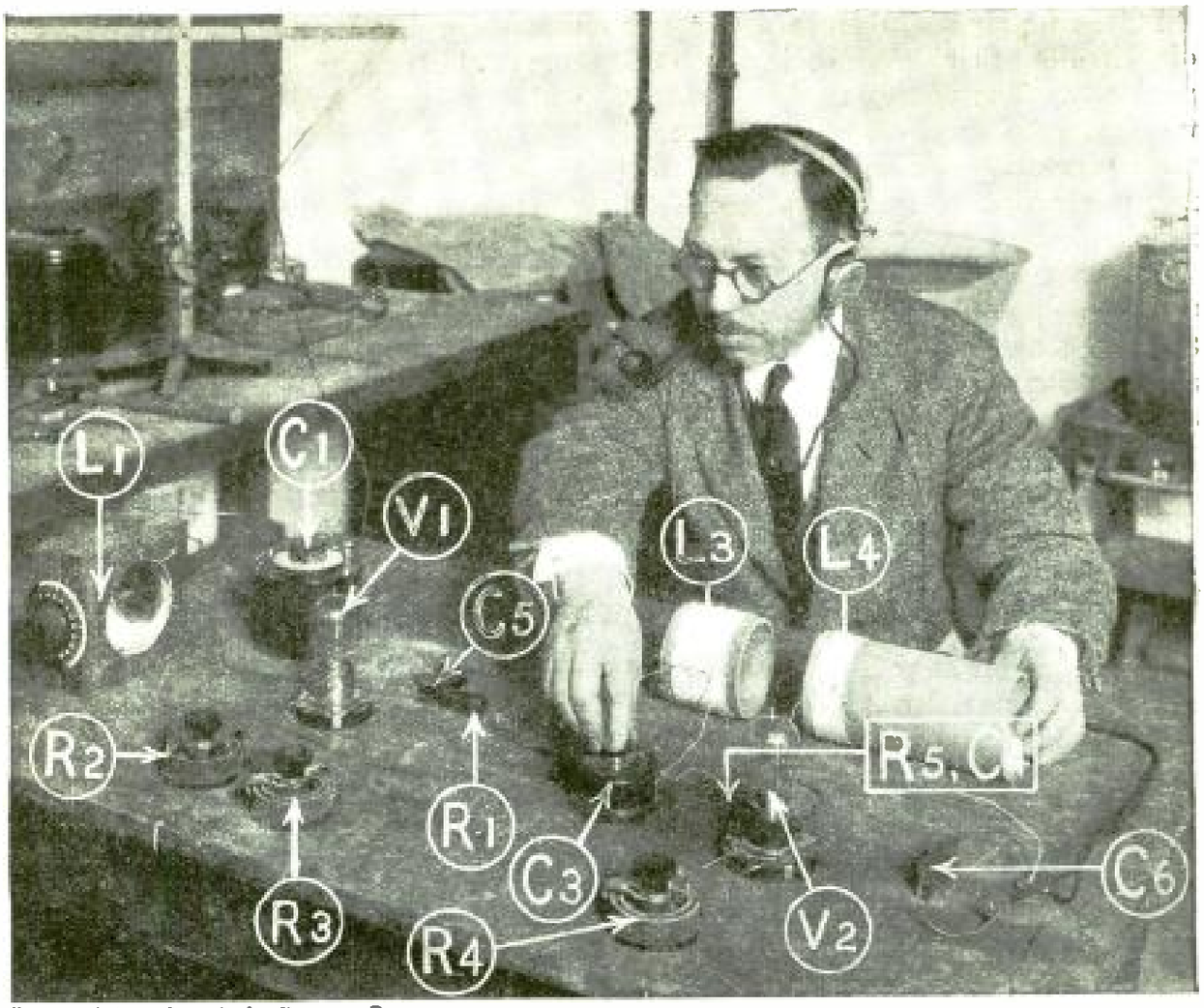
This will not be difficult if the operator now removes coil L_1 from the vicinity of L_3 and couples L_2 and L_3 with moderate tightness—of course, turning on the filament of the repeater tube also. If the potentiometer contact is too near the *negative* end the repeater tube will be likely to oscillate as he adjusts C_2 and L_2, so it is well to turn it well over toward the positive end of the potentiometer winding while he is making his first adjustments.

There is no reason why he should not use identical coils for L_2 and L_3 and the same kind of variable condensers for C_2 and C_3. If he does this, he may



A REPEATER TUBE SET THAT IS EASY TO TUNE

FIGURE 2—*This is a diagram of the set illustrated on the following page. It shows one stage of resistance-coupled radio frequency amplification, with a tuned regenerative detector circuit. This circuit will be found to be easier to tune than the circuit shown in Figure 1.*



From a photograph made for POPULAR RADIO

TUNING THE RESISTANCE-COUPLED SET

The designations of the parts, shown in circles on the photograph, correspond with the designating letters in the text and diagrams. If you want to try out these circuits, you will be able to identify the right parts, and hook them up properly. Mr. Hogan not only explains how to tune these circuits but he gives explicit directions for adjusting each instrument.

set C_2 and L_2 to the same values that have just been determined to the best for C_3 and L_3. Then the whole set can be tuned, simply by making comparatively small changes in the settings of the three condensers.

Once working, the antenna circuit may be left tuned to approximate resonance with the desired wave and the potentiometer set at a point well toward the positive end (so that the aerial cricuit will not oscillate) and then forgotten, until the operator wants to make a substantial change in wavelength. For smaller variations the condensers C_2 and C_3 are handled just like the primary and secondary condensers of an ordinary two-circuit tuner, and the couplings L_2-L_3 and L_3-L_4 are handled like the primary-secondary and secondary-tickler couplings of such an outfit used with regeneration. He can throw these circuits into oscillation by moving L_4 nearer L_3, in order to pick-up carrier waves by means of the beat-tone method, and he can thus get regenerative amplification and selectivity in these circuits. Yet the repeater tube will prevent the oscillations from feeding into the aerial circuit and radiating interfering waves.

The first tube is referred to as a radio frequency repeater rather than an amplifier because little amplification will be had at broadcasting wavelengths if

the potentiometer contact is kept far enough toward the positive end to prevent the aerial system and the first tube from regenerating and thus tending to oscillate. By decreasing the positive potential thus applied to the grid the operator can take further advantage of regenerative amplification in this first tube and get considerably louder signals, but if he goes far in this direction he will be back where he started, for the repeater tube will begin oscillating if the coupling L_2-L_3 is slightly reduced and the oscillations will be radiated as interfering waves.

Proper operation of this outfit requires the first tube to remain in the non-oscillating condition regardless of changes in the circuits; the regeneration supplied in the detector tube circuits is used for selectivity, amplification and heterodyne pick-up.

The constants for the instruments used in such receivers have been stated many times, but for the sake of completeness it may be well to repeat. There will be some deviation from normal, in a good many cases, to get best results; but a typical set of values of general utility is the following:

Condensers C_1, C_2 and C_3 of 0.0005 microfarad maximum capacity, preferably fitted with verniers; coils L_1, L_2, L_3 and L_4 each 50 turns of No. 22 B & S double-cotton-covered magnet wire wound on paper or bakelite tubes of 3½ inch diameter, with taps at 20, 30, 40 and 45 turns; potentiometer 200 ohms; filament rheostats 6 ohms; grid leak 2 megohms; grid condenser 0.00025 microfarad; by-pass condenser 0.005 microfarad; tubes UV-201 or VT-1; filament battery 6 volts (storage); plate battery two or three 22½ volt blocks. A good antenna would be a single wire from 100 to 150 feet long (including down-lead) with the horizontal portion some 40 feet or more above the earth. All of these values are stated for use on amateur and broadcasting wavelengths.

A little additional ease of adjustment may be had, at the cost of some selectivity, by using the circuit of Figure 2. The elements are the same as before, except that C_2 and L_2 are omitted and R_1 and C_5 added. R_1 is a coupling resistor of about 50,000 ohms and C_5 a fixed condenser having about 0.0005 microfarad capacitance. With this arrangement the only important variables, once the set is adjusted to approximately the best condition, are C_1, C_3 and the coupling between L_3 and L_4.

It will be found that with the Figure 2 circuit there is much less tendency for the repeater tube to produce oscillations in the aerial circuit; and that the potentiometer contact can be moved much nearer its negative terminal. Further, the tuning is considerably simpler than that of Figure 1. It will be noted that the plate circuit potential of the repeater should be increased to about 60 volts in order to offset in part the effect of the resistance unit R.

Either of these two circuits is capable of sharper tuning than the ordinary single-circuit regenerator and, on a good aerial, will give excellent results. With reasonable care in adjustment the user can do all the searching for long-distance stations he may desire, taking the full advantage of the beat-note for locating weak signals, and yet be secure in the knowledge that he is not interfering with his neighbors.

AN AMATEUR WHO BECAME AN EXPERT

Fifteen years ago Mr. Donle was a typical radio fan in Providence, Rhode Island. His interest in experimental work in both ionization and in pure electron vacuum tubes led to numerous inventions; he is now chief engineer of the Connecticut Telephone and Electric Company, in charge of its radio research activities; the "Donle tube" is his latest contribution to science.

The Most Sensitive Tube IN THE WORLD

A remarkable device that operates with a plate of liquid sodium instead of solid nickel and that picks up signals on a stream of ions instead of electrons; described by its inventor—

HAROLD P. DONLE

A NUMBER of years ago we completed a survey of the field of radio receiving. The purpose of this study was to determine the relative opportunities for improvement in the several subdivisions of receiving apparatus. The conclusion reached was that a great margin for advance existed in the process of detection. The phenomena of rectification were not completely understood apparently, and the efficiency of conversion shown by even the best detectors seemed to be quite small.

Since that time a substantial portion of our research and development work has been directed toward improving detector operation.

Having found a number of inherent limitations in the grid type detector tube, and realizing the dangers of interference-

production by oscillating regenerators, we set as our goal the development of a new detecting structure that would have so great efficiency that regeneration would be unnecessary. This was a large problem, and its solution has required a great deal of time and effort; even a summary of all the work done would make a long story.

In the course of this development we have produced several distinct types of detectors. Many of these had decidedly interesting (and, indeed, valuable) characteristics but in some cases the device possessed some weak feature that tended to neutralize its good qualities. As may be imagined, the research work has been extensive. Thousands of operative tubes have been built and studied; to analyze the performance of each has required a complete set of operational characteristics for every tube; even the labor of taking tens of thousands of observations for these curves was no light task. Our latest development, the intensifier tube, which was recently described before the Institute of Radio Engineers, incorporates many of the features worked out during the research just outlined.

In this very tube we have a non-amplifying vacuum tube detector of remarkable sensitiveness and stability. When using this tube in a properly designed two-circuit receiver, we invariably reproduce radio signals more strongly and more clearly than we can produce with a standard regenerator with a grid-tube. The high sensitiveness secured is largely due to the arrangement of electrodes used, in conjunction with ionization of an alkali metal such as sodium.

The new electrode arrangement that is utilized is not in itself sufficient to account for all the results; the structure works inefficiently in the absence of ionization, for ions are responsible for the accumulated charge on the "collector" electrode. Responses to signals are obtained in this tube by a breaking up of this charge when radio frequency impulses are impressed on the detector; the result is a relatively great change in the steady value of the current in the collector-filament circuit.

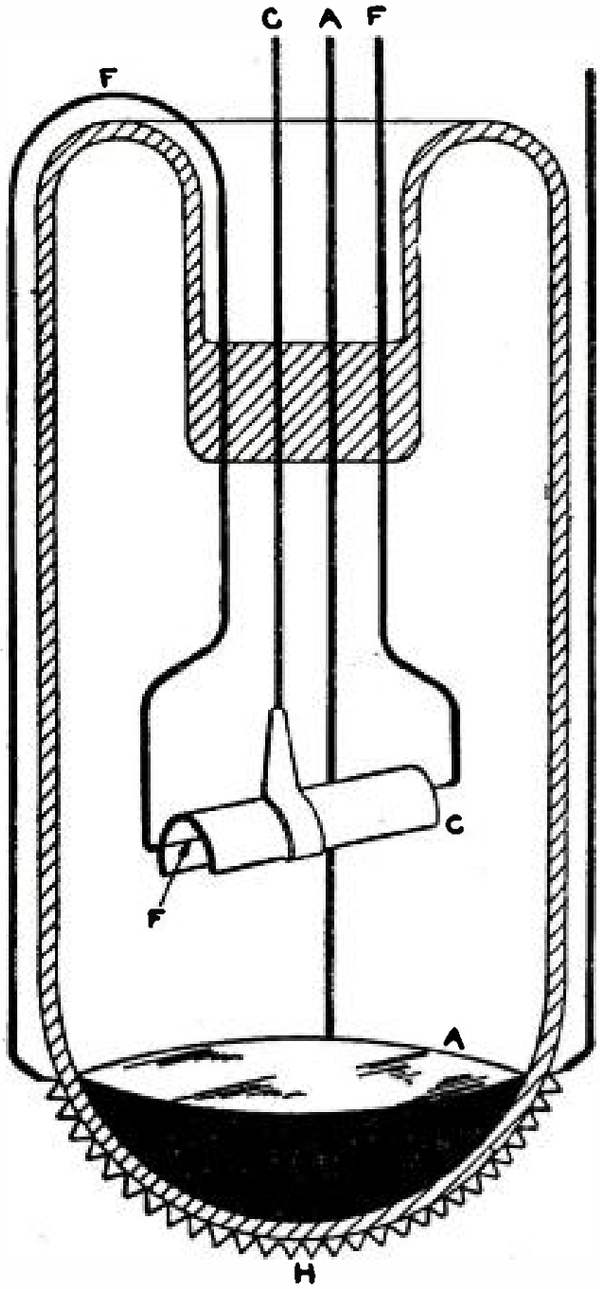
When a regenerator is adjusted for maximum sensitiveness, just short of self-oscillation, the circuits have a low effective resistance which results in a "tailing out" of speech or music and prevents clean-cut reproduction. This effect cannot be had with the intensifier, for its circuit and mode of operation are non-regenerative. Similarly, the intensifier cannot produce interference with reception by others; it is not capable of adjustment so as to radiate energy at the working wavelengths. This helpful characteristic, which allows the user to tune at will without fear of disturbing other people, caused Dr. Chaffee to christen the device "The Golden-Rule Tube."

Figure 1 shows a conventionalized cross-section of this new tube. A glass bulb contains the straight filament F, the collector electrode C (which is a trough-shaped piece of sheet metal supported above the filament) and the main anode A at the bottom of the tube. This anode is, in this particular form of tube, a button of metallic sodium. Connections to the electrodes are provided by way of the three wires that are shown; the second filament lead is brought out through an external heating coil H mounted outside of the tube proper.

The filament current passing through this heater serves to maintain the sodium anode at the correct operating temperature. The four terminals are brought out to the prongs of a standard detector base.

A useful circuit for taking advantage of the intensifier's characteristics is shown in Figure 2. The left-hand portion of the diagram is simply a form of the well-known two-circuit tuner. The detector connection is somewhat unusual, however. Current for heating the filament and the anode is drawn from a 6-volt storage battery, in the tubes now available, and is controlled by a rheostat R. The average current value is

about 1.6 amperes. The anode circuit contains the telephones and a dry battery of any convenient potential between 10 and 30 volts; no adjustment of the anode potential is necessary, for the battery may vary widely without much effect on signal strength. No by-pass condenser is needed across the telephones (or transformer primary, if an amplifier is used)



THE PARTS OF THE TUBE

FIGURE 1; *F is the filament, connected in series with the heater element H, which heats the anode A, causing it to give off ions that fly over to the collector plate C. All of these elements except the heater are enclosed in the inner glass shell.*

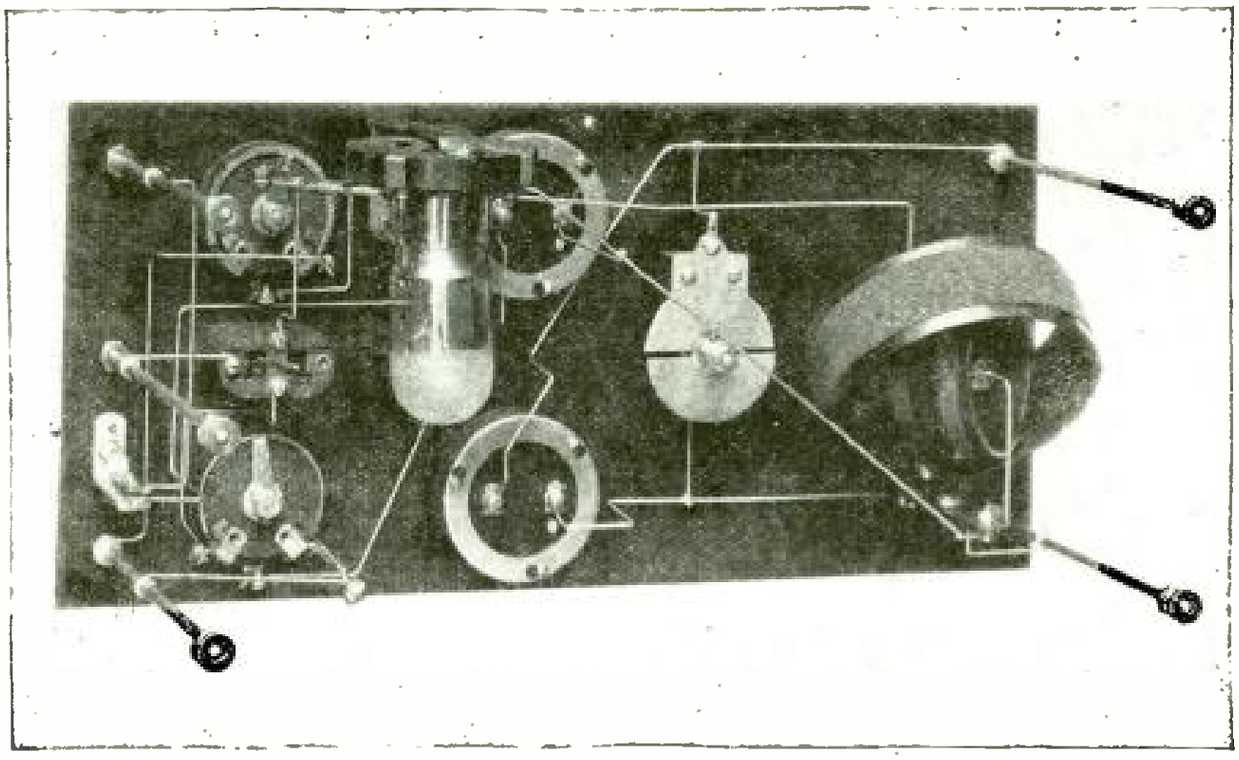
for no radio frequency currents appear in the anode circuit. The anode current is about 150 to 200 microamperes.

The most interesting thing is, however, the connection and behavior of the collector circuit. No stopping condenser or leak resistance is used, and the tube will not work properly if there is any such obstruction to prevent flow of current in the circuit from filament to collector.

The steady value of current in this collector circuit is relatively high; if the collector is connected directly to the filament it will measure as much as 1,500 microamperes or some ten times the normal anode current. To control the collector current conveniently a variable opposing or neutralizing potential is introduced by means of a potentiometer across the filament battery. The larger this neutralizing e.m.f. the smaller the collector current; the normal adjustment is in the neighborhood of 1.4 volts, giving a current of 600 to 800 microamperes or about four times the current in the anode-telephone circuit.

Another interesting feature is that this large collector-circuit current does not flow unless the anode circuit is closed. If we break the telephone connection, the anode current is of course interrupted. But the collector current at once falls to something like half its normal value. This unusual feature is one of the characteristics that identify the new phenomena used in this intensifier tube.

If microammeters are placed in both the collector and anode circuits, the steady value of current in each will be seen to drop as soon as radio signals are applied. The change of current on receiving signals is much greater than with grid tubes, and gives us not only a convenient way of measuring directly on a meter the intensity of quite weak radio waves but also an easy method of operating a telegraph relay on a telephone call-bell by radio. For instance, ordinary daylight signals received at Meriden (on a small aerial) from WOR at Newark, a hun-



AN INSIDE VIEW OF THE NEW RECEIVER

Notice that the tube is mounted in an inverted position. The arrangement of the various instruments and the wiring is clearly shown. All the connections to the set are made from the rear.

dred miles away, cause a drop in collector current of about 50 microamperes; it is simple to arrange a relay to be operated by such a current change.

The large effect which signals produce on the collector current makes it feasible to place the telephones directly in the input circuit. In this case, the anode circuit includes nothing but its battery and the collector becomes both input and output electrode. The collector circuit is one of low impedance, however, and the usual telephones are not suited to it. Their resistance also interferes to some extent with tube operation, so that it is better as a practical matter to place the telephones in the anode circuit. Nevertheless, for a given resistance in the collector circuit signal responses are as loud with the telephones in the input as in the anode circuit.

One other operating feature should be mentioned—selectivity.

Although with the intensifier we have no way of reducing circuit resistance by regeneration, the extraordinary sensitiveness of the device permits us to use exceedingly loose coupling in the receiving tuner. As is well known, this produces not only a high degree of selectivity but also gives great freedom from impulsive interference produced by static or nearby spark stations. Further, the intensifier has a valuable frequency-selecting power of its own; adjustment of filament current and collector potential permits discrimination between neighboring wavelengths by increasing the sensitiveness of the tube to any particular desired wave frequency within its range. As built for broadcasting reception the tubes may be adjusted to give maximum response to 360 or to 400 meters and at the same time to be poor detectors of interfering signals on 600-meter or longer wavelengths. The net result of these several possibilities is to give a practical and easily secured selectivity that is much higher than is ordinarily required.

Experimenters whose only experience with detectors utilizing ionization phenomena has been confined to grid tubes containing gas are likely to believe that any ionization effect must be of unstable

or transient character. A little work with one of the intensifiers will quickly demonstrate that it is the gas and not the ionization that causes the fugitive, rapidly changing adjustments of the old tubes. By using ionization of a metal vapor, and particularly of an alkali metal, we are able to produce in quantity detector tubes which have definite characteristics and the operation of which is uniform throughout the period of use. Control of the ionizing anode temperature gives us complete control of tube operation, and in order to keep an intensifying detector adjusted to maximum sensitiveness for hours at a time it is merely necessary to set the filament rheostat at a value that will maintain the requisite heating and to adjust the collector potentiometer at the best point for the particular signal strength and frequency, and leave them there.

As may well be imagined, we have had our own troubles in producing a tube of this kind. The operation is so radically new that we not only had to develop the device itself but also new methods and apparatus for testing it. The usual schemes used for investigation of grid tubes are of little value to us; for example, the absence of amplification and the presence of a relatively large direct current in the input circuit are not taken care of in the ordinary methods of measurement.

The experimental work has been well worth while, however, for we now have a dependable detector of higher sensitiveness than has ever been reached, yet one which cannot produce interference. Continuation of the investigation is showing further possibilities of increased sensitiveness, and present-day indications are that filament current consumption can be reduced to a point that will permit of dry-cell operation without loss in stability, selectivity or responsiveness of the new tube to radio signals.

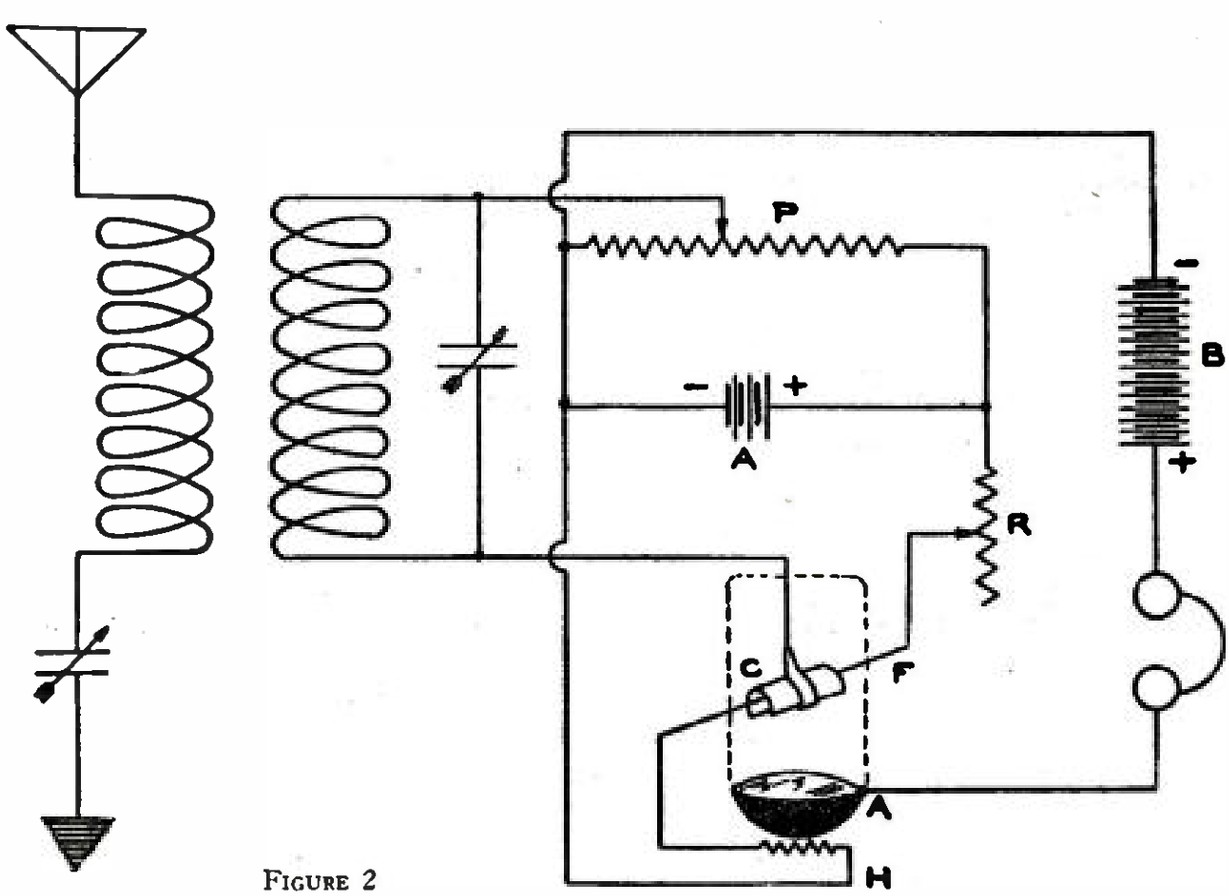
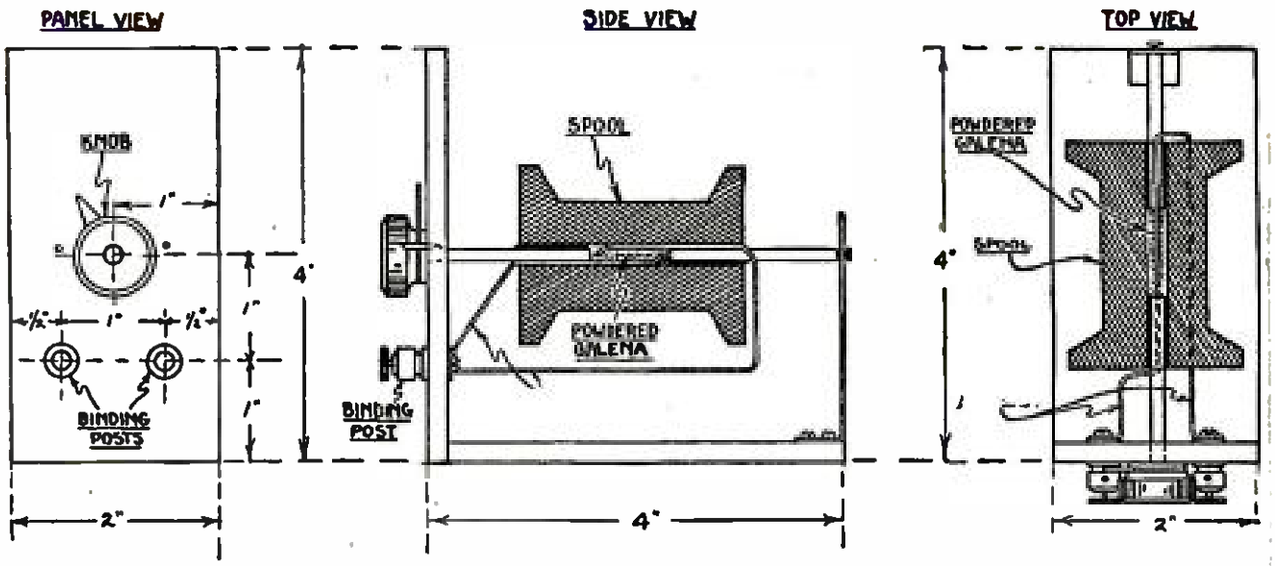


FIGURE 2

The electrical connections for the set that makes use of the intensifying properties of the new tube. This circuit has proven of exceptional sensitivity in detecting radio signals.



If you own a crystal detector set, you know how troublesome it sometimes is to find the "sensitive spot" on the crystal. Here is a home-made set that locates this spot for you. When the knob is rotated the powdered galena naturally tumbles into the right position between the catwhiskers.

How *to* Make a Crystal Detector *from* a Spool

By ALBERT GRUBER

MANY amateurs discover that it is difficult to find the sensitive spot on the crystal used as detector in their radio sets. The spool type of detector will eliminate this difficulty if constructed properly. The size of this detector is entirely optional to the maker and various dimensions may be used with success.

First obtain two panels the same size; 4 by 2 inches will suffice. Also four inches of a dowel pin the size of the inner diameter of the spool you are going to use.

Drill a hole the size of the diameter of the dowel pin used, in the exact center of the one panel. Two smaller holes are drilled for binding posts one inch from the bottom and each one-half inch from the side.

Place two small-gauge wires for catwhiskers in the hole of the spool in such a manner that the wires are on opposite sides and do not touch. Saw off 1¼ inches of the dowel pin, spread paste on one end and place in one end of the spool a distance of ½ inch.

Now fill the spool with powdered galena crystal, leaving enough space for the placing of the dowel in the other end of the spool. Be careful to keep the wires in place and be certain that the grains of galena will move freely when the spool is rotated. The balance of the dowel is pasted in place.

The panel should next be screwed to the base and a rear support made of a brass strip. The holes for the support of the rod should be in line with each other.

Place the spool detector in position securing it with small nails, one driven through the dowel at the rear of front panel, the other at the rear of the support.

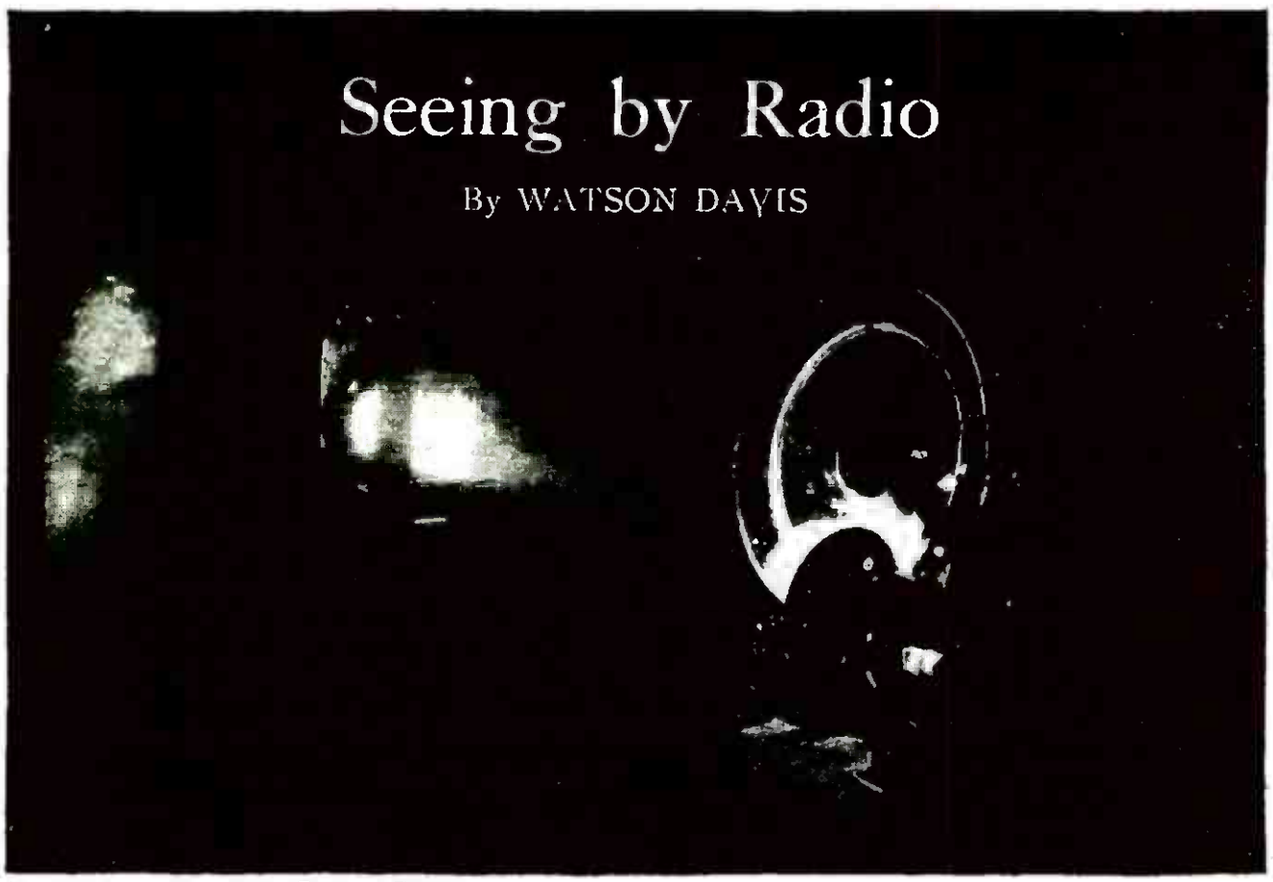
A dial or knob may be pasted on the part of the dowel that extends through the front panel, for adjustment of the detector.

The two catwhiskers are connected to the two binding posts. To operate, rotate the handle slowly and the wires inside the spool will come in contact with at least one sensitive spot in the galena.

This general plan may be varied in many ways without decreasing the efficiency of the detector.

Seeing by Radio

By WATSON DAVIS



From a photograph made for POPULAR RADIO

A Revelation of Some of the Wonders That Radio Holds in Store

PHOTOGRAPHS are now being sent by radio. As soon as the process is speeded up, motion pictures may be similarly sent. We may shortly see on the screen distant news events almost as soon as they take place; we may see at eleven o'clock in San Francisco an accident that "will occur" in New York at two o'clock the following afternoon! How these astonishing developments are made possible is something more than hinted at in this article—which contains the first detailed description of the remarkable invention of C. Francis Jenkins.—EDITOR.

BEFORE there were motion-picture theaters, C. Francis Jenkins was a real-life actor in some wild-west dramas in southwestern United States and Mexico. Before he came to Washington he got the fool idea of trying to solve the problems of motion pictures. Many other inventors of that time were also giving their best thought to apparatus that would bottle up motion and reproduce it at a later date. But Jenkins finally perfected movies, and today his contribution to the motion picture machine is in use in every commercial projection machine on the market—except his own.

And that is the beginning of the story of the possibility of seeing by radio.

If you have watched a motion-picture projector in action you will remember the slotted disk in front of the lens that, twirling around, blots out the image of the film when it is in motion. The film in the standard motion-picture machine moves with jerks and you see the image on the screen only when the film is stationary; the whirling shutter wheel suppresses the rest, but does it so fast that your eye cannot catch it doing it. Mr. Jenkins is responsible for the long opening and resultant long exposure in this shutter wheel that gives the illusion of continuous motion on the screen and makes motion pictures possible. And he also introduced the device that produces the jerking motion of the film.

To be the father of one of the essentials of the motion-picture machine would seem enough achievement for an in-

ventor. But if Mr. Jenkins invites you to a movie show in his laboratory on Connecticut Avenue, Washington, D. C., you will find a new kind of machine. The shutter wheel is conspicuous by its absence. There is no shutter; the light plays on the screen for the full time and not just part of the time. The film is in constant, continuous motion; it does not jerk along. A glass disk or wheel revolves perpendicularly to the beam of light which is projected through it near its edge and which carries the picture image.

If you examine the disk of common glass you will find that it has an edge of varying thickness. It is, in fact, a prism cut on the circumference of the disk. But it is not just an ordinary prism, for it has a constantly changing shape. At one end its base is at the edge and at the other its base is inside. Where the two ends meet there is an abrupt change, and directly opposite on the other side of the circumference the prism at that one point is just a piece of glass with sides parallel.

This "prismatic ring," as Mr. Jenkins calls it, is the essential part of the device for sending and receiving pictures by radio and it is the only new part.

Have you ever been in the old-fashioned houses that still have prismatic ornaments suspended from their chandeliers? Or do you remember a little of the physics of light that you learned in your high-school days? If so, you will know that the direction of a ray of light is changed by passing through a prism; that is, the ray is bent toward its base. It is this property of the prism that is used in applying the prismatic ring. A beam of light projected through the revolving prismatic ring will be refracted from one side to the other with the ring as the hinge.

In the Jenkins continuous motion-picture machine the light passing through the picture on the film is picked up by the prism and carried across the screen at the same rate that the film is traveling. If sixteen pictures each second are projected in this way, the action on the screen seems to be continuous.

This principle and these rings are used in the apparatus designed for sending pictures from place to place by wire or radio. The essential difference in the operation of the continuous motion-picture machine and the apparatus for sending pictures is that the picture transmitting apparatus projects the picture a small portion at a time, while the motion-picture machine throws the whole picture on the screen at the same time.

In order to send only a portion of the picture at one time, Mr. Jenkins uses two prismatic rings. These are so placed that their diameters intersect at right angles and the beam of light passes through both prismatic rings at the intersection. The ring that shifts the beam from left to right runs about a hundred times as fast as the other ring whose prism causes the image to move from the top to the bottom of the picture. The total effect of the two rings working together in the receiving set is that of a pencil of light tracing lines across the picture about a hundred times as fast as it moves downward.

In both transmitting and receiving apparatus there are duplicate sets of these rings and they do exactly the same thing. The transmitting set picks up the light from the picture to be sent, shoots it through a lens and impresses it upon a light sensitive cell. In the transmitting set there are only three essential parts; the set of prismatic rings, a lens to converge the light, and a light sensitive cell.

Do you remember the invisible eyes that guided our troop ship convoys across the Atlantic during the war?

This was accomplished by light sensitive substances, and it is this class of substance that is used in Mr. Jenkins' transmitting set. When a selenium or thalium salt is in the light it allows a greater amount of current to pass through it than when it is in the dark. The light sensitive cell that Mr. Jenkins

is now using is composed of thalium sulphide. When the prismatic rings impinge the picture point by point upon the light sensitive cell, the different light values of the different points cause variations in the electric current passing through the cell. This current of varying intensity is fed into a land telephone or radio transmitter and sent by wire or radio to the receiving apparatus, just as though it were a modulated current produced by talking into a telephone transmitter. It may be transformed into radio frequency, it may be amplified; the only essential thing is that it reach the receiving apparatus with the same variations of intensity.

The Jenkins transmitting apparatus has been in operation at NOF, the Navy Department's radio station at the Naval Air Station, Anacostia, D. C. Various photographs and line drawings have been sent to Mr. Jenkins' laboratory on Connecticut Avenue about five miles away. An ordinary nitrogen-filled lamp was the source of light and the photographic negative was placed between the lamp and revolving prismatic disks. To and fro the picture was thrown by the disks until in six minutes every point in the picture had been projected onto the light sensitive cell across the room enclosed in a protective cage or screen. Between the prismatic disks and light cell there was a "chopper," which consisted of a rapidly revolving perforated disk interrupting the current in such a way that it produced a variation. This caused an audible telephone signal in radio receiving sets that were tuned in on the proper wavelength, 425 meters, that was being used.

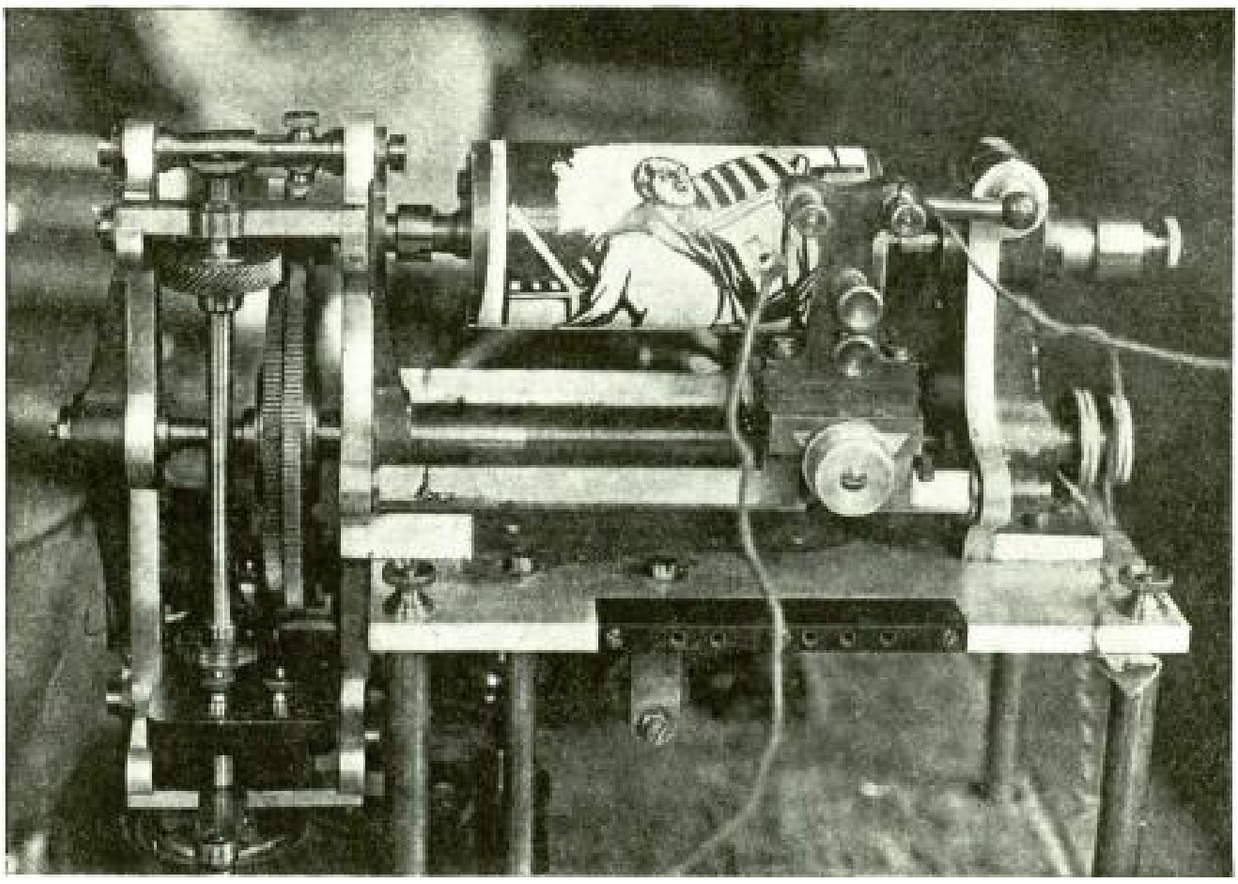
Radio fans have been able to *hear* the picture being sent.

In the radio picture receiver, the incoming current moves a small mirror. The extent of this movement depends upon whether the current represents a light or dark place in the picture that

Pacific & Atlantic

THE WHIRLING GLASS RINGS THAT PERFORM THE WONDER

These two glass discs (one of which revolves 100 times as fast as the other) literally "pick a picture to pieces." The "pieces" consist of horizontal lines of light and shadow that are traced from the film and are flicked across the screen at the rate of 16 complete pictures a second. The inventor, C. Francis Jenkins, is shown operating the device.



International

THE BELIN APPARATUS RECEIVES A PICTURE BY RADIO

The sliding arm, seen in the photograph with the two wires attached, slips across the rotating drum and records the picture that is being transmitted. It is the invention of a Frenchman, Edouard Belin.

is being transmitted. A beam of light, broken by the shadow of a human hair, is reflected by this mirror so as to pass through a slit and be impressed upon the photographic plate by the prismatic disks. When black is being sent, the reflected shadow of the hair completely excludes the light from the plate, but when a light portion of the photograph is being received the mirror vibrates and lets through sufficient light to reproduce the tone of the original photograph.

At present the motors which revolve the prismatic disks are synchronized through the use of the same city source of A. C. current, but Mr. Jenkins will use motors synchronized by tuning forks in the tests between cities. The synchronization of the revolutions of the disks is, of course, necessary to prevent distortion of the picture.

An ordinary spark or arc radio telegraph transmitter will transmit black and white or line drawings by the Jenkins method. The distance that such a picture can be transmitted is limited only by the range of the set. For the sending of photographs with their minute variations of tone, a high-grade telephone broadcasting transmitter, such as that installed at NOF, is needed, just as such a station is necessary to transmit the human voice. In this case also the range of picture transmission is only limited by the range of radio telephone transmission. Where the voice can be broadcast, the photograph can go also. Similarly photographs can be transmitted by the Jenkins method over ordinary telephone wires at ordinary frequencies or at carrier frequencies such as are now used on long-distance toll lines.

In one respect the transmission of photographs is simpler than that of the sound; there is no frequency variation in photograph transmission, as the varia-

PRESIDENT HARDING—BY RADIO
This is a specimen of a photograph as received by the Jenkins invention. Note the faint, horizontal lines.

tions in the shading of the picture are translated into current intensity variations only.

The results of the transmission are splendid pictures—photographs that rival the work of the most expert artistic photographers. They appear to have the quality of a steel engraving. The faint horizontal markings remind one of a photograph printed on very finely marked linen paper. The contrast and sharpness of the pictures are sufficiently good so that clear half-tones can be made from them suitable for newspaper and magazine use.

Motion pictures and "seeing by radio" are described by Mr. Jenkins as the next step in his process. To make still pictures move, more speed and light are necessary. Mr. Jenkins feels sure that these requisites can be achieved. He mentions his high-speed camera that can take 48,000 pictures a minute, and he tells how the simulation of motion will be obtained.

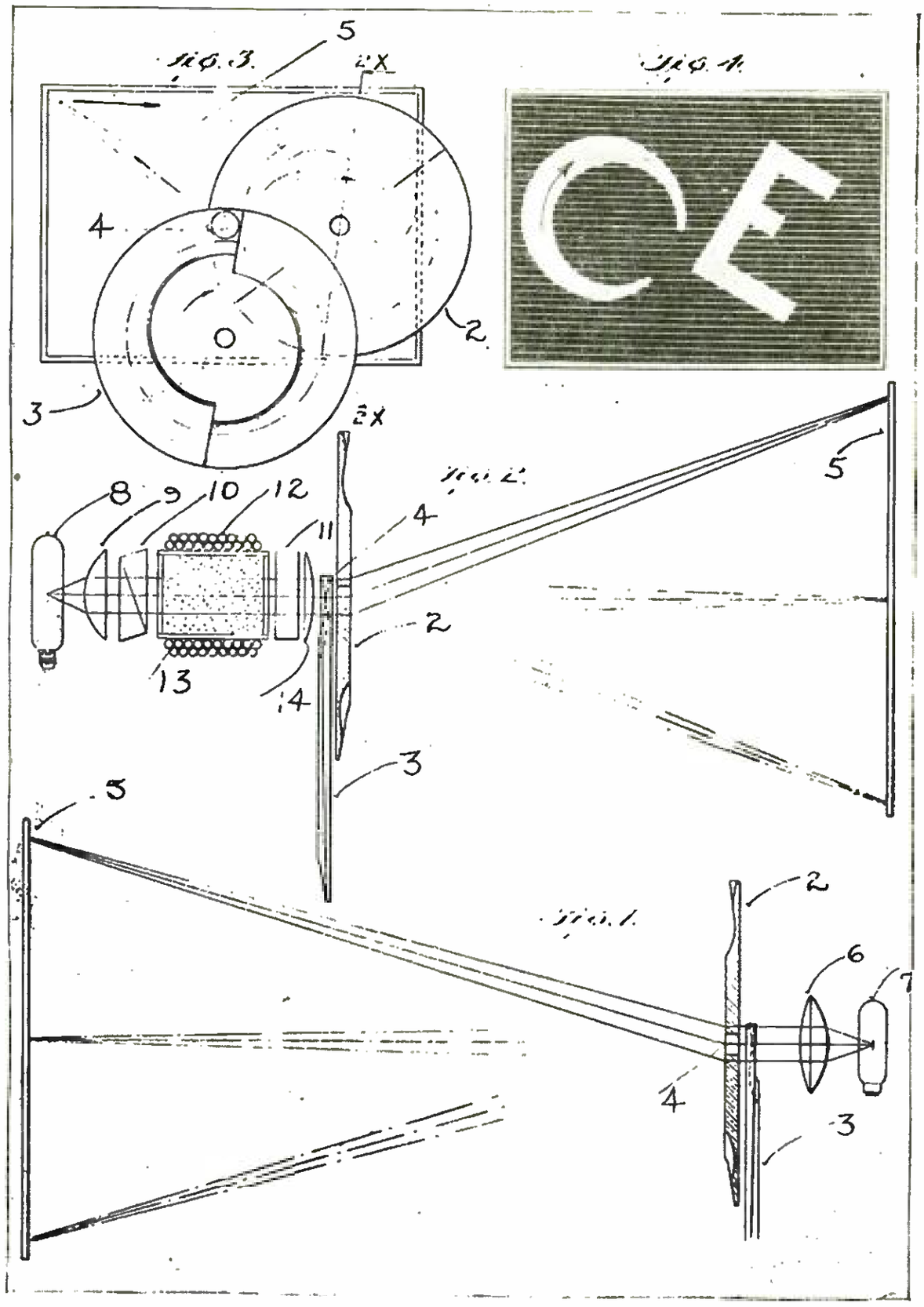
In order to make the projection appear continuously in motion, sixteen whole pictures must be flashed on the screen each second, just as is the case in the ordinary motion-picture machine today. That means that the up and down movement of one of the prismatic rings must be accomplished in one-sixteenth of a second and as the left to right motion is a hundred times as fast, the other ring must revolve 1,600 times a second. The light sensitive cell is ready for a new intensity of light 200,000 times a second. This would divide the path of the horizontal motion into over a hundred different light modulations which would, in Mr. Jenkins' opinion, give the necessary detail. The result would be a series of lines of light of varying blackness drawn so fast and so close together that they would form a complete picture, like the dots in a half-tone print. Because of the short time that each portion of the screen will be illuminated, an intense light source will be necessary.

Other inventors have been hard at work on the problem of sending drawings and photographs by wire. One of the most successful of these is Edouard Belin of Paris, whose progress is told in the French technical press.

The Belin process, like that of Jenkins, consists in converting the variations in the details of a photograph, or other matter to be sent, into corresponding variations of electrical current which are transmitted over the wires or by radio just as any other telegraphic message would be. At the receiving end these current variations are translated into terms of light so that a copy of the original picture is obtained. But the method of conversion is different.

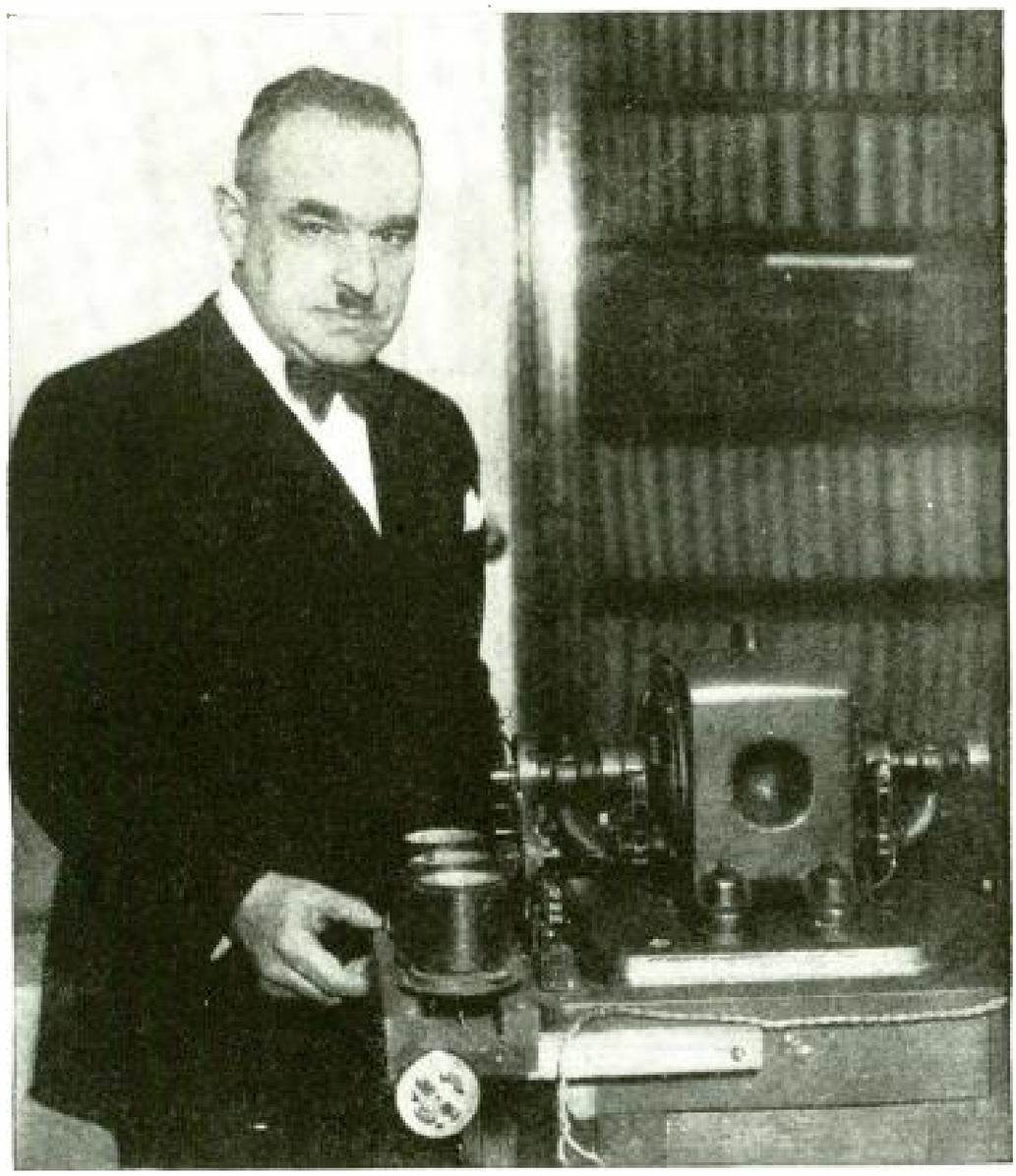
It is perhaps easier to see how this is done in the case of simple-line drawings, finger-prints and other solid black and white matter. The sketch of this kind which is to be sent over the wires or by radio, is made upon paper with an ink which leaves a slight deposit when dry and so makes a drawing in low relief.

This paper is placed upon the cylinder of a machine which resembles the ordinary cylinder phonograph and which is propelled by clockwork in much the same way. Resting on the cylinder there



HOW THE JENKINS DEVICE DRAWS PICTURES WITH PENCILS OF REFRACTED LIGHT

Figures 1 and 2 show how one disc throws a pencil of light slowly down the film while the other disc throws one in swiftly drawn horizontal lines. Figure 4 illustrates how these lines are combined to form the picture. Figure 3 shows the two discs in operation. The upper disc causes the horizontal motion of the beam of light and the lower disc causes the vertical motion across the picture to be sent.



Pacific & Atlantic

The FIRST MAN TO SEND A PICTURE BY RADIO ACROSS THE OCEAN—*Dr. Korn, the inventor, transmitted a photograph on June 7, 1922, from Sanpaolo, Italy, to Bar Harbor, Maine. The apparatus translates the picture into a series of code letters, which are decoded at the receiving stations and printed on a typing machine that makes dots of varying intensity—as shown on the page facing.*

is a stylus attached to a flexible plate which makes contact for the electrical current. As the cylinder that bears the drawing turns, the stylus traces its way over the raised portions as the needle on a phonograph explores the depressions in the wax record.

Every time a line or raised point comes under the delicate stylus, the flexible plate to which it is attached is depressed so that the current is broken. Through this simple make-and-break device the blank or raised portions of the paper are translated by interruptions in the current and the white background by the current.

At the receiving end there is a cylinder, similar to that in the sending apparatus, which is encased in an octagonal shield. On this cylinder is wound a photographic film ready to receive the picture. As this cylinder turns on its axis it also moves past a microscopic opening in the shield through which the light must be registered on the film at one tiny point at a time.

Pacific & Atlantic

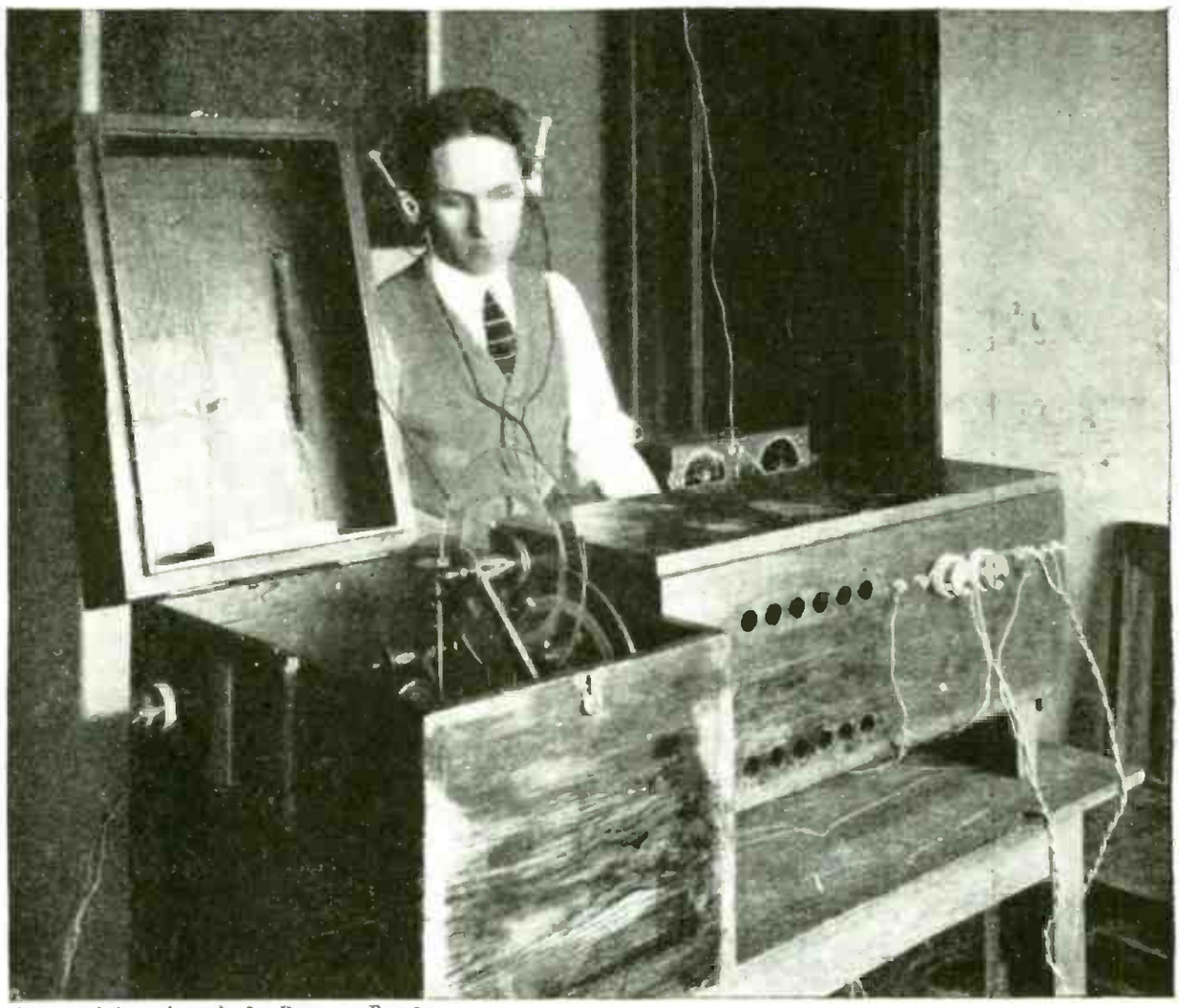
—AND A SPECIMEN PICTURE AS IT IS RECEIVED

The numerous dots of varying degrees of black correspond to code numbers; this picture is produced by typing the dots to conform with the code numbers. Less than 20 sizes of dots are used.

Now the transmitting device is sending only electrical current, and this cylinder in the receiving set is designed only to catch light. It is, therefore, necessary to translate the current into terms of light. To do this there is an ingenious contrivance. A small lamp is encased in a metal barrel and furnishes a constant source of light, the rays of which are converged by means of a lens onto a tiny mirror at such an angle that the beam of light will be reflected directly through the opening on the recording cylinder. Between the mirror and the recording cylinder, however, there is a little opaque screen in which is a single aperture.

The current coming over the wires or by radio tilts the mirror so that the beam of reflected light strikes the opaque screen and does not pass through the aperture in it. With the break in the current, the mirror swings back to the original position and sends its reflected ray through the opening in the screen and the microscopic hole in front of the revolving cylinder carrying the sensitized film.

In this simple black and white system



From a photograph made for POPULAR RADIO

THE JENKINS RECEIVING SET IN OPERATION

Here the radio impulses are being re-translated into light beams and flashed across the screen, in the form of quickly moving lines, by the two rotating discs—thereby re-creating the picture with lightning-like precision.

there are just two positions of the mirror so far as the receiving film is concerned. One in which it strikes the opaque screen and makes no record and one in which the reflected light is thrown through the aperture.

As the little mirror oscillates rapidly with the variations in the current and as the receiving cylinder with its sensitized film turns, a continuous spiral of exposures is made on the film and the separate turns in this spiral are so close together that to all intents and purposes a solid photographic negative is obtained.

A photograph is sent and received in practically the same way. A carbon print of the picture is made in the usual manner and this is wrapped on the cylinder. The cylinder is then placed in hot water with the result that the gelatine of the print adheres to the cylinder in accordance with its own degrees of blackness while the unexposed gelatine is washed away with the paper. In this way a coat of uneven thickness is obtained on the cylinder, thus forming a low relief of the photograph.

These variations in the surface of the sending record are translated into variations in the intensity of the current as in the case of black and white matter. At the receiving end, the little mirror now tilts in accordance with a greater number of current variations. Obviously, the opaque screen permitting the light to pass through or be shut out from

the recording cylinder entirely can no longer be used. In its place, a screen of graduated transparency is employed; that is, it varies from opacity at one end to transparency at the other, and the intensity of the beam of reflected light which filters through it and is converged by means of another lens onto the sensitized film depends upon what part of this screen it strikes. The variations of the surface of the sending cylinder are translated into variations of current intensity which vary the tilt of the mirror correspondingly and the screen varying the intensity of the light which makes the record.

Dr. Arthur Korn, professor of electrophysics at the Berlin High School of Technology, is the inventor of a process of transmitting photographs that depends upon reducing the picture to dots that can be coded and sent over telegraph wires or radio like any other message. The New York *World* recently reproduced such a photograph sent from Rome to Bar Harbor, Maine.

Prof. Korn, on analyzing photographs and half-tones, realized that for practical purposes all the values of light and shade could be reproduced with from 15 to 20 sizes of dots. He took the different sizes of dots and gave to each a letter.

The machine which does the coding is quite complex. The Korn apparatus uses a point of brilliant light traveling over the photograph, being cut on and off rhythmically by a commutator in such a way that it strikes the picture at accurately spaced points. An ordinary cabinet-size photograph receives the light at about 1,000 points. The light passing through the negative falls upon a selenium light-sensitive cell, the quantity which passes through depending on the darkness or lightness of the film at that point.

The cell is placed in the transparent cylinder on which the negative is coiled, and as the latter slowly revolves the light that passes through the negative falls on the selenium. A current of electricity from a battery passes through the selenium, and its resistance is varied by the values of the light.

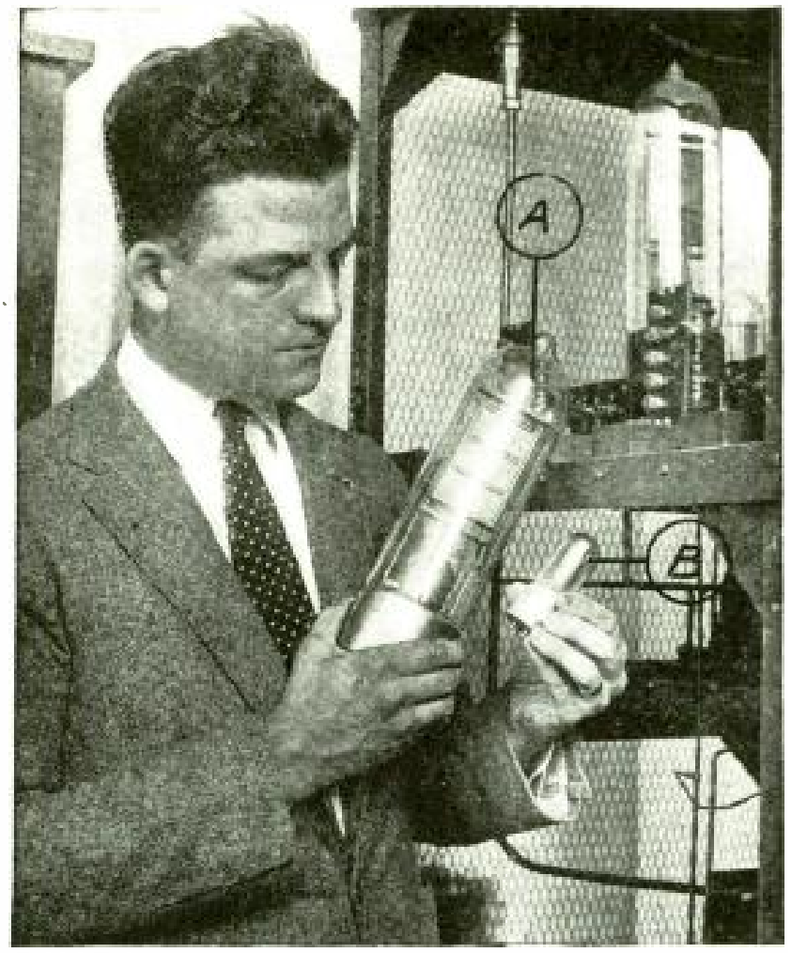
Each variation of resistance—of which in this case there would be seventeen—controls a key which drops to print a letter on a tape the instant it is actuated by the electric current, and the latter corresponds to the particular shade of the photograph.

In "coding" a picture about 1,000 letters are used. These are grouped by spacing into about 300 "words" which are sent by radio or by telegraph to any place. They are received by an ordinary telegraph or radio operator or by an automatic telegraphic receiving apparatus.

To decode or turn this word message back into a picture a Korn decoding instrument is necessary. This is a form of typewriter into which a sheet of paper about twelve by fifteen inches in size is placed. With the printed message before him the operator copies it on the keys; these, however, do not print letters, but dots of the sizes and shapes corresponding to the letters. As the code allows for the blank spaces between the dots the result is a very much enlarged half-tone reproduction of the original photograph.

In speed transmission the Jenkins apparatus appears to be far superior to both of the other methods that have been described. While the Belin and Korn methods may be used for commercial transmission of still photographs, it is difficult to imagine their use in the transmission of motion pictures by radio. But a complete picture in one-sixteenth of a second by the Jenkins apparatus does bring motion pictures and vision by radio into the realms of the possible. Mr. Jenkins also claims that his apparatus is the first that can send and receive a flat picture, a requisite to the perfection of seeing by radio.

It is hard to restrain the imagination when the perfection of the Jenkins process is assumed.



Kadel & Herbert

VARIATIONS OF THE "MAGIC BOTTLE OF RADIO"

The large tube, A, is used for transmitting; the small tube, B, is used for receiving only. Both, however, operate on the same principle and both contain the same three essential elements—a filament, a grid and a plate.

How the Vacuum Tube Works

ARTICLE NO. 1; HOW IT DETECTS AND RECTIFIES

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

By ALFRED M. CADDELL

A NEWSPAPER man once interviewed a doctor who had evolved a highly scientific system of diagnosis. Said the scribe, "I'd like to have you tell me about it."

"All right," agreed the medico. And he did. But he kept going on and on—finally putting a capstone on his explanation by observing:

"That is it; now do you understand?"

Whereupon a returned-from-vacation look came into the reporter's eyes and he replied:

"Well—er—I did until you commenced to talk about it!"

A similar situation exists today in radio. Many of the most common phenomena are not really understood by the layman at all. Take the vacuum tube, for instance—the device that everyone has had more or less of an introduction to and which is also known variously as the "electron tube," "triode," "thermionic valve," "heart of radio," "Aladdin's lamp" and a half-dozen trade names for good measure.

Let us see if we cannot strike up a democratic acquaintance with it and explain its action in simple, understandable terms.

Like the doctor, the radio engineer is so thoroughly versed in technical nomenclature that he naturally dresses his explanations in plots and curves with a technical preciseness that is bewildering.

"A tube," says he, "is an invaluable device, consisting of a highly evacuated glass bulb in which there is a filament, grid and plate. The filament, which is energized by the 'A' battery, throws off electrons which are attracted to the plate by a positive charge delivered by the 'B' battery. In their travel from the filament to the plate, the electrons are intercepted by the grid, which acts as a valve for radio frequency impulses. If the grid is made positive with respect to the filament, the plate current is increased, and if it is made negative, the plate current is decreased. The grid voltage is thus very effective in controlling the electrons flowing from filament to plate, as will be seen by the accompanying curve. Assuming that the grid potential is at A, and a sine-wave voltage impressed on the grid by the antenna circuit, as shown in Figure 21"—and off he goes!

All that is very well—and highly useful to readers who can follow him. But for the beginner, a clear conception of what takes place within the vacuum tube is more difficult to get. High and low vacuua (hard and soft tubes), evaporation of electrons, grid potential, voltages, negative and positive charges, saturation points and the like are terms he does not really comprehend.

So in order to understand the delicate action of this twentieth century marvel, we will have to liken it to something familiar in everyday life.

In this first article, then, we will democratize the vacuum tube's more simple function of detection or rectification—and do it in terms that the layman can understand.

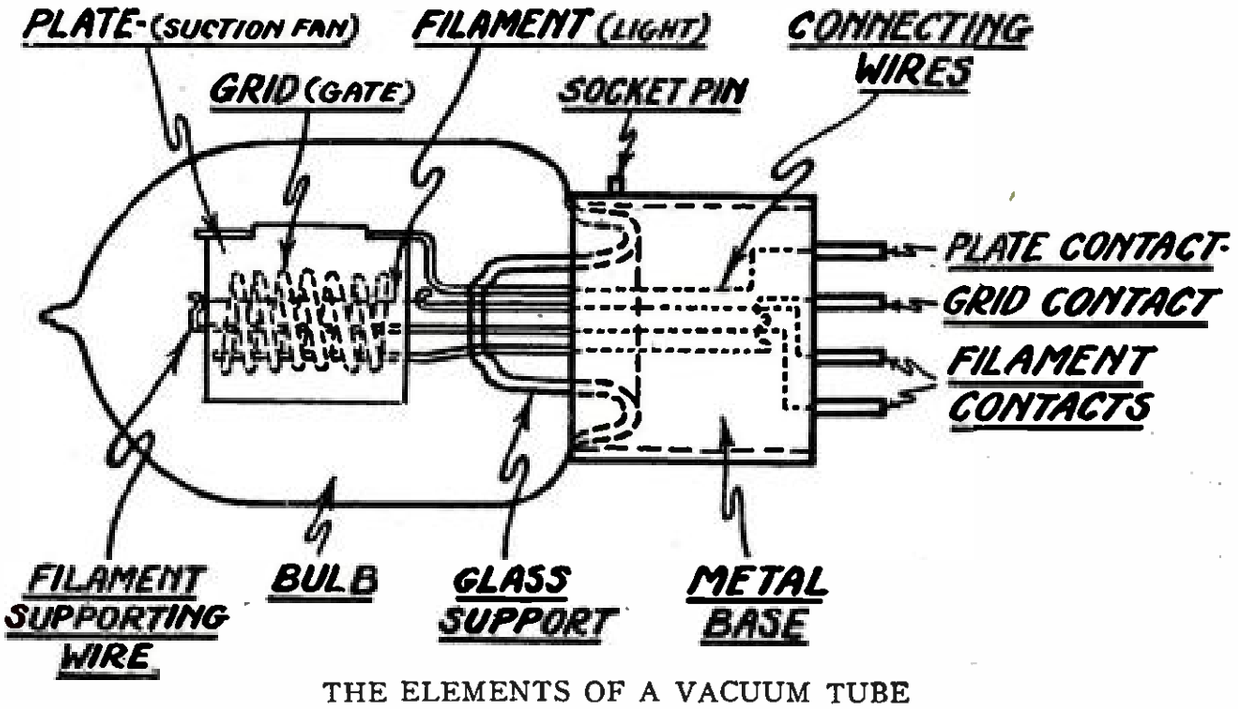
In the second article we will explain regeneration or "feed-back"; in the third we will explain amplification (cascade), and in the fourth we will explain high-frequency oscillation.

LET us imagine the vacuum tube as a street running from east to west. Let us imagine it as a *one-way street*, in which traffic can move only in one direction.

Let us imagine that this street has been completely housed by glass and all the air pumped out of it, leaving a vacuum.

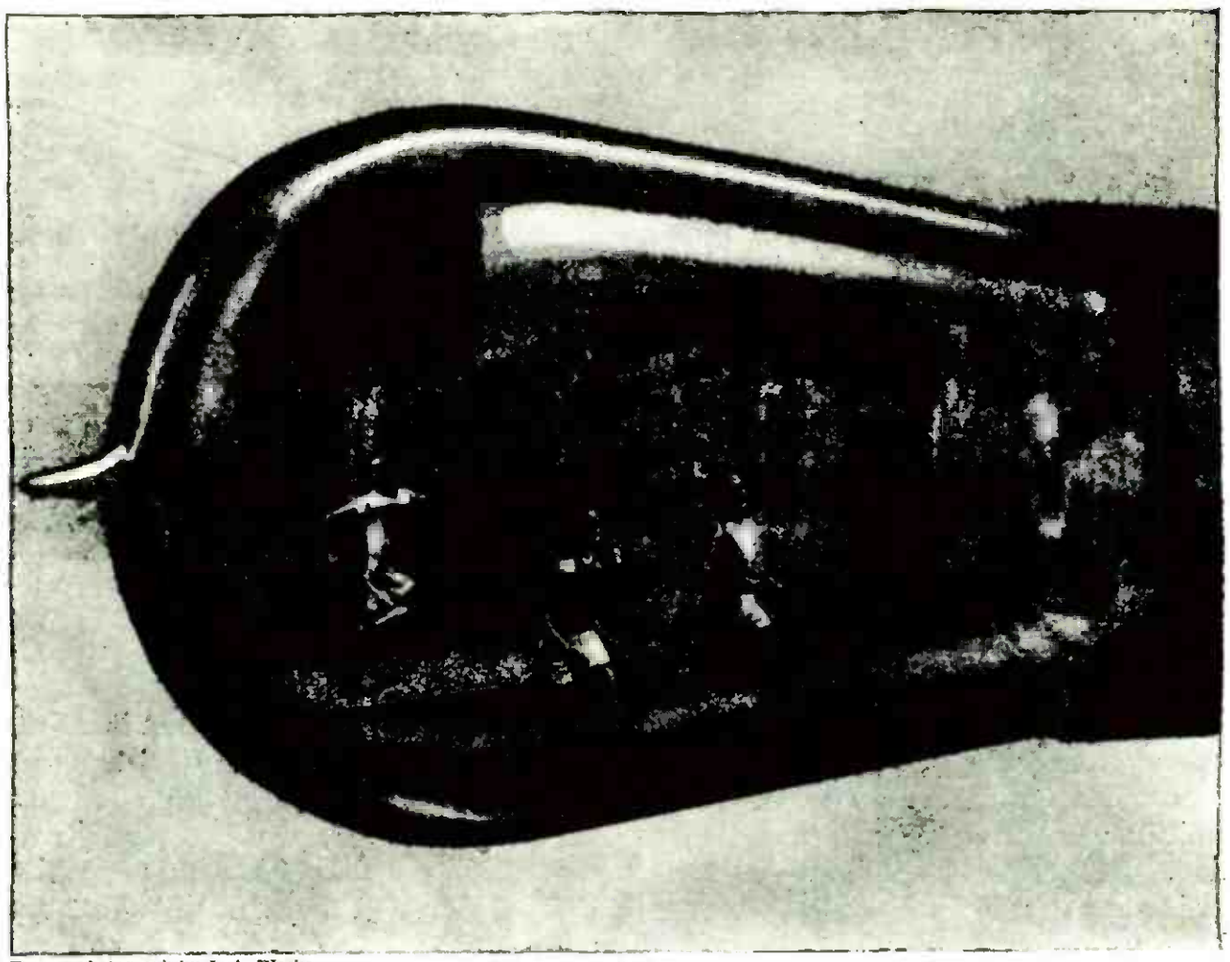
At the east end of this street is a light (a filament lighted by an "A" battery) that radiates continuous heat. At the west end of the street is a great big suction fan (a cold plate with a positive charge delivered by the "B" battery) which draws the heat toward it, so there is a one-way flow of heat in this street.

Then let us imagine this flow of "heat"



THE ELEMENTS OF A VACUUM TUBE

Here are shown the various parts of the tube—the cylindrical plate, the spiral grid and the filament, together with the other structural details of a tube which may be used as a detector of radio impulses.



From a photograph by J. A. Weeks

When the Grid Is POSITIVE

The tube may be likened to a one-way street at one end of which is a suction fan (the plate) which is drawing the runners (the electrons) toward it. The grid may be likened to a gate, which lies prostrate and permits the runners to pass over it when it is charged with positive electricity.

as a flow of electrons, and we get a general idea of what takes place in the tube.

This flow of electrons was discovered to be very sensitive to changes. It met with no atmospheric resistance, because it traversed a vacuum; there was no gas to ionize. Prof. James A. Fleming, of England, first employed this flow of electrons in wireless telegraphy as a detector of weak radio signals. He found that when radio frequency impulses,* intercepted by the antenna, were led into this tube or "street" through the filament, they were drawn through the suction fan (the plate) at the other end, where they become rectified and strengthened.

*Radio frequency impulses are electrical impulses that vibrate too fast—at the rate of more than 20,000 a second—for the ear to hear; audio frequencies lie below 20,000.

By this means it became possible for the listener with a pair of phones on his head to hear radio signals.

But this type of detector-rectifier proved of only passing sensitiveness. The question arose: Were the radio frequency impulses being introduced into this one-way street in the most efficient manner?

Evidently they were not. Whereupon Dr. Lee De Forest conceived the idea of installing a gate-valve in the middle of the street, not only to control the flow of electrons on their way to the fan (the plate), but to introduce the feeble high-frequency impulses caught by the antenna through the gate, so that a more sensitive action would result.

This De Forest gate was a most pecu-

From a photograph by J. A. Weeks

When the Grid Is NEGATIVE

When the gate is charged with negative electricity, the gate (the grid) rises to block the runners (the electrons), thus decreasing the number of runners who get through to the fan. The electrons that reach the fan (the plate) vary in number with the voltage changes in the gate (the grid).

liar kind of gate, constructed of imaginary shutters (varying polarity), so that when it wanted to allow electrons to pass through, all it did was to open the shutters. When it didn't want the electrons to get through it simply closed them. Bear in mind that the fan (the positively charged plate) at the other end of the street, naturally wanted to get all the electrons (the negative electricity) that it could to equalize the electric charges. But the grid said in effect:

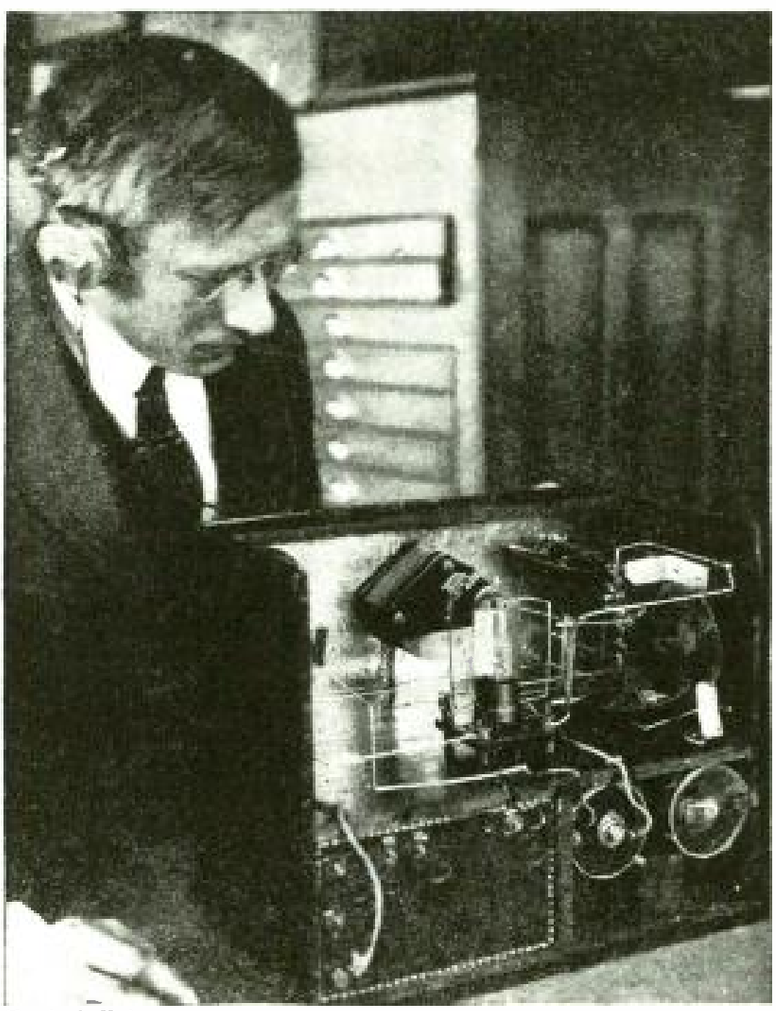
"No, I will allow you to have the electrons only as I see fit. I, too, have a mission to perform. I am an automatic radio frequency valve, connected to an antenna circuit which intercepts voice-controlled (or modulated) radio waves. It is my duty to bring them into the street so that they will control the one-way stream of electrons flowing therein

"These radio impulses that come through me are made up of successive positive and negative charges of electricity and inasmuch as electrons flow only one way in this street—there is a flow of negative electricity only — the negative half of the radio frequency impulses that come in through me repels the negative stream of electrons from the filament. Thus the negative frequency impulse causes my shutters to close, preventing the passage of electrons to the plate.

"But," continues the De Forest gate, "when the radio frequency impulse is positive (and every other one is), it causes my shutters to open, and the electrons dash off the filament and pass

through me to the plate. That is, these high-frequency impulses, patterned by the voice at the transmitting station, so control this one-way flow of electrons that the current flowing in the plate circuit (the output of tube) follows the general contour variations of the high-frequency carrier waves, flows through the telephone receivers and produces diaphragm vibrations. And these vibrations push and pull the surrounding air, causing sound waves to be produced.

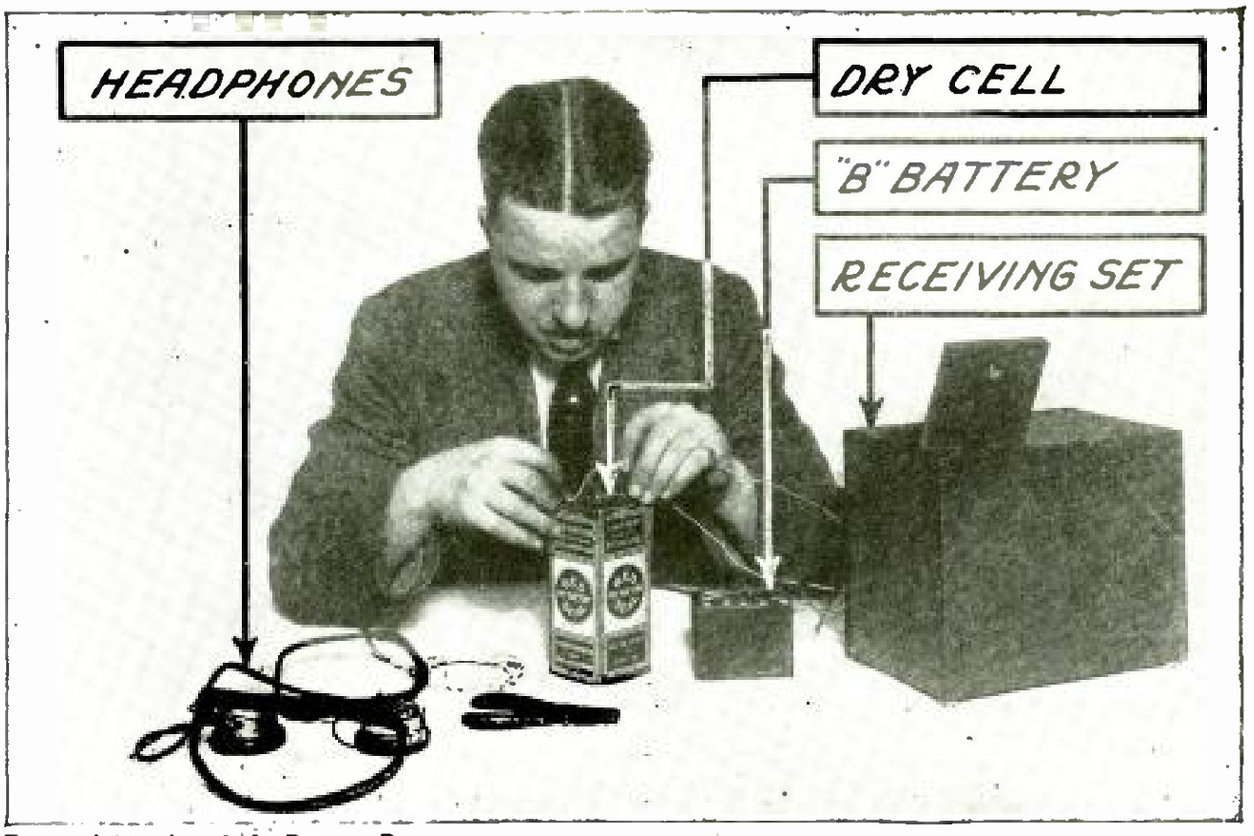
"Thus," emphasizes the gate, "I am the absolute master of the situation. While I produce no power and use no power, I usher into the street (the tube) the inaudible radio frequency impulses which control the stream of flowing electrons. Thus the flow, being controlled by the grid which is so sensitive to radio frequency variations, is caused to rush and stop, rush and stop, in its journey from the filament to the plate. Whereupon, by the aid of phone receivers, sound waves are created and the listener hears the message that was spoken by someone who was hundreds or thousands of miles away."



Harris & Ewing

UNCLE SAM DESIGNS A SPECIAL HOME-MADE RECEIVER FOR HIS LIGHTHOUSE KEEPERS

No one who has not actually lived in a lighthouse and experienced this form of isolation can fully appreciate just what radio means to the men of this branch of the service. The Bureau of Standards has just issued detailed instructions for the building of a set that is especially adapted for this purpose; it contains three spider-web coils, condensers, a 1½-volt tube that operates on a dry cell, and a "B" battery. The set is self-contained, and requires only a short antenna and a pair of headphones.



From a photograph made for POPULAR RADIO

HOW TO MAKE A SIMPLE

SINGLE TUBE RECEIVING SET

In this article the radio novice—who has reached the point where the crystal set no longer meets his needs—will find complete, detailed directions for building a really efficient receiver that is selective and economical to operate. The set may be built by any beginner at a cost of $25.00 or less.

By LAURENCE M. COCKADAY, R.E.

MOST beginners in radio who build their first tube set experience a great amount of trouble. Usually they have to call in outside assistance before the set is made to work at all.

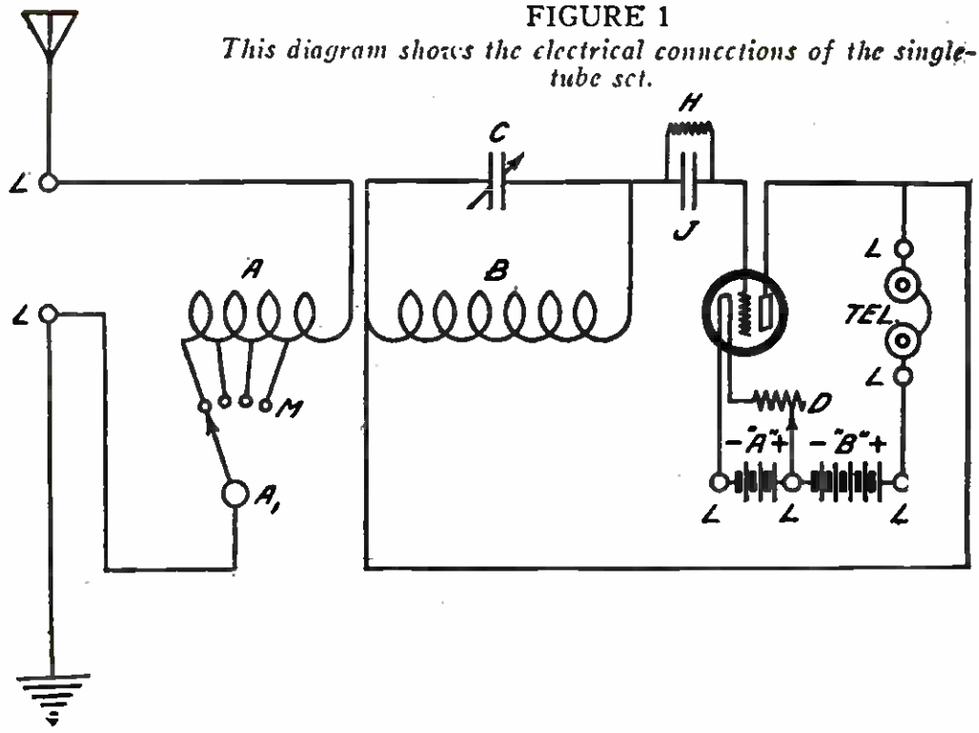
The reason is that most beginners start out with a too complicated set and consequently make an inordinate number of mistakes. This little set here described is simplicity personified; indeed, one of its best features is the fact that the builder can easily make the coils himself and thereby get the best possible kind of experience. The whole set should not occupy more than three hours to complete, exclusive of the time spent on the cabinet. The set may be used with the ordinary vacuum tube or with a tube that runs on a dry cell, thus doing away with the storage battery. Either tube may be used with one or two small sized 22½-volt "B" batteries.

The set will tune sharply, in spite of the fact that it has such a simple wavelength control. It will tune from 170 meters to 520 meters, which takes in the amateur band of wavelengths and the broadcasting between 360 and 400 meters and the ships' stations on 450 meters.

The set will give best results with a single wire antenna approximately 100 to 150 feet in length, with a ground for the set on a waterpipe. The electrical circuit diagram is shown in Figure 1.

FIGURE 1

This diagram shows the electrical connections of the single-tube set.



The Parts Used in Building the Set

In the diagrams in this article each piece of apparatus bears a designating letter; in this way the builder may easily determine how to mount the instruments in the correct places and how to connect them properly in the electrical circuit. The same designations are used in the text and in the list of parts below. This list includes the exact instruments used in the set from which these specifications were made up; however, there are other reliable makes of instruments which may be used in the set with excellent results. If other instruments than those listed are used, the only changes necessitated will be in the different spacings of the holes drilled in the panel for mounting them.

A—tapped primary winding, consisting of 45 turns of No. 18 S. C. C. copper wire.

B—secondary winding. consisting of 65 turns of No. 18 S. C. C. copper wire. (A and B are wound on a composition tube 3½ inches in diameter and 5¾ inches long.)

C—variable condenser .0005 mfd. (This condenser may be any reliable make in which the spacing between the edges of the rotary and stationary plates with the plates "all outs" is at least one quarter of an inch. In other words, a condenser with a low minimum capacity.)

D—filament rheostat, 5 ohms.

A1, C1 and D1—antenna switch knob, secondary tuning condenser knob and rheostat knob, respectively.

E—socket.

F—shelf panel, see Figures 2 and 3, 4 and 6.

G—brass angles for supporting the socket shelf. (See Figures 2, 3 and 4.)

H—grid leak (tubular), 1 or 2 megohms.

I—small phosphor-bronze angles for mounting grid leak. (See Figures 2 and 6.)

J—mica grid condenser, .00025 mfd. (This may be purchased or built according to specifications in the article on page 124 of the October, 1922, issue of POPULAR RADIO.)

K—phosphor-bronze contact fingers, for sockets. (See Figures 2, 3 and 4.) A regulation socket may be used instead of E and K.

L—binding posts.

M—switch points. (See Figures 5 and 6.)

N—small brass brackets. (See Figures 2, 4 and 6.)

O—peep-holes viewing the filament of the vacuum tube. (See Figures 5, 6 and 7.)

P—composition panel on which the instruments are mounted.

Q—cabinet, made of hard wood.

R—taps on the primary coil for antenna tuning. (See Figures 3 and 8a.)

How to Construct the Set

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

First of all the panel should be cut to the correct size (9 by 10 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 7. 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 condenser C should be mounted in the lower left-hand corner by means of two screws fastened through the panel, as shown in Figures 4, 5 and 6. The large dial (C1) should then be fastened to the shaft of the condenser as shown in Figures 4 and 5.

The rheostat D should then be mounted in the proper place with two screws (see Figures 3, 4 and 6), and the small dial D1 should be attached to it. (See Figures 4 and 5.)

The seven binding posts L may then be inserted through the panel and fastened tight by means of nuts on the rear of the panel P, as shown in Figures 3, 4, 5 and 6.

The next step is the preparation of the shelf assembly F. This shelf panel should be cut to the correct size (see Figure 2) and should have two brass strips G (Figure 2) fastened along its sides as shown in Figures 3, 4 and 6.

A square hole should be made in the shelf (as shown in Figure 2) for the socket, and the holes for the screws which secure the contact fingers K to the shelf should be bored and tapped. The fingers K are then fastened in place on the under side of the panel and the socket spinning E should be screwed down on the top of the panel F by means of two screws, as indicated in Figures 3 and 6. As an alternative, an ordinary socket may be used and secured to the shelf if the builder does not wish to make the socket himself.

The two phosphor-bronze spring contacts I for mounting the grid leak may now be made

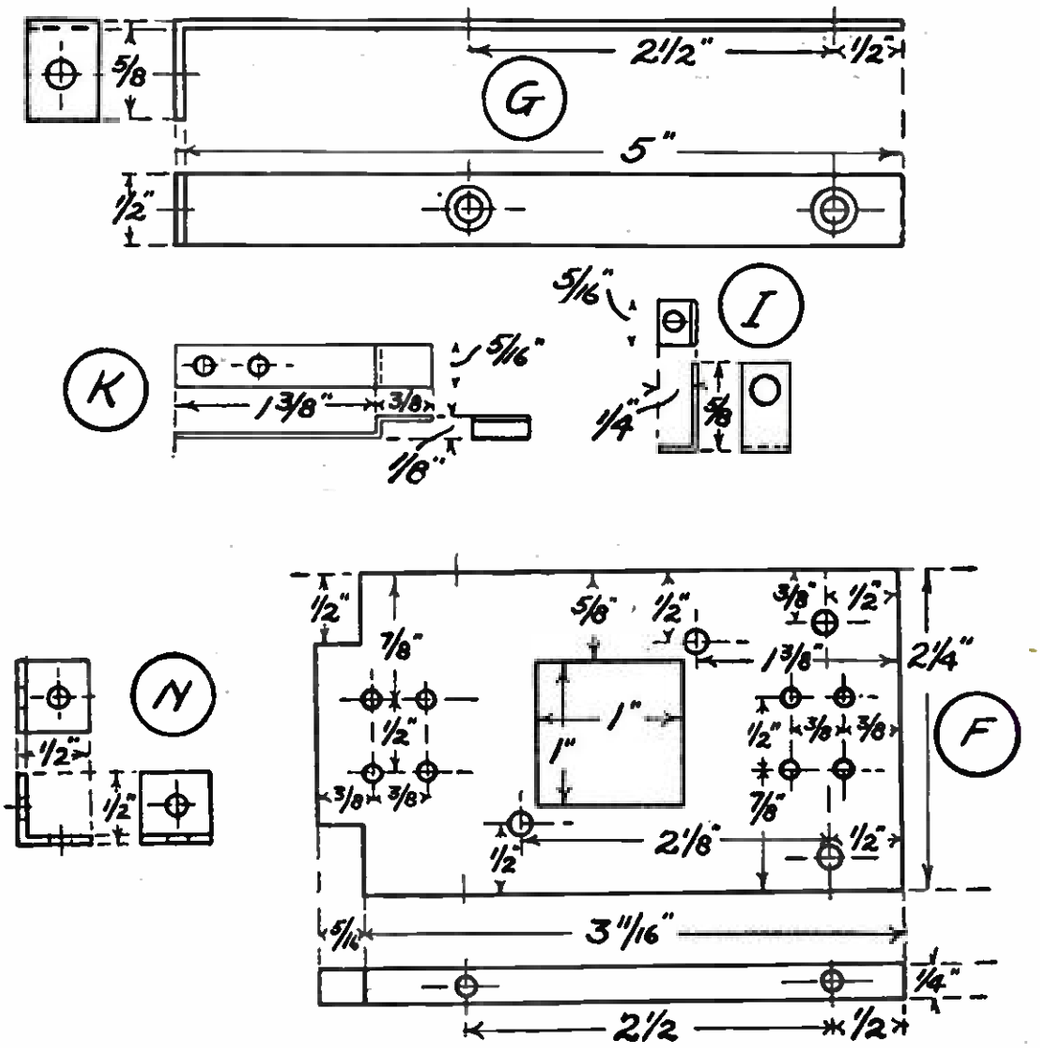


FIGURE 2

This diagram shows the dimensions of the metal brackets and contacts; also the correct shapes for bending. Pieces G and N are 1/16-inch brass. Pieces K and I are of springy phosphor bronze. Four of K are used for the socket contacts, two of I for mounting the grid leak, and two of G for supporting the shelf. The shelf should be made and drilled as shown at F.

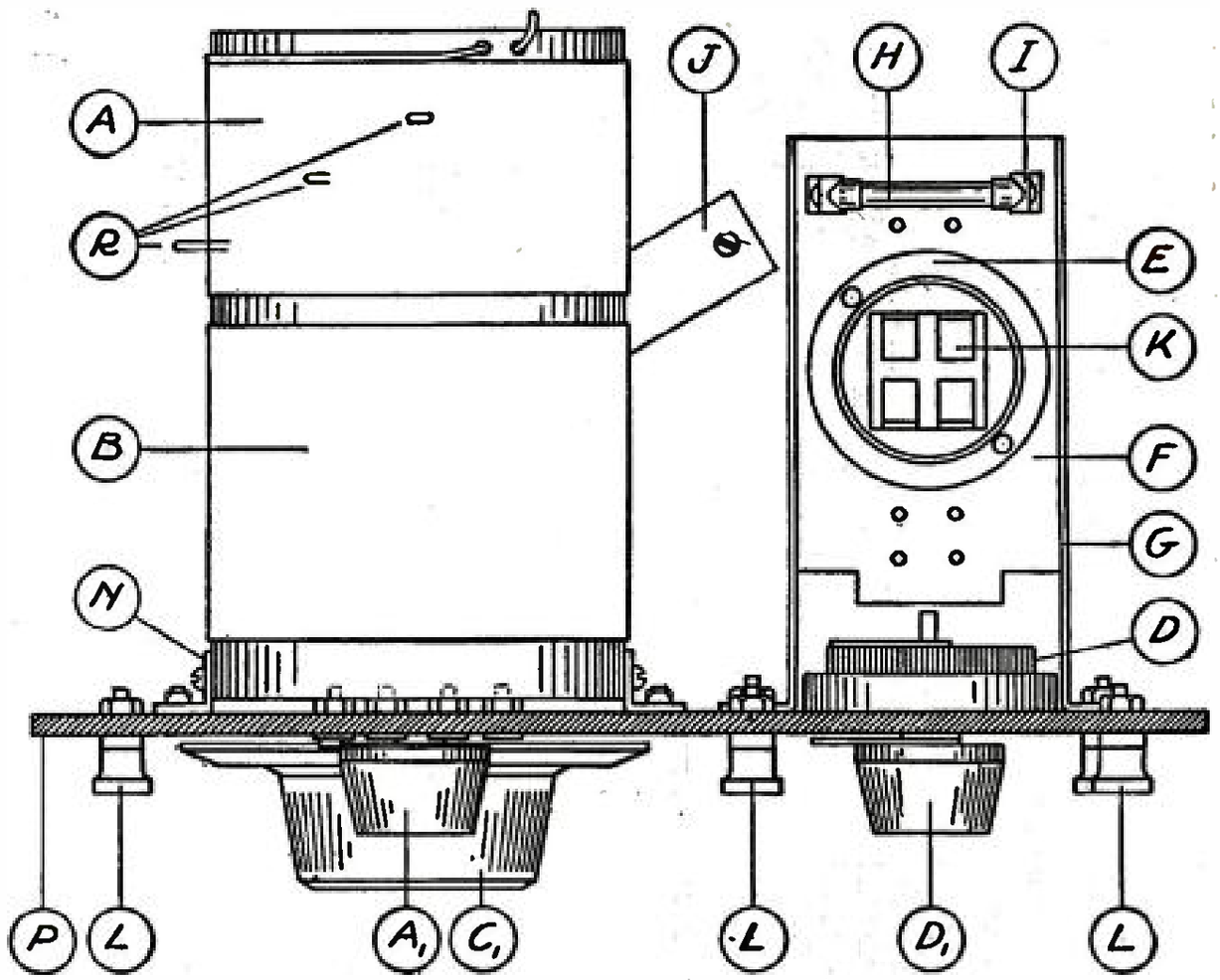


FIGURE 3

Top view of the set, showing the structural details for mounting the coil tube, the rheostat and the vacuum tube shelf. The binding posts are inserted through the panel and fastened tight with brass hexagon nuts. The condenser J is supported by the wiring itself.

(see Figure 2) and fastened as shown in Figures 3, 4 and 6. The grid leak H should be inserted in the two holes made in the contacts I for that purpose.

Mount the shelf F on the main panel P by means of two screws through the brass brackets G and the two holes in the panel on either side of the rheostat knob D1. The flathead screws are inserted through the panel and fastened on the rear by brass nuts, as shown in Figures 3, 4 and 6.

The next step is the preparation of the shelf tuner elements, consisting of coils A and B.

Start by cutting the insulating tube, which is 3½ inches in diameter, to a length of 5¾ inches. Bore two small holes a quarter of an inch apart in a line at right angles to the axis of the tube about ½-inch from one end of the tube. The holes should be just large enough to pass the No. 18 S. C. C. copper wire.

Now thread one end of the wire through one hole from the outside of the tube and then back through the other hole to the outside again, as shown in Figure 8b, and proceed to wind on 65 turns of wire that comprise the secondary coil B. Two more holes are then bored at the finish of this winding and the winding is terminated in the same manner as it was begun, by threading through these two holes.

One quarter of an inch beyond the last two holes bore two more starting holes for coil A and proceed in the same manner as with coil B, except that four taps are taken off, one at the 15th turn and one every 10th turn thereafter, as shown in Figures 3 and 8b; finish off in the same way as with coil B.

Leave the four end wires long enough for connections when the set is being wired; about six or eight inch lengths. The method of making a tap is shown in Figure 8a.

Now make the small brass angles N, as shown in Figure 2, and fasten the tube to the panel P. (See Figures 3, 4 and 6.)

Next, insert the four switch points M through the panel P and fasten with nuts on the rear of the panel. (See Figures 5 and 6.) The antenna switch knob A1 is fastened in place as shown in Figures 3, 4 and 5 and then the assembly work is complete except for making the grid condenser J. (Complete instructions for doing this were given in the

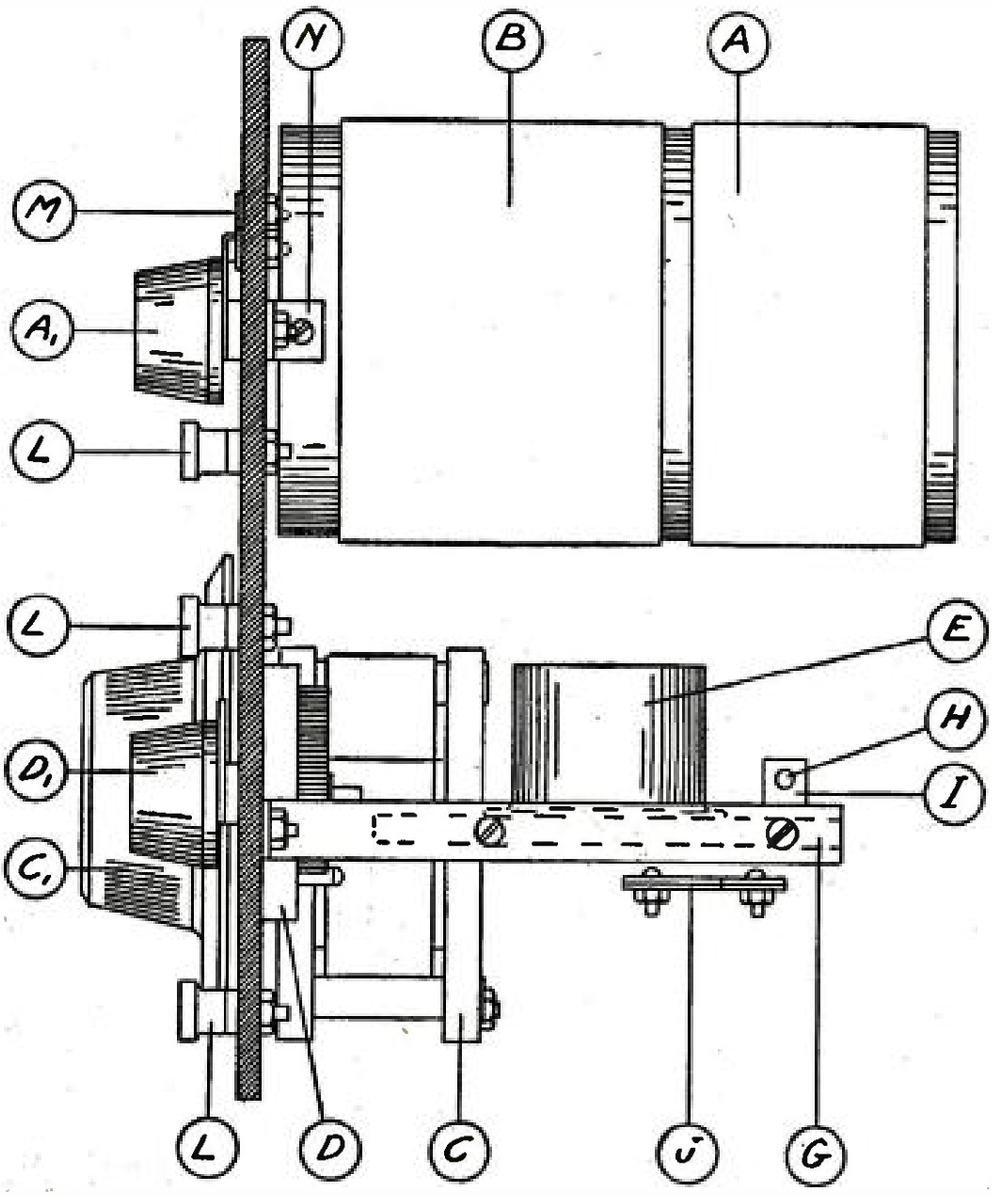


FIGURE 4

View of the set from the right side, showing how the shelf is fastened to the two brass brackets G by two screws which are threaded into the edge of the composition shelf. The coils are supported by means of two small brackets N.

October issue of POPULAR RADIO on page 24.)

It is much better to use mica dielectric condensers than the paper condensers. Any good mica grid condenser of .00025 mfd. capacity is suitable. The grid condenser is supported in place by the connecting wires.

A cabinet for the set may be obtained from a cabinetmaker at a reasonably small cost. Give the cabinet man the diagram in Figure 9 and ask him to make it of hard wood.

How to Wire and Connect the Set

Start by wiring the filament circuit and the "A" battery connections from the diagram in Figure 1. A good method for the beginner to follow is to select a connection running between two instruments on the diagram and wire up this connection in the set. When this is properly done, trace the same line over on the diagram with a colored pencil and you will know that that wire is completed correctly. If the same procedure is followed with all the rest of the connecting wires in the set you will have a sure check that nothing has been left out and no wrong connections have been made—all the connections on the diagram will have been covered with a colored pencil mark. If you have forgotten some detail, the omission will show on the diagram, as it will not be covered by a colored pencil mark.

When the filament circuit is completed connect the coil A to the antenna switch A1 by running the taps in through the end of the coil and soldering to the switch points M. (It may be necessary to loosen the tube from the panel to do this.) Then connect the antenna and ground binding posts as shown in Figure 1.

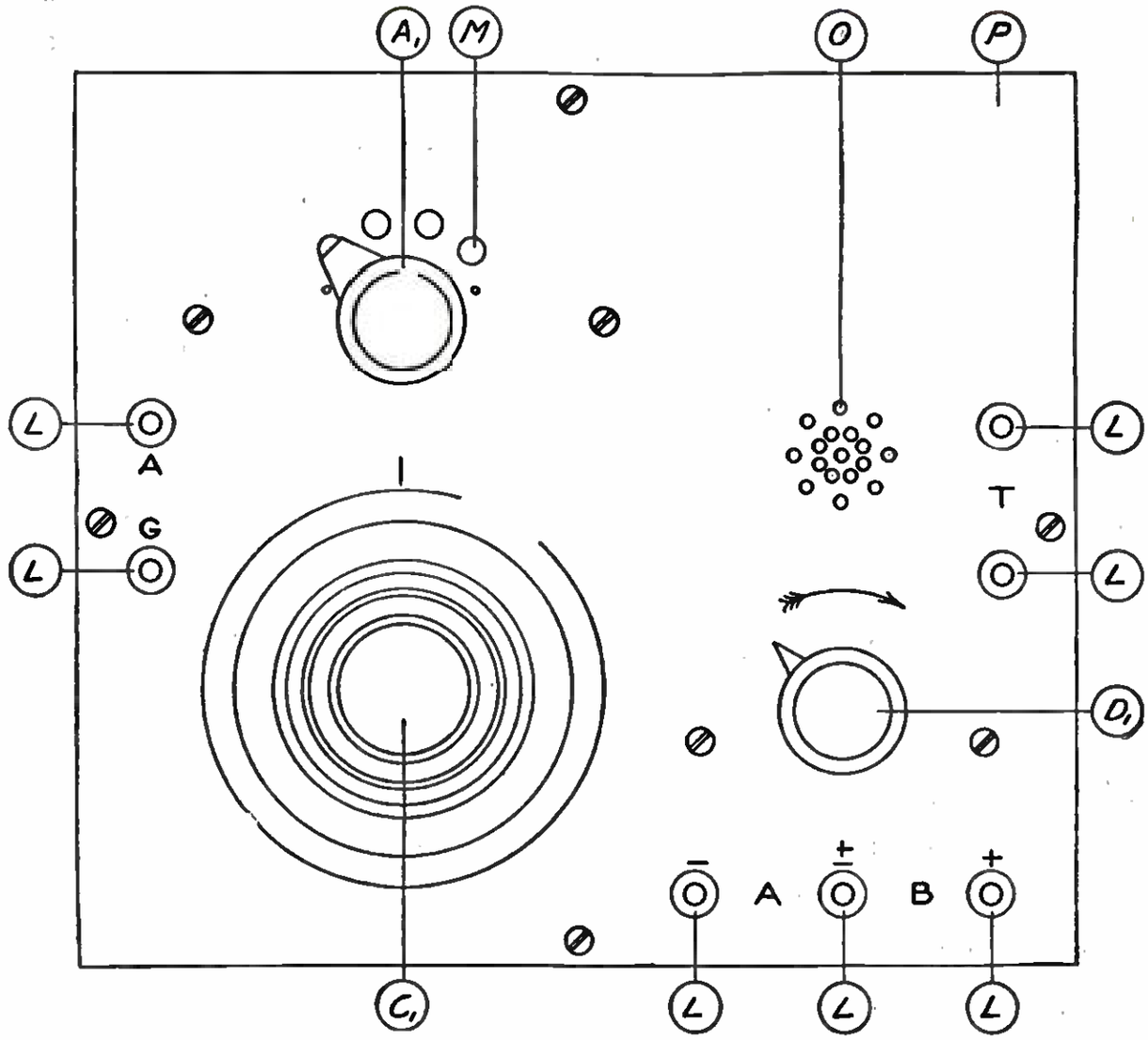


FIGURE 5

The layout for the front of the panel. This is the way the set will look when completed, provided the holes for mounting the instruments are drilled as shown in the diagram in Figure 7.

Next, wire up the secondary coil B to the vacuum tube grid and plate circuits, including the two binding posts L at the right side of the set (looking at the front of the set) in series with the plate of the tube. These two posts are for the telephones. The three binding posts at the bottom of the set are for the batteries. The "A" battery is connected between the outside left-hand post and the middle post, with the *positive* terminal on the middle post; and the "B" battery is connected between the outside right-hand post and the middle post, with the *negative* terminal on the middle post. (See Figures 1 and 5.)

The antenna and ground connections are made to the two binding posts at the left.

Operating Data

The following hints may be of value:

The set may be used with almost any type of antenna which has a horizontal length of over 75 feet, although, as stated before, a 100-foot single wire will be found best. It is best to use a water pipe for a ground.

To operate the receiver, turn on the filament of the tube by revolving the knob D1 in a clockwise direction until the correct filament brilliancy is obtained. Set the antenna switch A1 on the correct contact point for the wavelength on which you wish to receive (this will depend on the length of your antenna and should be determined by experience); and rotate the knob C1 until the desired signals are heard. Final adjustment with the filament knob D1 will boost up the strength of the signals to a maximum.

It should be remembered that the tuning with the dial C1 is very critical and the dial should, therefore, be rotated slowly and carefully. The amateurs tune somewhere between 0 and 15 on the scale and the broadcasting stations somewhere between 20 and 40. Ships tune in between 90 and 100 on 600 meters.

This set may be used with either a soft or hard six-volt filament tube and battery, or it may be used with a WD-11 1½-volt fila-

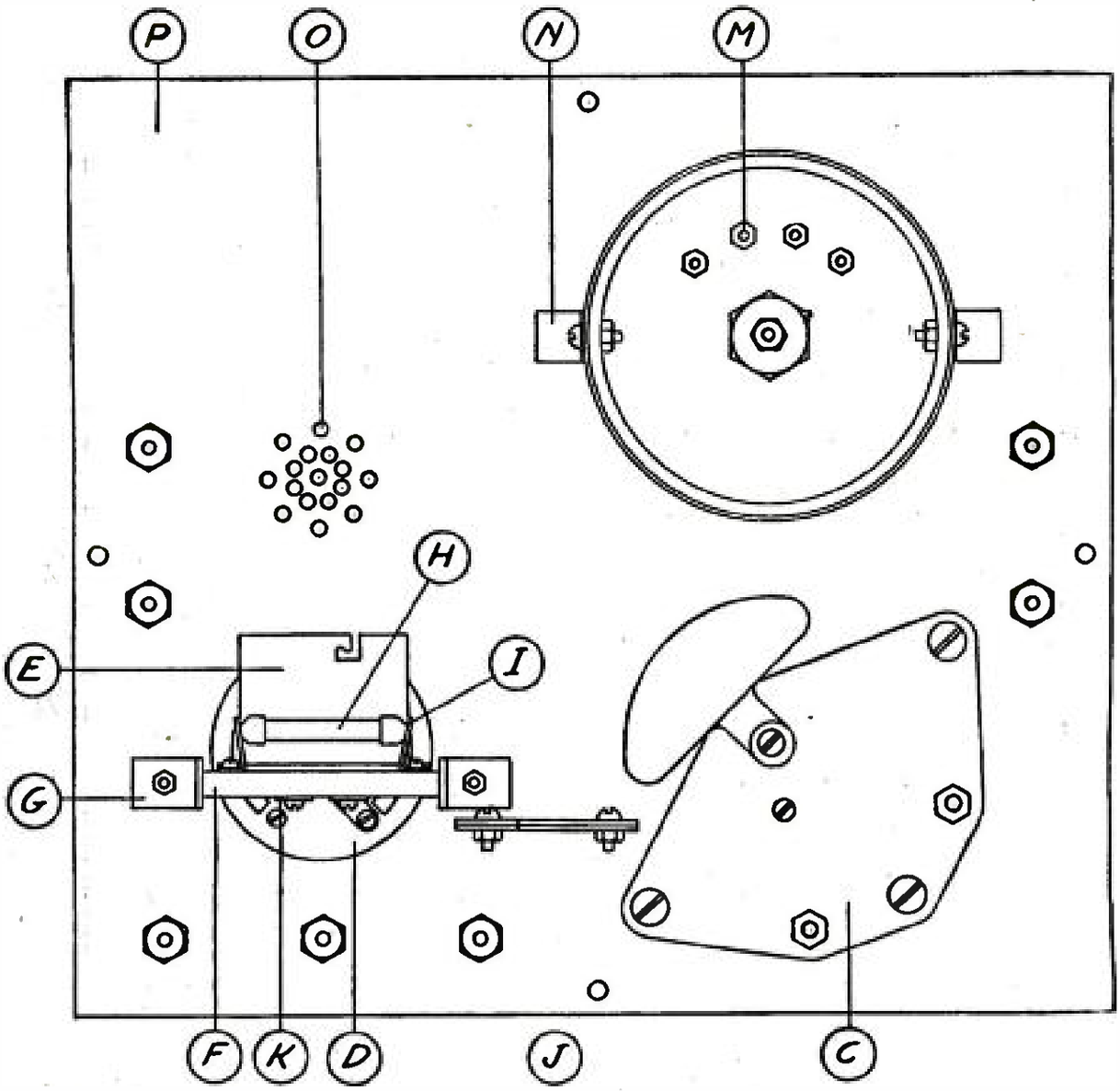


FIGURE 6

The rear view of the panel. The condenser C is mounted directly underneath the coils A and B, with the socket shelf right alongside of it. This arrangement does away with long connecting-wires which are a detriment to tuning efficiency in a set.

ment tube and a dry cell. The latter tube is recommended in case this is the beginner's first set, as it will run on one dry cell for a considerable length of time. If this tube is used it will require an adapter for fitting into the standard socket. This adapter is shown in Figure 10.

The set combines low price, simplicity of construction, sharp tuning, with a good distance range, and anyone *can* make and operate it.

You can do it!

HINTS FOR THOSE WHO BUILD THIS SET

DON'T rush at this job and make the set with any makeshift parts that you happen to have on hand.

DON'T do a sloppy job on the set; it is a simple piece of apparatus, and you should take pride in doing it well.

READ this article over two or three times before even deciding to make the set; in this way you will get a better idea of the task and be able to plan out just what you need in the way of supplies if you do decide to make it. Read the article through carefully enough times to become familiar with the design and construction.

Go over the list of parts and check off the material you may have on hand already.

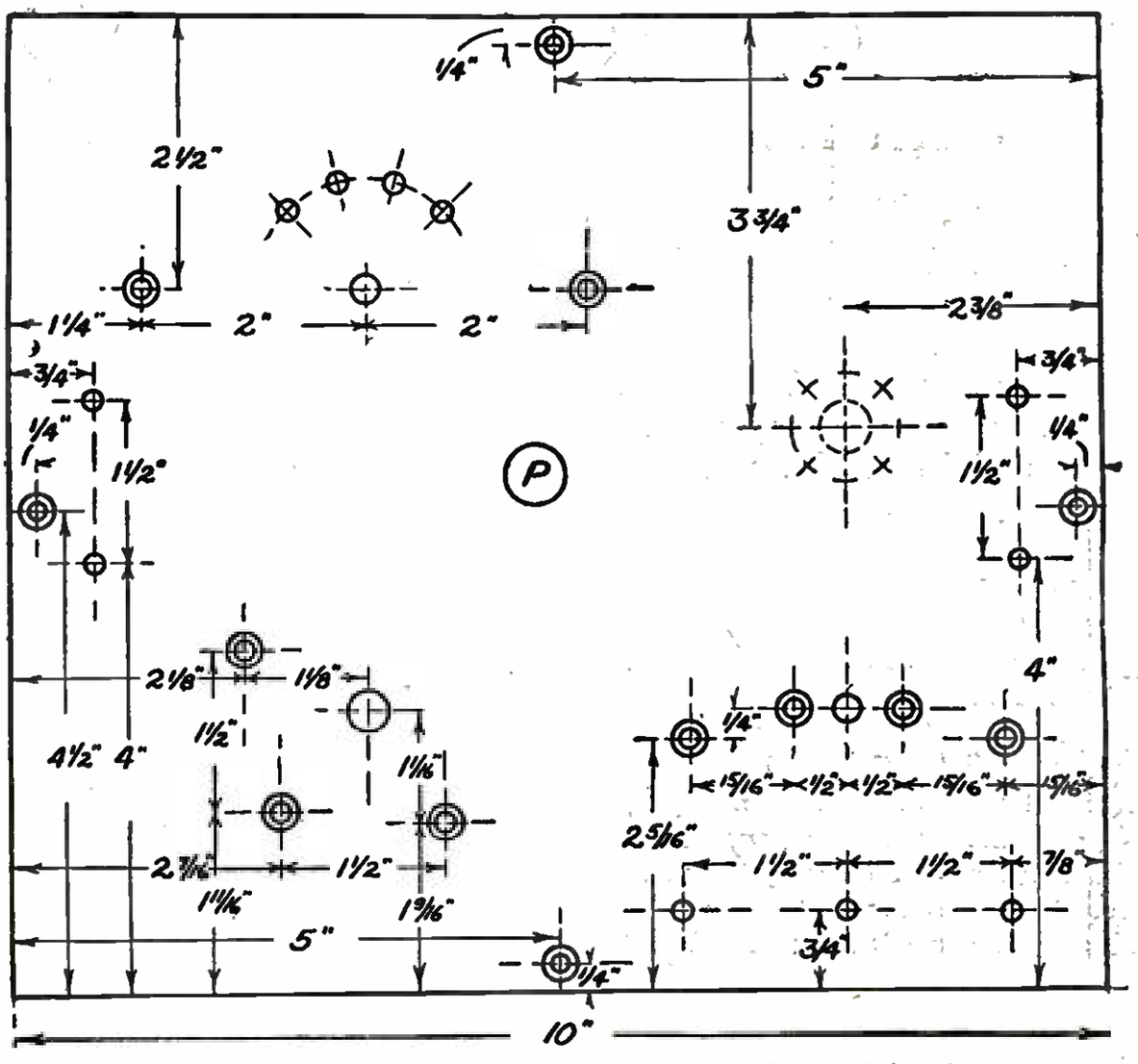


FIGURE 7

The above drawing gives the details for drilling the panel P. The holes outlined with a double circle should be counter-sunk so that the flathead screws will be flush with the panel surface.

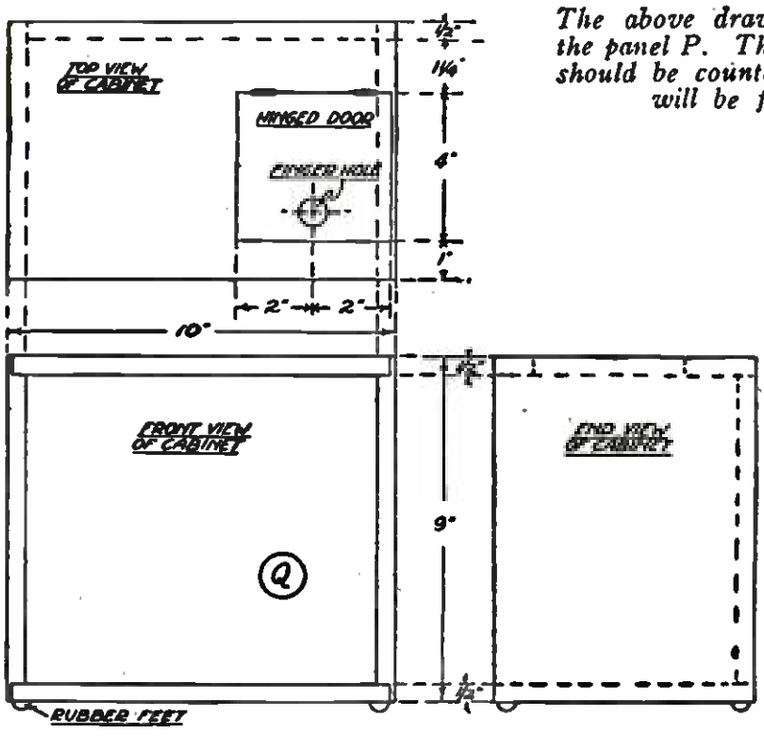


FIGURE 8

The dimensions for the cabinet. Give this drawing to a cabinet maker and have him do the work for you.

THE ADAPTER FOR THE 1½-VOLT TUBE

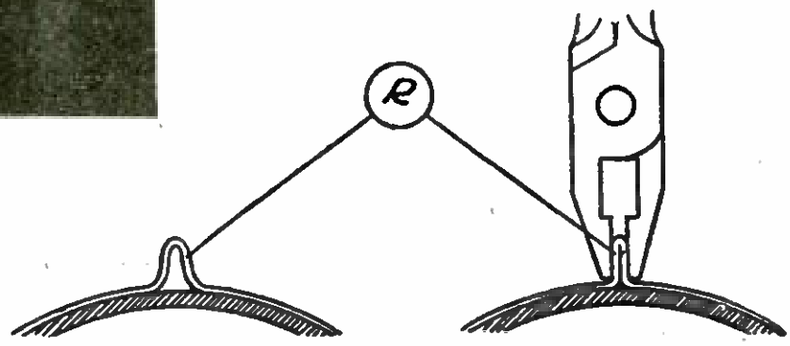
The tube is pushed into the adapter and then the adapter is inserted in the socket in the same manner as an ordinary tube.

CONSULT our advertising columns for the apparatus you have to buy.

AFTER getting all the parts, re-read the article again and get all your tools together and everything in readiness for the job.

START building the set exactly as the operations are described in the article, starting with the preparation of the panel and finishing with the wiring, and *sticking to details all the way through.*

IF you are a beginner you will probably take at least a week to learn how to tune the set to get good results and even from that time on the set will seem to improve and you will reach out for greater and greater distances. This means that you will have been learning to tune it better and better. Learning how to tune a radio receiver is something like learning how to ride a bicycle. It takes practice and concentration, but when you have the knack, you do it without thinking.



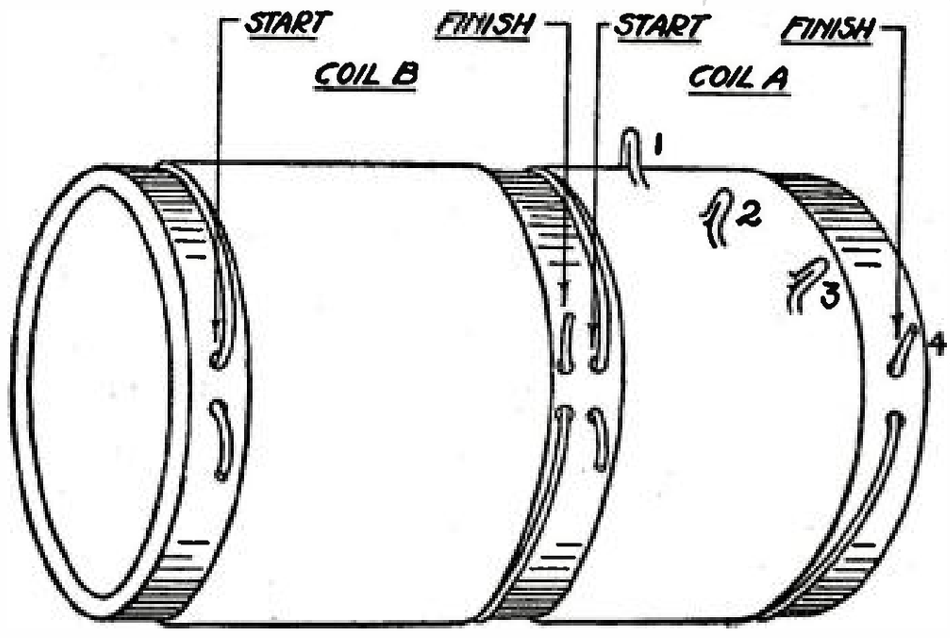


FIGURE 9

The top part of this diagram shows how to make a tap. It is squeezed together with the pliers after the coil is completed. The lower portion of the diagram shows how the coils are started and finished.

THE REMARKABLE NEW

"Glow" Transmitter

The microphone without a diaphragm—an instrument which contains no moving parts and which converts sounds into electric currents by means of a vibrating column of ions

By DAVID LAY

Westinghouse

THE "PILLBOX" MOUNTED IN ITS CASE

The inventor, Dr. Phillips Thomas, is a consulting engineer, who is a member of half a dozen learned societies and a former Major in the Chemical Warfare Division of the Army.

A CONCERT over the radiophone ought to be heard as perfectly as though the listener were actually present in the concert hall. That is the ideal. There is a good chance that it will soon be a reality. We need only a few more improvements as successful as the new glow discharge transmitter* devised by Dr. Phillips Thomas of the Westinghouse Research Laboratories.

I saw this transmitter a short time ago at KDKA, the Westinghouse broadcasting station at East Pittsburgh. I heard it work. Unless I am much mistaken, it is destined to be one of the four or five important radio inventions, perhaps the single one which will add broadcasting to the permanent amusement *repertoire* of the United States.

The new transmitter looks like an ordinary drugstore pill box. You could put half a dozen of them in your pocket. One end of the pill box is open, or rather this end is closed only by a fine-mesh screen, to keep out the dirt. Inside the box you see a little glittering point of light. This is the bright spot at the negative end of the discharge. You talk at the pill box and every tone and inflection of your voice goes out with the broadcast wave. You play music at the pill box and the music goes out; goes out exactly, every overtone and shade of tonal color reproduced precisely as it was played.

If you have been listening in on KDKA lately, you have probably heard the new transmitter without knowing it. You have wondered, perhaps, why the music seemed to be so much richer and fuller on some nights than on others. That may have been, of course, because of better tuning of your receiving set or because of unusual freedom from static,

*Announced for the first time in POPULAR RADIO for March, 1923.

but probably it was simply because Dr. Thomas was trying his transmitter.

All tests have been successful and the transmitter will soon go into service as the only transmitter used at KDKA, for music, if not for all kinds of broadcasting. Thus will pass into history one of the great worries of the broadcast impresario; worry over how to seat his orchestra, how to balance and tune his instruments, how to coach his players in order to get even a passable result.

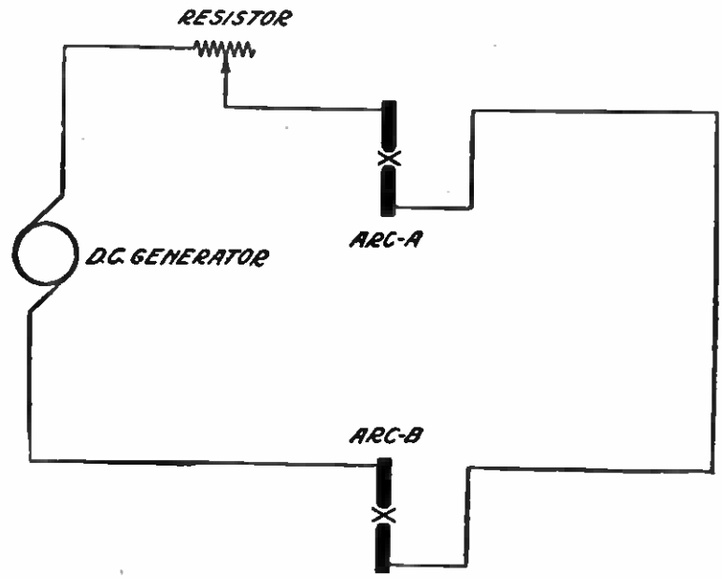
This broadcasting of instrumental music, especially of orchestral music, has always been extremely difficult. The orchestra produces too many kinds of tones. Not only do the tones range in pitch from the treble squeak of the piccolo to the growl of the double-bass, but they vary also in quality, in what musicians call "tone color." A note played on the clarinet, for instance, does not sound like the same note played on the cello. All of the minute variations in pitch and quality, the broadcaster of instrumental music must reproduce. He must contrive, somehow, to get each tiny shade of sound into the ether wave which carries his concert to the waiting audience.

With the usual types of transmitter this is worse than difficult; it is impossible. A transmitter which registers well enough the high tones of the wood-wind, usually fails on the deep tones of the brass or of the organ. One which reproduces successfully the moderate pitch of the human voice, fails both on the high tones of the orchestra and on its low ones.

This was the situation when the problem was tackled by Dr. Thomas and his associates.

A large part of the trouble they traced to the transmitter or microphone. Radio telephony requires two devices, neither of which is new. One of these is the transmitter, the other is the earphone used in the receiver. These have similar purposes. They change sound energy into electric energy, and *vice versa*. The transmitter picks up sound and converts it into electric energy. The earphone receives electric energy and converts it into sound.

The trouble with broadcasting heretofore has been that the transmitter did not do its part of the job very well. It has failed to convert the sound waves



THE PHENOMENA OF "THE TALKING ARC LAMP"

Electrical students will remember their laboratory experiment in which two arcs were connected in series with a generator and a resistor; when the arc A was spoken into, the arc B (which may have been located in another room) repeated the spoken word. Here was another case of sound waves that were picked up by means of an electrical discharge.

perfectly into electric waves. Some kinds of sound, certain tones or over-tones, it would not convert at all.

The culprit in the transmitter is the diaphragm. All of the usual devices for converting sound into electric energy—the transmitter, the telephone, the microphones—operate by means of a vibratory diaphragm.

Consider the ordinary telephone transmitter. Inside the mouthpiece is a thin plate of metal. This is the diaphragm. When sound strikes it, it vibrates just as the windows will rattle from an explosion or from a deep and powerful organ note. The back and forth vibration of the diaphragm is changed into an electric vibration by means of a loose contact with a carbon button, or by an electro-magnet, or in some other way. The exact way does not matter. The important point is that there must be a diaphragm. And if the diaphragm fails to respond perfectly to each tiny vibration of the sound waves, the conversion of the sound into electric waves, its transmission by telephone or its broadcasting, will not be perfect.

Now this, as it happens, is exactly wherein diaphragms fail. They do not respond perfectly to the sound waves. It requires a certain amount of sound energy to make a diaphgram move, it requires a perceptible push against it, just as a cannon ball on a level table requires a push to make it move. This is the law of inertia. "Bodies at rest tend to remain at rest." When a sound wave hits the diaphragm it has to push the diaphragm in order to produce a vibration. If the sound wave happens to be a very feeble one it may be unable to push the diaphragm sufficiently. Right then that particular sound wave drops out. No wonder you cannot pick them up in your receiver. They have never even started toward you.

Another fault of diaphragms is their tendency to vibrate only in response to sound waves of a certain frequency or pitch; waves, that is, which have a certain number of vibrations a second. Any material substance which will vibrate in response to sound waves has a certain characteristic pitch to which it is naturally tuned, to which, as physicists say, it is resonant.

If two violins, side by side, have their A strings tuned alike, a note played on one A string will cause the other A string to vibrate and sound the same note. This is the phenomena of resonance, or sympathetic vibration. There is a story that Caruso, having ascertained the note of a wine glass by tapping it, sang that note at the glass with such intensity that the glass was shattered by its own resonant vibrations.

The diaphragm of an ordinary radio transmitter or of a telephone has a pitch corresponding to about 1,000 vibrations a second. This means that for a tone of this frequency the diaphragm will vibrate most easily. It will respond fairly well to tones not too far from this frequency; usually, for ordinary transmitters, to tones between about 200 to 3,000 vibrations a second. This is the approximate range of the human voice. For the speaking voice, therefore, this ordinary telephone repeats the tones well enough for practical purposes; in other words, the pitch range of the voice and of the ordinary sized telephone diaphragm are about the same.

But when we come to music this range is not enough. The highest note of the piano has over 3,500 vibrations a second. The orchestra goes higher (for instance the piccolo, on its highest D, reached a pitch of 4,750 vibrations a second). Some of the instruments, on the other hand, go too low for the ordinary diaphragm. The bass viol, the tuba and the bassoon go well below 100 vibrations a second. The deepest pipes of large organs go down to 16 or even to 8. For these extreme tones, both high and low, the ordinary diaphragm is worthless. It cannot pick them up at all; it cannot, so to speak, hear them. It fails to translate them into electric pulses and they

Westinghouse

A PRACTICAL TEST OF THE NEW TRANSMITTER IN THE STUDIO

Here the transmitter must register not only the thrilling tones of the soprano and the booming notes of the basso, but it must reproduce truthfully the hundreds of tone variations which are present in the music of an orchestra.

drop out of the music which is sent.

This was the situation which confronted Dr. Thomas. All existing transmitters worked by means of diaphragms. All diaphragms were bad in principle. At least they were not perfect. What was needed was a transmitter without inertia, and with the capacity to respond to all tones, regardless of pitch.

It did not seem likely that any diaphragm could be constructed to meet these conditions and so Dr. Thomas was bold. He threw the diaphragm away. He rejected altogether the principle of the diaphragm transmitter and set out after a new principle. He found it. It was the principle of the direct-current glow discharge, the principle which he uses in his new transmitter.

Twenty years ago physicists used to play about in the laboratory with an interesting scientific toy, the "talking arc lamp." You connected two direct-current arc lamps in the same circuit together with certain condensers and inductances. You talked at one of the arcs so that the sound waves from your voice hit against the flame of the arc. The other arc, connected in series with the one you talked at, repeated your words. The two arcs were put in different rooms, so that an arc lamp burning peacefully on the classroom table could be made to inquire about the football score or the trim of the professor's whiskers, much to the amusement of the embryo physicists.

Evidently the arc converts sound waves into electrical waves by variations of its arc length due to passage of currents of modulated air. Hence, since there was a definite mass of heated ma-

terial in the arc stream, it took more energy to push through high notes than low, so that it had a slight frequency discrimination. It also took so much energy, all of which was converted into heat, that the electrodes burned away quite rapidly and it was impossible to prevent hissing and sputtering, either continuous or intermittent. The high temperature at the electrodes precluded the use of any pure metal alloy, which might have served to reduce the noises.

This new discharge transmitter is in no sense an arc. Its characteristics are all radically different from those of an arc. It is not in any sense a reversion to the ordinary speaking arc.

The new development is a means of utilizing the change in voltage-current characteristic of the massless portion of a glow-discharge ionization current, this change produced directly by air pressure changes in the current stream.

The glow discharge has two sensitive portions, the Faraday dark space and the positive column. The Faraday dark space is massless and is the portion used in the new transmitter.

The successful completion of this work required months of patient research and the perfection of a multitude of details. It was necessary to discover what voltage and amperage of the discharge would make it both permanent and properly sensitive to sound. It was necessary to find a satisfactory material for its terminals, a material which would neither burn out too fast, nor interfere with sound sensitiveness, nor produce bubbling or sizzling sounds of its own. It was found, among other things, that only half of the discharge was adequately sensitive to sound waves. The other half of it had to be shielded by a hollow insulating shield.

All these details have been worked out satisfactorily. The discharge is operated by direct current. The gap length is only a millimeter or two between terminals of a special alloy. The voltage used is about 3,000 volts, but the amperage is extremely low—so low that the high voltage constitutes no danger to life. Tests with the discharge as a transmitter have shown perfect conversions of sound vibrations, perfect modulation, from frequencies as low as 10 or 20 vibrations a second up to over 6,000 vibrations a second, and probably as high as the audio limit of 15,000 or 20,000. And each electric pulse corresponds in intensity to the sound pulse which gave rise to it. The sequence of electric vibrations is an exact copy of the sequence of the sound vibrations which set it up.

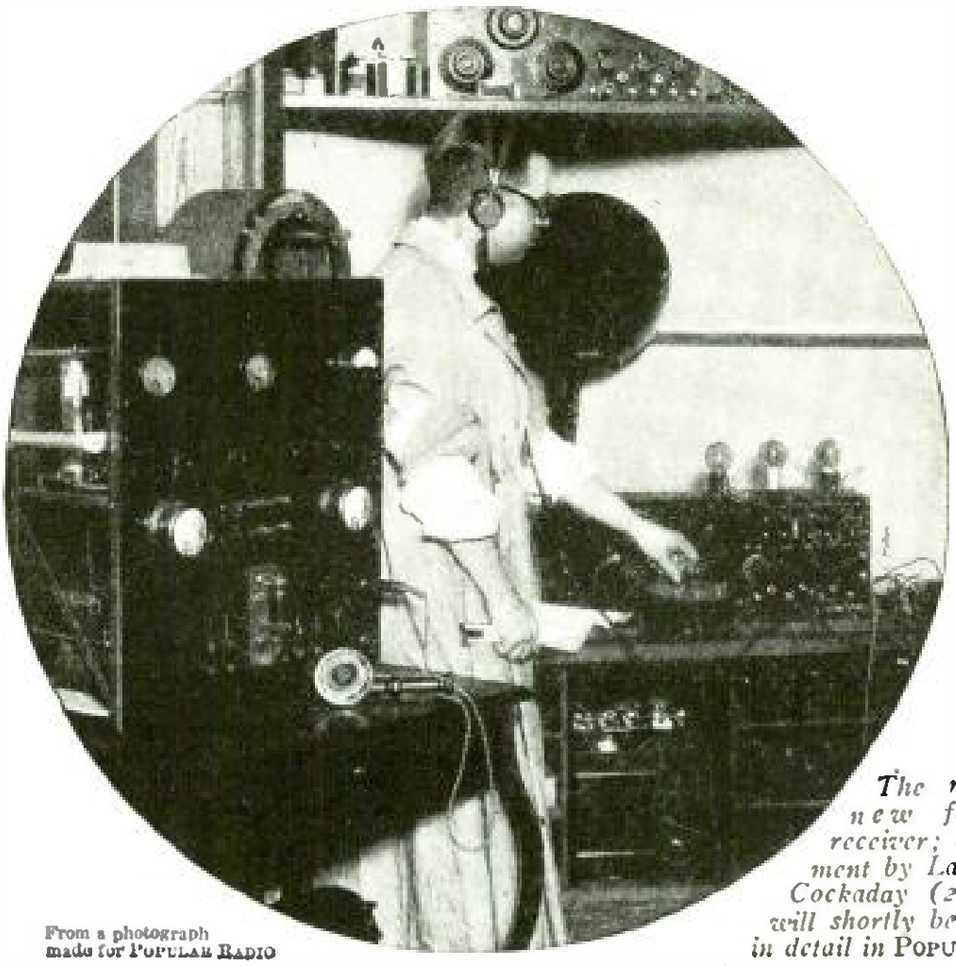
That is, the broadcasting is for the first time perfect. If anything is wrong with the music now it will be in the receiving set or in the musician, not in the transmitter.

The new transmitter was developed for broadcasting, but its usefulness will not stop with this. One imagines that it will be a useful tool in general scientific investigation. There is, for instance, much talk about the means of communication between insects. It seems evident that insects can communicate with each other in some way which we do not understand. There are two suggestions. One, due to Dr. E. P. Felt, State Entomologist of New York, is that insects may be able to communicate by electromagnetic waves, by radio. Another suggestion is that they communicate by sounds too shrill for us to hear. The highest pitch audible to even the most acute human ear is about 20,000 vibrations a second. If insects produce sounds still more shrill than this we could never detect them by our ears alone. We could not hear them.

But Dr. Thomas' ionic detector *could* hear them. We could pick up such sounds, reduce their frequency, and make them audible. Or we could record them electrically.

And this is only one out of innumerable ways in which the new instrument, if it fulfils one-half of its promise, will be assisting the scientist and also, one feels sure, the common man.

¶ *"The radio engineer will be the prophet and the architect of a new social era, the inventor of the first successful system for the education of all the people."*—MAJOR-GENERAL GEORGE O. SQUIER.



From a photograph made for POPULAR RADIO

The remarkable new four-circuit receiver; a development by Laurence M. Cockaday (2XK) that will shortly be described in detail in POPULAR RADIO.

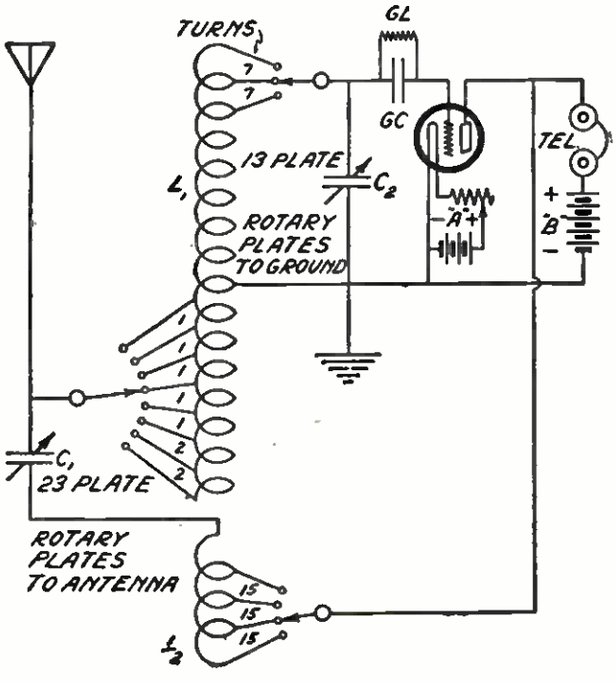
Five Modern Radio Sets

Examples of the Constructive Work That Is Being Done in the Development of the Radio Art by Experienced Amateurs

THE present-day interest in radio is the direct outgrowth of the tinkerings of that handful of American amateurs who first started to investigate the mysteries of "wireless" shortly after Marconi made his startling announcement that he could "telegraph without wires." Since that historic day the ranks of the amateurs have expanded until, a couple of winters ago, the broadcasting wave burst upon the public. Immediately everybody began to take more than a passive interest in radio. To the amateur lies the credit for the rapid development of this new art, both in the fields of experiment and of practical usage.

These five sets were shown at the annual exhibition of the Radio Association of Greater New York as evidence of what the amateur is doing in the construction of his own receiving and transmitting apparatus.

From a photograph made for POPULAR RADIO



THE WIDELY-KNOWN "REINARTZ" TYPE OF RECEIVER

This type single tube receiver is simple to build and consequently has found favor among the C.W. enthusiasts of this country and abroad. The tuning with the receiver is simple; distant signals may be picked up with ease with only one tube.

This set was built by Arthur K. Ransom (2QK). Mr. Ransom completed the set in two evenings' work at home. Immediately upon connecting it to his antenna and ground, he began to receive a long list of amateur and broadcasting DX stations. The set tunes sharply for C.W. and telephone stations, although it is not as selective with spark signals.

The main part of this set is the spiderweb combination inductance. It consists of two coils in one. The plate coil is wound on 9 spokes on a 2½-inch center by weaving in and out between the spokes. Taps are brought out at the 15th, 30th. and 45th turns. At the 45th turn the coil is broken and a lead is brought out.

The second coil is then started and wound in the same direction as the plate coil on the same form, and taps are brought out at the 2nd, 4th, 5th. 6th, 7th, 8th, and 9th turns to the antenna switch; a tap for the ground connection is made at the 10th turn, and taps are also made at the 26th, 33rd, and 40th turns for the grid switch. The coil may be wound on thin cardboard, with the spokes cut out with shears.

Two 23-plate variable condensers may be used. These condensers usually have a capacity of about .0005 mfd.

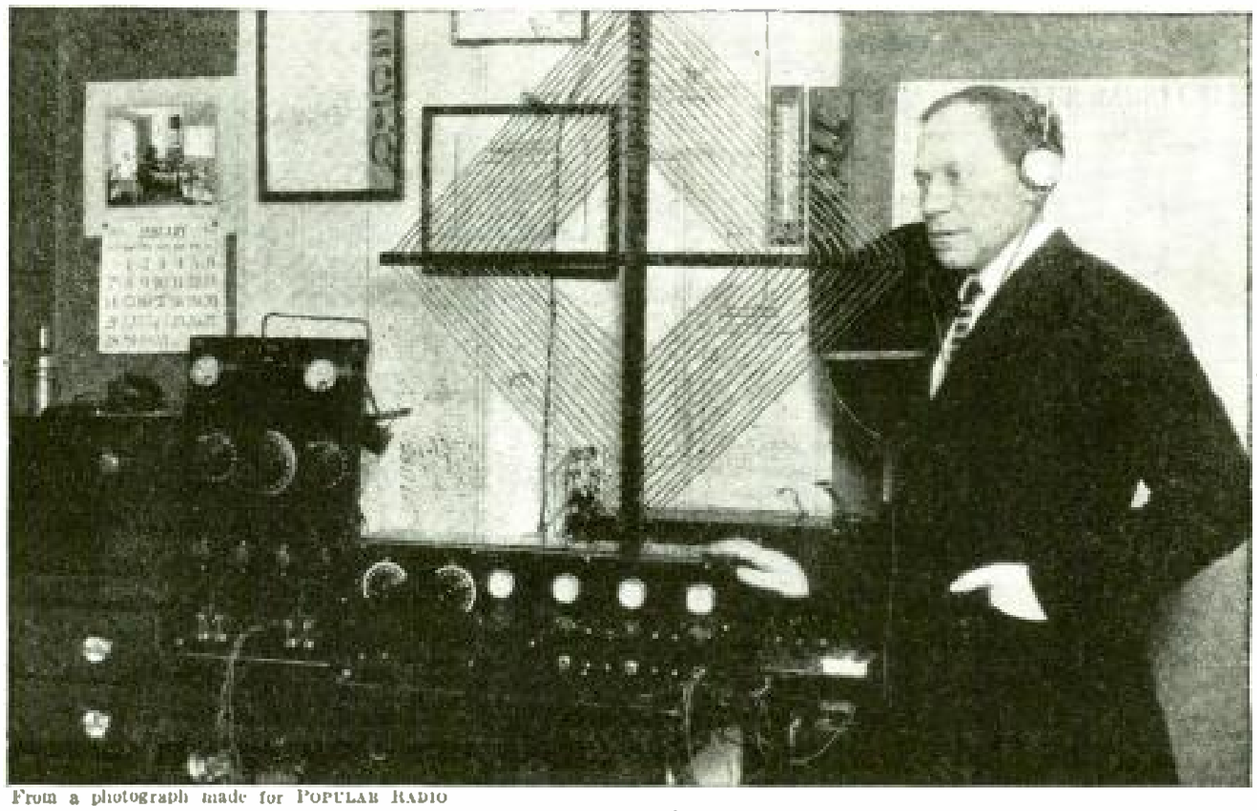
In this set the coil is centrally mounted on a bakelite panel with the antenna taps located directly beneath, and the grid and plate taps above.

The variable condensers are fastened to the panel on either side of the tuning inductance, and are equipped with knobs and dials for control.

All of the connections between the various instruments and switches are made with square tinned-copper bus-bar wire. The bus-bar connections are run in straight lines in a workmanlike fashion and the set has an appearance that is comparable with the best of commercially manufactured apparatus.

As all of the instruments and connections are mounted directly on the panel, the set may be taken out of the cabinet and inspected at any time without disarrangement of the wiring.

The set will tune from approximately 150 to 400 meters. It may be made to respond to higher wavelengths, however, by using 43-plate condensers (.001 mfd.).



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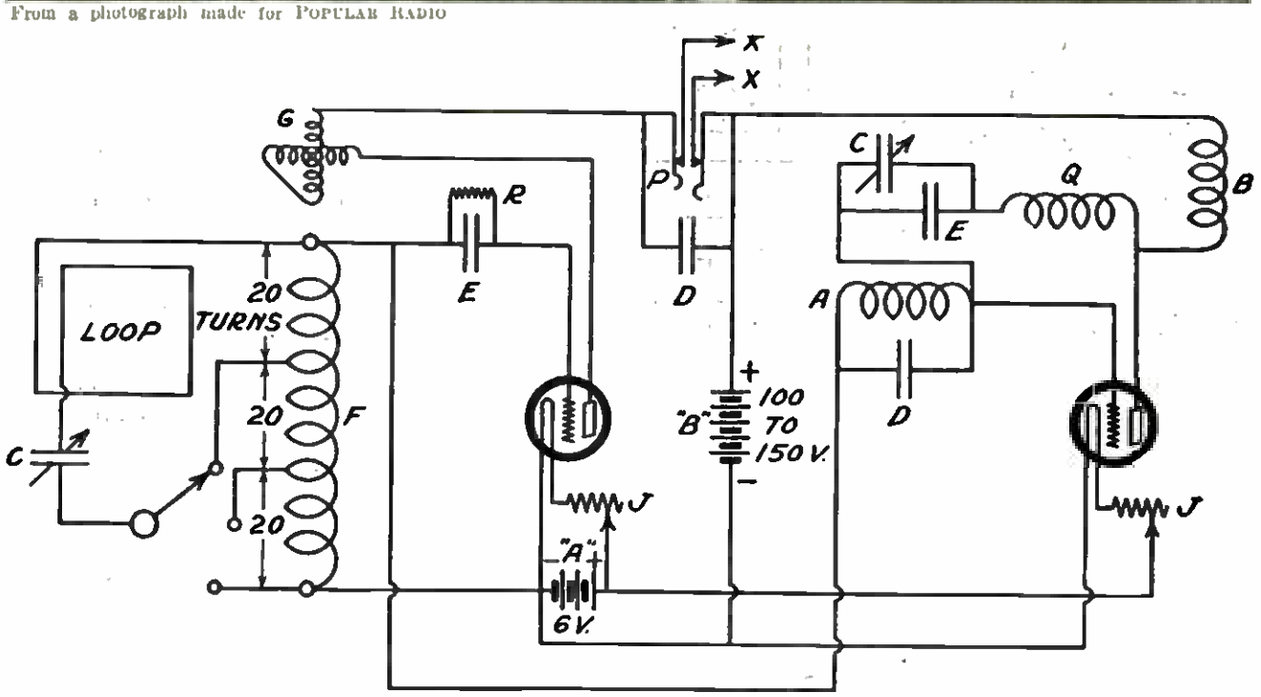


ONE OF THE BEST OF THE SUPER-REGENERATIVE SETS

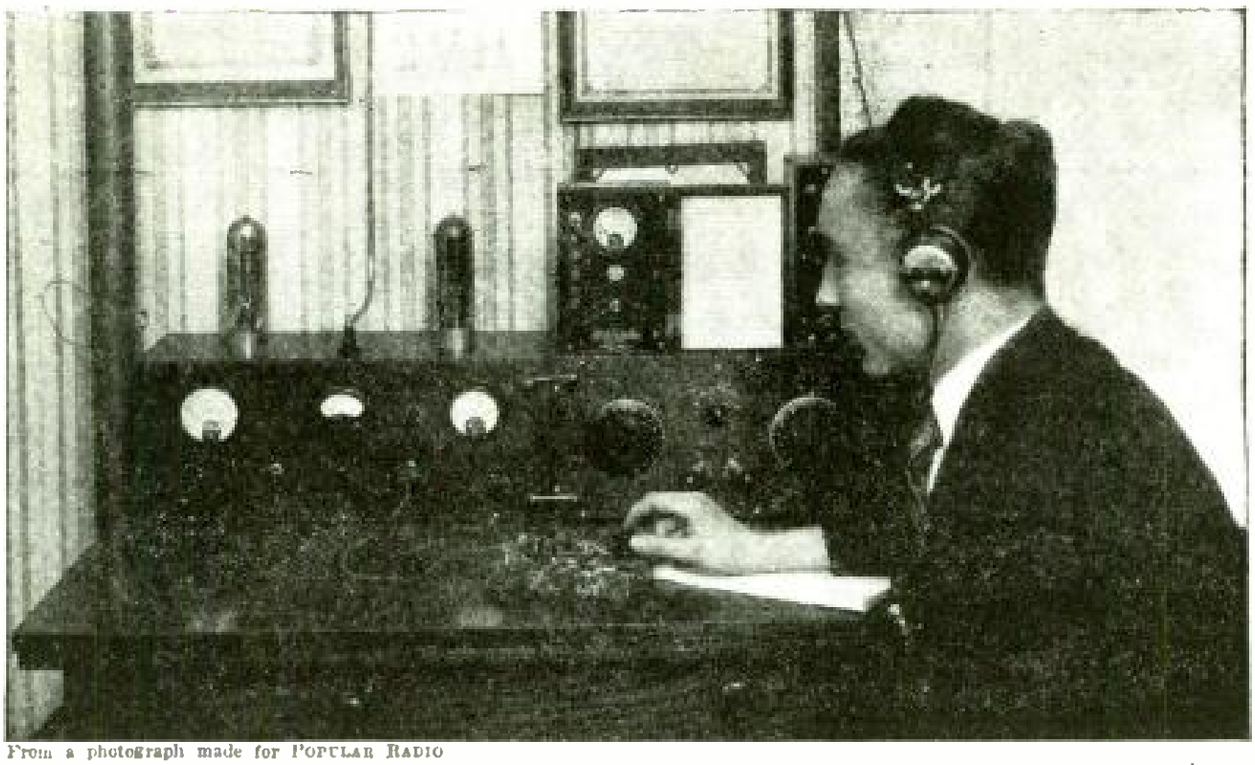
This receiving set was built by Leo Johnson (2CTQ). The parts used are:

A—honeycomb coil, L-1,250
B—honeycomb coil, L-1,500
C—2 variable condensers, .001 mfd.
D—2 mica fixed condensers, .002 mfd.
E—2 mica fixed condensers, .0005 mfd.
F—60 turn coil, of No. 18 S.C.C. wire, wound on a 3½-inch tube and tapped every 20 turns
G—variometer
J—filament rheostats
P—double circuit jack
Q—honeycomb coil, L-200
R—grid leak, 1 megohm

The loop antenna consists of 12 turns of tubular braided antenna wire wound on a loop 2 feet square. Two stages of audio frequency amplification have been added to the circuit at the points XX.

In operating this set it was found that Western Electric 216-A tubes gave superior results to other tubes, both in respect to clarity of reproduction and strength of signals.

The set operates on a loop two feet square which is wound with 12 turns of tubular braided antenna wire.



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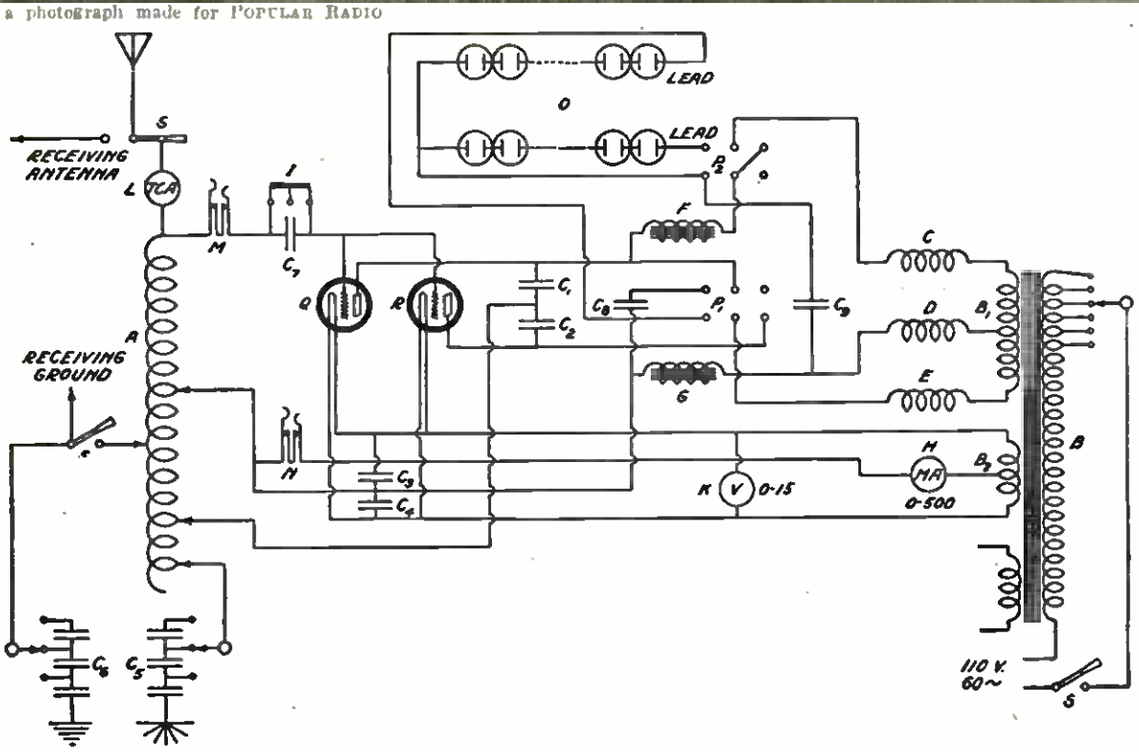
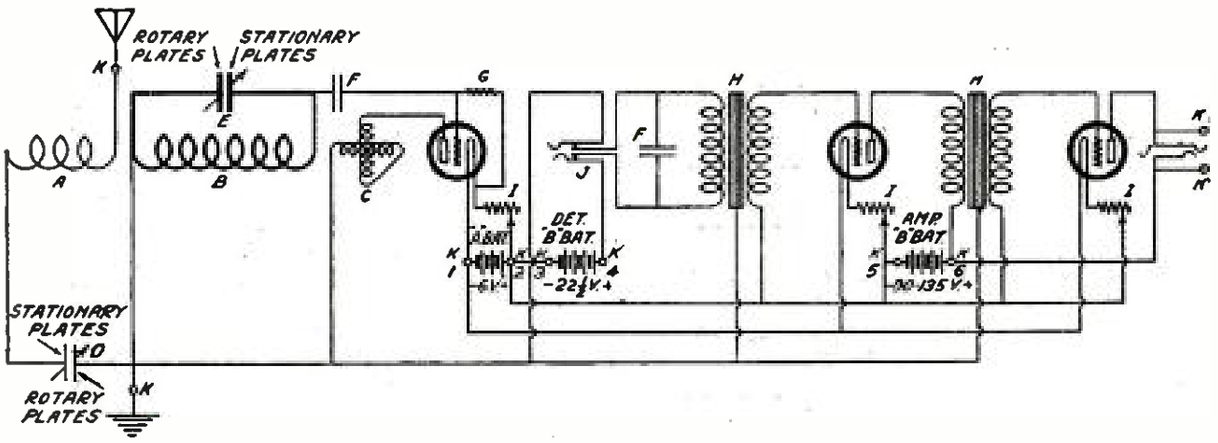


AN EXCEPTIONALLY POWERFUL C.W. TRANSMITTER

This set was built by Paul Haus (2VH). With this type of transmitter, the amateur is enabled to transmit to any district of the United States, to Cuba, and Canada, and across the ocean. Over 300 sets of this type were heard in Europe this winter. The parts used in its construction are as follows:

C1 and C2—high voltage condensers, .002 mfd.
C3 and C4—bypass condensers, .0005 mfd.
C5 and C6—series condensers, .0003-4-5 mfd.
C7—grid condenser, .0005 mfd.
C8 and C9—filter condensers, 1 mfd.
A—tuning inductance, 33 turns of No. 10 wire wound on bakelite strips; diameter of coil, 5 inches.
B—C.W. transformer, 750 watts
C, D and E—honeycomb coils, L-200
B1—high voltage winding, 1,500 volts each side of center tap
B2—filament winding, 12 volts
F and G—iron core chokes, 1½ henries
I—grid leak, 2,500 ohms
K—voltmeter, 0-15 volts A.C.
H—milliameter, 0-500 M.A.
L—thermo-couple ammeter, 0-5 amperes
M—jack for microphone transformer and chopper
N—key jack
O—aluminum-lead chemical rectifier, borax solution, 48 jars
P1 and P2—4 pole double throw switch
Q and R—UV-203 radiotron 50 watt tubes

From a photograph made for POPULAR RADIO



A REAL "DX" RECEIVER

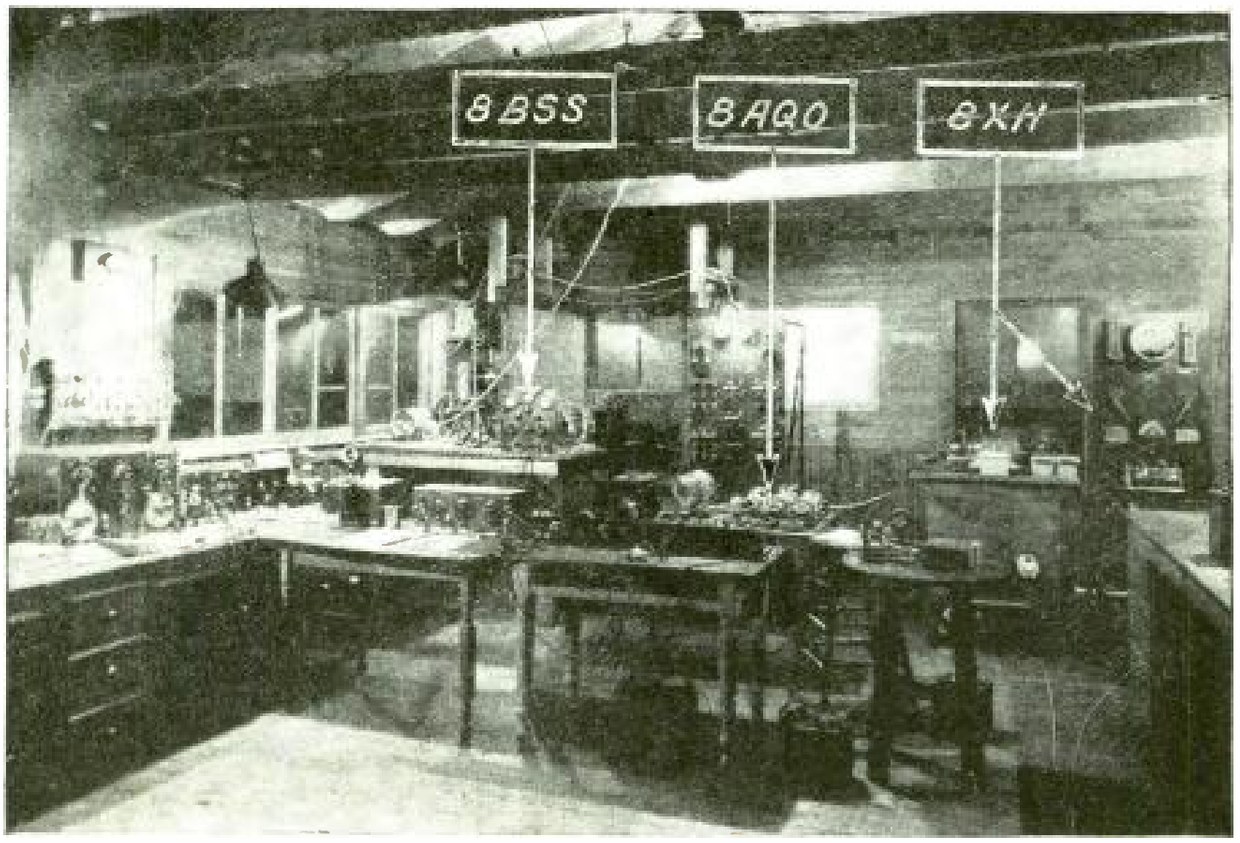
Long-distance receivers that are built by the amateurs themselves are usually wonderful pieces of apparatus, both as to design and construction; they offer convincing indication of just how much the amateur has contributed and is contributing to the art of radio. This receiver, built by J. C. Gorman, has picked up practically all of the broadcasting stations east of Denver, Colorado. It consists of the following parts:

A—primary coil, 25 turns No. 18 S.C.C. wire wound on a 3½-inch tube
B—secondary coil, 60 turns No. 18 wire wound on the same tube with ¼-inch separation between A and B
C—variometer
D—variable condenser, .001 mfd.
E—variable condenser, .0005 mfd.
F—mica grid condenser, .00025 mfd.
G—grid leak, 2 megohms
H—audio frequency amplifying transformer
I—filament rheostats
J—1 two-circuit jack and 1 single-circuit jack
K—binding posts

How many times has the novice had trouble with his set? How many times has he called upon a neighboring amateur for advice and had the more experienced man come over to his house and put his set into operation again? This is one of the pleasures of the regular amateur—to help his less experienced friends in their problems and to instill greater interest in radio among his acquaintances. Why not join a radio club yourself and learn more about radio?

Indeed, one of the most important activities of the amateurs is their radio club work. At these meetings, to which anyone interested in radio is welcomed as a visitor, lectures on new developments and apparatus are given, with educational features for novices and amateurs alike.

Engineers, amateurs and novices alike find much of interest in this association with their fellow radio enthusiasts at radio club meetings.



REPORTED TO BE THE "FINEST AMATEUR STATION IN THE WORLD"
This "three in one" radio station (its three call letters are 8AQO, 8BSS and 8XH) is owned and operated by C. B. Meredith of Cazenovia, New York. It was the star performer of the recent transatlantic tests, and was heard on the other side oftener than any other. It is probably the most complete amateur station in the world; its cost is estimated at about $30,000!

Over the World's Back Fence

The Radio Amateur Begins to Talk to His Neighbors On Other Continents

Just what effect the breaking down of international and intercontinental barriers by the radio amateurs may have upon civilization is a subject for hopeful speculation. But the widespread spanning of oceans on low-powered transmitters is a present and highly significant fact. How the amateurs are doing it is here told by the traffic manager of the American Radio Relay League, which organized the successful transatlantic tests.

BY F. H. SCHNELL

THE down-east farmer who tied a pair of his hip boots to the first telegraph wire and went back to his home in the hills confident that they would be delivered to his son in Baltimore—or was it Washington?—can now attach a pair of his hob-nailed shoes to the antenna of the nearest amateur station with the same hope that they will be sent by radio to his brother, Arthur, in South America.

If there were more of this type of individual who look to every new invention as having infinite possibilities, there would not be so many to marvel at the feat recently accomplished by American amateurs during the third transatlantic tests of the American Radio Relay

League which definitely established international amateur communication by radio.

It should be remembered that these tests were conducted by the radio amateur who knew more about "wireless" ten years ago than the vast majority of fans know today. Even without regeneration or vacuum tubes he was a "stickler" for the technique of the game and lost no opportunity to acquire technical knowledge. The amateur is a type which developed soon after Marconi's achievement became known to the world and he has ever been hopeful of some day catching up and saying:

"I'm with you old man; let's show 'em what we can do with this radio thing anyway."

This opportunity came with the third annual American Radio Relay League transatlantic tests. When 6KA, operated by F. E. Nikirk, of Los Angeles, California, loped across the country in its peculiar western fashion and started to tickle the ether around Paris about 15,000 amateurs in the United States, Canada, Porto Rico and the Hawaiian Islands took their receivers off, and with a grin spread across their faces, announced:

"Did we? I'll say we did!"

That the tests were a success beyond the amateurs' most hopeful dreams became evident long before the final reports had been prepared by the operating department. The first successful attempt of the British and French stations to transmit their signals to this country also gave evidence of the ability of American amateurs in reception, so that the results were highly satisfactory for all concerned. Although only three foreign stations 2FZ (the Wireless Society of Manchester); 5WS (the Radio Society of Great Britain) and 8AB (operated by Leon Deloy at Nice, France), "got across," it should be remembered that the total number of stations transmitting from these two countries was thirty-four, while 324 qualified for the final tests for transmission from this side of the Atlantic.

The radio amateurs of this country were literally "keeled over" by the report that 316 of their stations were heard by European amateurs, and straightway began to make ready for the final test of achievement; instantaneous two-way transmission of complete messages by the

De Georges

ONE OF THE FIRST STATIONS TO BE HEARD OVERSEAS

Harry Collins at work in his radio station 2AJW, at Babylon, Long Island. His small transmitter, with a few 5-watt tubes, he literally "threw together" in time for the transatlantic tests.

most efficient transmitting and receiving sets in both continents. This point achieved, and with reports coming in from remote countries and operators on board ships off the coast of Australia and Japan, American amateurs will be looking forward expectantly to that day in the not too distant future when their messages will encircle the globe.

The showing during the preliminary tests when British amateurs logged 23 American amateur stations was almost equal to the finals last year when Paul F. Godley was sent to Scotland by the League to copy the signals of the American transmitting stations. The number of stations heard during the first week of the tests this year was almost five times the number of those heard during the entire tests of 1921. Never before had any American stations been heard in Switzerland. Signals from two Canadian stations were reported this year as compared with one last year. An amateur station in Porto Rico, operated by L. Rexach, was reported. He operated only five minutes on the first night—before his tubes blew out.

The ability of American amateurs to transmit has been demonstrated as never before, although indications are that British and French amateurs outclass them when it comes to long-distance reception.

With amateurs of all countries alive to the possibilities of long-distance communication with amateurs of other countries that have been indicated by the enterprise of American, Canadian and European operators during the tests, amateur radio may be expected to take a decided jump forward, provided the other governments will grant the necessary privilege of transmitting to those who are now restricted. American amateurs have shown the way; it only remains for others to develop along the same lines.

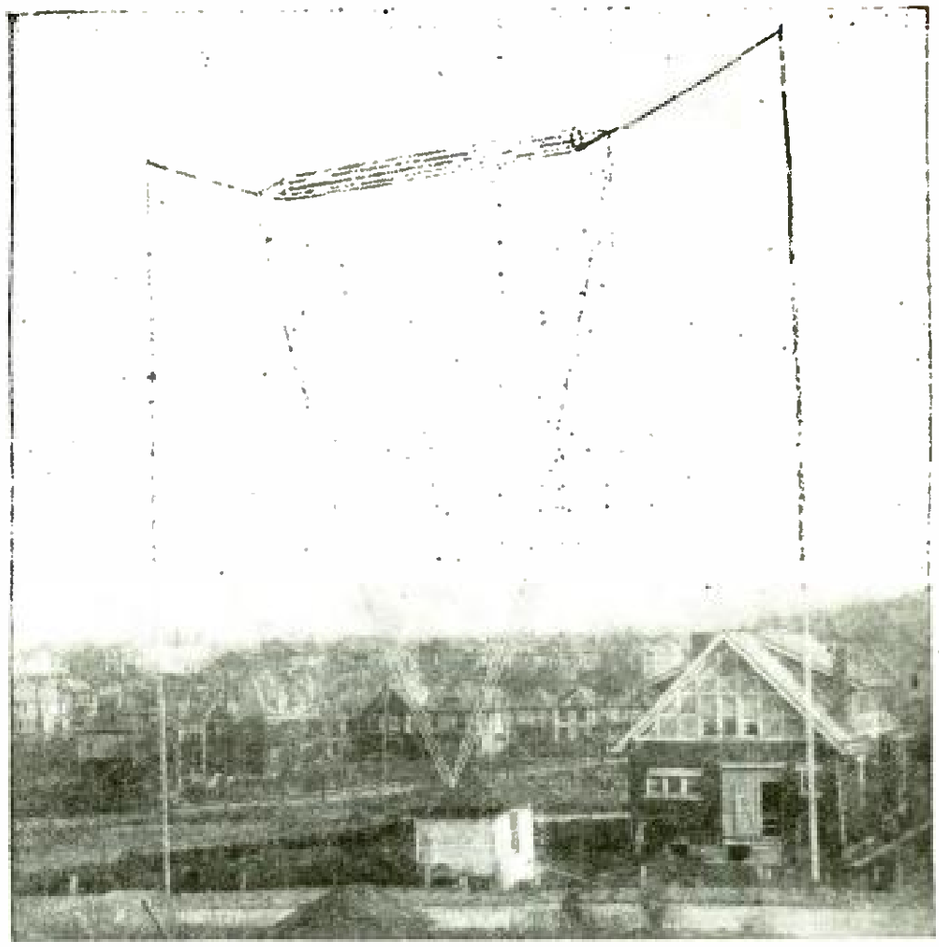
It is almost beyond the stretch of the imagination to conceive just what may come with international amateur radio communication, the ability of a private citizen of one country to talk with a private citizen in another country with the same ease that one radio amateur now communicates with another a few hundred miles distant.

It is rather difficult for the average man, talking with his neighbor over the back fence, to imagine that it will be only a matter of time before he can talk as easily with friends in Europe.

The American amateur by these tests has done more than bring the two continents closer together; he has paved the way for greater international relations between citizens of all countries. It will be some months before results of these tests can be definitely determined; reports already coming in seem to indicate that records yet undreamed of have been made by our transmitting stations that took active part in the tests.

The amateur has kept abreast with the progress in radio to a surprising extent. He does not lack imagination as to the possibilities of his home-made apparatus. If a census were taken he would not be found the least active among those who helped to make radio what it is today. He has delved into all branches of the art. While his apparatus may be apparently a collection of stray parts, it will be found usually that his equipment is equal in efficiency to the more costly ready-made apparatus.

The radio amateurs of this country will soon be able, sitting in their own private homes, to communicate constantly with the amateurs of European countries in their private homes, and then the American boy will be even more active in the transmission and reception of messages than now, and his parents, who may not be so well initiated into the mysteries of radio, are going to be astonished by the achievements of his inexpensively made amateur radio. Even at this late date when it is fast going out of fashion to be surprised at anything, the individual who uses the telephone and telegraph as a matter of daily routine is going to register at least a hint of



A REMARKABLY EFFICIENT AMATEUR ANTENNA

Radio station 8SP at Fairmont, West Virginia (owned and operated by A. Kisner) is noted for its reliable long-distance work. One of its outstanding features is its novel cage antenna with two smaller cage lead-ins, one at either end.

astonishment at the thought of communicating as easily with individuals across the water.

Of course the amateurs will hold to their friendly messages without any thought of infringing on the rights of the commercial companies in message handling. The amateur aim is of experimental nature rather than from the standpoint of financial return. Amateur operation is for the love of the game and the knowledge acquired as a result of experiments by which the art may be further advanced. Interest in short-wave communication is growing and an effort is being made to locate interested amateurs in the Southern Hemisphere, as it is believed that it is possible to connect American and the English-speaking people in South Africa and South America.

This test was regarded by Hiram Percy Maxim, president of the League, as one of the most impressive we have had happen during the present generation. Mr. Maxim says, "I feel as I felt when Peary announced that he had stood at the North Pole, where with a single step he moved from the Eastern to the Western Hemisphere."

A striking similarity to this statement can be recited from my own experience; it brings to mind a conversation I had with Leon Deloy, the only French amateur to transmit successfully to amateurs in this country in the transatlantic tests. During the war, when I was stationed at the Transatlantic Control Office in Washington, he was in the French Signal Corps and also stationed in Washington. I discussed with him the future of amateur communication and mentioned

casually that we amateurs would be one day chatting with each other *via* transatlantic amateur radio. He said that he thought it would be possible and that he hoped the French Government would permit amateur transmission, which up until this time it had not. All this has happened in the short space of three years; in a letter received just a few days ago from Deloy, he says:

"Well, OM, this is a great day for me and I know you will be glad too, as the first half of your prediction of three years ago has come true! Now for the other half! I must get through to you."

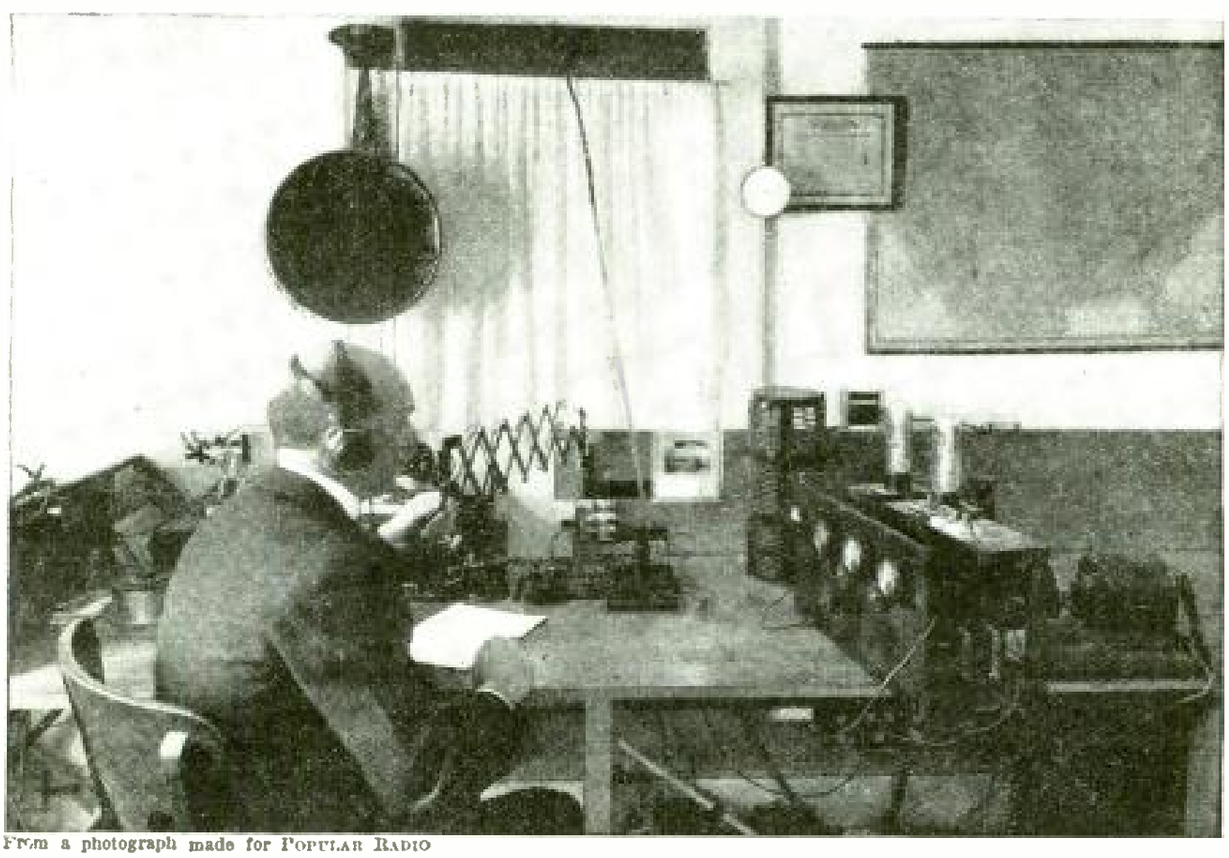
Deloy's station did get through and was copied for an hour on one night of the tests by C. A. Service, assistant secretary of the League, who also was with us at Washington.

But what is even more surprising to me is that not only did well-equipped, powerful amateur stations that qualified in the preliminary tests "get across," but also a large number of crude home-made sets, some of them with no more power than it would take to heat the filament on a 50-watt electric lamp. Probably a vast majority of our most successful stations during the transatlantic tests represented a collection of home-made parts, carefully tuned for greatest efficiency.

During the preliminary tests, Mr. Maxim often referred to his own set (1AW) as a "mere toy," saying to me:

"Schnell, we need something with a bigger bite, this is only a little nibble."

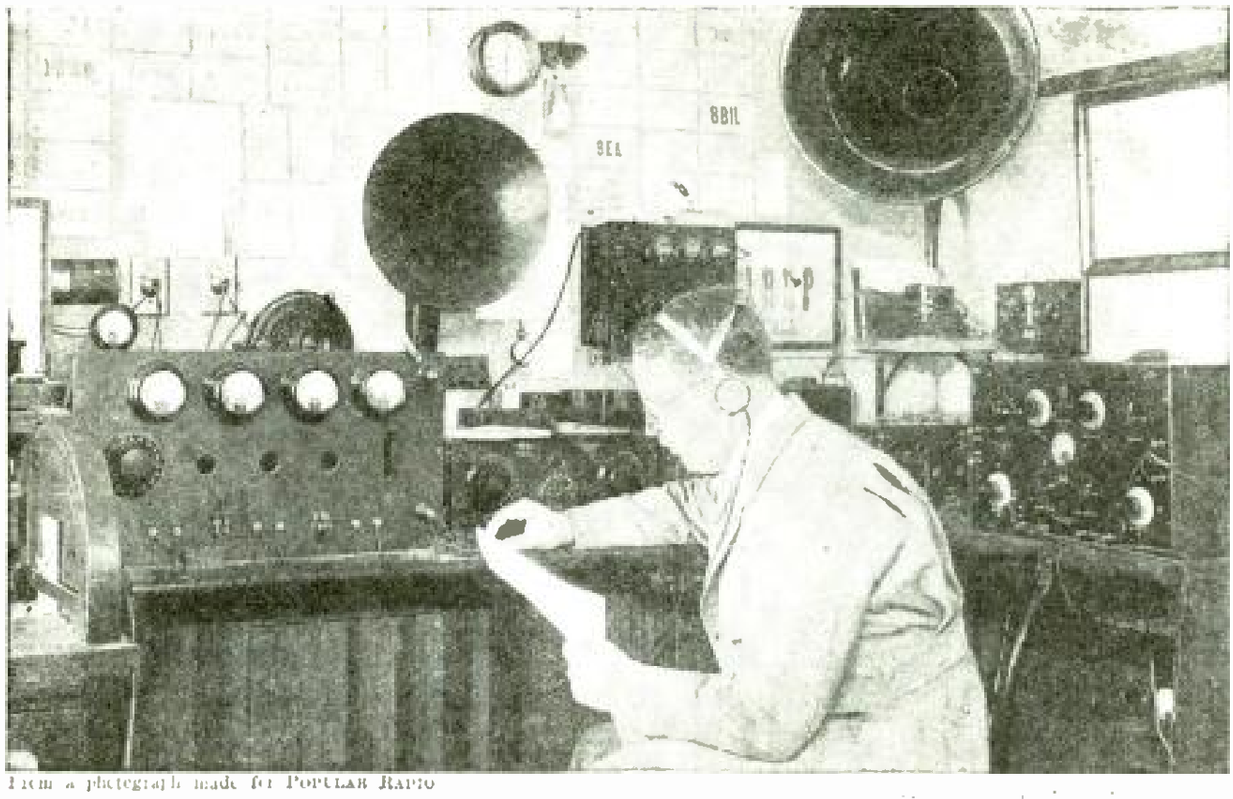
He meant particularly the little transmitter consisting of four 5-watt tubes with which we were able to squeeze about two amperes into the "toy antenna" consisting of a four-wire cage with wires spaced about one and one-half inches



From a photograph made for POPULAR RADIO

A YANKEE AMATEUR WHOSE SIGNALS ARE HEARD BY HALF THE GLOBE

Here is J. O. Smith, at the helm of his record-breaking station at Valley Stream, Long Island. "J. O." has tried out about every kind of circuit and all of the various types of transmitting tubes. But it does not seem to make much difference what he uses he is always breaking records.



From a photograph made for POPULAR RADIO

HE TALKED WITH EUROPEAN AMATEURS
FIVE CONSECUTIVE NIGHTS

Floyd L. Vanderpool and his exceptionally complete radio station 1BEP, at Litchfield, Connecticut. The powerful C.W. transmitter at the left was heard on five evenings in succession by both English and French amateurs.

apart. Practically speaking it was a large single wire antenna and nothing more, 80 feet high at one end and about twelve feet at the near end, and when I reported to him that 1AW had been heard by amateurs in France, he exclaimed:

"My ideas and training on radio will need smoothing out and some explanation for this low-power business of transatlantic communication will be forthcoming."

Station 1AW was one of the last to give up the old spark, but with the coming of broadcast listening and for fear of unjust complaints and criticism because of spark interference, Mr. Maxim changed over to C.W. in time to avoid any such happenings, and the good showing was the cause of his remark that the spark at 1AW will be heard no more.

There is no more enthusiastic amateur than Herbert Hoover, Jr., whose station (3ZH) at Washington, D. C., was heard by amateurs in Switzerland on December 21st, the last day of sending by American stations. The first thing which he did on his return from college for the holidays was to rig up a special radio set at the Bureau of Standards in order to take part in the transatlantic tests. In a letter to me he thus described his station, which was successful in "getting over."

"It consisted of four 'Mullard' tubes, with an input of about 150 watts each. As they got warm over 1,000 watts input, the station would be rated at 500- or 600-watts output. High-voltage dry batteries were used for the plate supply and at 1,500 volts they put six amperes into the antenna. I erected both the antenna and set just for these tests through the courtesy of Dr. Stratton, who will be overjoyed at the good news.

"The antenna is a 50-foot cage, 2 feet in diameter, strung from the Navy mast to the Electrical building. It is about 125 feet high and the lead-in is partly cage (6 inches) and partly ribbon. As the high-voltage battery leads extended

all the way through the building, they in themselves, acted as a very good ground. When using the reversed feedback circuit, I tuned the counterpoise (a semi-circular pan of 30-foot radius) to the rest of the set with a separate inductance, and used no other ground connection at all.

"I tested during the 'free-for-all' that evening and afterward worked 9BHX, but DX work was very hard, for the wave is 240 (I can't get lower on account of battery leads) and very sharp. The receiver is a D.S. amplifier with an external heterodyne, and it has a 'CR' skinned a mile! NOF is going, too."

It is not without the bounds of possibility to pre-suppose that an amateur "relay around the world" is not far off. Were there radio amateurs in Australia, Japan, China and the Philippines, this would be but a matter of making the necessary arrangements and conducting the preliminary tests. Preliminary tests are necessary because the weak points are thereby located and readily reinforced. As an example of what is possible, a message may be started from London, England, picked up on the Atlantic Coast of the United States, relayed to the Pacific Coast, thence to the Hawaiian Islands, to Japan, Australia and the Philippines, thence perhaps through one or two European countries, back into London.

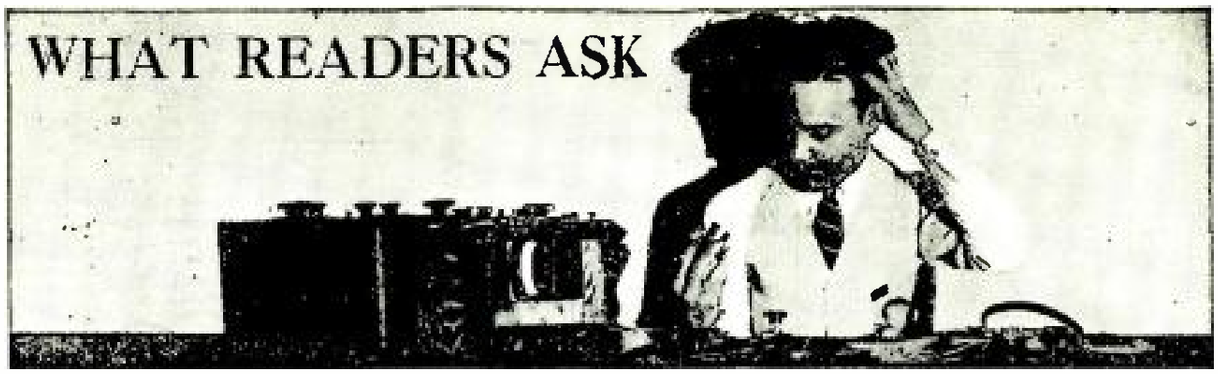
With our successful "radio" acquisition of the Hawaiian Islands and Porto Rico during the last year, there is every reason to believe that we may connect up with countries in the Southern Hemisphere, especially South America and South Africa.

Who would dare to be bold enough to say?

From a photograph made for POPULAR RADIO

A YEAR-OLD STATION THAT HAS BEEN LOGGED IN SIX COUNTRIES

The amateur radio station 3BLF at Richmond, Virginia, is owned and operated by the youthful C. R. Hofmann and W. R. Deavers. Its C.W. signals have been logged all over the United States as well as in Canada, Hawaii, Cuba, France and England.



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: I have read the article on the DX regenerative receiver in the January issue and would like to know if this circuit could be simplified so that only one or two controls need be used for tuning. I wish to use one tube only (for detector). Will you kindly furnish me such a diagram?

A. L. WILLIAMS

ANSWER: A simplified modification of the DX circuit is shown in Figure 1. Coils A and B are wound on a 3½-inch tube with a separa-

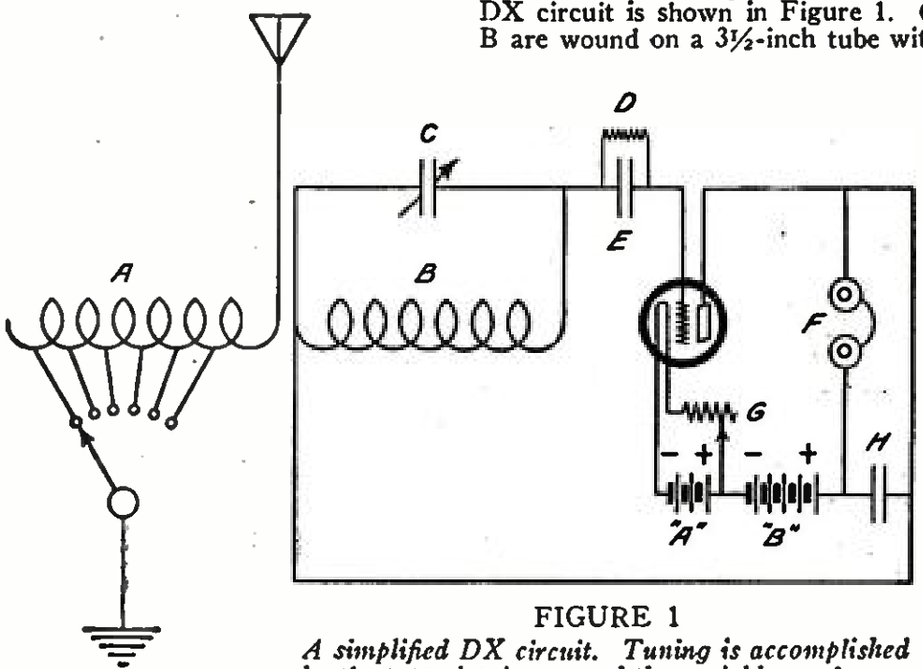
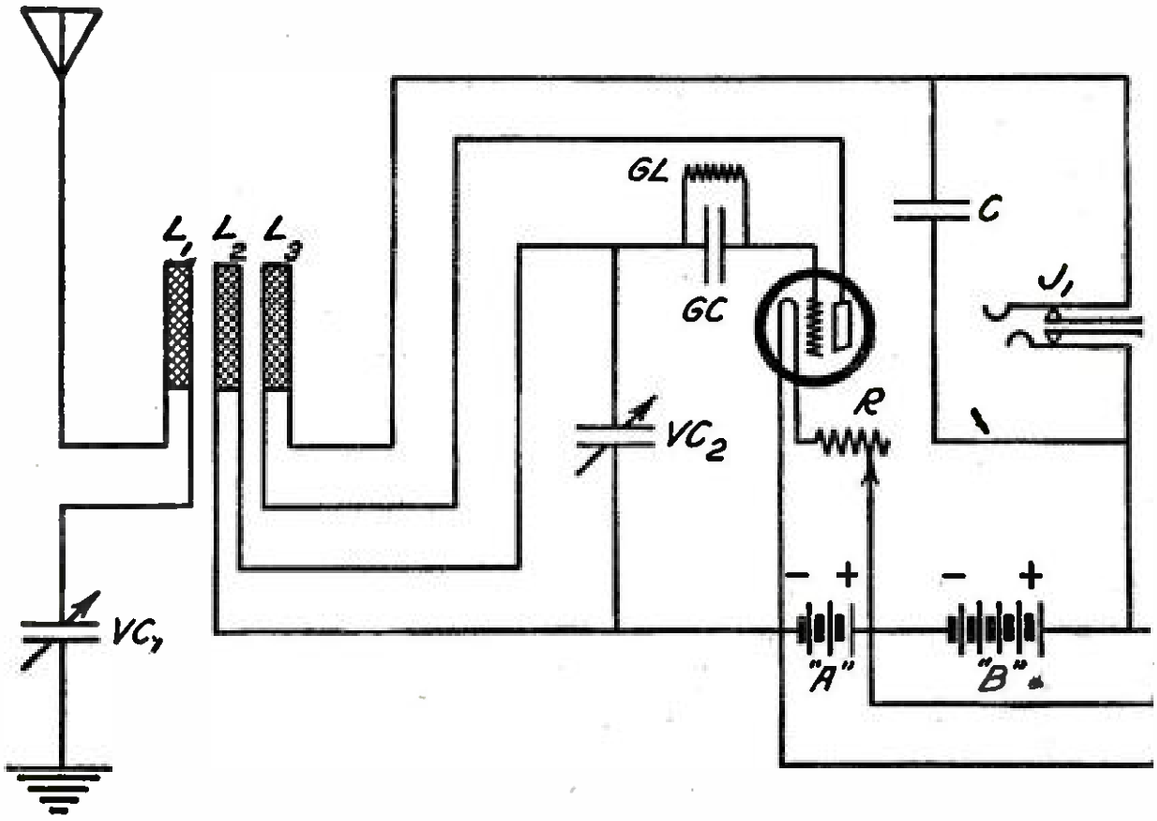


FIGURE 1

A simplified DX circuit. Tuning is accomplished by the tapped primary and the variable condenser.



tion between them of ½ inch. The primary coil A consists of 30 turns of No. 18 S.C.C. copper wire tapped every five turns. The secondary coil B consists of 65 turns of the same wire. The condenser C is a variable .0005 mfd. The grid leak D is 1 or 2 megohms; the grid condenser E is of .00025 mfd. capacity; the rheostat G is approximately 5 ohms; the fixed condenser H is a telephone condenser, .001 mfd.

The antenna tuning is accomplished by means of the taps on coil A. Secondary tuning is done with condenser C. Regeneration is controlled with rheostat G, which should have a vernier attachment. This circuit will be found exceptionally selective and easy to tune.

* * *

QUESTION: Will you kindly give me a hook-up showing how to add two stages of audio frequency amplification to the honeycomb circuit shown in Figure 1 on page 59 of the May issue of POPULAR RADIO?

WILFRED BURGESS

ANSWER: The circuit is shown in Figure 2. The two jacks J1 and J2 are double circuit jacks, and J3 is a single circuit jack. The transformers AFT are audio frequency transformers. This circuit will enable you to use a loudspeaker.

* * *

QUESTION: In one of your diagrams in answer to a question, you specify Radiotron UV-200 tubes for detection and UV-201 tubes for amplification. Out on this coast we find the Cunningham C-300 and C-301 sold more in the radio stores. Is there any preference between these two types? As far as I can see they are constructed exactly alike.

FRANCIS STERN

ANSWER: Both of these two makes are good. The UV-200 and C-300 are soft tubes and are used as detectors, and the C-301 and UV-201 are hard tubes and are used as either detectors or amplifiers.

* * *

QUESTION: What kind of wire is most suitable for a receiving antenna?

HAROLD JENKINS

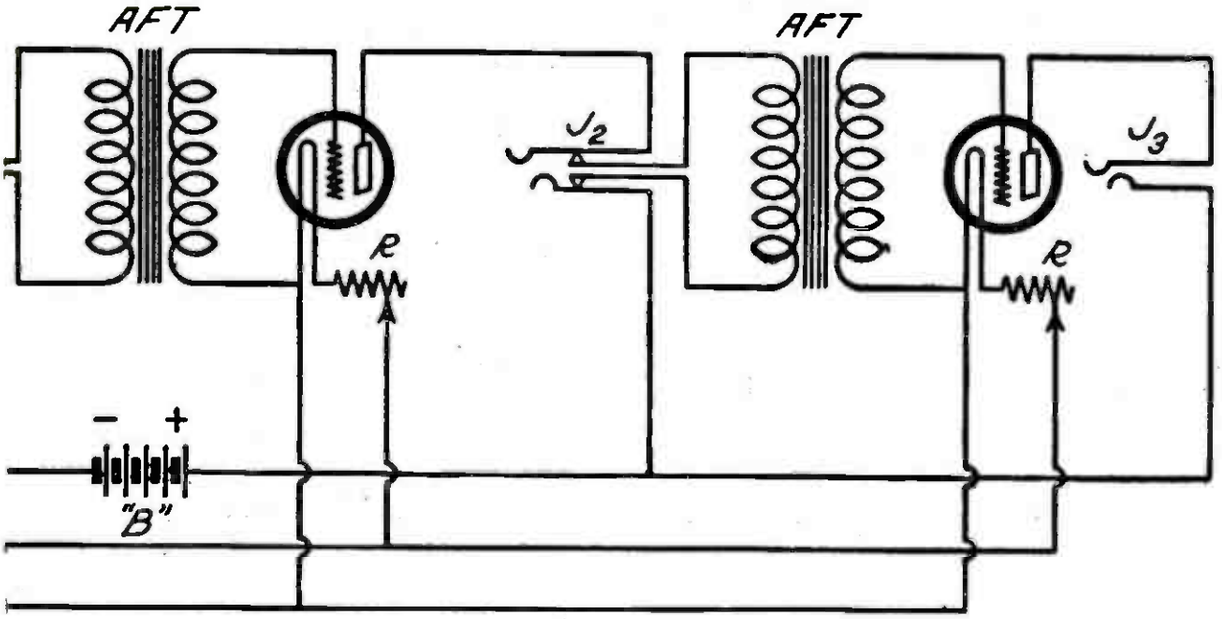
ANSWER: Seven-strand copper wire is the wire that is most generally used for the antenna. It is usually No. 12 or 14 and is kept in stock by most radio dealers.

* * *

QUESTION: Please give me a diagram for a small radiophone transmitter that uses a Radiotron amplifier tube. I want the simplest hook-up that works. This will be my first transmitting set and I want to get familiar with a small one to start with. I want to work the set on

FIGURE 2

A three-coil honeycomb set with two stages of amplification that gives loud and clear signals on a loudspeaker.



a bank of "B" batteries. If this is possible please let me know what voltage batteries to use on the plate.

HOWARD V. BROOKS

ANSWER: We have drawn the circuit for you in Figure 3. The two coils P and S have 60 turns of wire wound on each of them. Coil P is wound on a 4-inch tube and coil S is wound on a tube slightly smaller so that it may be slipped inside coil P. The variable condenser VC should be of .001 mfd. capacity. It is advisable to tap the two coils at every other turn and make adjustable connection to them, for tuning, by means of clips. The variable condenser will be valuable in getting the set to oscillate properly. A voltage of approximately 100 to 125 volts should be used on the plate of the tube, but voltage less than this may be used, with, of course, a corresponding decrease in distance range. The microphone transmitter is connected to a loop consisting of a single turn of insulated wire wrapped around coil P. This, by absorption, causes the output of the set to be modulated at voice frequencies, when the microphone is spoken into. A transmitting license is required.

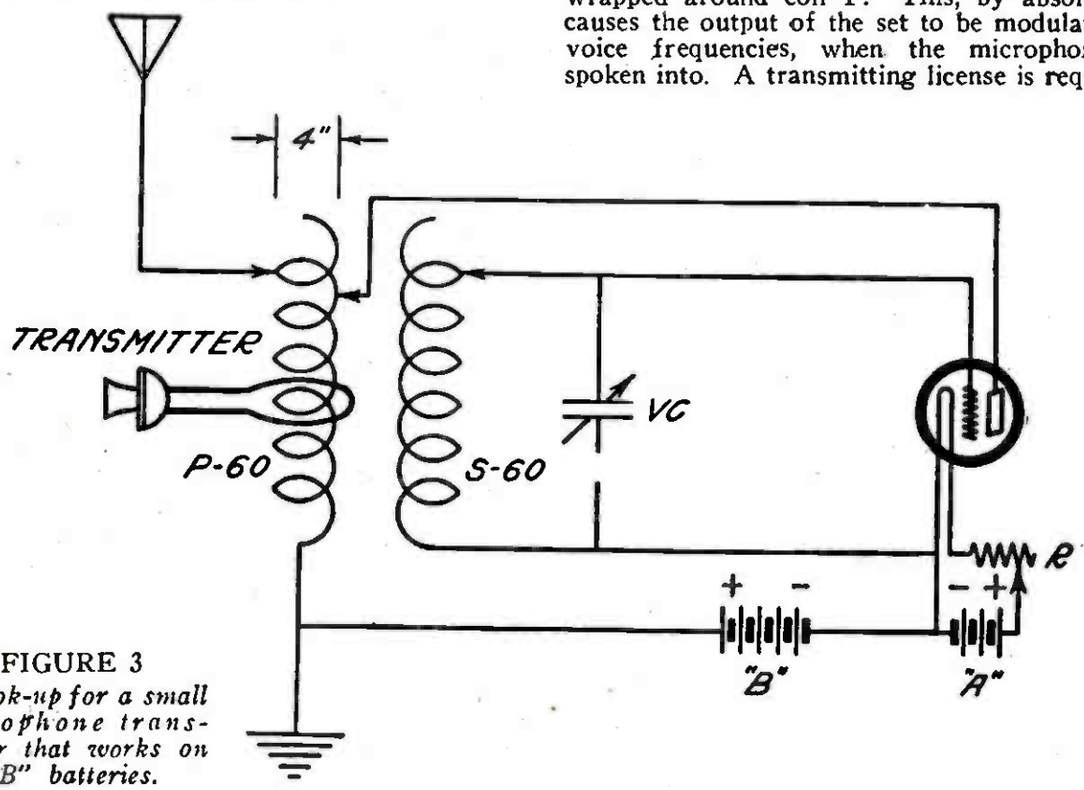


FIGURE 3

A hook-up for a small radiophone transmitter that works on "B" batteries.

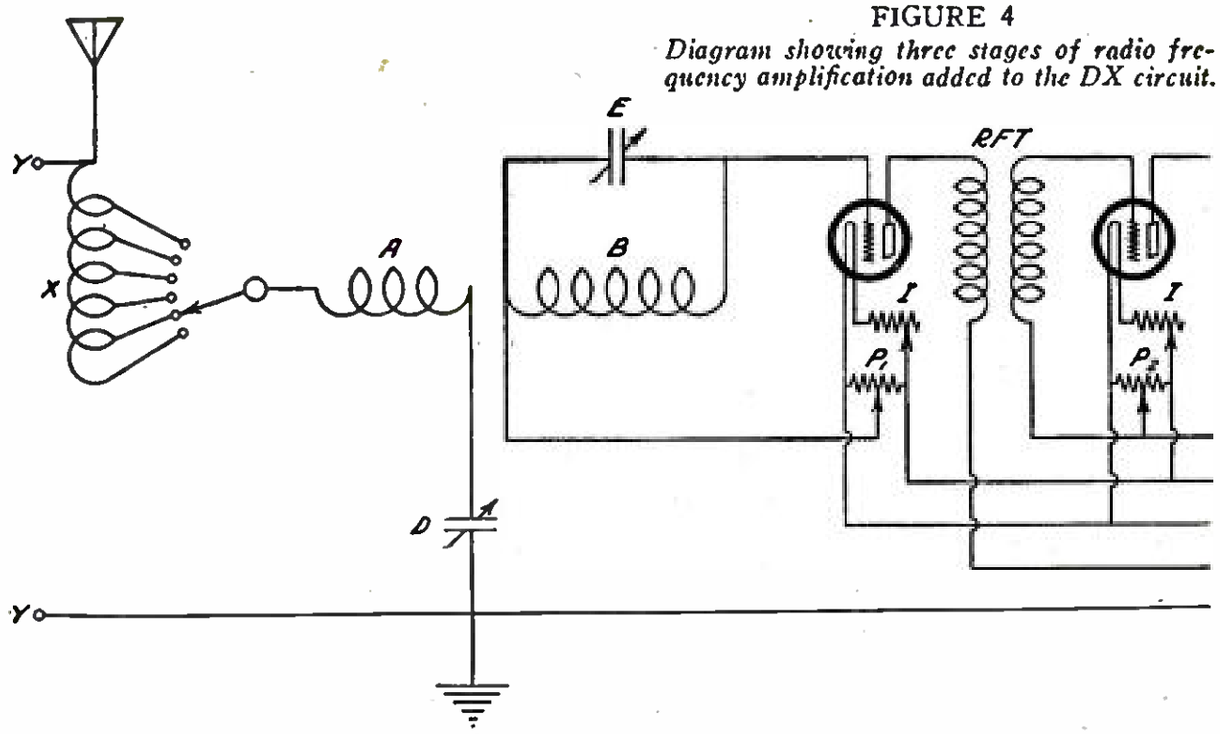


FIGURE 4
Diagram showing three stages of radio frequency amplification added to the DX circuit.

QUESTION: I have built the DX regenerative receiver described in your January number.

I have not been able to hear the other coast as yet, but I believe that if I added a few stages of radio frequency amplification to it, I could. Sharpness of tuning is its best quality. Would it be possible to add radio frequency and still retain the fine tuning qualities? If so, please send me the hook-up.

R. K. BENTMAN

ANSWER: The circuit diagram in Figure 4 shows how to add three stages of radio frequency amplification to the DX receiver. The variometer has been eliminated and a loading coil has been added. The two binding posts YY are for connection to a loop antenna if used. The potentiometers P1, and P2 are to control the grid circuits of the radio frequency tubes; they may also be used to control oscillation so that the circuit will receive C.W. The three radio frequency amplifying transformers, RFT, must be of a reliable make and have a wavelength range that will include that of broadcasting, as your query indicates that is the phase of receiving that interests you most. The other designations on the diagram refer to the same parts they did in the article in the January issue of POPULAR RADIO.

* * *

QUESTION: What is the normal distance range of the different types of radio receivers? I would like to know this roughly, so that I will be able to pick out a type of set that will suit my purpose.

ARTHUR C. STRANG

ANSWER: If you will refer to the article on page 24 in the January issue of POPULAR RADIO you will find data that will answer your inquiry in much greater detail than we could do in this space. The article contains data on this subject which should prove invaluable to the novice in selecting his set. There are two charts that will show you, at a glance, the type of receiver that will be best for you to use.

* * *

QUESTION: How many turns of wire should be wound on the rotor and stator of a variometer for use in the plate circuit of a regenerative receiver? I want to make one myself and am going to copy the design of one of the wooden variometers now on the market.

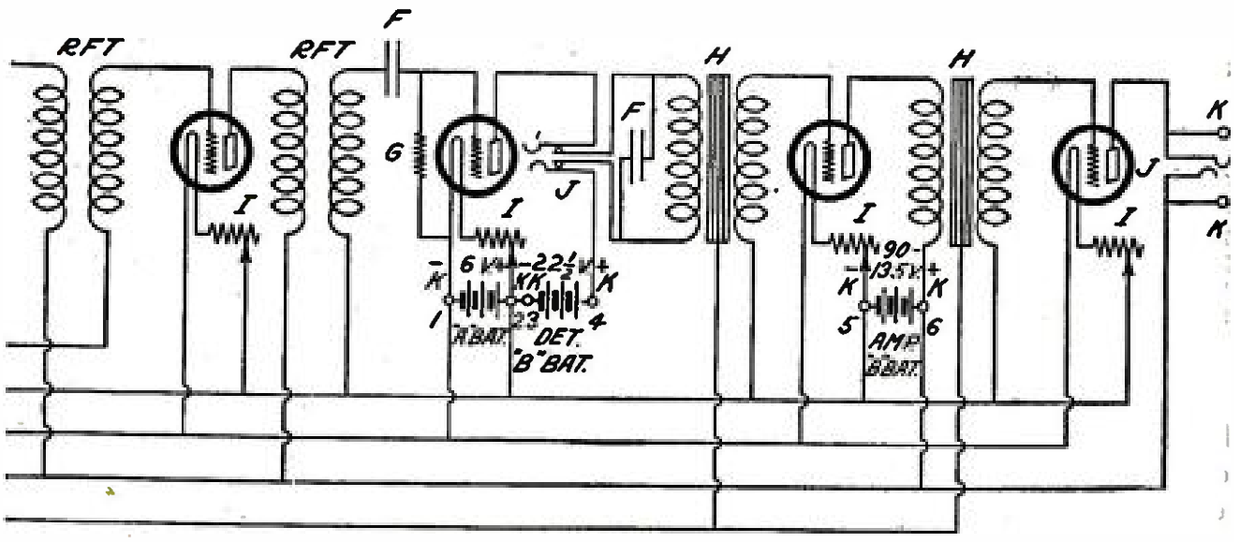
ROBT. M. ASHTON

ANSWER: If you make the variometer stator and rotor forms of approximately the same size as the most commonly used variometers you may use 40 turns on the stator and 50 turns on the rotor with good results. Use as little shellac as possible on the windings.

* * *

QUESTION—Can a variometer be used as a variocoupler?

L. E. T.



ANSWER: Yes. If the stator winding is detached from the rotor winding it can be used as the primary coil, with a variable condenser in series with the antenna circuit for tuning. The rotor winding may then be used as the secondary, with another variable condenser connected in shunt to it for tuning the secondary circuit. Or, in the single circuit regenerative hook-up, the rotor may be used as a tickler, as shown in Figure 3, page 223 of the July issue of POPULAR RADIO.

* * *

QUESTION: Will you kindly give me a circuit for a C.W. transmitter using one 5-watt tube, for telegraphy? I should like a circuit that will be simple to construct and yet efficient. I have heard a great deal of the "British aircraft circuit" and would like to use it if you think it would serve my purpose.

A. R. WOODWORTH

ANSWER: The circuit shown in Figure 5 will be suitable for your use, and it is easy to operate. The plate coil L1 consists of 40 turns of No. 12 D.C.C. copper wire wound on a tube four inches in diameter. The grid coil L2 should be wound on a tube which fits inside the plate coil L1, and should consist of about 10 turns of the same sized wire. This coil is shunted by a variable condenser, but if the coil is tapped the condenser may be eliminated. The condenser C which is connected across the high voltage terminals of the transformer may be between .001 and .005 mfd. capacity. The same transformer is used for lighting the filament. The hotwire ammeter is used to measure the antenna current. A milliameter, 0 to 100 milliampere scale, may be inserted in the plate circuit to measure the plate current if desired.

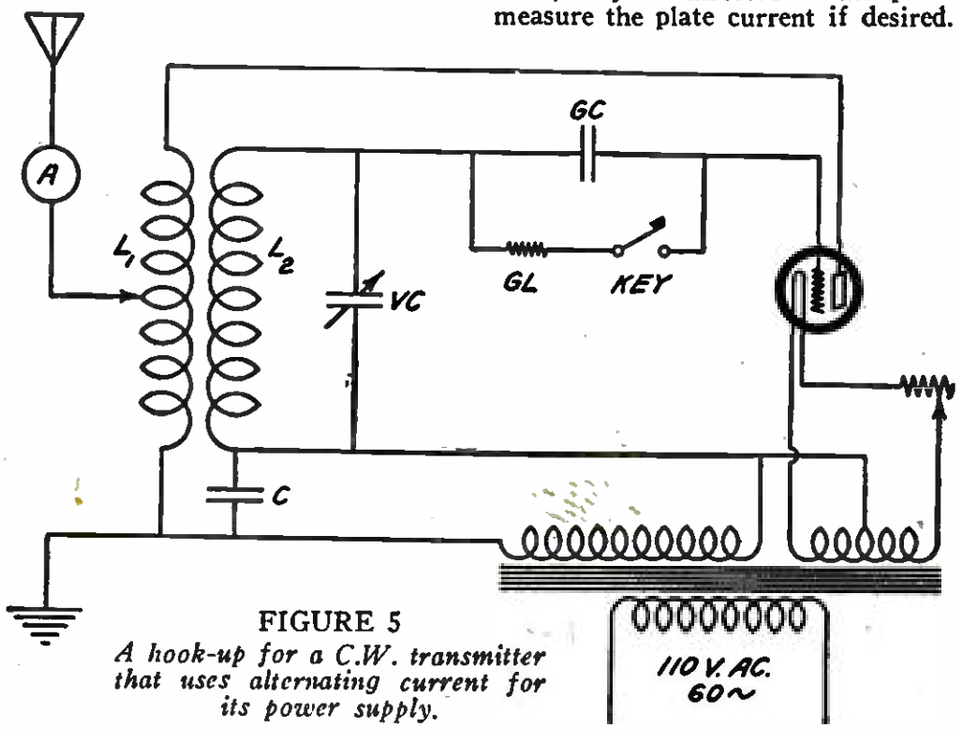


FIGURE 5

A hook-up for a C.W. transmitter that uses alternating current for its power supply.

QUESTION: Are paper grid condensers as good as mica grid condensers?

DONALD DIETZ

ANSWER: Paper condensers are not as reliable as the mica dielectric type because the capacity of the paper type is liable to vary with temperature and with pressure. Try this: use a paper grid condenser and tune in a signal. Then pinch the condenser between the fingers and the signals will tune in and out.

* * *

QUESTION: What is the greatest number of stages of audio frequency amplification that can be used with clear efficient reception?

THOMAS MCCOOMBS

ANSWER: With two stages of audio frequency working efficiently, getting the maximum out of the vacuum tubes by means of the correct circuit, the correct transformers (transformers with the proper input and output impedances) and the best tubes, the signal strength will be as loud as with numerous stages, using instruments and tubes that *do not* match up properly. It is our opinion that two stages of audio frequency amplification constitute the greatest number of stages that should be used. There are many instances where three stages have been used with good results, but in most of these cases the amplification obtained in each stage has not been at a maximum. When more than two stages are employed with maximum amplification in each stage, there are usually many extraneous noises present that tend to interfere with and distort the received signals. Even with only two stages of amplification attached to a regenerative receiver the distortion, caused by regeneration, is often noticeable.

QUESTION: An amateur friend of mine recently interested me in transmitting (I was a broadcast listener up to this time); he made me a transmitting inductance and told me all the parts to buy for an A.C.C.W. vacuum tube transmitter. I am sending you a sketch of the inductance. My friend told me at the time that one coil was for the antenna circuit, one for the grid circuit and one for the plate circuit, and that the last two coils were to be shunted by variable condensers for tuning. He also made me a diagram to connect up the set, which I have unfortunately mislaid. I cannot get in touch with him and am impatient to get it hooked up and working so that I will be a *regular* amateur. Will you kindly help me out with a circuit that will show how to connect the power transformer for one Cunningham 5-watt transmitting tube? I have already learned the code and obtained a license.

ROBERT V. ASHCROFT

ANSWER: You will find the circuit you need in Figure 6. You will need another condenser C which should be about .002 mfd. capacity, and a grid leak 8,000 to 10,000 ohms. The key is inserted in series with the grid leak, for telegraphy. You will also need an antenna-current meter which should have a full scale deflection up to about 2 amperes.

You will get better results with this circuit if you use a counterpoise instead of a ground.

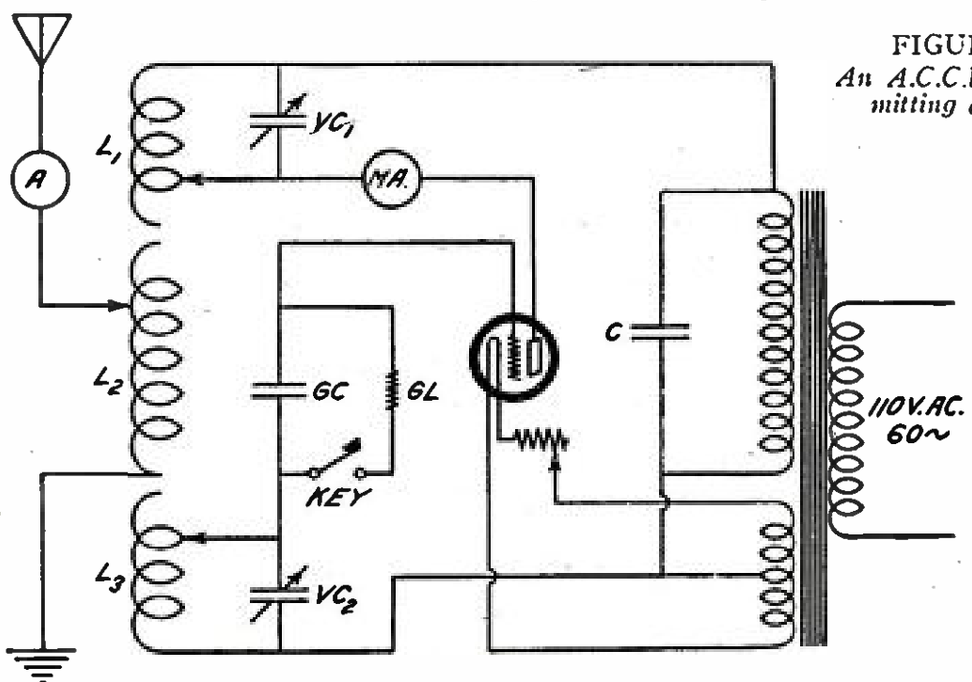


FIGURE 6
An A.C.C.W. transmitting circuit.

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.*

Will the Senate Pass the New Radio Bill?

OF such importance to the radio fans as well as to the radio industry is the fate of the White Bill in the Senate that POPULAR RADIO has requested a last-minute report on it from one who had been perhaps more intimately identified with it than any amateur in the country. Here it is:

Just as this is written the word comes that the Senate has taken action which would tend to sidetrack radio legislation. In an effort to hasten through impending bills of major importance, the Administration has used every argument which would affect their passage. If the Senate does not take action on the radio bill during this session it will probably be a year before action can be taken at all. Those who have worked so diligently in an effort to put through this legislation during the present session view the possibilities of the immediate future with concern.

There have been many attempts made to have our Congress pass radio legislation since the first radio laws were placed on the statute books back in 1912. Most of these efforts have been made as the result of the desires of a particular class or of a particular organization. Always—and mainly on this account—the attempts have given rise to controversies as they have been brought before the Congressional committees for hearings. Notwithstanding the many attempts, no changes in the laws of 1912 have yet been effected.

Unlike past attempts at revision of radio legislation, the present bill (which is known in Congress as the White Bill) came about as a result of a conference of radio men called by the Secretary of Commerce, Herbert Hoover. The interests of the Army, the Navy, the commercial companies, the amateurs and the general public were all well taken care of and were fully represented at the conference. Secretary Hoover appointed a committee of representative radio men whose recommendations were drafted into the bill.

The hearing on the White Bill before the Committee of Merchant Marine and Fisheries was a short one. No objections of importance were raised to the bill as framed; most of the comment had to do merely with the clarification of certain phrases.

For example: the amateurs wanted to be recognized by law in such way that their future would be secure, while certain commercial companies wanted the wording of the bill to be changed so as to differentiate between lawful and unlawful monopolies.

From all appearances, it was upon this point of differentiation between lawful and unlawful monopolies of radio that the fate of the bill in the Senate hung. One of the Senators from Texas wished to so amend the bill as to prevent the creation of a radio monopoly. As soon as it appeared that considerable discussion and delay was inevitable, the whole measure was sidetracked.

The efforts of Secretary of Commerce Hoover have been so productive of results in the past, and his abilities to show the great need for this legislation have proven so potent, that in all quarters there is hope that even yet some action may be taken, but the indications are that action during this session is unlikely.

Legislation that will modernize present radio laws is an absolute necessity. Everyone who is getting the least of enjoyment out of radio broadcasting and the operation of amateur receivers and transmitters is vitally interested in securing legislation at the earliest possible moment. Possibly an extra session of the Congress will be called; there is some likelihood of it. On the chance that a session will be called, it is recommended that those who have the welfare of radio at heart continue to forward communications to their Senators and Representatives urging action.

Send this message to your Congressman and to your Senator at Washington:

"I favor the radio bill, H. R. 11964."

And sign it with your name and address.

PAUL GODLEY

results are obtained regularly; in comparison with an outside aerial twenty-five feet high and one hundred feet long, the trouble from static is greatly reduced and the signal strength is good. But noting the setting of the tuner with the outside aerial, and then with the screen, when receiving from the same station, it was found that the natural wavelength of the screen is almost identical with that of a one-hundred-foot wire placed outside.

The efficiency of the screen aerial may be better judged when the simplicity of the set is considered. A single variometer in series with a fixed condenser with two taps is used for tuning: one tap of the condenser gives the variometer a range from 200 meter amateur stations to the 412 meter naval station at Anacostia; the second tap permits the 600 meter ship stations to be tuned in.

A single UV-201 tube is used for a detector and the plate circuit is tuned with a second variometer. Each variometer is made of two cardboard tubes carrying eighty turns of wire—forty turns on each tube.

With this simple set the following stations have been picked up regularly during July and August, except on two occasions when local electrical storms were extremely severe: WJZ, 150 miles; NOF, 300 miles; KDKA, 350 miles; WWJ, 450 miles. WGY, twenty miles away, comes in so clearly that the announcer's breathing can be distinctly heard.

The only disadvantage so far observed is that the body capacity of a person walking over the screen affects the tuning; this effect, however, is not noticeable when anyone on the lower floor passes under the screen.

The size of the screen does not appear to be critical except that if it is made too small it does not pick up sufficient energy. In experimenting with a small screen about three feet square it was possible to get the carrier waves from the various broadcasting stations, but the voice could not be distinguished.

T. A. Bryson

* * *

A Home-Made Connecting Block for Extra Headphones

ALL you will need, if you want to make your connecting block yourself, is a piece of bakelite, a small phone condenser and binding posts, the expense of which is less than twenty-five cents. Then follow these directions given by a New Jersey radio fan which are illustrated diagrammatically in the figure shown on this page:

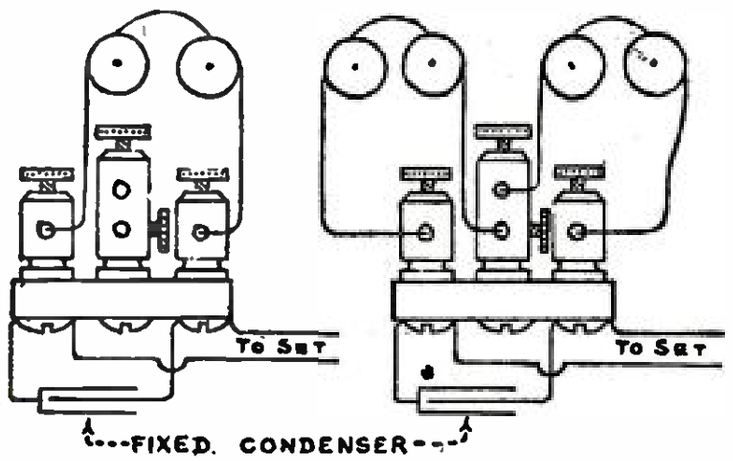
When more than one set of phones is used with a receiver, they should be connected in series. It is best to shunt a small fixed condenser across the circuit, as shown in the diagram.

The block for connecting the two sets of phones is fitted with three binding posts, which are mounted in a straight line. The central post is of the two-hole type and is left "blind"; it is not connected in the circuit. The two end binding posts are of the ordinary type and are connected in the circuit in the usual manner. The posts are spaced about ¾ inch apart, and the fixed condenser is connected across the two outside posts.

When only a single pair of phones is used, they are connected to the end posts as shown at the left of the diagram, but when two sets are used, the connections are made as shown at the right.

More than two sets of phones can, of course, be provided for by using the desired number of "blind" posts mounted in the same manner.

W. C. Michel



YOU CAN MAKE IT YOURSELF FOR A QUARTER

A small square of insulating material, three binding posts, a small fixed condenser and a few minutes' work, and you have a neat and compact block for connecting your headphones.

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PAUL GODLEY

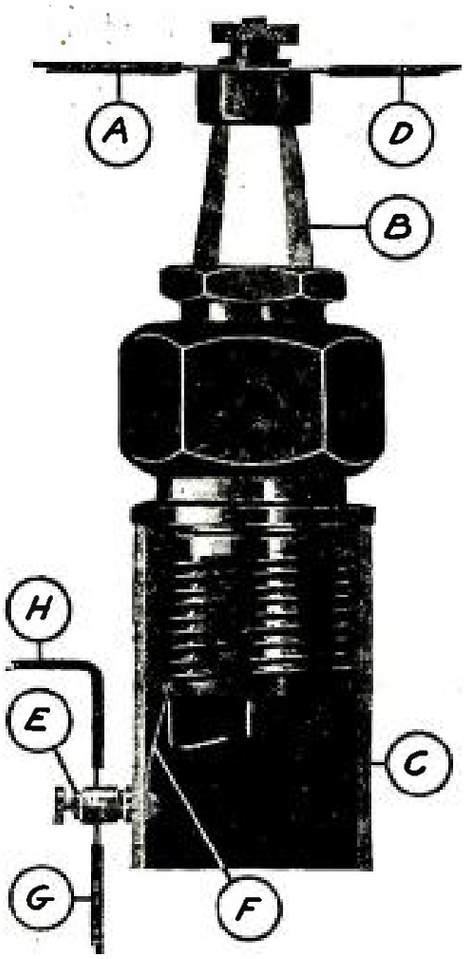
Radio Holds the Hotel Bread Line

ENTERPRISING hotel managers have been quick to seize upon radio as a means for bringing in good entertainment for their guests at a low cost. Last summer the broadcast concerts of the great New York Philharmonic Orchestra (initiated by this magazine) were received in tiny hostelries that could not even support a pianist! How the same idea is being adapted on western ranches is told in this letter from Los Angeles:

The Fontana Farms Company has an 18,000-acre ranch six miles west of San Bernardino. Recently the ranch opened up for sale 2,000 acres of young vineyards, and every Sunday brought to the place carloads of possible buyers. As many as a hundred guests have registered at the ranch dining-room for Sunday dinner. But as the seating capacity was only fifty, the manager was confronted with the problem of entertaining guests while they waited their turn at the table.

Radio solved his problem. He purchased one of the largest radio sets he could find in all Southern California, and installed it with loudspeaker in the reception room. This outfit, which is of the short wave regenerator type, is capable of being tuned from 200 to 600 meters and easily picks up messages from as far away as Denver. The idea is being adopted by other hotel owners.

CLARENCE M. LINDSAY



HOW THE TRANSFORMATION IS MADE

Here are shown the details of the converted spark plug. A is the aerial wire; B is the insulating column of the plug; C is the fibre tube; D is the aerial connection to the set; E is the extra binding post; F is the connecting wire; G is the ground wire and H is the ground connection to the set.

* * *

How to Convert a Spark Plug into a Lightning Arrester

HAVE you a little lightning arrester in your home? If not, you can make one yourself out of a spark plug and save a tidy little sum of money into the bargain. A correspondent from Kansas City tells in this letter how to do it:

An efficient lightning arrester for outdoor use can be made from a spark plug. The plug is used complete and must be in good condition. A wire is soldered to the metal body of the plug, then a 2-inch length of fibre tubing is pushed up over the threads. Near the bottom of this fibre tube, a binding post is mounted, and the other end of the wire soldered to the metal body is connected to this binding post, as is shown in the diagram on this page. If this arrester is used in an upright position, the bottom need not be sealed. In use, the aerial lead-in is connected to the plug terminal and the ground connection is made at the binding post.

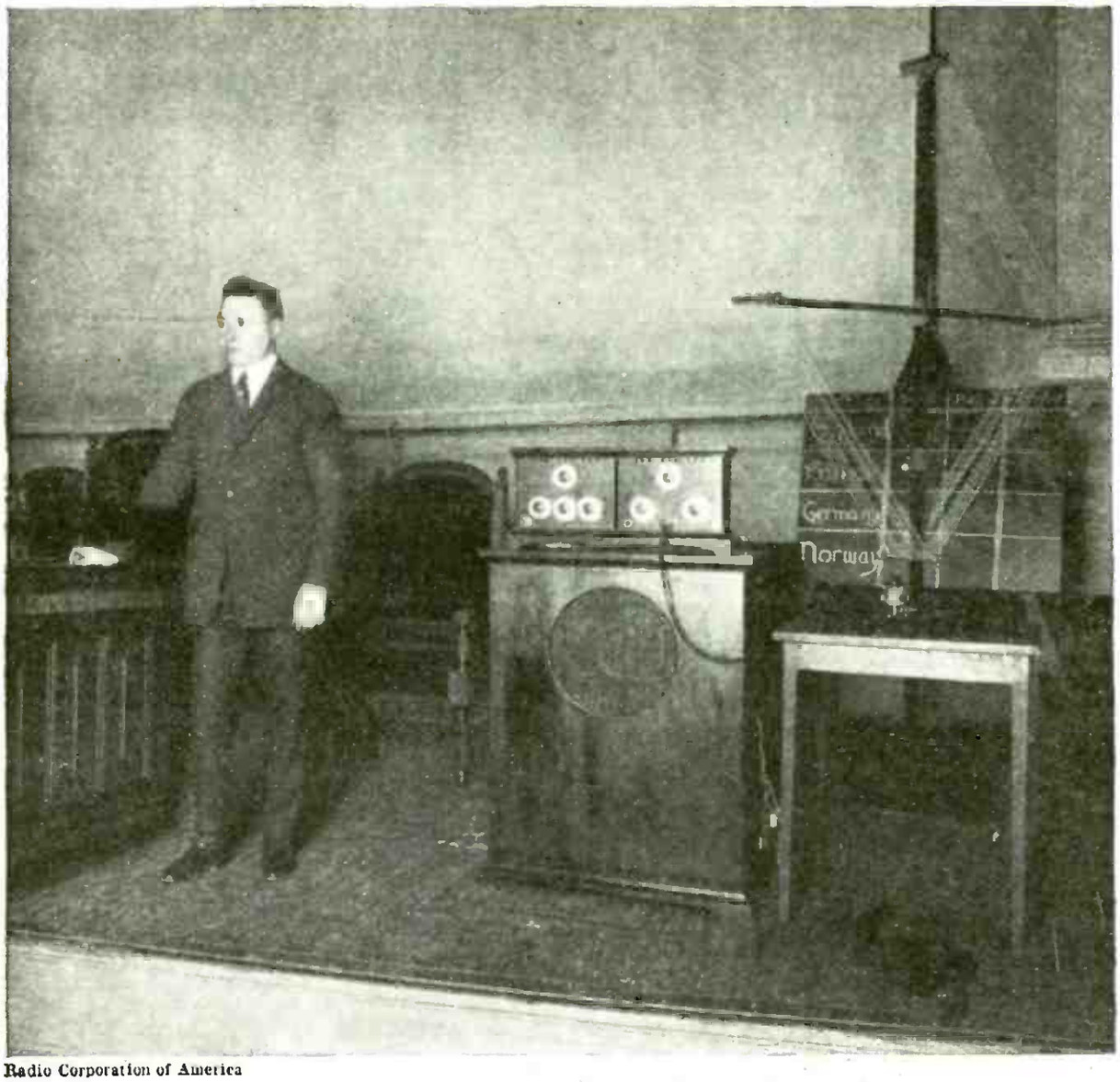
MARION J. ESTES

* * *

A Startling Announcement by Radio

FROM "the great open spaces, where men are men" comes this unexpected little item; William P. Bear assures us that he heard the announcer of a broadcasting station actually make this naive statement by radio:

"This is Station XXX. Mr. Jones will now sing *Put Me in My Little Bed* accompanied by Miss Smith."



Radio Corporation of America

COMMUNICATING ACROSS THE ATLANTIC WITH THREE COUNTRIES IN 11 MINUTES

When Mr. Sarnoff recently spoke before a meeting of the Electrical Society in New York he demonstrated, with the aid of radio apparatus on the lecture platform, the possibilities of inter-continental signalling by establishing contact with England, France and Germany in less than four minutes each.

A Condenser-Antenna For Indoor Use

A HOME-MADE indoor loop is usually not an attractive interior decoration and requires a comparatively large space to permit turning to point in the direction of the sending station. A condenser-aerial to take the place of the loop has been devised by a radio fan with an ingenious turn of mind. He writes:

The condenser aerial here described was installed in a house set in a clump of tall trees and partially shut in by hills rising one to two hundred feet higher than the roof of the house.

The flat tin roof, twenty-two feet above the ground, was first well grounded. On the second floor, which is about half-way between the roof and the ground, a woven wire copper screen, five feet wide by six feet long, was spread on the floor and covered by a rug. This screen forms the aerial; the ground wire for the aerial is connected to a water pipe.

It will be observed that the ground and roof form two outside plates of a large condenser, while the wire screen is the intermediate plate. The dielectric is made up of air, wood and floor coverings.

With this aerial and a simple set good

results are obtained regularly; in comparison with an outside aerial twenty-five feet high and one hundred feet long, the trouble from static is greatly reduced and the signal strength is good. But noting the setting of the tuner with the outside aerial, and then with the screen, when receiving from the same station, it was found that the natural wavelength of the screen is almost identical with that of a one-hundred-foot wire placed outside.

The efficiency of the screen aerial may be better judged when the simplicity of the set is considered. A single variometer in series with a fixed condenser with two taps is used for tuning: one tap of the condenser gives the variometer a range from 200 meter amateur stations to the 412 meter naval station at Anacostia; the second tap permits the 600 meter ship stations to be tuned in.

A single UV-201 tube is used for a detector and the plate circuit is tuned with a second variometer. Each variometer is made of two cardboard tubes carrying eighty turns of wire—forty turns on each tube.

With this simple set the following stations have been picked up regularly during July and August, except on two occasions when local electrical storms were extremely severe: WJZ, 150 miles; NOF, 300 miles; KDKA, 350 miles; WWJ, 450 miles. WGY, twenty miles away, comes in so clearly that the announcer's breathing can be distinctly heard.

The only disadvantage so far observed is that the body capacity of a person walking over the screen affects the tuning; this effect, however, is not noticeable when anyone on the lower floor passes under the screen.

The size of the screen does not appear to be critical except that if it is made too small it does not pick up sufficient energy. In experimenting with a small screen about three feet square it was possible to get the carrier waves from the various broadcasting stations, but the voice could not be distinguished.

T. A. Bryson

* * *

A Home-Made Connecting Block for Extra Headphones

ALL you will need, if you want to make your connecting block yourself, is a piece of bakelite, a small phone condenser and binding posts, the expense of which is less than twenty-five cents. Then follow these directions given by a New Jersey radio fan which are illustrated diagrammatically in the figure shown on this page:

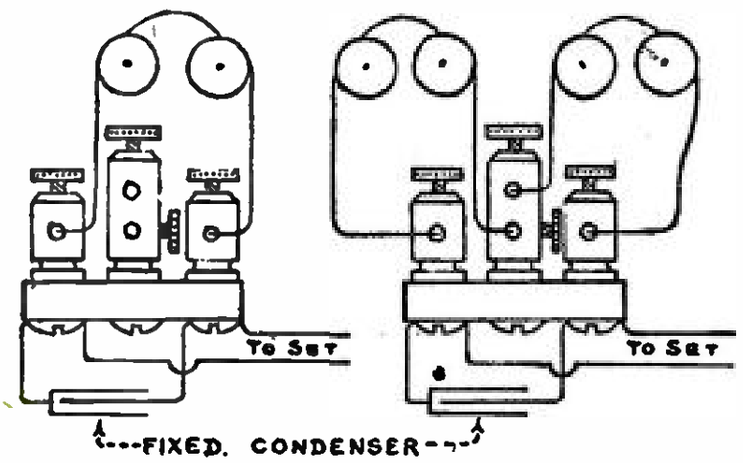
When more than one set of phones is used with a receiver, they should be connected in series. It is best to shunt a small fixed condenser across the circuit, as shown in the diagram.

The block for connecting the two sets of phones is fitted with three binding posts, which are mounted in a straight line. The central post is of the two-hole type and is left "blind": it is not connected in the circuit. The two end binding posts are of the ordinary type and are connected in the circuit in the usual manner. The posts are spaced about ¾ inch apart, and the fixed condenser is connected across the two outside posts.

When only a single pair of phones is used, they are connected to the end posts as shown at the left of the diagram, but when two sets are used, the connections are made as shown at the right.

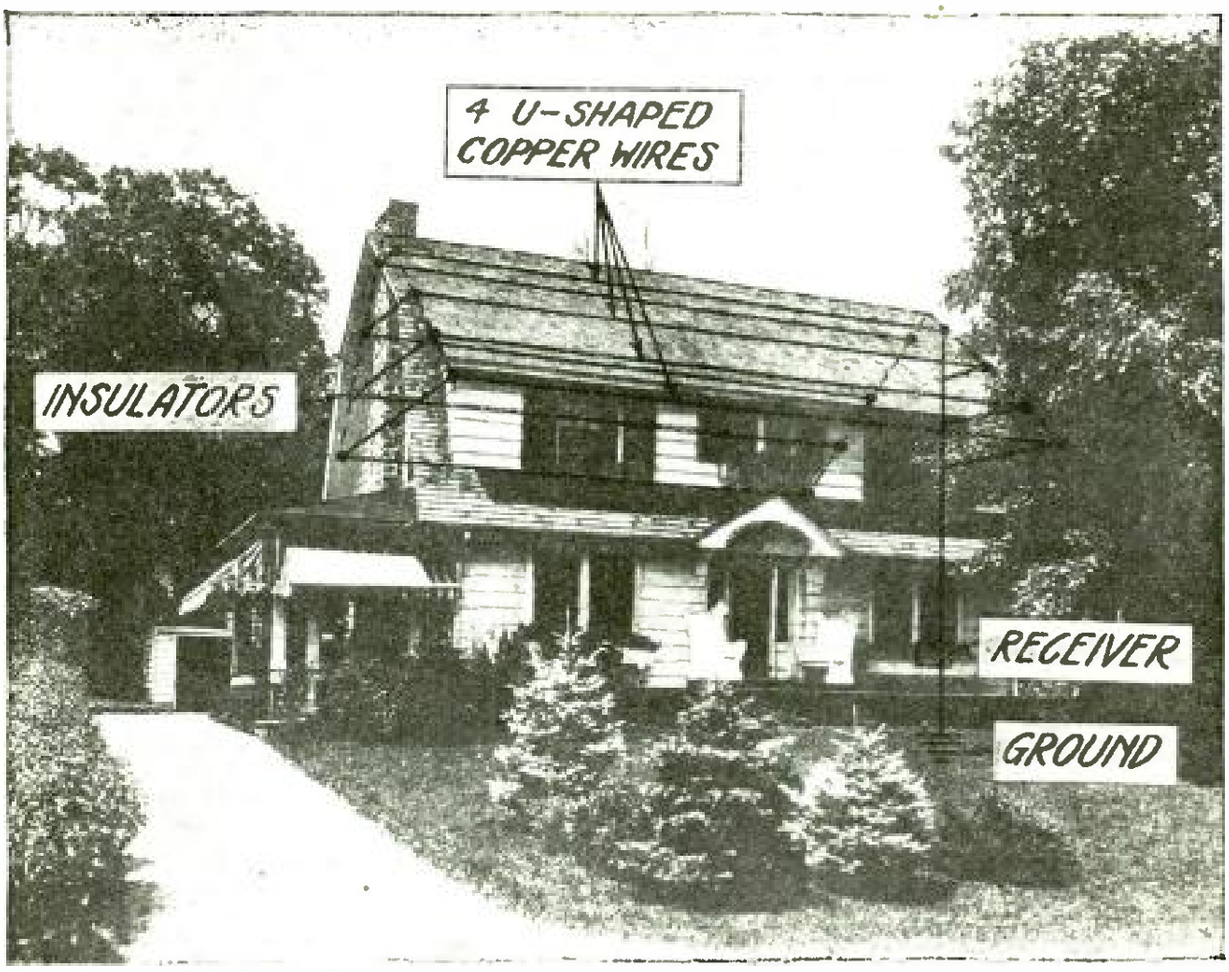
More than two sets of phones can, of course, be provided for by using the desired number of "blind" posts mounted in the same manner.

W. C. Michel



YOU CAN MAKE IT YOURSELF FOR A QUARTER

A small square of insulating material, three binding posts, a small fixed condenser and a few minutes' work, and you have a neat and compact block for connecting your headphones.



From a diagram made for POPULAR RADIO

No more troublesome and unsightly outdoor antennae will annoy the amateur who rigs up his wires under the rafters in his attic—secure from so many of the dangers that threaten the fan's exposed aerial.

An Indoor Aerial with a Crystal Set

AN ingenious radio fan in Elizabeth, New Jersey, finds it impractical to string up an outdoor antenna. So he has solved the problem of a successful indoor aerial for use with a crystal set, thus:

Crystal sets will work satisfactorily with a properly designed indoor aerial, despite the word of "experts" to the contrary. The sets should not, however, be used with a loop antenna.

My house is about fifteen miles from the New York City stations, WEAF, WBAY and WWZ, seven miles from WJZ and about five miles from WOR, WAAM and WBS. At the south end of my attic I put up an insulator and fastened a wire which was, of course, dead ended. I carried it to the other end of the attic to an insulator, carried it horizontally a distance of six inches across to another insulator and back to the end where I began, thence down to the set on the second floor. This was done with four wires fastened on the slanting roof, one below the other a foot apart, making thus four "U" aerials, all joined to one lead-in. The diagram shows how the wires were strung.

By the use of galena or silicon in several different detectors (including home-made ones) I get all the broadcasting stations in the Metropolitan district, some amateur phones and plenty of 200 meter and 600 meter code. As I get the New York City stations but not WHN or WRW, which are twenty-five to thirty miles away, apparently my range with these four "U" pairs is about fifteen miles. I am of the opinion that more pairs would increase the range as well as the signal strength.

With a honeycomb regenerative hook-up, using one stage of amplification and a Baldwin phone, this aerial will pick up enough energy to operate a phonograph used as a loudspeaker.

In cases where it is impossible to set up an outdoor antenna but where there is an attic or other place for the stringing of at least two "U" pairs, and if the location is within fifteen miles of a broadcasting station, this indoor aerial certainly is worth trying on a crystal set.

GUY M. CHASE

Practical Pointers About Your Grid Condenser and Grid Leak

DON'T overlook the importance of your grid leak and grid condenser! Perhaps the trouble you are having with your set may be traced to a cheap grid-leak-condenser; certainly there are many such on the market. How this trouble may be avoided is here pointed out by an old-time amateur:

Two friends of mine who recently installed their first vacuum tube sets have both had trouble from the same causes—defective grid leaks or grid condensers.

In the first case the new set simply did not function. The hook-up was gone over several times, but nothing wrong was found. The tickler and battery connections were reversed; a new ground connection was tried; a new "B" battery was purchased in the belief that the first one was run down, but there was no improvement. I went through the routine of testing for him, and by a process of elimination, I arrived at the conclusion that the fault was in the grid-leak-condenser—a combination affair that he had purchased for about ten cents. There was no need to go further.

In the second case the owner of the set was able to hear the nearby broadcasting stations as soon as he hooked up, but his range was limited to the powerful nearby stations. He also had a combination grid-leak-condenser, but the trouble was found to be not in the condenser but in the grid leak. When another grid leak, made with two binding posts mounted on a piece of fibre and connected with a pencil line, was shunted around the condenser, a great improvement was at once noticeable.

A new and reliable mica grid condenser and leak was finally installed in his set and the trouble which had been given him was remedied immediately.

The first night after we made this change we were able to pick up WGY at Schenectady, 175 miles distant, and a few minutes later KDKA at Pittsburgh, 330 miles distant.

To satisfy our curiosity we ripped apart the combination grid-leak-condenser that we originally used and found that the pencil line in the lead was not continuous, due to the rough surface of the fibre on which the line had been drawn; in other words the pencil only "hit the high spots" of the fibre.

Get a good mica condenser of about .0003 mfd. and a reliable grid leak of 2 megohms and watch your set reach out for the long distance stations.

S. GORDON TAYLOR

Western Electric

ONE OF THE MOST COMPLETE AMATEUR STATIONS IN AMERICA

To advance the radio art, Col. Edward H. R. Green has just completed a remarkable experimental station, WMAF, on his estate on Buzzards Bay, Mass., where he will afford facilities for fans who show promise of making real contributions to science. "No loafers wanted," he warns. "A real inventor does his best work nights and Sundays."

BROADCASTS

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

1,500,000 Sets Owned by American Fans

SOME idea of the rate at which the public interest in radio is "dying out" may be derived from the figures computed by a recent canvass of the country, which indicates that there are now approximately 1.500,000 receiving and transmitting sets owned by radio fans—exclusive of the commercial and governmental apparatus. The center of interest is Pittsburgh, where there is one set to every six houses.

* * *

A Scheme for "Taxing" Outdoor Aerials

THE solons of the City Council of Chicago have apparently been reading about the custom observed by European governments of imposing taxes on amateur sets, and are considering an ordinance that will put a tax of $3.00 a year on receivers and $5.00 on transmitters—in the form of a fee for inspecting outdoor antennas. What will happen when the outdoor antenna is supplanted by the indoor aerial?

* * *

Let the Radio Waves Do Your House-Work!

GEORGE FRANCHETTE, president of the "Society for the Study of Wireless," in France, has just put to domestic service the radio station on the Eiffel Tower. At six o'clock in the morning the radio waves from the tower set his alarm clock going, operate apparatus that closes his windows, turn on the heat and begin boiling his morning cup of chocolate.

* * *

How Radio Is Growing Abroad

THE rapid and inevitable growth of radio abroad is convincingly demonstrated by the government reports which show that the value of radio apparatus exported from the United States in 1922 just about trebled that of goods exported in 1921. Orders during 1922 came from practically every country in the world.

* * *

Radio Matriculates at Yale

DR. LEE DE FOREST, a graduate of Yale University, has established a fund at his alma mater for the purchase of a radio library, another fund for the giving of lectures on radio to advanced engineer students.

Noon and Midnight Time Signals "Interfere"

As Dr. Einstein points out, time is relative, after all, and noon and midnight occur simultaneously at opposite sides of the globe. So it is that radio operators on the Pacific can tune in on the midnight signals from the Honolulu station NPM, and by a quick adjustment can pick up the noon signals sent out from the station POZ in Nauen, Germany.

* * *

The Chief "Reform" Needed in Radio

"FEWER and better broadcasting stations" was the gist of the replies to a questionnaire sent out by the National Radio Chamber of Commerce to fans, dealers and manufacturers.

Kadel & Herbert

THE BELL OF STATION WOR

Fans who have heard the delightful notes of the chimes of the famous Newark station may here see not only this instrument, but also the capable Miss J. E. Koenig, the Manager.

Grand Opera Stalls at Home

GRAND opera is now being broadcast in England. Some of the performances at Covent Garden, long the home of this form of musical entertainment in London, are being sent out on the ether by arrangement with the British National Opera Company, in the same manner as the grand opera performances have been broadcast from the Auditorium in Chicago during the past two years and more recently in Philadelphia.

Only the Metropolitan Opera Company in New York still refuses to broadcast programs.

* * *

A Move for Standardizing Radio Parts

AT the request of six of the foremost organizations of radio engineers and manufacturers of and dealers in radio apparatus, the U. S. Bureau of Standards called a conference in New York on January 12th with the main purpose of considering whether or not radio apparatus should be made in standardized designs and, if so, how this standardization could best be brought about.

The action of the conference may be summarized by stating that it agreed unanimously:

1. That standards for radio apparatus and service should be formulated.

2. That a broadly representative national committee on radio standardization should be formed under the leadership of the Institute of Radio Engineers and the American Institute of Electrical Engineers, following the procedure of the American Engineering Standards Committee.

* * *

A Transmitting Station on Wings

AIRCRAFT are now following ships in the utilization of radio equipment to add to the safety of the passengers. The first airplane to be licensed as a "limited commercial station" for both transmitting and receiving was the *Airline Arrow No. 1*, of the Airline Transportation Company of Los Angeles. Others are following suit. It is probable that radio will be extensively used in aircraft, especially in those which make flights over the ocean.

* * *

How Many Broadcasting Stations Can the Ether Hold?

JANUARY, 1923, was the first month since the beginning of the broadcasting wave that fewer new stations were licensed than were dropped out. This has been interpreted as an indication that 570 licensed broadcasting stations in the Class A and B groups constitute the saturation point, so far as numbers of stations is concerned; from now on the competition will be in quality. A new station, if it is to succeed, will have to offer better service than the old stations.

* * *

The Navy Clears the Ether

LARGELY because it does not wish to interfere with radio traffic, the Navy is closing several stations following the recommendations of the Rodman Board. The stations already closed are at Cape May, N. J.; Grande Isle, La.; Navassa, W. I.; Pass a Loutre, La., and St. Petersburg, Fla. A station at Seattle will be abandoned as soon as the Navy Yard at Puget Sound can take over the work. Stations at Baltimore, Md., Mobile, Ala., Miami, Fla., and Port Arthur, Texas, will be auctioned as soon as invitations to bid can be sent out. The station at Managua, Nicaragua, will be disposed of when arrangements for commercial facilities have been made. Ten stations in the Great Lakes have been offered to the Army.

* * *

Gold in Antenna Wires

THE latest trick for the improvement of radio apparatus is to use gold-plated wire in the antenna. Gold-plated wire does not corrode; its use, therefore, climinates the high skin resistance which is caused by corrosion.

"MENUS BY MAGIC"

Every morning Miss Florence Davis broadcasts from station WWJ in Detroit daily hints for the housekeeper whose job it is to select the food for dinner which explains why she receives so many letters from grateful husbands!

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.

A REMARKABLE CRYSTAL SET

THE simplest type of crystal set, using a loose coupler, is bringing programs from WOC in Davenport, Iowa, to Toledo, Ohio. Walter Brimmer, fourteen years old, made the coupler himself, from plans published in POPULAR RADIO, using 100 turns for the primary, tapped in tens and units, and 80 turns for the secondary, tapped in tens.

His aerial is a single wire, 85 feet long and 35 feet high. He also hears WWJ, Detroit, Mich., KDKA, Pittsburgh, Pa., and a Cleveland station. Interference is easily tuned out with the coupler, which is one of the best tuning instruments for a crystal set and even for the more complicated tube sets.

* * *

A ONE-TUBE SET THAT SPANS THE CONTINENT

WITH one vacuum tube, Harry K. Larson of San Francisco hears New York concerts plainly; he also hears most of the other stations in the United States.

The ultra-audion single tube hook-up is used in this set with the exception that the grid leak is connected to the negative of the "A" battery, enabling one end of the secondary coil to be connected to the grid and the other to the plate. The coil in this case was a variocoupler with a variometer in the antenna circuit. A 43-plate variable condenser is also included in the secondary circuit.

As local conditions do not permit the erection of a long antenna, Larson uses three strands 50 feet long and 35 feet high.

* * *

AN ORDINARY DETECTOR TUBE HOOK-UP THAT PICKS UP BOTH CANADA AND CUBA

STATION CFCF, Canada and PWX, Cuba can be heard in Atlanta with the ordinary detector tube hook-up, according to H. L. Grosbeck, who has heard some 90 stations with such a set.

The set is home-made, of the regenerative type, with a variocoupler, two variometers and variable condenser.

Grosbeck attributes his success to his cage aerial, which is 12 inches in diameter, with 6 wires 60 feet long, and 50 feet high.

* * *

A USEFUL COUNTERPOISE

A COUNTERPOISE is given credit by John E. Carson of Pittsburgh for bringing in signals from Los Angeles with one tube. Carson explains that his success came after considerable experimenting with the regenerative circuit. Many arrangements which brought startling results to others would not work as well for him as some less complicated systems.

His antenna is made of three strands, 110 feet long and 60 feet high. The counterpoise has three strands of similar length which are run 8 feet above the ground.

The set brings in California regularly, as well as Denver, Colo., Winnipeg, Canada, Havana, Cuba, and scores of others in between.

* * *

AN AERIAL ON A TIN ROOF

AN aerial but 40 feet long and 15 feet above a tin roof gives one tube a range of half the continent in the set of Homer Brewster in Brooklyn. The aerial is in the form of an inverted L, with 4 wires 35 feet from the ground.

Brewster uses two variometers in his regenerative hook-up and 48 volts on the plate of his detector tube.

Stations WDAP, Chicago, WOC, Davenport, Ia., WHB, Kansas City, Mo., and WGM, Atlanta, Ga., are heard regularly and clearly.

* * *

A SINGLE CIRCUIT COVERS 1,800 MILES

WITH only one tube in a single circuit regenerative set, George R. Worth of Chicago has heard Los Angeles, Calif., which is 1,800

miles away. He also hears Dallas, Tex., and the larger stations of the Eastern coast under favorable circumstances. Four strands are used in his aerial, which is 160 feet long and slants from an altitude of 55 feet to 40 feet.

* * *

DRY-CELL TUBES AMPLIFY

THREE dry-cell tubes bring in New York and Atlanta, Ga., for Arthur F. Walker of Boston, Mass., as well as a number of stations closer to him. He uses a single circuit regenerative set with two stages of audio frequency amplification. His aerial is made of two wires about four feet apart, 30 feet high and 80 feet long.

* * *

WHAT ONE FAN ACCOMPLISHES WITH TWO VARIOMETERS

WITH the use of two variometers and a single tube, on clear nights Milton F. Conklin of Cincinnati, O., receives from KGW in Portland, Ore., more than 2,000 miles away.

His set is used with a three-strand antenna 140 feet long and 35 feet high.

* * *

A FREAK *RICOCHET*

COVERING the distance from Chicago to New York with a crystal set startled Rockaway Beach, N. Y., until the strange feat was explained by Frank J. Bennett, whose regenerative set first caught the waves and relayed them to his friend next door. Bennett's aerial is 200 feet long and runs parallel with that of his friend, which is 50 feet distant.

* * *

International

THE WORLD'S BEST HOME-MADE SET—FOR THE MONEY

The universal success of the $11.00 to $15.00 crystal receiver developed by the Bureau of Standards for the special benefit of amateurs who "build their own" is proclaiming it as a standard of excellence. Its usual range is fifteen miles, but it has on occasion received up to 1,000 miles.

A JERSEY FAN PICKS UP CUBA WITH DRY-TUBE CELL

STATIONED in Newark, N. J., L. S. Fisher hears PWX, Havana, Cuba, with a dry-cell tube that requires but 1½ volts to light the filament. He uses a variocoupler and one 43-plate condenser.

The antenna used is a single wire, 140 feet long. It is pointed in the direction of Cuba, which accounts in part for the performance of the tube. The wire is 55 feet from the ground. The ground connection is made in the usual manner to a water pipe.

* * *

NEW YORK HEARS PORTO RICO ON A SINGLE CIRCUIT RECEIVER

SEVENTEEN stations more than 250 miles away are heard with a dry cell tube and single circuit tuner by Allen Berman of New York City. His record for distance is WKAQ. San Juan, Porto Rico.

The aerial is made of two strands 120 feet long and 60 feet high. This forms a fairly good antenna for any kind of set. With the little dry-cell tube it brings in most of the large eastern stations.

* * *

AN AMATEUR SET REACHES 1,000 MILES ON TWO TUBES

WITH one stage of audio-frequency amplification, James A. Carver has heard 43 stations in 17 different states. He lives in Philadelphia and his record in reception is from WBAP, Fort Worth, Tex., over 1,000 miles away.

The set consists of a variocoupler, variometer, variable condenser and the two tubes. The aerial is a single wire 110 feet long and only 20 feet above the ground. The range of the set could be considerably increased by raising the aerial, but it is possible that this form is fairly well suited to local conditions.

* * *

A 30-FOOT INDOOR ANTENNA

With a single wire 30 feet long strung inside his home, Austin F. Milford of Fort Worth, Tex., receives from Denver and Kansas City by using two stages of audio frequency amplification. His set consists of the ordinary variocoupler, variometer, and 43-plate variable condenser.

* * *

A SINGLE CIRCUIT COVERS 1,800 MILES

WITH almost the worst possible local conditions, James F. Vincent in Chicago hears New York stations regularly with one tube. His antenna is only a single wire, 100 feet long, running parallel to a 5,500-volt power line, a house circuit and several telephone wires. The telephone wires come within five feet of the antenna at one point.

A regenerative hook-up is used with two coils, a primary coil with 50 turns and a tickler coil with 25 turns. The set is tuned with the tickler and a condenser in the antenna circuit.

ATWATER KENT

Receiving Sets and Parts

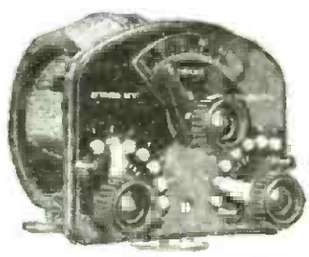
Complete Set consisting of Coupled Circuit Tuner, Detector Unit and 2-stage Amplifier. Other sets shown in circular

Mounted Variometer

Type 11 Tuner

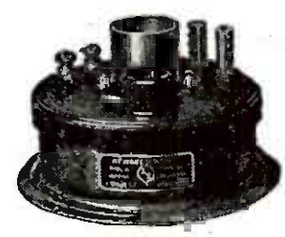
ATWATER KENT Receiving Sets and Parts are built with the most particular care. From the moulding of the condensite forms and winding of the various coils, through the assembling and finishing of the units to the final mounting and wiring, every step is subjected to the most rigid inspection. It must be "just so." This is the reason why ATWATER KENT radio equipment has that "different" look that makes it instantly noticeable in any surrounding.

Atwater Kent products would sell on appearance.



Mounted Variocoupler

Detector Unit



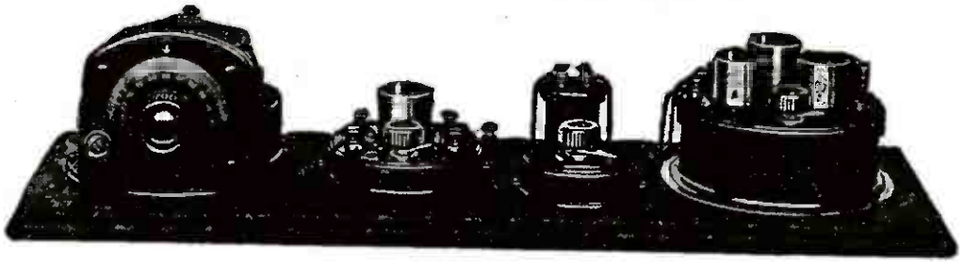
1-stage Amplifier

ATWATER KENT MANUFACTURING COMPANY

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

ATWATER KENT

Receiving Sets and Parts



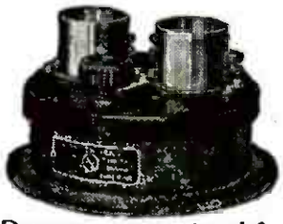
Complete Set consisting of Type 11 Tuner, one stage of Radio Frequency Amplification, and Detector 2-stage Audio Frequency Amplifier

BUT appearance is not the only feature that is watched. Even though the factory is pushed to its utmost capacity by the extraordinary demand for ATWATER KENT sets and parts, every unit is carefully tested to make certain that its performance is right. By this means, the radio fan is sure of getting a part or set that is not only strikingly handsome in appearance, but works perfectly, and gives the utmost satisfaction.

They stay sold on quality of performance.

R.F. Transformer

Standard Vac. Tube Unit



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

Detector 2-stage Amplifier

Potentiometer

ATWATER KENT MANUFACTURING COMPANY

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

For Radio Frequency Sets

Constantly Making New Distance Records
Here's a Complete Assortment

Crosley Model VI

This set consists of one stage of Tuned Radio Frequency Amplification and Audion Detector. It is normally for use with head phones but is especially recommended to be used with any type of loud speaker. Additional amplification is unnecessary if head phones and horn are used in receiving local stations. With the Crosley Receiver Model VI distant broadcasting stations are brought in loud and clear. It also eliminates static to a large extent.
Mounted on formica panel, Adam brown mahogany finished cabinet without tubes, batteries or phones. Price.....$30.00

Crosley Model VIII

A new set offering exceptional value. Contains one stage of tuned radio frequency amplification, detector and one stage of audio frequency amplification. Also offered as a portable instrument, using 1½-volt tube. Price, without batteries, tubes and phones, Regular Model VIII, $48.00, Model VIII, Portable $60.00

Crosley Model X

The most complete receiving set on the market. A 4-tube set consisting of one detector, one stage of tuned radio frequency and two stages of audion frequency amplification. In placing this receiver on the market, we are offering you a unit whose range, volume and selectivity is remarkable. Nothing can compare with it at twice the price. Developed in the CROSLEY laboratories, this unit is absolutely the last word in long range Radio Receiving Apparatus. Used with head phones and loud speaker, it will bring in distant stations all over the house. Price without phones, batteries or tubes $55.00

Crosley Receivers

From our smallest complete receiving outfit at $25, including other sets incorporating Crosley radio frequency tuned amplification at $28, $48, $55, and up to our beautiful Console Model XXV, price $150, Crosley instruments offer the highest efficiency at the lowest cost.

CROSLEY
Better—Costs Less
RADIO RECEIVER

Crosley Parts

We also manufacture a complete line of parts for those who wish to make their own outfit. Among these are Variable Condensers, Knobs and Dials, V-T Sockets, Variometers, Vario-Couplers, Rheostats and the well-known Crosley Radio Frequency Amplifying Tuner.

CROSLEY MANUFACTURING CO.
416 ALFRED ST. CINCINNATI, O.

Crosley ACE Regenerative Receivers $20.00 and up

ANNOUNCEMENT

Powel Crosley, Jr., President of the Crosley Manufacturing Company, has acquired controlling interest of the capital stock of The Precision Equipment Company, of Cincinnati, licensed to manufacture regenerative apparatus under Armstrong Patents. Crosley management, production and sales methods already have enabled us to offer even better apparatus at lower prices.

Crosley Model V Regenerative Receiver

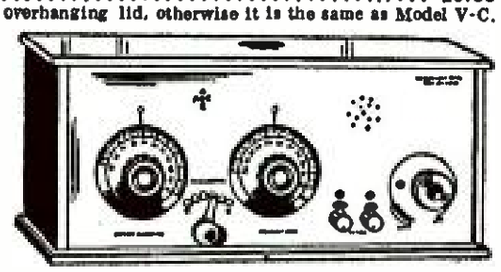
Remarkable records are being achieved by owners of the Crosley Model V regenerative radio receiver, which is the greatest result-producing one-tube set being manufactured today. With a range of from 150 to 600 meters, this little wonder brings in amateur, broadcasting and commercial stations. Concerts broadcast more than 1,000 miles away are heard by those who own the Model V. The cabinets are arranged to permit use of the one and one-half volt tubes, with which they operate very efficiently. Use of these tubes eliminates necessity of buying more expensive "A" batteries. The name "Crosley" is used by permission of the Crosley Manufacturing Company. Made in two models. Both have Adam brown mahogany finished cabinets and beautifully engraved panels. The Crosley two-step amplifier matches this unit perfectly.

Model V-C $20.00
Model V-D 19.00

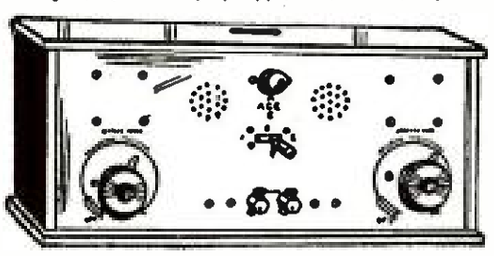
Model V-D has overhanging lid, otherwise it is the same as Model V-C.

ACE TRU Regenerative Radio Receiver

No powerful station in the United States is too far away to be copied by owners of the Tru radio receiver. The cabinet of the Tru is beautifully finished, the panel is of genuine formica and all the parts are the most efficient obtainable. Without amplification, the Tru will bring in distant stations loud and distinct. In comparison with any of the highest quality instruments available, the Tru receptor will equal, if not surpass, the performance of any of them. If the owner desires to operate a loud speaker, an amplifier must be added, and we recommend the AV-2, illustrated below. Price of the Tru Receptor (formerly $65), now.....$35.00



ACE AV-2 Two-Step Amplifier



The AV-2 Two-Step Amplifier designed to be added to the Tru radio receiver, with which it matches perfectly, may be used in conjunction with any audion receiver. Ace type transformers and sockets are used in the AV-2. The cabinet is beautifully finished. The panel is of genuine formica. There is a switch permitting use either of one or two stages of amplification, and also special binding posts for the use of head phones in conjunction with a loud speaker. Experiments have shown that the amplification constant is approximately twenty times that of the incoming signal on the first stage and 400 times on the second. Price of the AV-2 (formerly $65) now..$35.00

ACE Tube Socket

A real good socket, built to stand long and hard service. There is no moulded base to melt when the soldering iron is applied. Instead this is of real sheet formica, one quarter inch thick. Substantial metal die casting—pure phosphor-bronze springs. This socket has been designed to prevent shortcircuiting and burning out of the expensive vacuum tubes. Prong contacts are carefully adjusted. One and one-half volt tubes may be used in these after adapters are inserted.

We recommend the adapters made by the Crosley Manufacturing Company.

Price $1.00

ACE Condenser

Capacity .0005 Mfd.

Exclusive features of this condenser are too numerous to dwell upon. These, however, include balanced non-warping plates, carefully adjusted, and a fine positive gear vernier, with a five to one ratio.

Price with Vernier.... $7.50
Without Vernier 5.00

ACE Transformer

Enormous amplification has been attained and foreign noises have been eliminated through use of the Ace transformer. A generous core of high-grade transformer iron supports rugged primary and secondary windings. The core, in turn, is supported by two nickel-plated cones, which permit of base or panel mounting. Plainly marked terminals through insulation bushings in the shell provide convenient connections in the circuit.

Price $5.00

Licensed under Armstrong U. S. Patent No. 1,113,149. October 6, 1914. For use by radio amateurs in radio amateur stations, to radio experimenters and scientific schools and universities, for use in experimental and scientific schools or university radio stations. The Crosley Manufacturing Company has discontinued the sale of regenerative radio receivers, but Crosley dealers will be able to supply you with those made by the Precision Equipment Company.

WRITE FOR CATALOG OF COMPLETE SETS

THE PRECISION EQUIPMENT CO.

POWEL CROSLEY, Jr., President

416 GILBERT AVE. CINCINNATI, OHIO

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

P812—43 plate .001 Mfd. $2.29
P813—21 plate .0005 Mfd. 1.80
P814—11 plate .00025 Mfd. 1.32
P815—3 plate Vernier 1.05

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

P824—23 plate .0005 Mfd. Price $3.25
P826—43 plate .001 Mfd. Price $3.95

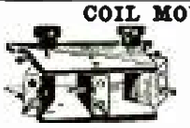
The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial. Separate small knob mounted above dial controls a three-plate vernier condenser. This arrangement permits of very fine tuning. High-grade design and construction. Finely finished. Suitable for 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	Range	Art. No.	Not Mntd.	Art. No.	Price Mntd.
25	120- 250	P301	$0.39	P320	$0.97
35	175- 450	P302	.42	P322	1.00
50	240- 720	P303	.49	P323	1.07
75	390- 910	P304	.54	P324	1.12
100	500- 1450	P305	.58	P325	1.16
150	600- 2000	P306	.63	P326	1.21
200	900- 2500	P307	.72	P327	1.30
250	1200- 3500	P308	.78	P328	1.36
300	1500- 4500	P309	.82	P329	1.40
400	2000- 5000	P310	.97	P330	1.55
500	2800- 8100	P311	1.12	P331	1.70
600	4000-10000	P312	1.27	P332	1.85
750	5000-12000	P313	1.43	P333	2.00
1000	7900-15000	P314	1.70	P334	2.38
1250	9750-19500	P315	1.92	P335	2.60
1500	14500-26500	P316	2.18	P336	2.76

COIL MOUNTINGS



P340 Three coil mounting $3.59
P341 Two coil mounting $2.69

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. P732 Each.....86c

VACUUM TUBES

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

P105 Detector. Each....$4.45
P110 Amplifier. Each.... 5.95
P115 5 Watt Transmitter 7.70

MYERS TUBES

P113 High-Mu Audion. Has 5 times amplification of ordinary tubes. Oscillates anywhere from 2 to 300 volts on plate. Each $5.00
P116 Receptacle for above. Each... 1.00
P117 Adapter to adapt Myers tubes for use in any standard socket. Each...$1.05

MYERS CHOKE COIL

P119 Each.....$3.50

VACUUM TUBE SOCKETS

Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections. Right angled contact springs
P140 Each.....39c

PORCELAIN BASE AND TUBE

P144 Crosley for either panel or table mounting 30c

High Grade combination type for panel or table mounting. Metal tube. Highly insulated base.
P146 Each.....45c

GRID CONDENSER

P162 Mounting holes spaced to fit lugs of above leak Cap. .00025 MF.....14c
P163 Same as 162 but higher grade. Enclosed in metal case.....39c

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed.
P100 Each.....18c

VARIOMETER

P410—Completely assembled, price $2.69

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

P411—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.

P415 Price, completely assembled $2.45
P416 Not assembled, but all parts complete. Price, except wire $1.18
P417 Rotor ball only. Each.....29c

RADIO FREQUENCY AMPLIFYING TRANSFORMER

P995 Each.....$2.95

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.

P234 10 to 1 Mounted. Each.....$3.48
P235 10 to 1 Unmounted. Each.... 2.95
P236 3 to 1 Mounted. Each..... 3.40
P237 3 to 1 Unmounted. Each.... 2.85

FILAMENT CONTROL RHEOSTATS

Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
P130 Each.....54c

Best grade. High heat resisting base. Diam. 2⅛ in. cap. 1½ amp. Resist. 6 ohms. 1¼ in. Knob with pointer.
P132 Each.....48c

POTENTIOMETER

Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 140 ohms.
P133 Each 98c

VERNIER RHEOSTAT

Gives exceedingly fine control of a battery current. A necessity for best receiving results.
P135 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.

P180 Signal Corps type, small size. 15 cells. 22½ volts. Each. 95c.
P182 Large Navy size. 6½x4x3. 15 cells. 22½ volts. Each.....$1.75
P184 Variable Large Navy size, 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each.....$1.80
P186 Double Navy size 6½x4x6. 30 cells. 45 volts. Suitable for amplifier circuits and power tube use. Two or more of these units in series may be used in C. W. and radiophone circuits. Each..$3.40
P188 Combination Tapped 45 volts, 30 cells, 6½x4x6 battery. Tapped to give 45. 22½. 21. 19½. 18. and 16½ volts. Handles both detector and amplifier tubes. Each $3.55

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

USE BARAWIK STANDARD PARTS

YOU SAVE MONEY WHEN YOU BUY FROM US

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

SOLID BARE COPPER WIRE

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

Solid Bare Copper Wire, size 14
P240—100 ft. coil 45c
P242—500 ft. coil $2.15

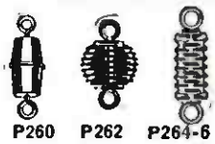
Solid Bare Copper Wire, size 12
P244—100 ft. coil 61c
P245—500 ft. coil $2.75

STRANDED ANTENNA WIRE

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

P248—100 ft. coil 65c
P249—500 ft. coil $2.95

ANTENNA INSULATORS



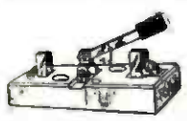
P260 P262 P264-6

P260 Size 1x3¼. Two for.....17c
P262 Size 2⅛x3¼. Two for.....58c
P264 Size 1½x4. Two for.....80c
P266 Size 1½x10½. Two for $1.35

OUTDOOR LIGHTNING ARRESTER

P980 Price.....$1.68
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.

P385 Single Pole Single Throw. Each 20c
P387 Single Pole Double Throw. Each 32c
P384 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.

P380—1" Radius
P381—1¼" Radius } Each
P382—1½" Radius } 19c

SWITCH LEVER STOP

Brass, polished nickel finish.
P386—Dozen 18c. Hundred $1.05

ONE-PIECE DIAL AND KNOB

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

P900 2¼" Diam. for 3-16" shaft. Ea..19c
P901 2¼" Diam. for ¼" shaft. Ea....19c
P904 3" Diam. for 3-16" shaft. Ea.....25c
P905 3" Diam. for ¼" shaft. Ea.....25c
P906 4" Diam. for 3-16" shaft. Ea....42c
P907 4" Diam. for ¼" shaft. Ea.....42c

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:
P390 Open circuit. Each.....43c
P391 Closed circuit. Each....49c
P392 Two circuit. Each.....60c
P393 Single-cir. fila. control..69c
P394 Two cir. fila. control..85c

P395 Plug. Large space with set screws for attaching cord. Each.....54c

COMPETITOR JACK AND PLUG

Well made, durable, smooth working. Interchangeable with any standard Jacks and Plugs. Solder connections. Nickel finished metal parts. Fiber barrel on Plug.

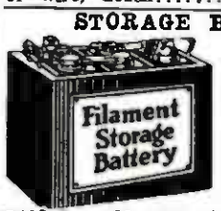
P387 Open Circuit Jack. Each.....27c
P388 Two Circuit Jack. Each.....35c
P389 Standard Plug. Each.....35c

BINDING POSTS

P370-2 P376-8

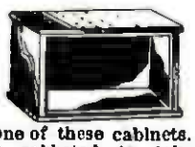
Brass, polished nickel finish. Washer and 6-32" screw extending ⅝"....
P370 Large size—barrel and knob ¾" long, dozen 85c
P372 Smaller size—barrel and knob 9-16" long, dozen 70c
P374 Large size with composition knob, dozen 60c
P376 Large size with hole for phone tip or wire, dozen.....80c
P378 Small size with hole for phone tip or wire, dozen.....38c

STORAGE BATTERY



A very high grade battery made especially for radio service. Guaranteed. Properly cared for will give years of service for filament lighting.
P194 6-v., 40 amp. size. Each..$10.00
P196 6-v., 80 amp. size. Each....$12.50

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"	5⅛"	6½"	7"	P420	$2.48
6x10½"	5½"	10"	7"	P422	2.75
6x14"	5½"	13½"	7"	P424	3.30
7x14"	6½"	13½"	7"	P423	3.60
7x18"	6½"	17½"	7"	P426	3.90
7x21"	5½"	20½"	7"	P425	4.20
9x14"	8½"	13½"	10"	P428	3.70
12x14"	11½"	13½"	10"	P430	4.40
12x21"	11½"	20½"	10"	P432	5.25

SOLID GENUINE CONDENSITE CELERON PANELS

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

Panel Size Inches	⅛" thick 3-16" thick Art. No.	Price	Art. No.	Price	¼" thick Art. No.	Price
6x7	P450	$0.50	P460	$0.75	P470	$0.98
6x10½	P451	.75	P461	1.18	P471	1.47
6x14	P452	1.05	P462	1.55	P472	2.05
7x14	P458	1.20	P468	2.60	P478	2.40
7x18	P453	1.55	P463	2.30	P473	3.10
7x21	P457	1.78	P467	2.65	P477	3.60
9x14	P454	1.60	P464	2.30	P474	3.10
12x14	P455	2.10	P465	3.10	P475	4.15
12x21	P456	3.15	P466	4.65	P476	6.20

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.
P201 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.
P770—2000 ohm.....$4.00

OTHER STANDARD BRAND HEADSETS

P751 Murdock 56, 2000 ohm.....$4.45
P752 Murdock 56, 3000 ohm..... 4.95
P764 Frost 2000 ohm..... 4.20
P766 Frost, 3000 ohm..... 4.95
P756 Red Head, 3000 ohm..... 5.85
P758 Western Electric, 2200 ohm.. 9.50
P754 Baldwin Type C with universal jack plug $12.00
P755 Baldwin Type C unit..... 5.50
P768 Brandes, 2000 ohm..... 7.15
P789 Holzer-Cabot, 2200 ohm.... 7.20

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

PROGRESS

NATURALLY, at this early stage, the Art of Radio Communication is not standing still. It is undergoing a normal evolution.

The low-hung, straight line automobile of today is unlike its cart-like predecessor of twenty years ago, although the principle of locomotion remains the same.

So, too, the design of Radio apparatus advances. Insulated panels and live shafts are supplanted by metal panels and completely insulated instruments—the obvious thing to do, making unnecessary the use of a shield. Unsightly, protruding knobs are replaced by recessed dials and straight tuning bars, permitting fine adjusting without cramping the hand. The tap switch is removed entirely from the panel and becomes an integral part of the variocoupler, being placed *inside* the rotor, thus eliminating all soldering of primary leads.

It is significant that all these improvements have been developed in the Eisemann laboratories.

Descriptive literature will be sent upon request

EISEMANN MAGNETO CORPORATION

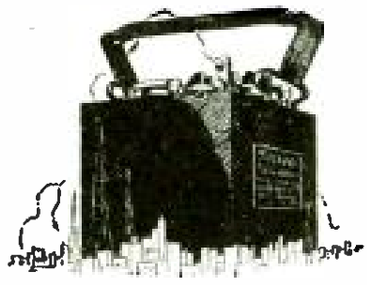
WILLIAM N. SHAW, *President*

DETROIT BROOKLYN CHICAGO

How much do you expect your battery to do?

TURNING the dials with a battery that is a constant offender is not much fun. You cannot thoroughly enjoy radio broadcastings unless your battery is up to the job.

Exide Radio Batteries are conservatively rated and give full ampere-hour capacity. They maintain steady voltage and deliver uniform filament current to the tubes. From plates to connector terminals each detail is the result of experience gained in every field of battery service by the oldest and largest makers of storage batteries in the world.



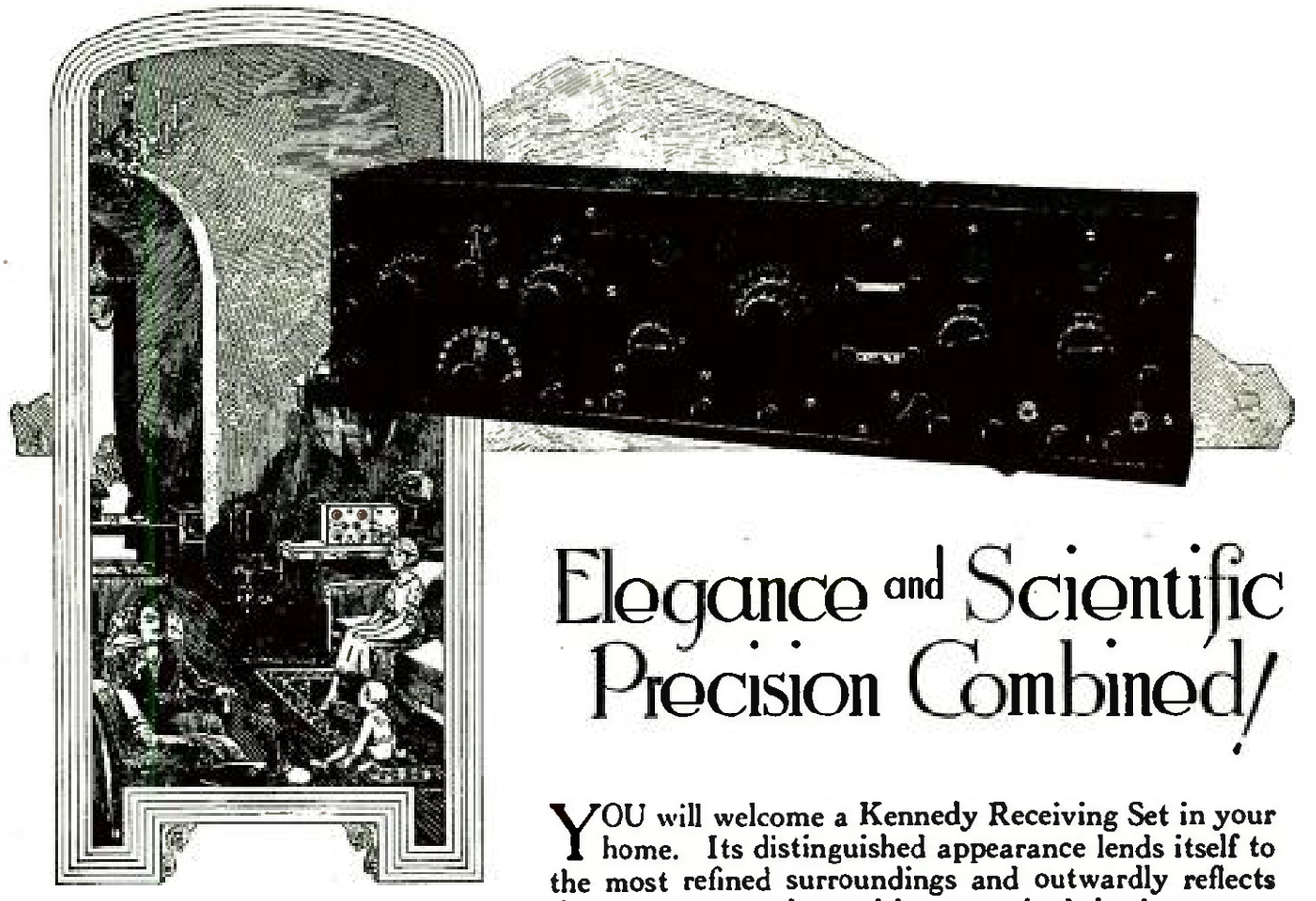
Exide Batteries play a leading role in the industrial world. They propel trucks, mine locomotives, and submerged submarines; they operate the fire alarm system and send your voice over the telephone. Most of the government and wireless commercial stations are equipped with Exide Batteries.

Your radio dealer will show you an Exide Radio Battery, or you can get one at any Exide Service Station.

Exide
BATTERIES

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia, Pa.

Service Stations Everywhere
Branches in Seventeen Cities



Elegance and Scientific Precision Combined

YOU will welcome a Kennedy Receiving Set in your home. Its distinguished appearance lends itself to the most refined surroundings and outwardly reflects the accuracy and precision exercised in its manufacture.

In a cabinet of beautifully finished hardwood and mounted behind a richly polished panel you will find a series of precision instruments—each correctly designed in itself and each exactly co-ordinated with the balance of the set.

Ease of control, long distance reception, elimination of interference and the utmost pleasure and satisfaction in its use are assured with a Kennedy receiver.

The Kennedy Variometer
This, as well as all other parts, is scientifically constructed by Kennedy artisans. The minute clearance between rotor and stator, the firm windings and positive contact eliminate dielectric losses and increase sharpness of tuning.

Arrange with your Kennedy Dealer for a demonstration. Or write us direct for further information.

THE COLIN B. KENNEDY COMPANY
SAN FRANCISCO SAINT LOUIS

KENNEDY

The Royalty  *of Radio*

KENNEDY
uses

KENNEDY EQUIPMENT

KENNEDY EQUIPMENT

Formica Panels and Insulation

THE COLLIN B. KENNEDY COMPANY uses Formica exclusively for its panels, tubes and other insulating parts in its entire line of Receiving Sets.

The handsome appearance of Formica, its high dielectric strength and wonderful uniformity meet the exacting Kennedy standards and have contributed to the creation of the splendid Kennedy reputation.

A list of the companies that use Formica Insulation reads almost like a directory of the leading independent radio manufacturers.

This patronage of men who know radio insulation establishes Formica's claim to leadership in its line.

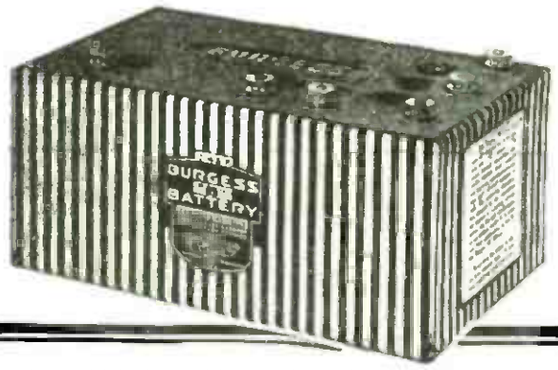
DEALERS: Formica advertising and sales support is the most aggressive and effective in the industry. The Formica Insulation Company treats you right.

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



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.

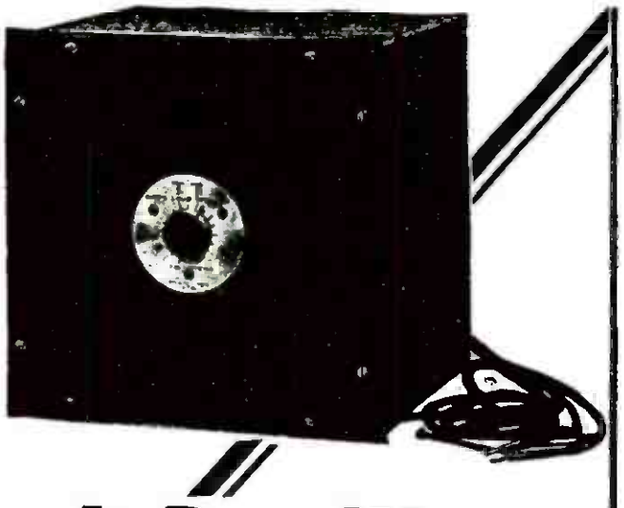
BURGESS BATTERY COMPANY

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"



IT DOES WHAT YOU WANT IT TO DO!

BECAUSE of its unique amplification adjustment which allows you to get the utmost from your set, whether receiving distant stations or powerful local broadcasting.

DON'T CONFUSE THE TIMMONS TALKER with the ordinary horn type of loudspeakers—it is self-contained in a beautiful solid mahogany cabinet (approximately 10" x 10" x 9") and requires no extra batteries. It has no delicate mechanism to get out of order.

YOU WILL BE DELIGHTED with its rich, mellow tone and beautiful appearance. To own a TIMMONS TALKER is to achieve real radio refinement. It is sold by most worthwhile dealers; we invite your correspondence if not sold by your dealer.

DEALERS

TIMMONS TALKER

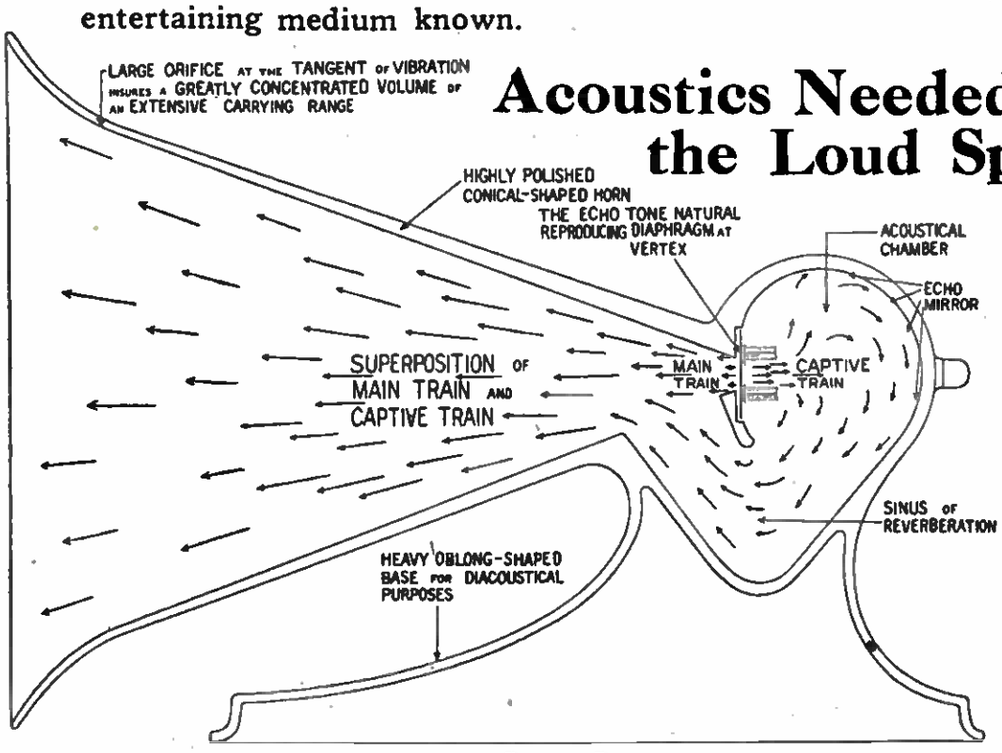
We have a most attractive proposition that will appeal to both dealer and jobber.

We will be glad to ship any dealer or jobber (with privilege of return) an instrument C. O. D. for inspection.

J. S. TIMMONS
337 E. Tulpehocken St.
PHILADELPHIA, Pa.

Echo-Tone Places Radio Among the Fine Arts!

A standard long-distance receiving set equipped with an ECHO-TONE now is considered to be the latest musical instrument and the most diversified entertaining medium known.



Acoustics Needed to Perfect the Loud Speaker

Echo-Tone is more than a loud-speaker, it is an acoustical instrument. An instrument scientifically designed especially for Radio Telephony. It is heavy for diacoustical purposes, it has its own natural reproducing diaphragm of a secret composition which is non-periodic, and by adopting an acoustical chamber, an Echo-Mirror and a Sinus of Reverberation, it has applied Resonance to the Loud-Speaker.

PATENT PENDING

ECHO-TONE

A Value Which Marks A New Epoch

SPECIFICATIONS

Diameter of horn: 15 inches.
Length of instrument: 20 inches.
Base: 15 inches x 6 inches.
Over All Dimensions: 15 x 16 x 20 inches.
Weight: 15 lbs.
Material: Casted aluminum.
Finish: Mahogany grain.

Mechanism: Baldwin Type C Unit equipped with The Echo-Tone Natural Reproducing Diaphragm.

Cord: Black mercerized.

Increased Volume From Any Set. No Extra Battery Or Transformer Used. Operates On One Or Two Stages Of Audio With From 22½ to 135 B Battery Voltage On Plates.

The Workmanship—Material—Performance—and Price are Echo-Tone's Answer to The Public Cry for Better Quality Apparatus.

RETAIL PRICE $35.00

Did You Ever Hear Radio

with a volume, clarity and tone so natural that you would swear the artists were in the room, and with a carrying range so extensive you could hear it plainly thruout your home? Or, is this what you have been waiting for, before you bought a Radio Set? Well, at last, your wait is at an end; for that is what Echo-Tone has given to Radio—and to such an extent that head telephone sets are not even needed to tune in!

Demonstrated in your home on your own set

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

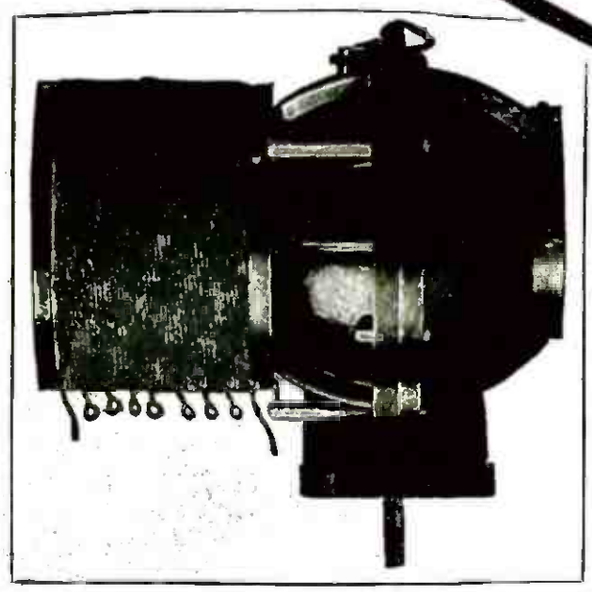
Introducing ECHO-TONE, thruout the country, we are sending a limited number to responsible dealers on a 10-day trial with the privilege of returning at our expense if it does not prove to be entirely satisfactory. Write at once if you wish to be the dealer to secure the demonstrating ECHO-TONE that has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

You deal direct with us—no middle man.

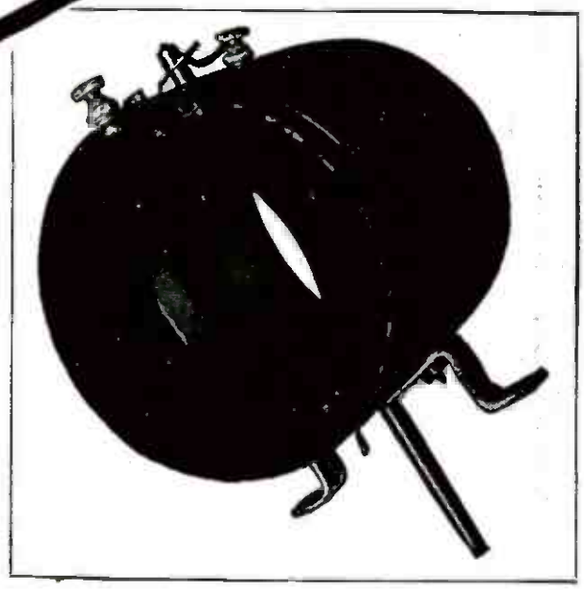
WILLIAMS RADIO COMPANY

1438 WASHINGTON BLVD. WEST **DETROIT, MICH.**

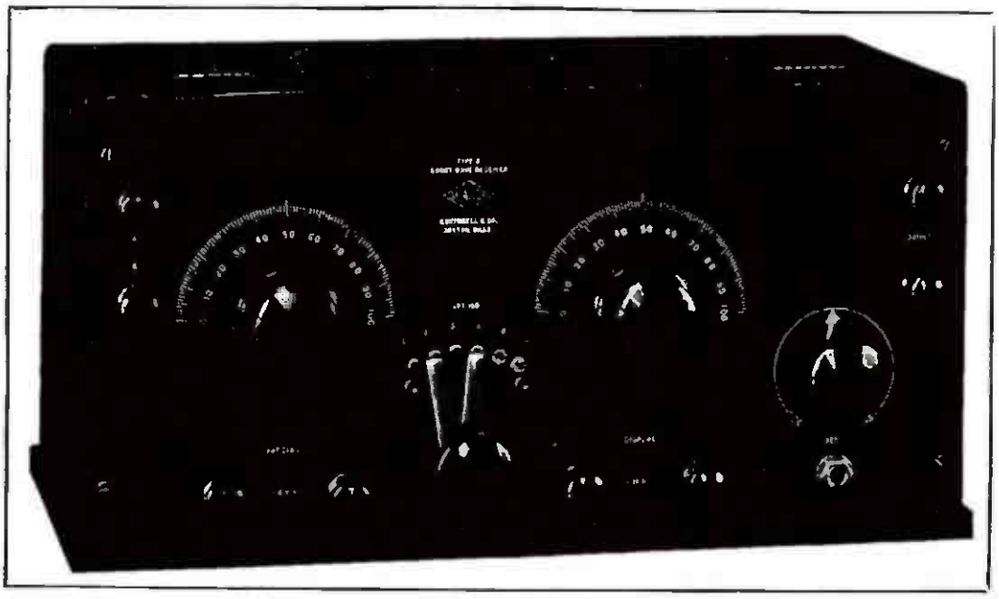
SE-AR-DE



Catalogue No. 165 . . . $13.00



Catalogue No. 166 . . . $5.50



KNOCK DOWN SET TYPE AD $28.00
Range 1000 Miles. Fitted for Std. or WD 11 Tube

R. MITCHELL & CO.

255 ATLANTIC AVE. BOSTON, MASS.

Brandes

ARE you getting long distance radio stations—are you catching clear and distinct the faintest signals that mark the extreme range of a good receiving set? A Brandes *Matched Tone* Radio Headset will make the faint signals understandable. The two receivers are perfect sound-mates—they are matched in tone to improve the clearness of the message. Brandes *Matched Tone* Headsets are guaranteed to get the best results obtainable from any set.

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

District Offices:

76 Pearl Street, Boston, Mass.
709 Mission Street, San Francisco, Cal.
Munsey Building, Washington, D. C.
802 Forsyth Building, Atlanta, Ga.
33 South Clinton Street, Chicago, Ill.
1220 Nicollet Avenue, Minneapolis, Minn.
704 Granite Building, Pittsburgh, Pa.
1028 Fourth Avenue, Huntington, W. Va.

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.

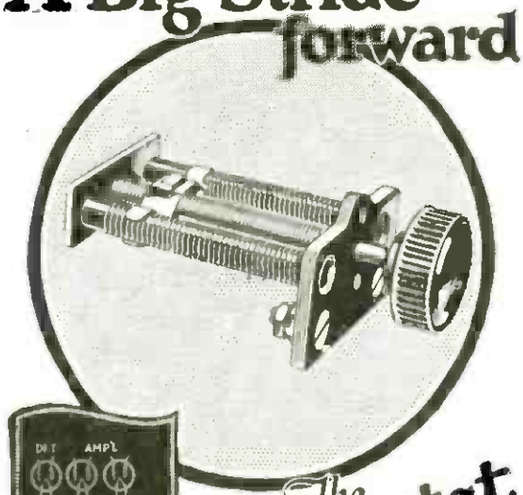
Matched Tone

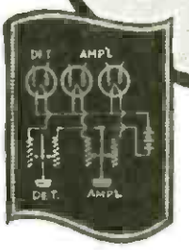
TRADE MARK REG. U.S. PAT. OFF.

Radio Headsets

Dept. P.R.

A Big Stride forward





The Autostat
A Super Rheostat

Can be used with 6-Volt or WD11 Detector Tubes, two Amplifying Bulbs, or one 5-Watt Power Tube.

THE AUTOSTAT presents an entirely new principle in filament rheostat construction and radio takes another BIG step forward.

No longer is it necessary to turn a "hair's breadth" to tune in that elusive station, for with the AUTOSTAT you can give the knob a substantial turn and get a superfine adjustment. No other rheostat to date possesses the necessary "fineness" of adjustment to eliminate interference and "tube howls" under all conditions. But the AUTOSTAT, with its micrometer adjustment, will positively give these much-sought-for results.

How It Works

Two parallel mounted resistance tubes are connected in series by a "micrometer-operated" slider—the length of wire in circuit depending upon the location of this movable slider. Forty turns of the AUTOSTAT knob are required to complete the variation from minimum to maximum resistance—against one-half to three turns on others.

This exclusive patented construction means:

1. One full turn of AUTOSTAT knob produces finer tuning than a "hair's-breadth" turn on any other.
2. Economical—only two AUTOSTATS required for a three-bulb set.
3. Greatly increased receiving range and clearness of signals.
4. A uniform change in resistance with each turn of the AUTOSTAT knob.
5. Indestructible wire-wound fireproof lava resistance element.
6. Unqualifiedly guaranteed.

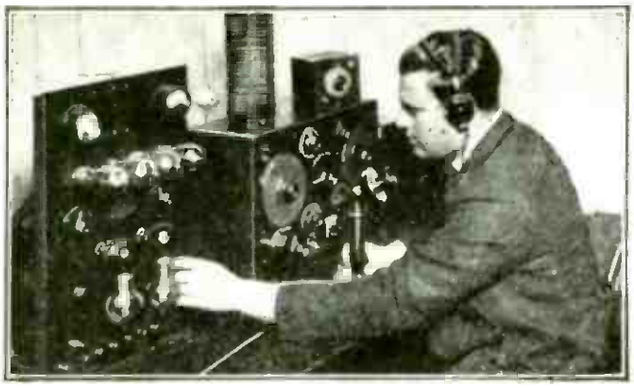
***Popularly priced.* $1.35**

Dealers

See your jobber or write direct for Radio's most attractive Rheostat proposition.

The AUTOMATIC ELECTRICAL DEVICES CO.
132 W. Third St., Cincinnati, Ohio

Builders of Precision Rheostats Since 1914



More Money For You in RADIO

THE amazing expansion of Radio has opened up thousands of wonderful new positions on land and sea. Big salaries, fascinating, easy work, short hours, and a wonderful future are offered to ambitious men who get into Radio now.

Take advantage of these wonderful opportunities to step into a big paying position in this great new field. Radio offers you an opportunity to travel and see the world, with all expenses paid, and a fine salary besides. Or you can stay at home and work up to a position paying up to $10,000 a year. One of our recent graduates secured a position one week after graduating, paying a salary of $300 per month.

Easy to Learn Radio at Home

Hundreds of men are already earning handsome incomes in this wonder science. If you want to get into a profession where opportunities are unlimited make Radio your career—become a Certified Radio-trician.

Thousands of Certified Radio-tricians are wanted to design Radio sets; to make new Radio improvements; to manufacture Radio equipment and to install it; to maintain and operate Radio equipment and to install it; to maintain and operate great Broadcasting stations and home Radio sets; to repair and sell Radio apparatus; to go into business for themselves; to operate aboard ship and at land stations.

You can easily and quickly qualify in your spare time at home through the help of the National Radio Institute. Prominent Radio experts will help you. Four wonderful instruments are furnished free, making the work thoroughly practical. The same plan that has already helped hundreds of our graduates to real success and real money in Radio is open to you.

Special Opportunity Now Open

The urgent need for radio experts and the calls which come to us for our students prompt us to make a special offer open to new students for a limited time. Through this special offer your enrollment will be accepted at a special rate, and you will receive, without extra cost, our new course in Wireless Telephony.

Big Book Free

No other field today offers such great opportunities as Radio. Take your choice of the many wonderful openings everywhere. Prepare now to step into the most interesting and best paid profession today. Read about the opportunities open now—the different kinds of work—the salaries paid. Write today for the free 44-page book that tells how America's first and biggest Radio school can make you a Certified Radio-trician in your spare time. Mail the coupon or write a letter NOW.

NATIONAL RADIO INSTITUTE, 1345 Pennsylvania Ave., N. W., Dept. 32-D, WASHINGTON, D. C.

National Radio Institute, Dept. 32-D
1345 Pennsylvania Ave., N. W.
Washington, D. C.

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 Radio-trician. Also tell me how your free employment service will help me to a position and particulars of your special short time offer.

Name ..... Age.....

Street .....

City ..... State.....

Compare These Prices

WHY PAY MORE WHEN YOU CAN GET ROCK BOTTOM PRICES FROM US

Just glance over our list and send us your Money Order. Twenty-four hours after receiving your order it is on its way to you.

LIST PRICE		OUR PRICE
$ 5.00	Radiotrons UV-200	$ 4.25
6.50	" UV-201	5.75
16.00	Baldwin Phones, type C	12.00
7.75	" Units Loud Speakers	6.00
8.00	Federal 2200 Ohm Phones	6.00
8.00	Brandes Superior "	7.00
5.00	Acme Transformers	4.25
1.00	Double Jacks	.60
.70	Single "	.50
2.50	Bull-Dog Plugs	1.25
	Contact Points, per doz	.15
	Switch Levers, 1½" radius	.25
45.00	Magnavox	38.00
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.50	Aerial Insulators	.20
1.00	100 ft. Solid Aerial Wire	.40
75.00	Paragon RA-10 Set	68.00
25.00	90 ampere guaranteed Storage Battery	18.00
1.00	Rheostats	.75
1.00	Fada Rheostats	.75
1.00	Vacuum Tube Sockets	.65
18.50	Homchargers	15.50
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1.75	" "	1.10
1.50	Dials	.75
1.00	"	.40
2.75	De Forest Detectors	1.95
.75	Sockets	.60
4.50	Thordarson Transformers	3.75
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	½ Megohm Grid Leaks	.60
	1½ " " "	.65
1.00	Grid Leak Holders	.65
1.00	Double Phone Cords	.60
.50	Single " "	.35
	Duplex Phone Adapters, fits Edison, Victor or Columbia	1.75
	Genuine Bakelite Panels, per sq. in.	.02
	Spaghetti, per ft.	.09
12.00	Genuine Western Electric Signal Corps V.T.-2-Tubes	9.00
112.00	De Forest type Honeycomb Set, special Mahogany Cabinet	65.00
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35.00	Audmiax Loud Speakers	18.50
6.50	Turney 3,000 Ohm Phones	4.25
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5.00	Fischer Variometers	3.75
6.00	" "	4.75
5.00	" VarioCouplers	3.75
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8.00	Atwater-Kent Variometers	7.00
8.00	" " VarioCouplers	7.00
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16.00	Atwater-Kent 2-step amplifier	13.75
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1.50	Thordarson Rheostats	1.15
	Bus Wire for wiring sets, per ft.	.02

Honeycomb coils, all sizes, 20% discount. Space being limited, we are obliged to omit many items.

Write for our Quotations

Cut Rate Radio Co.

Dept. A P. O. Box 472 Newark, N. J.

Riding in the Day Coach is Cheaper

But the greater comfort and convenience of a Pullman chair are certainly worth the difference in price that is asked. In most things—including radio equipment—*you get what you pay for.*

You can buy a single-circuit receiving set for considerably less than you will pay for a Paragon three-circuit receiver. Of course, with a single-circuit receiver you must expect mixed messages, continuous jamming between different stations and generally unsatisfactory results.

With a Paragon three-circuit receiver, you can tune in accurately on the station you wish to hear, on any night that it happens to be broadcasting, and get a complete programme, clearly rendered.

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
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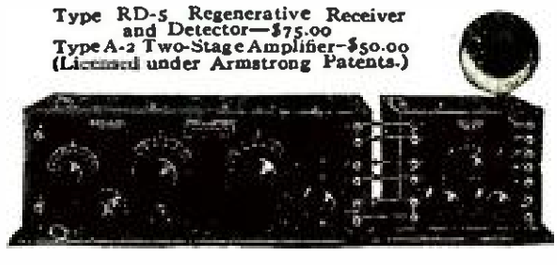
V. T. Sockets	Switches
Detectors	Variometers

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



BRISTOL AUDIOPHONE JR.

Loud Speaker

For Radio-Phone Reception the AUDIOPHONE JR. is a strictly high-grade instrument, built to Bristol standard and backed by the Bristol reputation of 33 years.

The Audiophone Jr. is complete and self-contained—needs no separate battery or other accessories—goes to you ready for use on connecting to your receiving set.

It is a true sound reproducer, bringing to home or public hall the distinctive qualities of the original performance. Characterized by its round, full, mellow tones—its ample volume—and freedom from blurring, mechanical distortion, and metallic effect. It has made radio a real source of restful, refreshing entertainment.....**Price, $22.50**

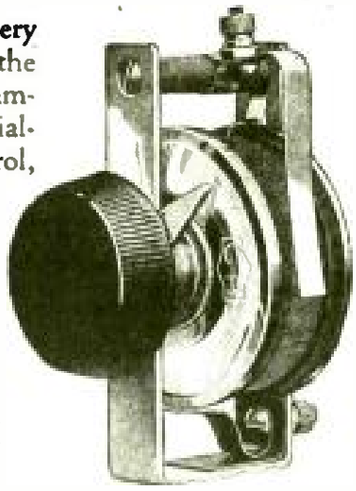
The Audiophone Jr. can be used with any two or three stage power amplifying outfits. Where two stage amplification does not give the desired volume, the range of the Audiophone will be made ample by the addition of a Bristol One Stage Power Amplifier .....**Price, $25.00**

Bulletin 3006—L on request—Demonstrations arranged for

THE BRISTOL COMPANY
Waterbury, Conn.

Increase Your Range

This new "A" Battery Potentiometer by the engineers of Cutler-Hammer, world-known specialists in rheostatic control, will bring new stations to your receiving set, and give you increased signal strength for better reception.



It is correctly designed for maximum service—with a resistance unit that cannot be displaced under constant usage. Demand the C-H trademark—*it is your guarantee of satisfaction.*

Resistance 300 ohms. Panel Mounting. Pointer Indicating. Adjustable Contact Fingers. Genuine Thermoplax Knob Convenient Binding Posts for easy wiring. Finished in dull satin nickel.
Type 11602 ..... $1.50

THE CUTLER-HAMMER MFG. CO.

Member Radio Section, Associated Manufacturers of Electrical Supplies
MILWAUKEE · WISCONSIN

Over a Quarter Million C-H Radio Rheostats Now in Use

C-H RADIO "A" BATTERY POTENTIOMETER

RHAMSTINE*

Amplifying Transformer

MODEL B

$4.00

Postage 10c

with W D-11 TUBES
It is the peer of them all.
Write for Free Catalog!
Dealers: Send for discount sheet on Rhamstine* Products!

Manufactured by
J. THOS. RHAMSTINE*
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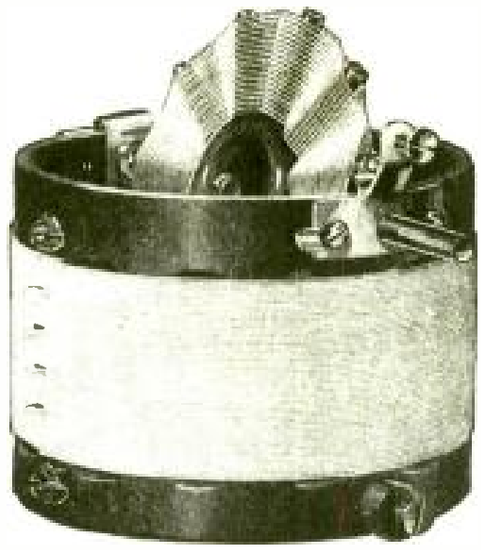
Maker of Radio Products



HARTMAN VARIOCOUPLER

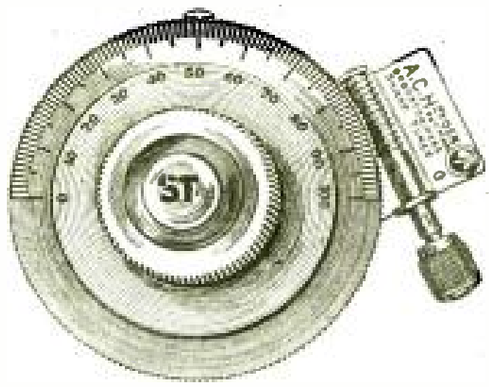
WITH
SPIDER WEB ROTOR
PROVIDES
REMARKABLE SELECTIVITY IN TUNING
Designed for us by Alfred A. Crossley

Price $6.50

Write for bulletins on Hartman Radio Products

THE HARTMAN ELECTRICAL MFG. CO.
MANSFIELD, OHIO

Use ACH SHARP TUNER DIALS



YOUR CHOICE OF
Rough tuning with dial, or one thousandth of an inch in either direction with the Sharp Tuner Knob. Both controlled by center Knob ST. Eliminates a Vernier condenser.
Can be installed on any set, making difficult tuning easy.

GUARANTEE

If purchased direct and you find the ACH Dial does not warrant your own personal award of merit, return it and we will refund your money. What better guarantee can we give!

Price of ACH 3-inch Dial Complete $2.50

A. C. Hayden Radio & Research Co.
BROCKTON, MASS., U. S. A.
Mail Orders sent prepaid in U. S. A.

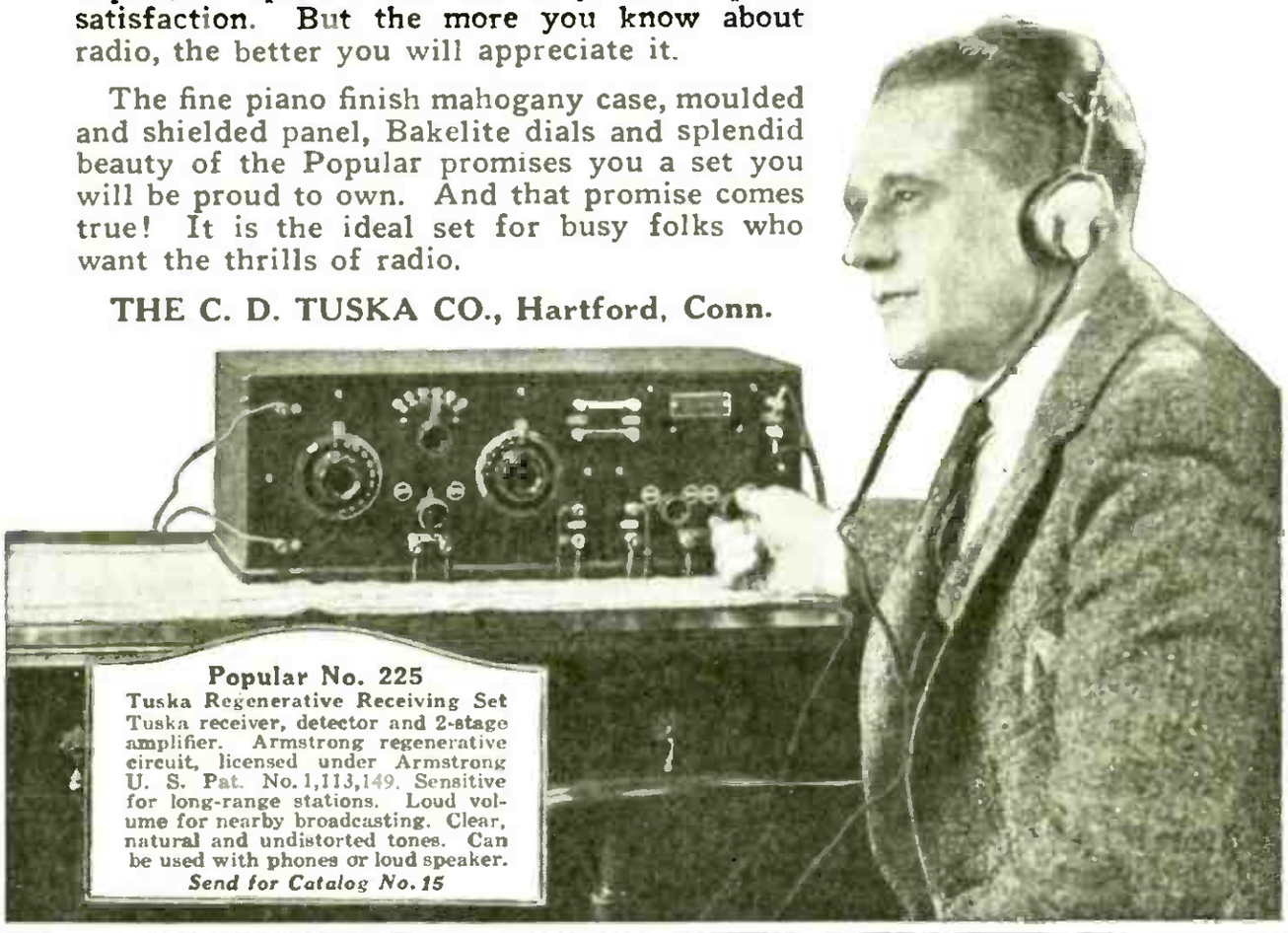
Popular!
-for good reasons

RADIO enthusiasts wanted an expertly designed, moderate-priced set that any intelligent man or woman could operate. So we built the Popular, to sell at a popular price.

Just two dials to turn to find the stations broadcasting within a range of 500 miles. As you become more experienced you can reach out twice as far. You don't have to become an expert to operate this set to your complete satisfaction. But the more you know about radio, the better you will appreciate it.

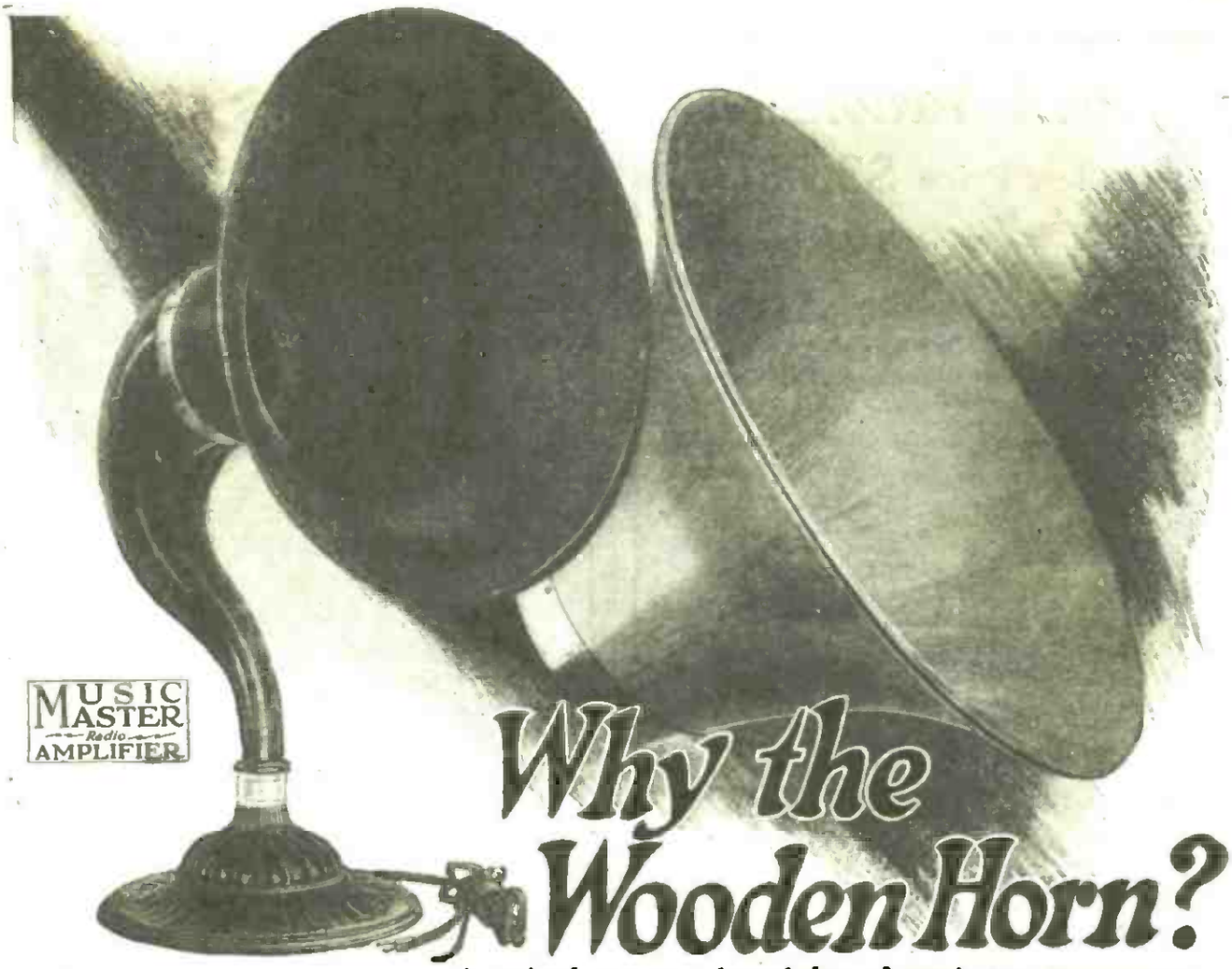
The fine piano finish mahogany case, moulded and shielded panel, Bakelite dials and splendid beauty of the Popular promises you a set you will be proud to own. And that promise comes true! It is the ideal set for busy folks who want the thrills of radio.

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



Popular No. 225
Tuska Regenerative Receiving Set
Tuska receiver, detector and 2-stage amplifier. Armstrong regenerative circuit, licensed under Armstrong U. S. Pat. No. 1,113,149. Sensitive for long-range stations. Loud volume for nearby broadcasting. Clear, natural and undistorted tones. Can be used with phones or loud speaker.
Send for Catalog No. 15

TUSKA RADIO



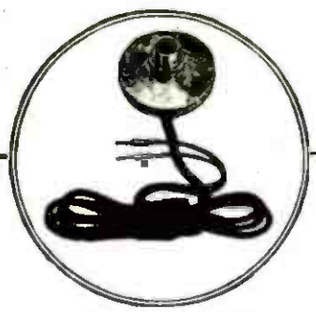
MUSIC MASTER Radio AMPLIFIER

Why the Wooden Horn?

A trained ear or a knowledge of music are unnecessary. Anyone can appreciate the Music Master Radio Amplifier. The Wooden Horn gives a sweetened and mellowed tonal quality to the reproduction that imitates the human voice more closely than any other type of amplifier.

The principle was proved by ceaseless research of phonograph experts years before radio was a reality.

The specially designed reproducing unit found in the art-metal base of the Music Master is attached directly to the cast aluminum gooseneck, which, being a non-vibrating material, carries the mechanically created sound to the wooden horn, by which, beautifully enriched, the message is delivered to the audience.



Geraco Phonograph Attachment converts your Victrola or Columbia into an efficient loud-speaker.

Complete . . $10

For sale through Jobbers and Dealers everywhere

Complete, ready to attach in place of headphones, no batteries or extra circuit required—

14 inch (Home Model)	$30
21 inch (Concert, Dancing, etc.)	$35

Your dealer will demonstrate the Music Master. There's a thrill in store for you when he does.

JOBBERS / DEALERS { A Music Master will be sent to members of the trade with full privilege of return. Complete details and prices on request.

GENERAL RADIO CORPORATION

Makers and Distributors of High-Grade Radio Apparatus

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

Write for description and details of complete line.

GERACO PROVEN RADIO PRODUCTS

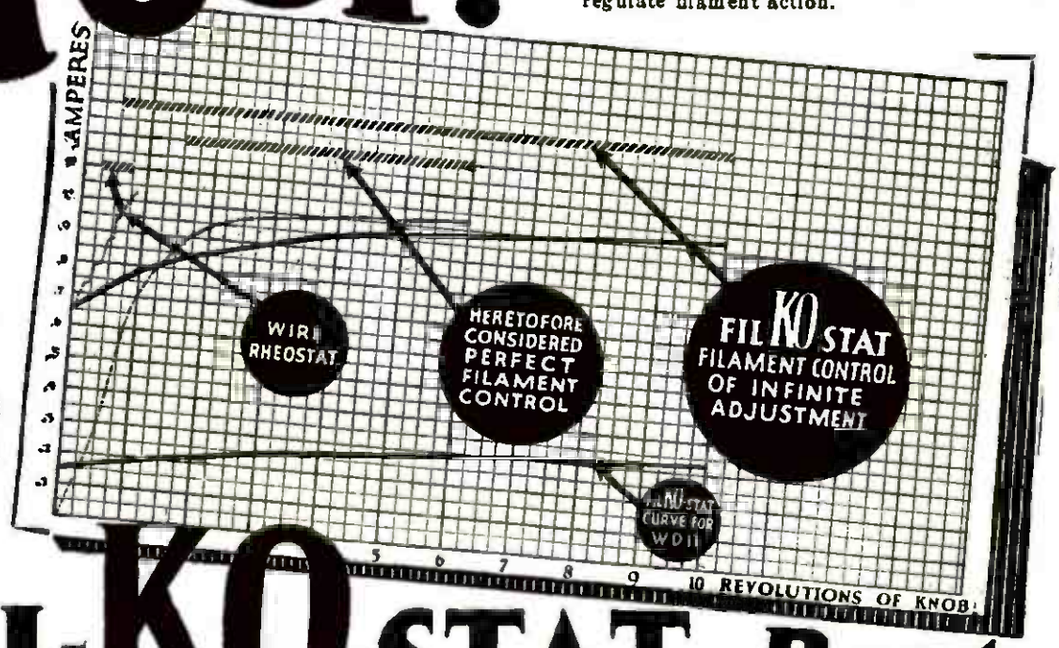
"GERACO" on radio apparatus means that it is thoroughly tested and guaranteed.

Proof!

Graphic proof of FIL-KO-STAT superiority as shown here can be had in any laboratory equipped with Bureau of Standards instruments.

Practical proof of FIL-KO-STAT superiority is evident the moment you put FIL-KO-STATS in place of the devices you now use to regulate filament action.

Here's the Comparison of Fine Adjustment Control Range of FIL-KO-STAT With Rheostats and Other Filament Controls Clearly Indicating How FIL-KO-STAT Excels, and Showing Wherein it Permits Perfect and Gradual Current Increase With Infinite Adjustments.



FIL-KO-STAT *Best* Filament Control

—a step forward in Radio. Not an adaptation of some old method of current control. Not a rheostat. ***A FILAMENT CONTROL,*** distinctly designed to utilize the great tuning possibilities of the vacuum tube itself. FIL-KO-STAT regulates FILAMENT HEAT. Gives absolute control of ELECTRONIC FLOW, consequently permits FINEST TUNING POSSIBLE. Perfect, gradual increase of filament heat assures longer life to tubes. Fine adjustment of fractional currents makes it ideal for Dry Cell tubes. Infinitesimal control of electronic flow gives a corresponding fine adjustment so very essential in DX tuning.

Say "FIL-KO-STAT" to your dealer today. If he has none in stock *send his name* and your remittance direct to

The Filament Control of Infinite adjustment
FIL-KO-STAT
CURRENT INCREASE PERFECT AND GRADUAL
LIKE THE RISING SUN
Trade Mark Registered

Infinitesimal Control
Of Electronic Flow.

Definite Off
Indicating complete "A" Battery disconnection.

Fine Adjustment
Starts where tube *begins* to function.

At Full On
Resistance practically zero.

Absolutely Silent
Non-microphonic free of all noises.

No Current Variations
Resistance constant at any setting.

No Discs to Break or Chip
Resistance element so finely divided further division impossible.

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.

Manufactured by

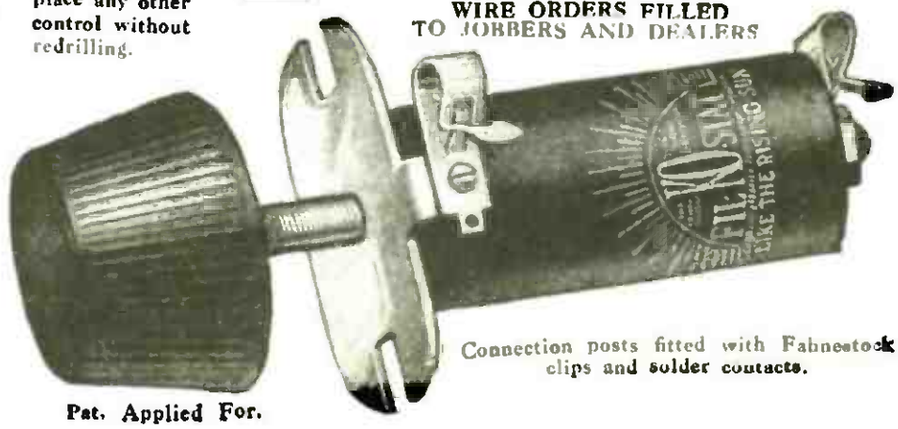
DX INSTRUMENT CO.
HARRISBURG PA.

FIL-KO-STAT is compact (exact size shown). Takes little space on panel. Can replace any other control without redrilling.

PRICE
$2.00

SOLE INTERNATIONAL DISTRIBUTORS
RADIO STORES CORPORATION
Dept. P R 218-222 W. 34th St. New York

WIRE ORDERS FILLED
TO JOBBERS AND DEALERS



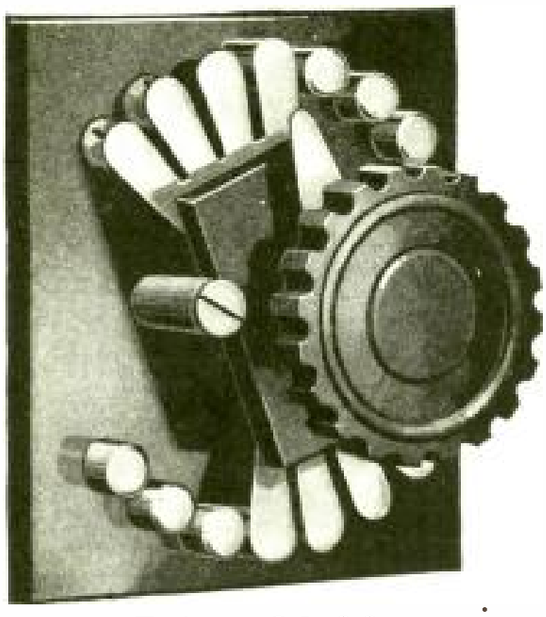
Connection posts fitted with Fahnestock clips and solder contacts.

Pat. Applied For.

FIL-FONE SWITCH

One Installation **One Movement for all Filament Control**

No Jacks **No Plugs** **No Separate Switches**



Price, $3.00

Design and Circuit Connections Protected by Patents Pending

The ***Fil-Fone Switch*** is the latest addition to our remarkably complete line of Radio Products. Designed for convenience and elimination of surplus parts. Gives the operator perfect control of his tubes without noise or inconvenience of plugging in phones from one stage to another.

The ***Fil-Fone Switch*** automatically lights the filaments and connects the "B" Battery and telephones to either Detector, first stage of amplification or second stage of amplification as desired, with a positive and progressive operation. It has an "OFF" position which disconnects the filament battery, "B" battery and phones from the set.

This method of filament control is sure to be universally adopted in set building because of its simplicity, convenience and saving of expense. Sold ready for mounting, with complete wiring diagram.

Send for Free Descriptive Circular, F. F. S. No. 1

(Complete catalog of Radio Parts with useful Radio information sent on receipt of six cents in stamps for mailing.)

The A-C Electrical Manufacturing Co.

DAYTON **OHIO**

Makers of Electrical Devices for Over 20 Years

Radio Catalogue FREE

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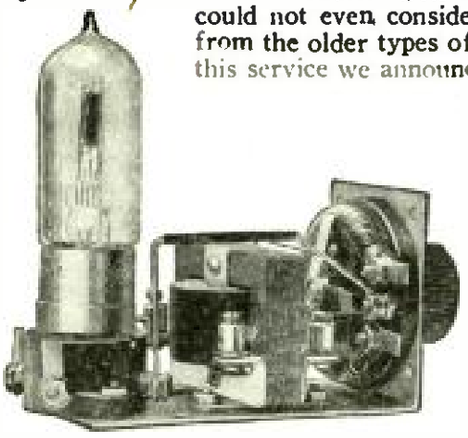
The new WD-11 vacuum tubes requiring but a single dry cell to heat the filament have opened up a whole new field in radio. Sets are now brought within the reach of vast numbers who could not even consider them before. These new tubes differ in construction from the older types of tubes and require different associated instruments. For this service we announce the following:



TYPE 300-A AMPLIFIER UNIT

A compact unit consisting of our Type 231-A Amplifying Transformer, Type 225, Filament Rheostat and Type 282 WD-11 Tube Socket mounted on a nickel finish brass mounting. These parts are all wired ready for the external connections. The mounting is so designed that the unit may be used on a table or mounted behind a panel with only the rheostat knob projecting.

Price $7.50

TYPE 300-B AMPLIFIER UNIT

This unit is similar to the 300-A unit except that it is equipped with standard socket for UV-201 tubes.

Price $8.00

TYPE 282 WD-11 TUBE SOCKET

A socket of molded bakelite arranged with positive contact springs to take the WD-11 tubes. This is a socket in itself, not an adapter.

Price . . . . . 80 cents

TYPE 255 RHEOSTAT

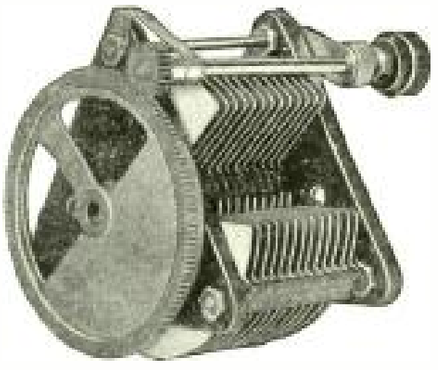
A rheostat of molded bakelite, not a substitute, for panel or table mounting, smooth in operation and attractive in appearance. Resistance 6 ohms, with current carrying capacity of 1.25 amperes. May also be supplied with a resistance of 3.5 ohms and a current carrying capacity of 2.5 amperes.

Price $1.00

TYPE 247 CONDENSERS

These already popular condensers may now be equipped with gear and pinion providing a vernier adjustment with but a single setting. A low loss condenser with a micrometer adjustment at a fair price. Used in large quantities by such representative organizations as the Western Electric Company. Made in eight types.

Prices . . . $3.25 to $7.75



TYPE 231-A AMPLIFYING TRANSFORMER

Remember that this transformer is particularly suited to the WD-11 as well as to the UV-201 and 201-A tubes.

Price $5.00

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An Improved RHEOSTAT another PACENT development

SIMPLE — STURDY — FINELY ADJUSTABLE — EASY TO MOUNT

You'll welcome the many advantages in the new PACENT RHEOSTAT. It is beautifully constructed, flawless in performance, the simplest to assemble or take apart when mounting. The turn of one screw separates the two units (as illustrated). Unit 1 consists of the pointer, knob and shaft moulded in one piece. Unit 2 remains intact when rheostat is separated, permitting the careful contact adjustment made at factory to remain undisturbed. Changing from panel to table mounting is simply a matter of a few seconds. The wire element will safely carry 1½ Amp. continuously. The base of the rheostat is heat-resisting and will not crack or warp. The rheostat turns with the smooth, "velvety" feel of precision instruments, making perfect control easy. Another instance of PACENT quality at reasonable cost.

The PACENT Potentiometer (same size and incorporating all the advantages of the PACENT rheostat) Catalogue No. 88, $1.25.

WRITE FOR DESCRIPTIVE BULLETIN P-4

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"How I Located My Trouble"

A Massachusetts radio enthusiast tells of a happy discovery that finally solved his difficulties.

"I COULDN'T figure out what was wrong with my radio set," states a Fitchburg business man whose experience is interesting because it shows how one simple little adjustment will sometimes make such an amazing improvement in results.

"I had erected my antenna in just the right way, had connected up my different instruments with the greatest care, had added improvements that were designed to bring my apparatus to the highest possible perfection," he continues.

"I spent a good many hours talking over my problems with dealers and experts. I followed one suggestion after another. But still the same old trouble!"

Do You Have This Trouble?

"In spite of all my efforts, when I wanted to hear some particularly interesting broadcasting program, other stations kept breaking in; I found difficulty in getting long distance points; and intermittent squeals, whistles and howls would persist, no matter how I tuned or adjusted my dials.

"I was pretty nearly convinced I'd have to get some high-priced installation man to come out to my home and set me right, when purely by chance I happened to pick up a copy of POPULAR RADIO—and thumbing through its pages I found the very answer to my problems!

"There in black and white, diagrammed and explained, was a simple, practical suggestion that turned the trick for me."

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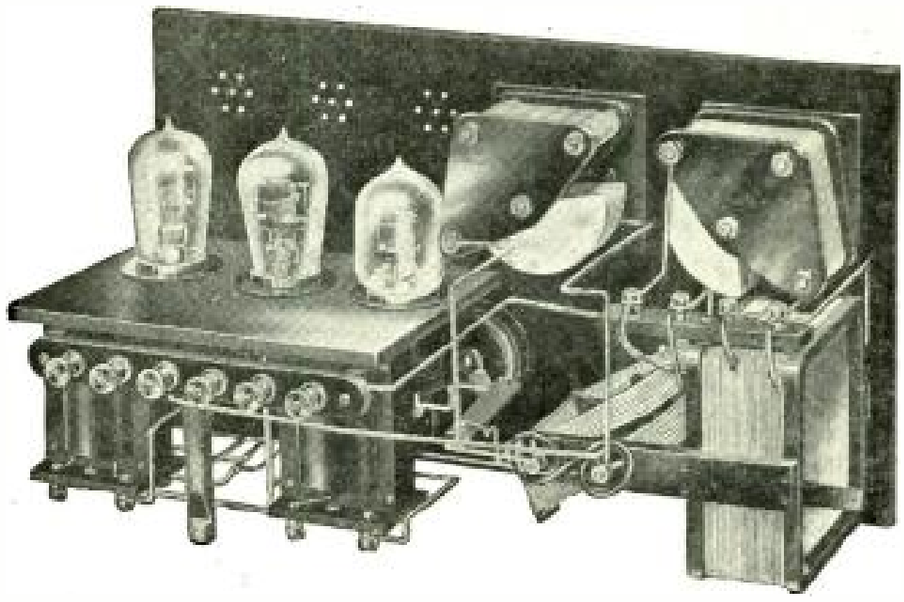

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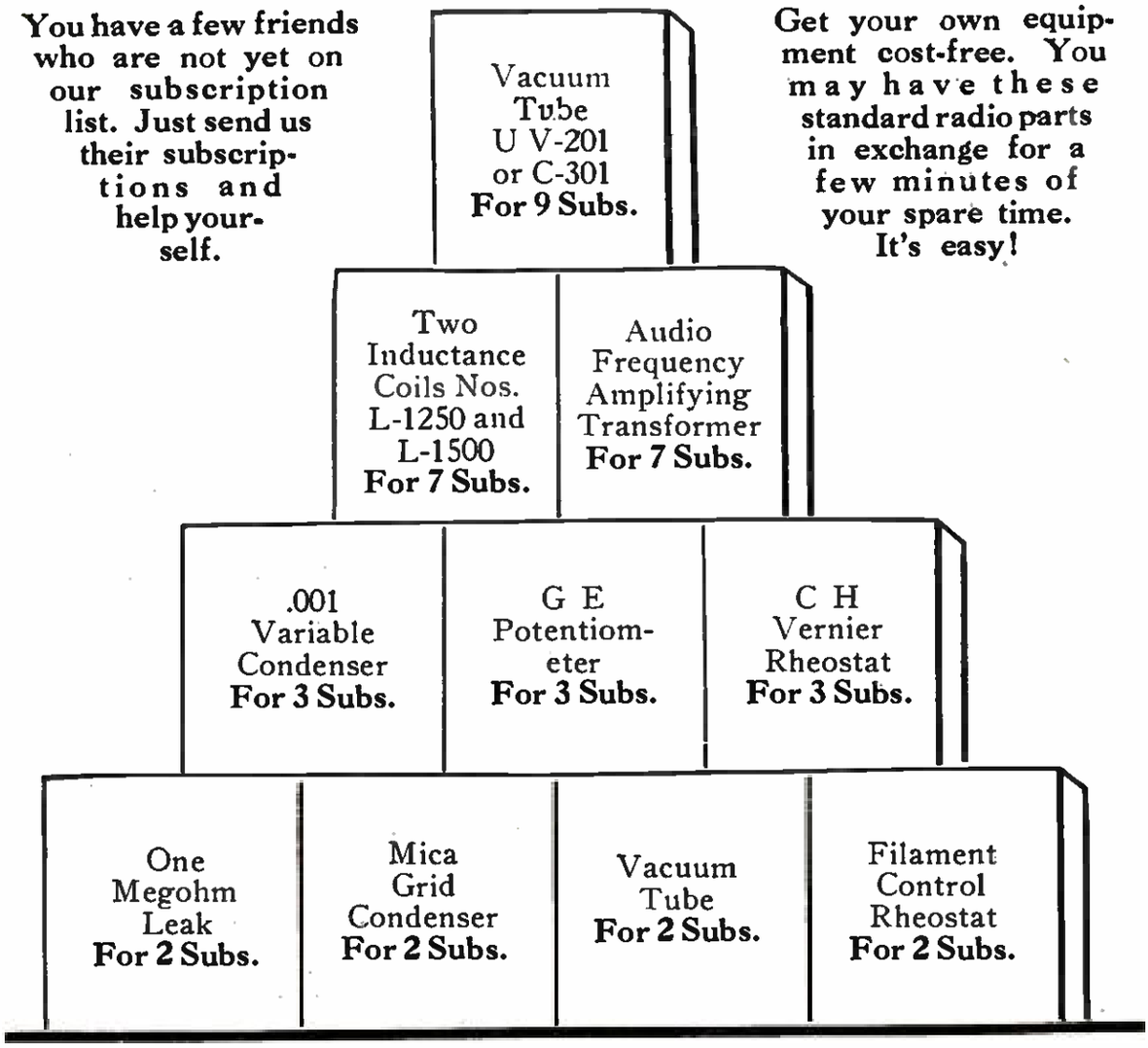

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THE LIST PRICE IS BUT $85.00 WITH AN ADDITIONAL CHARGE OF $15.00 FOR THE ADAPTER.

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.

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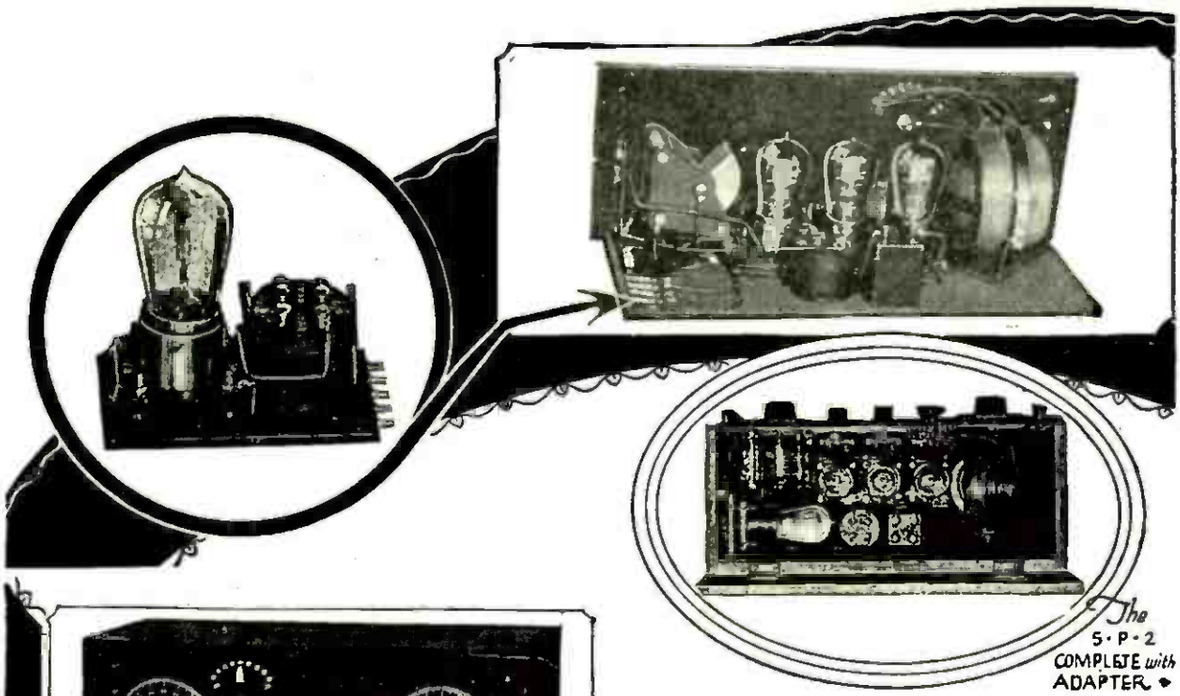

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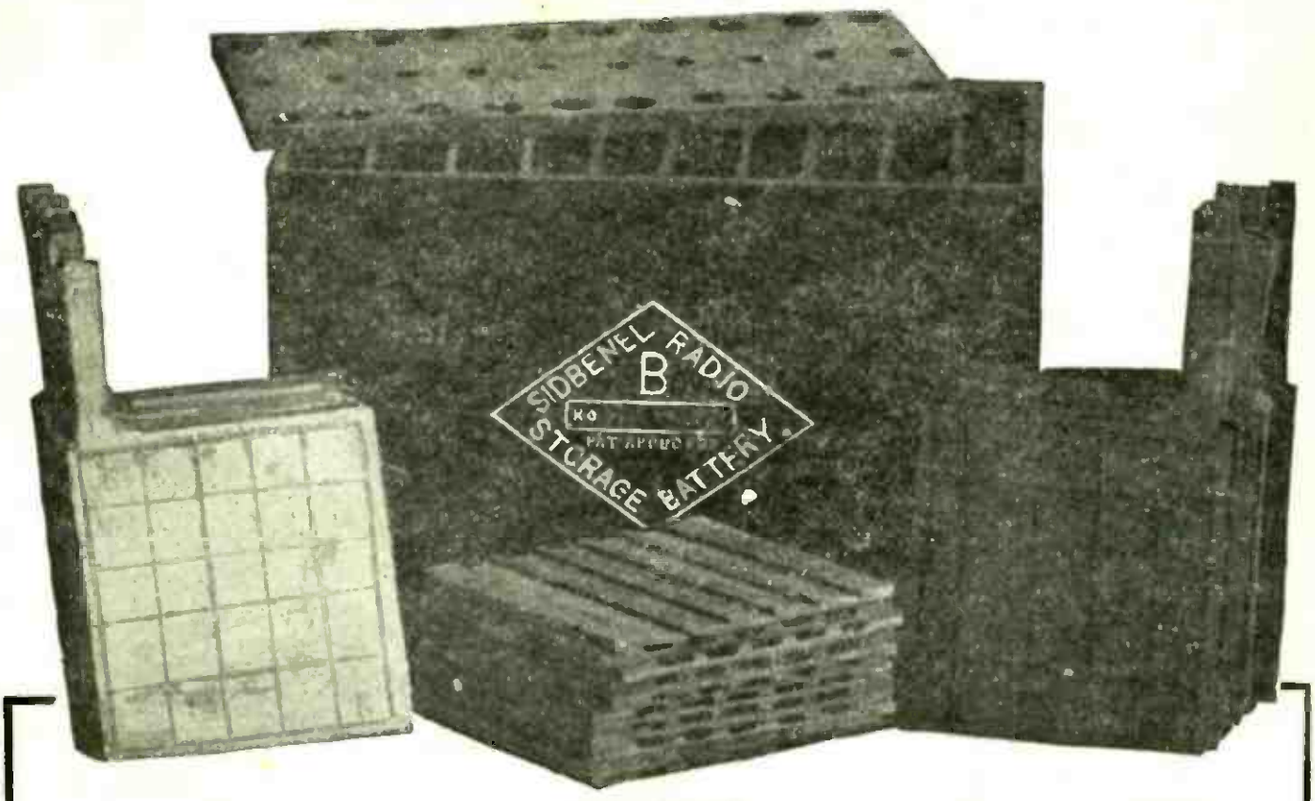

PATENTS PENDING

THE invention is chiefly in the composition of the plates and construction of the battery boxes, which are of hard rubber moulded into ten compartments. Size 2½ x 3 x 4½ per unit. Illustration shows its very sound and rigid construction.

The plates are especially treated with a newly discovered chemical that eliminates howling and screeching, otherwise known as electrical static generated in every known type of dry "B" Battery. A single charge will last approximately six months. Recharged in a few hours to its original full capacity. For less than ½ cent the battery is thus ready for another six months' use.

The enormous amount of energy in this battery enables the vacuum tube to make weak signals exceptionally loud and clear. You cannot appreciate the difference unless you have made a comparative test. Where used for high power for C. W. transmission no choke coils are required, as there is no A. C. humming or motor generator noises.

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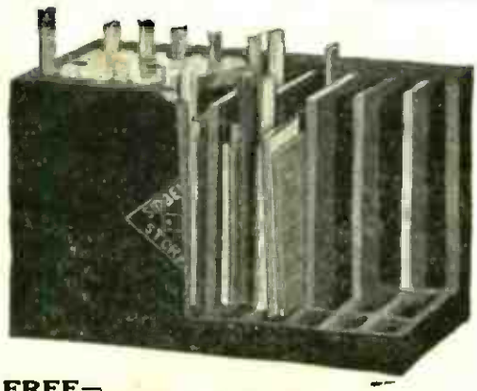

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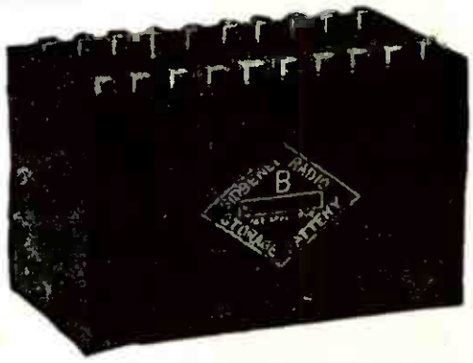

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