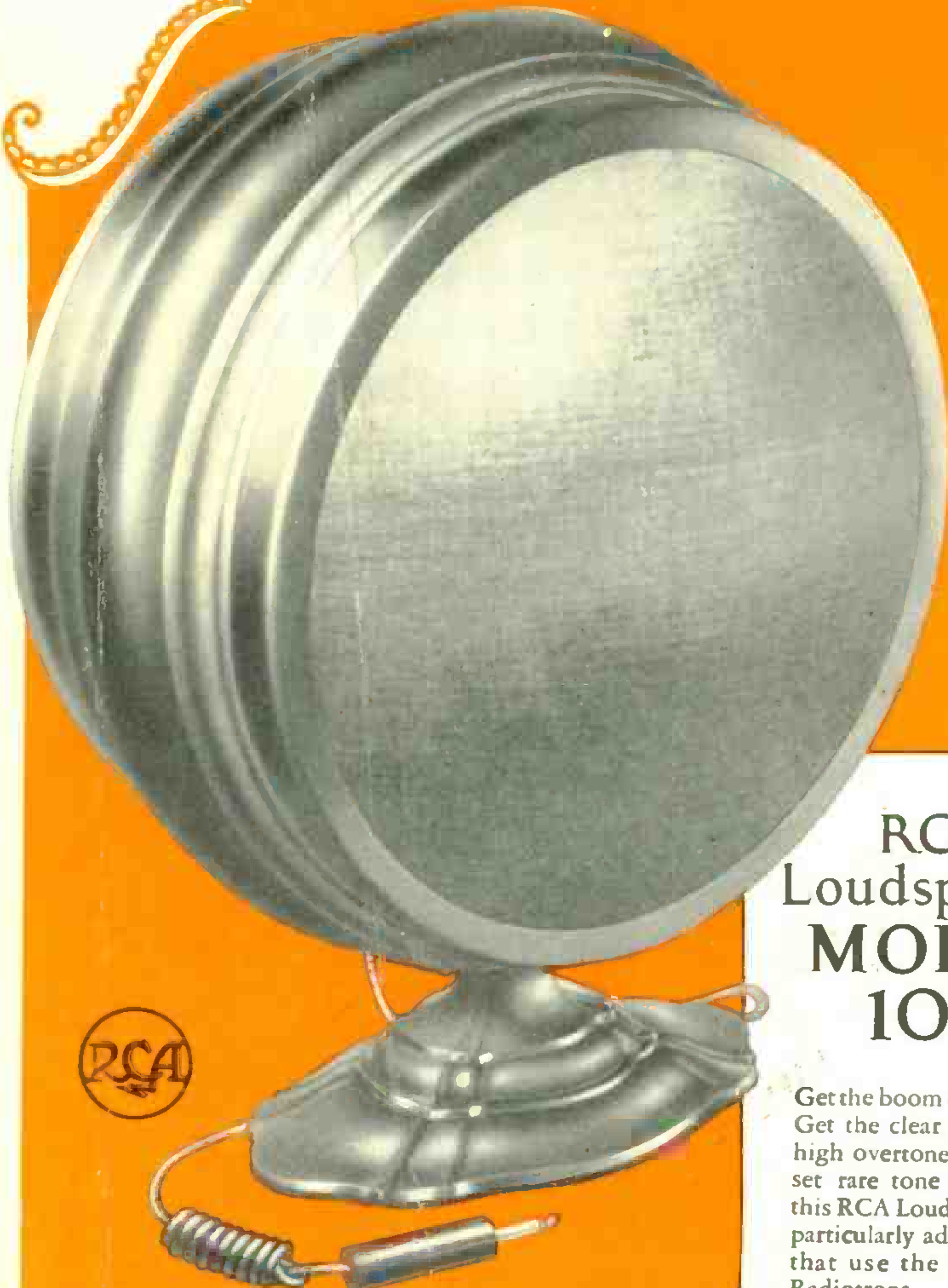
Popular Radio

25¢

APRIL • 1926

Announcing—

The POPULAR RADIO MEDAL FOR CONSPICUOUS SERVICE



POPULAR RADIO

EDITED *by* KENDALL BANNING

FOUNDED 1911

CONTENTS *for* APRIL, 1926

(*Cover design by Frank B. Masters*)

VOLUME IX — NUMBER 4

DEPARTMENTS

VOLUME IX — APRIL, 1926 — NUMBER 4

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Printed in U. S. A.

LAURENCE M. COCKADAY, *Technical Editor*

E. E. FREE, Ph.D., *Contributing Editor* — JOHN V. L. HOGAN, *Contributing Editor*

PAGES WITH THE EDITOR

THE avalanche of letters and questionnaires that have descended upon the Editor as the result of his appeal (published in this department of the February number) for opinions on the relative merits of the various editorial features that appear in POPULAR RADIO have given incontrovertible evidence of the extraordinary personal interest that our readers take in the magazine.

* * *

WHILE the personal contact between readers and members of the staff of POPULAR RADIO have always been many, never before have such a large number written in at one time to give us the benefit of their suggestions and opinions. The staff is still struggling to handle the correspondence that has, during the past few weeks, literally piled into the sanctum.

* * *

BOTH the questionnaires as well as the letters that accompanied them are of very great value indeed in determining the plans and policies of POPULAR RADIO. For it is obvious that the more closely in touch with the readers the editors can get, the better can the editors learn the desires and needs of the readers—and consequently the more efficiently may the demands of the public be met.

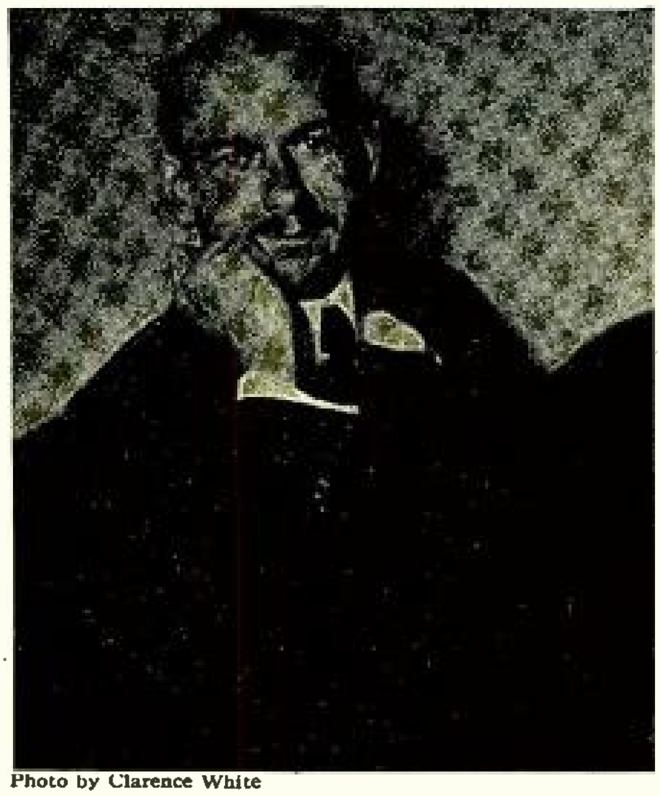


Photo by Clarence White

THE DESIGNER OF THE POPULAR RADIO MEDAL FOR CONSPICUOUS SERVICE

Walter D. Teague, one of the foremost designers in America, was for two years president of the Artist's Guild and has twice been awarded the coveted medal by the Art Directors Club for decorative design.

To the hundreds of friends and critics who took the time and trouble to express their opinions, the gratitude of POPULAR RADIO is here extended. That their efforts have not been made in vain will be demonstrated in a practical manner in the future issues of the magazine.

* * *

BEGINNING, for example, with the very next number!

* * *

WITH the coming issue of POPULAR RADIO—the May number—this magazine will celebrate its fourth birthday with a big special Anniversary Number.

* * *

THE happy occasion will be observed not only by an issue that will contain a much larger amount of reading matter and larger illustrations than have ever appeared in the magazine, but by a permanent increase in the page size from the present "standard" size (6¾ by 10 inches) to the "flat" size (8⅛ by 11¼ inches).

* * *

THIS increase in the page size of POPULAR RADIO, aside from the opportunities it gives for reproducing the circuit and constructional diagrams and charts on a larger scale, also makes it possible to print the magazine on presses that print in colors.

* * *

BEGINNING *with the May number, therefore,* POPULAR RADIO *will be printed in colors.*

* * *

THIS innovation will permit the reproduction of the more important constructional diagrams in blue-print form and the *facsimile* reproduction in color of graphs—an improvement that will be appreciated particularly by the experimenter who makes practical use of these essentially practical illustrations.

* * *

WITH this issue the first formal announcement is made (on page 363) of the institution of the Popular Radio Medal for Conspicuous Service—a form of recognition to amateurs which POPULAR RADIO has long had in contemplation and preparation.

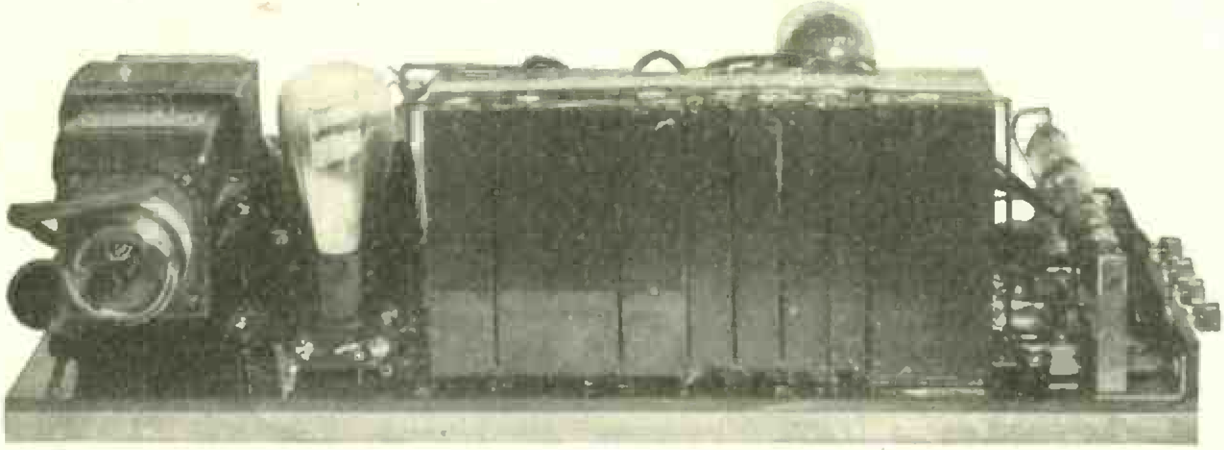
* * *

THE enthusiastic response that POPULAR RADIO met when it first advanced the idea of instituting such a medal can be no better evidenced than in the character of the personnel of the Committee of Awards and of the Advisory Committee, which include some of the foremost men and women engaged in public service, in scientific work and in the radio art.

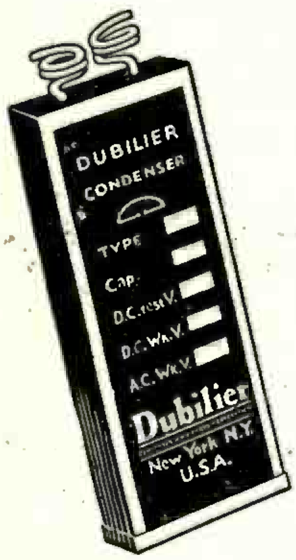
* * *

READERS are not merely invited but urged to notify the Committee of Awards of anyone who, in their belief, is entitled to the recog-

(*Continued on page 6*)



Power Amplification --without "B" Batteries



For the filter circuits in "B" battery eliminators use only Dubilier Filter Condensers.

Dubilier Filter Condensers are used in the Laboratory Model of the new Power-Pack Amplifier, designed by Albert G. Craig, because of the unusually high voltages developed in this circuit.

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Insist on getting Dubilier filter condensers. If your dealer cannot supply you, write directly to us.

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CONDENSER AND RADIO CORPORATION

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(*Continued from page 4*)

nition that the award of the Popular Radio Medal for Conspicuous Service will confer.

* * *

"Having read the latest issue of POPULAR RADIO from cover to cover, I have come to the conclusion that simple language is used throughout, and that all of the articles are written so clearly that a person who doesn't know a thing about radio can readily understand them. . . . POPULAR RADIO is certainly one of the outstanding radio publications of the present time."

—WILLIAM D. SLADE, *Brooklyn, N. Y.*

* * *

WHO among our readers have observed the effect of radio reception on wild animals? Numerous experiments have been made on animals in captivity with conclusive results, but here is a letter from a reader who is an experienced deer hunter and who suggests a unique use of radio as a lure for wild game:

"As a reader of POPULAR RADIO *I would like to advise my huntsmen friends, through your magazine—particularly those who go deer hunting every season—to instruct their guides to set up radio receiving sets in their favorite hunting grounds once or twice a week, and to tune in during the night. They may be surprised to learn that every season the male deer (with three-inch horns) will follow these radio concerts, and will leave other districts for miles and miles around.*

FREDERICK W. KERTEL,
Hunter in the Adirondacks.

"P. S. It is not against the law to coax the game away from other districts."

Kendall Banning

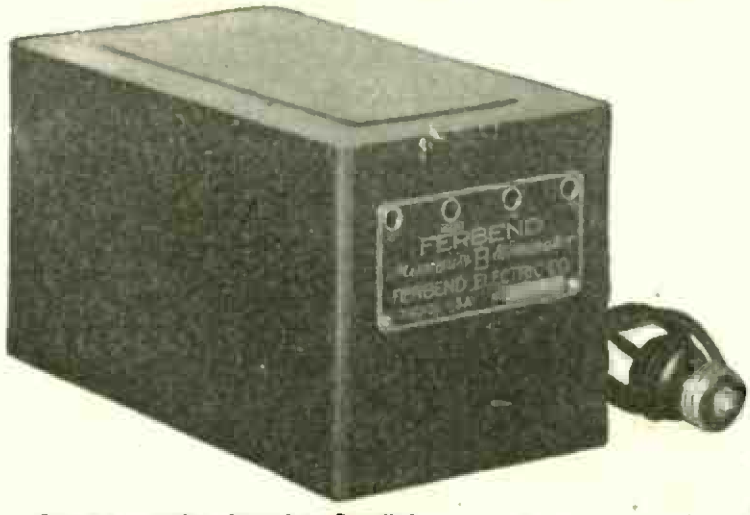
Editor, POPULAR RADIO

From a photo made for POPULAR RADIO

TESTING THE ACCURACY OF THE WAVELENGTH SCALE ON A READY-MADE RECEIVER

Intensive experimental work in the POPULAR RADIO LABORATORY *furnishes the material for many of the series of articles which are published in the magazine under the title "How to Get the Most Out of Your Ready-made Receiver." Here Mr. Taylor is engaged in obtaining data on the Ferguson set which will appear in the next number—for May.*

Within Reach of All



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D. C. Model, price . . . . $ 9.75

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Always Something Worth While in
POPULAR RADIO

"WHEN *I open* POPULAR RADIO *I always find something in it worth while.*"

L W Austin
PRESIDENT, INTERNATIONAL UNION
OF SCIENTIFIC RADIO TELEGRAPHY

From a photograph made especially for POPULAR RADIO by Campbell-Gray, London

The Fastest Projectiles on Earth

By special apparatus electrons can be separated from the atoms to which they belong and shot out in streams, as is being done in this special vacuum tube demonstrated recently at the Science Exhibition at Wembley, England. The lighter streak on the white, phosphorescent screen shows how the path of the electron stream is bent by the magnet which the operator holds. The speed of electrons in such streams may exceed a million miles a minute.

Popular Radio

VOLUME IX APRIL, 1926 NUMBER 4

1,000,000 Miles a Minute

Radio waves are the speediest thing in the universe. Only slightly less speedy are some of the tiny electrons which fly about inside the atoms of matter. The interaction of the radio waves with these electrons, for example, when a wave reaches a receiving antenna, introduces us to an astounding new world of vast speeds and of infinitesimal time units—a world which this article describes.

By E. E. FREE, PH.D.

IF you leave a silver dollar on your work table over night, and if you are reasonably lucky in your house companions, the silver dollar will still be there in the morning. In any event it will not have run away all by itself.

But if you leave the family cat on the work table the result will probably be different. Kitty's whereabouts in the morning are beyond prediction.

That is the difference between motion and an apparent lack of it.

The cat possesses a mechanism of muscles and nerves and whatnot which makes him self moving. The silver dollar —as it seems—does not.

Nevertheless it would be a great mistake to assume that the silver dollar was motionless. In fact, it contains a stupendous amount of motion—millions of times more than that exhibited by a jumping cat. All this motion is internal. It is locked up, under ordinary conditions here on earth, inside the atoms of silver in the metal.

All atoms are believed to consist, you remember, of two kinds of very tiny separate particles. One kind are electrons, the same electrons which operate our vacuum tubes and energize our antennas and are so generally useful and indispensable in radio. The other kind of particles are the positive electric particles or protons. The simplest known atom is that of hydrogen gas. This has only two particles; one electron and one proton. The proton is at the center of the atom and the single electron revolves around it, much as our earth revolves around the sun. Other atoms are constructed similarly, but are more complex. The silver atom, for example, has a clump of some one hundred and seventy protons and electrons for its atomic sun. Around this revolve forty-seven electron planets, each in its own orbit. There are atoms still more complicated. One of them, uranium, contains nearly five hundred protons and electrons, 92 of the electrons being planetary ones and revolving in a system of orbits so complicated that we do not yet understand it at all.*

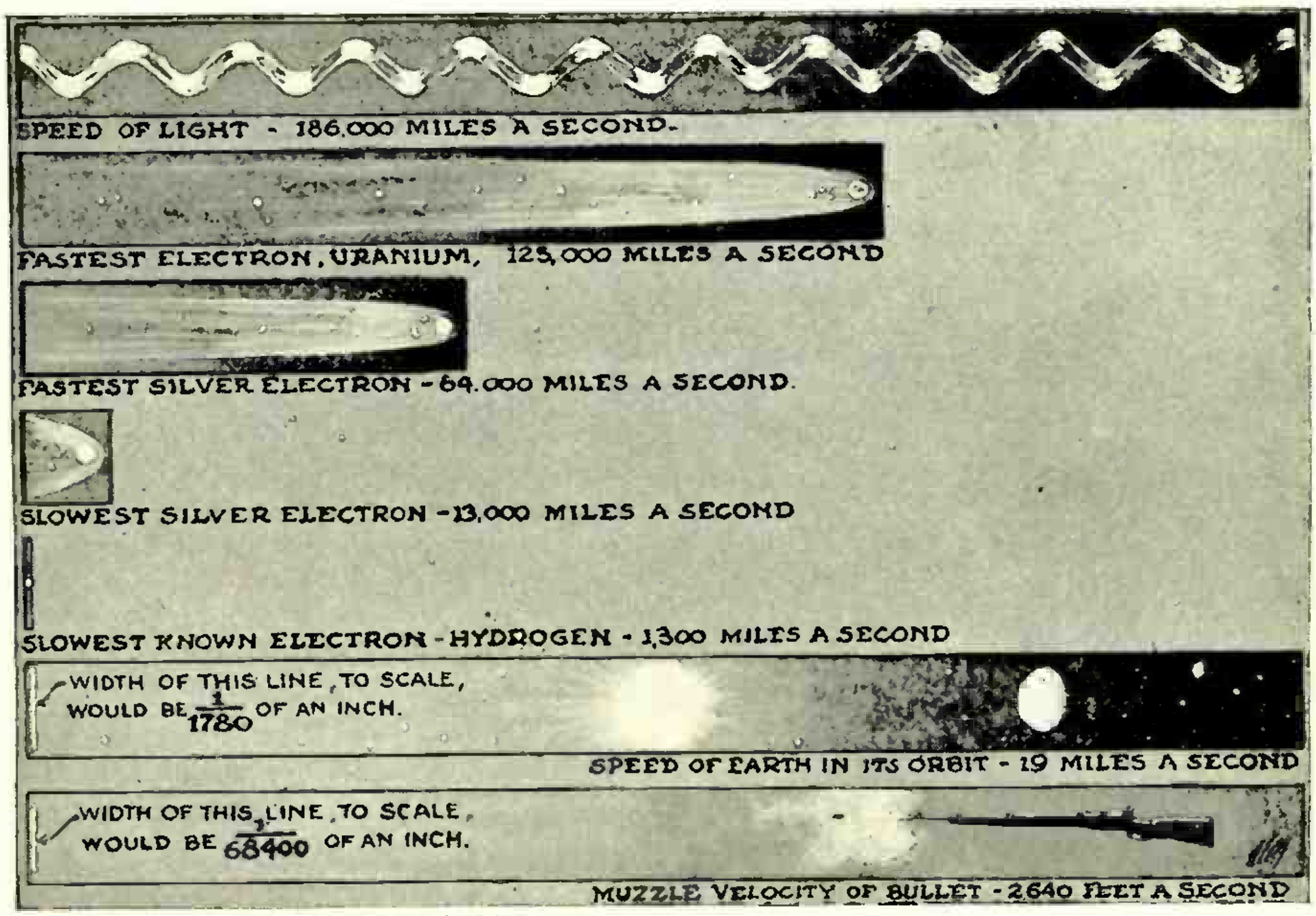
The speeds with which these electron planets traverse their orbits inside the atoms are so enormous that it is virtually impossible to comprehend them. The fastest of them are believed to be two which occupy the inmost orbits in the atom of uranium. Their speed has been calculated as nearly 125,000 *miles a second*.

*For an outline of modern atomic theory see: POPULAR RADIO for January, 1924, pages 41-48; for April, 1924, pages 319-327; for December, 1924, pages 546-553. Sir William Bragg's articles on the atom in POPULAR RADIO for August and September, 1925, January, 1926, and in this issue, may be consulted also. One of the best popular books on atomic theory is "Atoms and Rays," by Sir Oliver Lodge, George H. Doran Company, New York City, 1924.

Even the slowest of all known electron speeds, that of the single electron of the hydrogen atom, is believed to be over 1,300 miles a second. In the atoms of the silver dollar the speeds range from about 12,000 miles a second up to over 64,000 miles a second. A million miles a minute is slow in atom land. The uranium electrons reach three hundred times as much.

These figures are as meaningless to most of us as is the difference between a billion dollars and a trillion dollars. We never hope to see either of them. But let us try—for the case of the speeds, not of the dollars—some comparative illustrations.

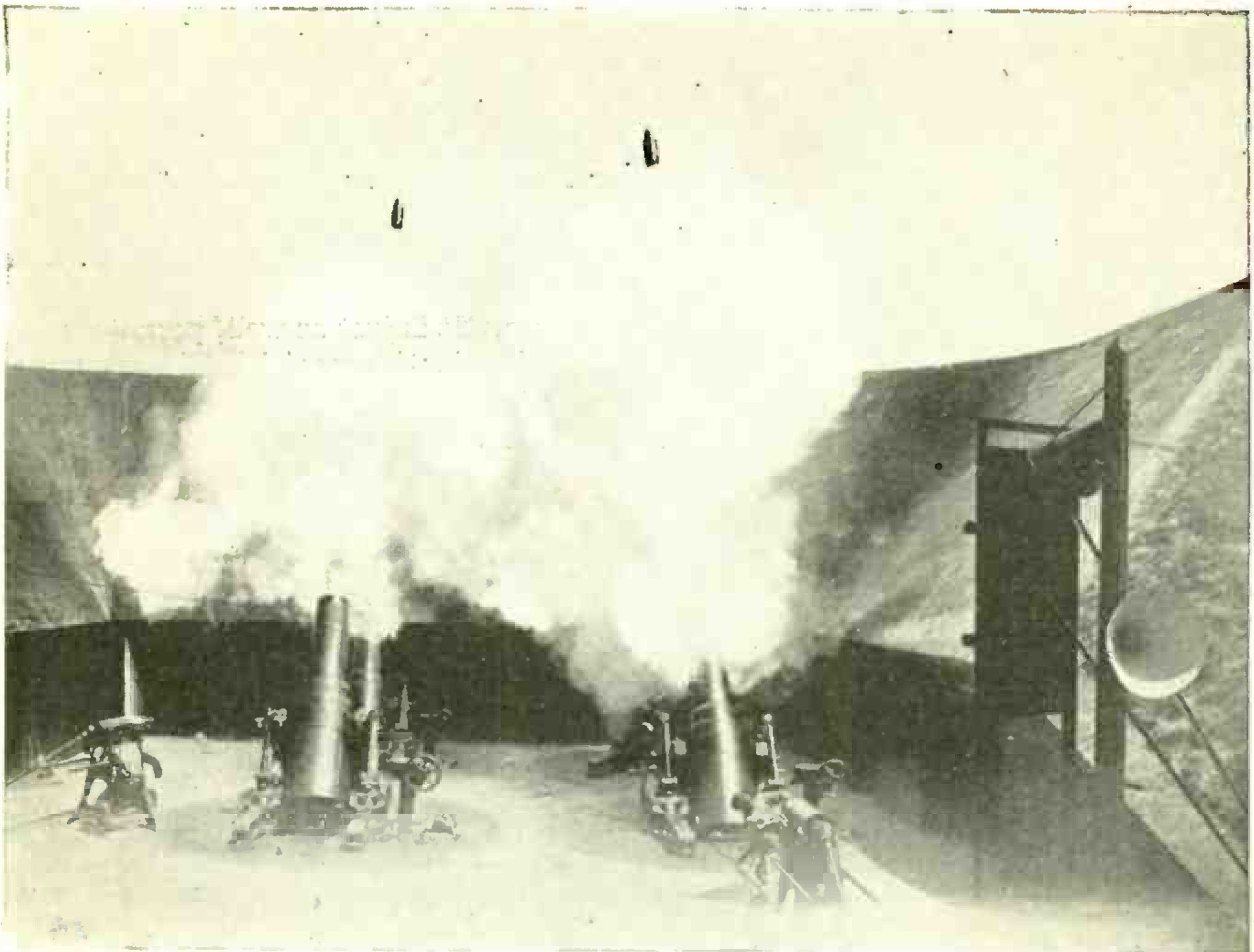
Suppose that you have a family cat who is a great jumper and suppose that by some magical gland food or something you activate the cat to still greater prowess. Suppose he grows able to



From a drawing by Arthur Merrick for POPULAR RADIO

RADIO'S NEAREST RIVALS IN SPEED

The length of the wavy line at the top represents the speed of radio waves and of light, which are the fastest things in the known universe. Below are a few electron speeds, all represented to scale. Ordinary speeds, like that of a rifle bullet, are very slow in comparison, as is indicated on the bottom line.



Brown Bros.

THESE FLYING SHELLS ARE REALLY SLOW

Although the shell leaves a big gun at a speed which makes it totally invisible except to the most rapid of instantaneous cameras, this speed is so much slower than the speeds of radio waves that an ordinary radio wave can pass back and forth along an antenna more than two hundred thousand times while the shell is moving as far from the gun mouth as you see it above.

jump as fast as those speediest electrons in the silver dollar, those which move at the rate of 64,000 miles a second or more. Of course, such a cat would not remain very long on earth, for one good jump would take him off beyond the other side of the moon.

Suppose that this activated cat and the silver dollar are both resting on your work table and suppose that the cat, as he jumps, knocks off the silver dollar so that it falls to the floor. Every one knows that it takes no great time for the dollar to fall. For most people, it falls too rapidly for muscular motion, no matter how quick, to catch it.

But the dollar falls far more slowly than the cat jumps. If all this happens in New York City and if the cat jumps west, kitty will be passing San Francisco when the dollar has fallen about nine inches of its way to the floor. If the cat is speeded up a little more, so that its speed equals that of the fastest electrons in the atom of uranium, he will be on the other side of the moon before the clock ticks twice. If a man fell toward the center of the earth with the speed of these atomic electrons he would go clear through to China while an ordinary individual was falling down on a slippery pavement.

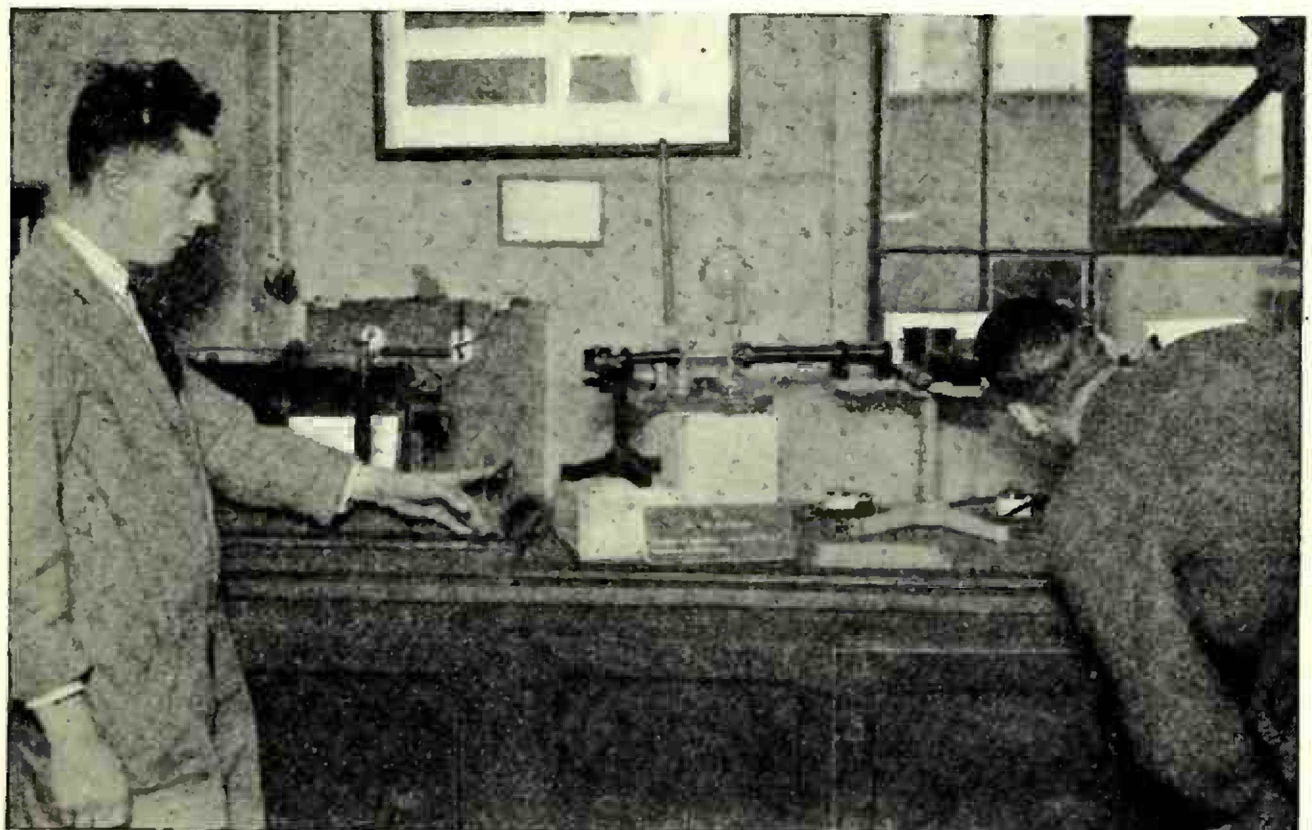
Other comparisons are possible on the basis of the amount of energy in the motion. A speeding locomotive, for example, is a very energetic thing. If it hits a solid obstacle like a wall or another locomotive, a vast amount of energy is set free. Everything is smashed. It would take many men exerting energy with sledge hammers for days to break up the iron and steel of an engine as thoroughly as it is broken up in a second or two by a really first class wreck.

Motion means, then, that much energy is involved. The motion of the atomic electrons is no exception. Knowing the speeds of the flying electrons in a silver dollar, it is possible to calculate without difficulty the energy that they possess. This turns out to be actually more than the energy involved in the speeding locomotive. It is, in fact, over four hundred times as much.

A full sized railway wreck, with two heavy locomotives and trains of cars hitting each other head on, will set free only about as much energy as is contained in the motions of the electrons in ten cents' worth of silver.

Needless to say, if one suddenly stopped this electronic motion in silver or in any other metal, the energy set free would be so vast that the entire atomic structure would probably disintegrate. If some magician spoke to your silver dollar the fatal word that stopped its motion suddenly, that dollar would instantly evaporate into white hot gas. It is just as well, perhaps, that today's scientist-magicians do not know this magic word or are likely, in the present state of atomic knowledge, to discover it.

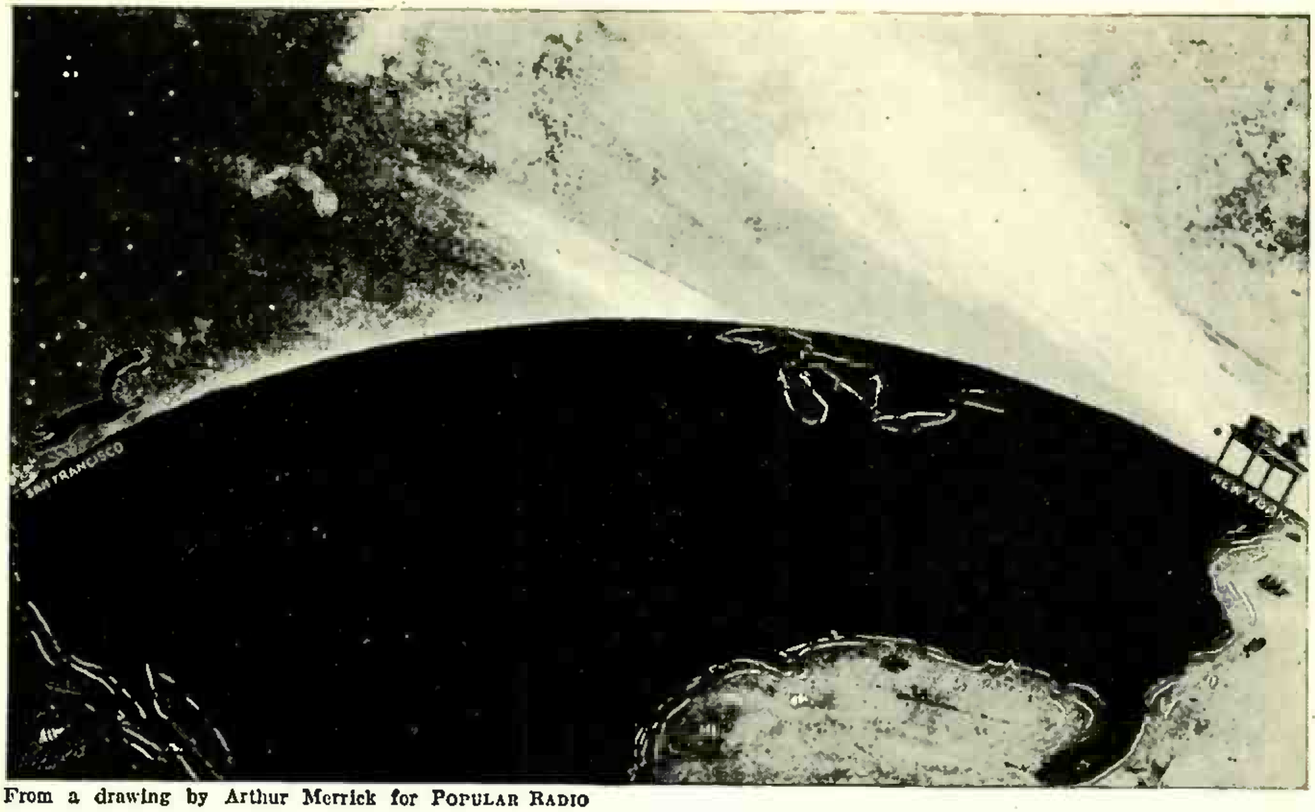
But what, you ask, has all this to do with radio? Granted that the electrons inside a silver dollar are executing a very speedy imitation of a whirling dervish, granted that the energy contained in them is vaster than a railway wreck and that their motion is comparable in agility to that of an imaginary thousand-league cat; what of it? Does this help



From a photograph made especially for POPULAR RADIO by Campbell-Gray, London

SPEEDY ELECTRONS BREAK UP ATOMS

In this apparatus, exhibited recently at the Science Exhibition, at Wembley, England, a stream of high-speed free electrons is passed through nitrogen gas in the glass tube in the center. The atoms of nitrogen are hit by the electrons and disrupted. As they return to their usual forms light is produced. The observer is watching this light through the spectroscope. This photograph and that used as the frontispiece are published by special permission of the British Empire Exhibition Committee of the Royal Society.



From a drawing by Arthur Merrick for POPULAR RADIO

ELECTRON SPEED WOULD REACH PACIFIC IN AN INSTANT

Suppose that a cat could jump as fast as an electron does in the atoms of a silver dollar. And suppose that the cat jumped just as a dollar fell off a table. The cat would pass San Francisco before the dollar had fallen a foot toward the floor. This gives you some faint idea of the tremendous speeds which exist inside an atom.

us to detect radio waves any better or to reach out for longer distances with our new short-wave transmitters?

Not yet, perhaps. But the last word in radio has not been said. There are still worlds to conquer. The answer of the future concerning the value of studying atomic speeds and atomic time units may be very different to the answer one might be tempted to give today.

It is really this matter of our time units which is most important. We humans live in a world for which a second seems a short time and a million years a very long one. Yet there exists, we know, the greater universe of the stars, in which a million years is a very short time indeed. The age of even so young and transient an astronomic body as our earth is reckoned in billions of years and the age of a really vast sun in hundreds of billions.

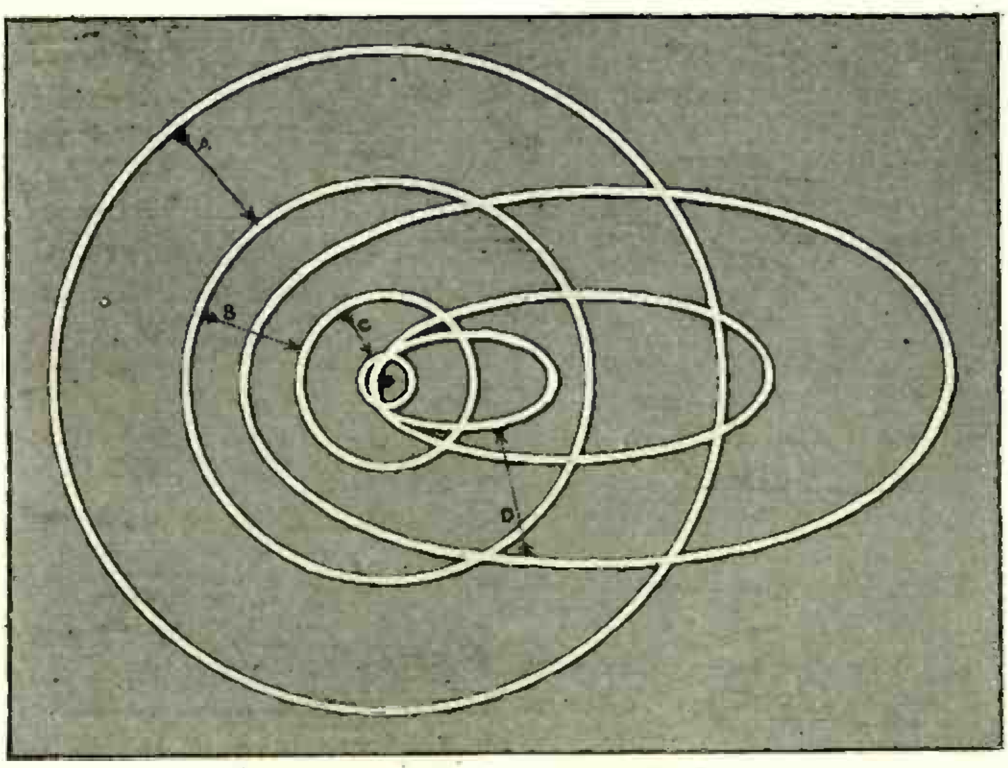
Just so there exists a tinier world of atoms in which the time units are far shorter, in comparison with ours, than ours are in comparison with the times which mark the lives and deaths of stars. Our fundamental time unit is the day, the time of one revolution of the earth about its axis. The fundamental time unit for a hydrogen atom may be taken, perhaps, as the time in which its single electron revolves about the atomic nucleus. This time is approximately one six-quadrillionth of a second. Over six million billions of these revolutions occur in each of our seconds. Were this hydrogen-atom time unit taken as equivalent to a day, the time measured by a terrestrial second would stretch out, in comparison, for nearly eighteen trillion years; an even vaster difference, you notice, than exists between our human time-scale and what is now believed to be the time-scale of the stars.

When their time units are considered, radio waves and the still shorter ether waves that constitute light and X-rays and gamma rays belong to the realm of the atoms rather than to the time-world which is familiar to us. Ether waves move with the greatest speed now known. They probably possess the greatest speed which is possible to anything inside our universe. They are faster, even, than the speediest electrons in the speediest atom of uranium.

A radio wave will move from Chicago to New York in a little less than one two-hundredth of a second, which is less time than it takes you to hear a revolver shot fired within a foot of your ear. This same radio wave will pass along the length of a usual one-hundred-foot antenna in about one ten-millionth of a second. If it arrives at right angles to the antenna wire, the time which it has to influence the electrons in the wire is still shorter, probably substantially less than a billionth of a second.

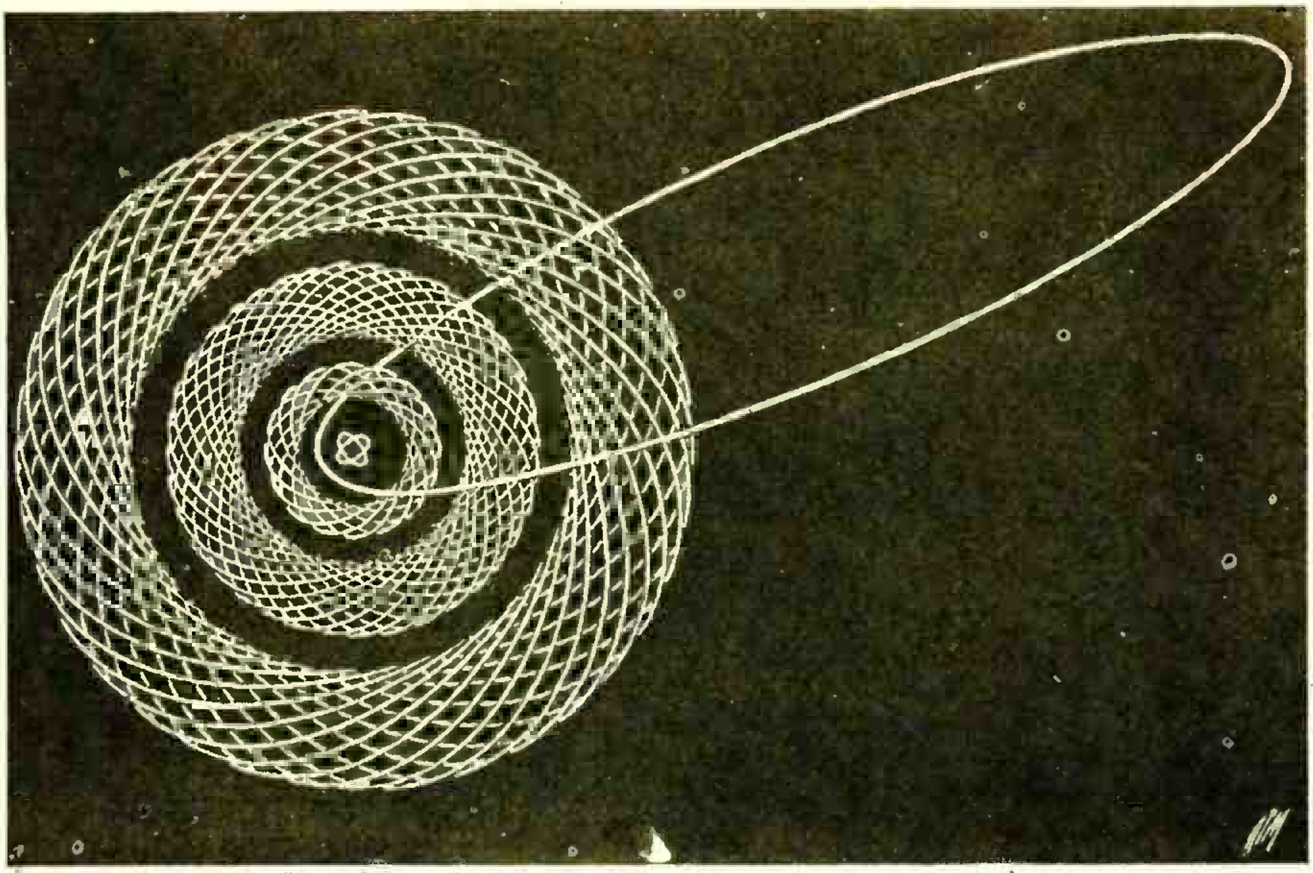
Like all the other figures which one rattles off glibly when atoms or ether waves are under discussion, these statements mean nothing whatsoever to the average human mind. They must be visualized by comparison. The time occupied by a rifle bullet in leaving the gun barrel when a gun is fired is usually about one five-hundredth of a second. This is two hundred thousand times longer than the time which a radio wave takes to pass along the length of an antenna. While the bullet is leaving the gun there is time for as many back-and-forth reflections of a radio wave (or of a light beam) in a one-hundred-foot antenna as there are individual letters of printed type in this issue of POPULAR RADIO.

But, short as is the time which a radio wave spends thus in dalliance with your antenna, the times of the atomic rotations are far shorter still. Each of the atoms of copper in an antenna wire possesses 29 planetary electrons. The speediest of these electrons moves with a velocity of about 40,000 miles a second; the slowest has a speed of a little less than 10,000 miles a second. The times



HOW ELECTRONS PRODUCE ETHER WAVES

The white curves represent some of the orbits which may be occupied, in turn, by the single electron of an atom of hydrogen. Ordinarily, the electron revolves, with tremendous speed, in one or the other of these orbits. Under some circumstances, however, it may jump from one orbit to the other, as is indicated by the black lines. Such a jump sends out a pulse of ether energy in the form of light.



From a drawing made for POPULAR RADIO by Arthur Merrick

AN ATOMIC PICTURE OF A SILVER DOLLAR

This diagram gives a rough idea of the structure of an atom of metallic silver. Each of the white curves represents the normal orbit of one electron. In all, there are 47 of them. One of the orbits extends much farther out from the center of the atom than do the others, and this fact is responsible for some of the peculiar chemical properties of silver. The actual atom is much more complicated than this simplified diagram.

needed for one revolution are, respectively, about one five-sextillionth of a second, for the fastest electron, and about sixteen times as long for the slowest electron. Again, the figures so transcend human experience that they mean nothing. Let us compare them, however, with the time needed by the radio wave to pass the antenna.

This time, we have just seen, is about one ten-millionth of a second. It is one two-hundred-thousandth of the time which a bullet needs to be fired out of a gun. Yet this short interval is over three hundred million times longer than the revolution time of even the slowest of the electrons in the copper atom. While a radio wave is passing once along the length of an ordinary antenna each of the electrons in the copper atoms will revolve from three hundred million times to over five thousand million times, depending upon whether one considers the slowest of the electrons or the fastest of them.

Let us put this conception, also into more familiar images. Imagine a vast line of airplanes arranged, one behind the other, in a field. Imagine the propellers of all of them spinning at the rate of six thousand revolutions a minute, which is quite fast even for an airplane propeller, easily fast enough to lift the plane off the ground. But the planes are imagined held down somehow, each propeller spinning. Let these typify the spinning atoms of copper in the antenna wire.

Now let us imagine a projectile of some sort fired past all these spinning propellers, or through them, to represent the moving radio wave which comes along and traverses the antenna. How fast will this projectile have to move to bear the same speed-relation to the revolving propellers that the radio wave bears to the fast revolving atoms?

The answer is a surprise. The speed of this projectile need not be more than *one third of an inch a day*. The slowest snail would be bored were he compelled to travel no more rapidly. Even molasses in January flows faster than this.

In fact, then, radio waves are not so fast after all, when they are compared with the astounding number of revolutions made by the electrons in the atoms. This does not mean, of course, that the speeding electron actually moves through space faster than the radio wave does. That, we have said, is probably impossible. What happens is that the atomic orbits are so small that the radio wave is in the substance of the antenna long enough for a vast number of individual atomic rotations to occur; a number which could be represented, with any adequacy at all, only by enough airplanes to fill the whole earth.

The practical point is that the speed of radio waves and the speeds of atomic rotation belong to the same order; they are parts of the same time-universe, the universe whose proper unit is a billionth of a second or less, instead of the day-unit or the year-unit which we find more convenient. As science progresses in the study of the interaction between ether waves, and the atoms and electrons of matter we shall have to devote more and more attention to this inconceivably rapid and short-timed universe where billionths of a second are long.

This interaction of matter and radiation constitutes the greatest present-day problem of physics. If ether waves did not affect the atoms of matter at all we would have no way of knowing that such waves exist, for we ourselves are composed of matter. Light is an example. A fire consists of a vast assemblage of atoms in trouble. Because of intense chemical reaction or perhaps merely because of heat, these atoms are losing and gaining electrons very rapidly. Such electronic shifts produce ether waves of light. These waves fly off with their tremendous speed of 186,000 miles a second and come, some of them, into a human eye. Here they meet atoms, the atoms of the retina. They do something to these atoms. No one knows just what they do but many scientists now believe that they cause the emission of electrons from these atoms, just as light rays do in the photoelectric cells now coming into use in the radio transmission of pictures. Whatever happens in the retina, the ultimate result is an electric message to the brain. The owner of the eye sees light.

There is involved, you perceive, a succession of interactions between the atoms in the fire, the ether waves and the atoms in the eye. Similarly, the longer radio waves affect in some manner the electrons in wires, so that radio reception becomes possible. All these interactions, so vital to almost everything in the universe, occur in very tiny spaces, spaces belonging to the size-scale of the atoms. They occur, too, in very tiny times, times of the order of billionths of a second or less. In the time while a silver dollar is falling from your work table to the floor whole lifetimes of atomic changes may have come and gone.

"Master-Lessons" Broadcast to 1,000,000 School Children

"Among our 25,000,000 school children in the United States, there are probably 1,000,000 who are studying approximately the same subject at the same time. Were there a radio set in every school, it would be possible to broadcast master-lessons in various subjects which would be rich in suggestion. . . . Geography could be made an adventure by introducing frequent talks by men and women who had recently visited areas which the children were studying. . . . Every state school system should investigate the possibilities of using this new tool—probably the greatest contribution to the advancement of popular intelligence since the invention of movable type at the middle of the 15th Century."

—Joy Elmer Morgan

¶ Are you tempted to join the army of 17,000 transmitting amateurs? If so, this article will tell you how to do it

From a photograph made for POPULAR RADIO

HOW TO LEARN THE CODE

The man in the picture is sending himself code letters on a buzzer which he hears in the headphones. This is one good way to practice the receiving speed required for an operator's license.

HOW TO GET

An Operator's "Ticket"

What you must know about radio to pass the Government's First-grade Operator's examination—and how you can prepare for it

By HOWARD S. PYLE

THE embryo amateur, enthusiastic over the prospect of actually owning and operating radio equipment for talking back to those he hears, is of two classes.

Foremost are those who enter any project in which they become interested with a whole-souled enthusiasm that closely approaches foolhardiness. These rush madly into the amateur game and purchase many dollars worth of transmitting equipment, and after confidently assembling it, they write a letter, or call in person at the office of the Supervisor of Radio for their district and request "a license, please!" And here they meet their first brick wall, for no amount of battering will break down the necessary formalities of obtaining a license to operate their equipment.

The second class of enthusiasts about to enter the amateur field are those who proceed cautiously and methodically in any project which they undertake. They discover almost immediately, generally through conversation with some local amateur, that Uncle Sam *insists* on a demonstration of their telegraphing ability before the dreaded Omnigraph, or "infernal machine" as it is often called. He will also inquire further into their knowledge of radio through the medium of a comprehensive written examination. Our seeker for an amateur license then, will as his next step, endeavor to gain some information on what to study and on just what points to prepare himself for such an examination. And here he meets *his* brick wall!

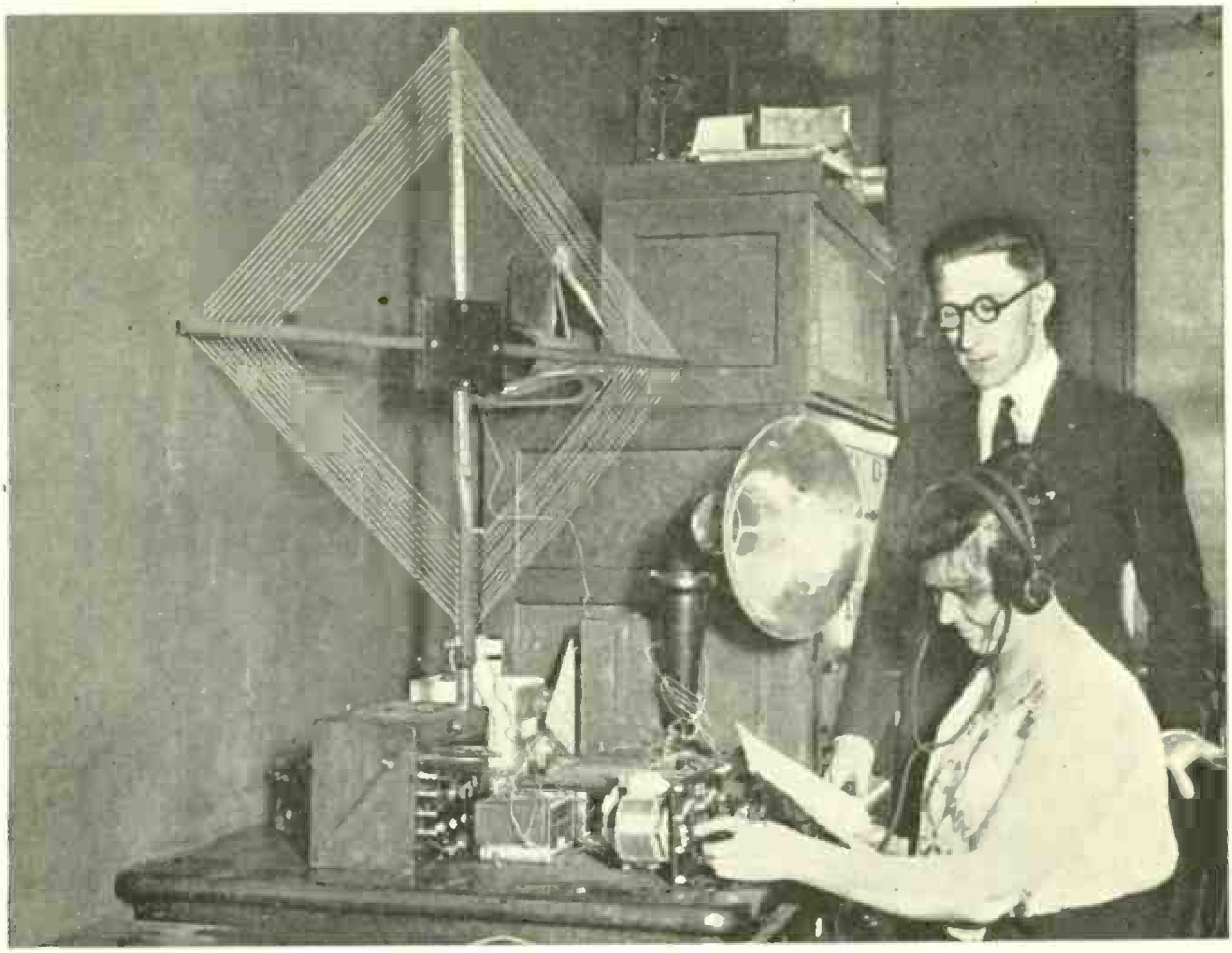
Obviously, the question sheets of the Department of Commerce are not public property in the sense that they are not promiscuously distributed to those who express a desire for them. On the contrary, they are carefully guarded in the Radio Supervisors' offices. There is, of course, no objection to the general gist of such papers being known, for it serves as a guide to enable concentration of effort along the proper lines, to a prospective applicant. For instance, it would be extremely foolish for a student to laboriously master the fundamentals and circuits of arc transmitting equipment in preparation for an examination where such material would be foreign. But nevertheless, an intelligent and helpful guide to preparedness for the amateur examination is practically impossible to secure.

This article tells the requirements for the amateur, first grade, radio operator's license.

The Department of Commerce, in drawing up the examination questions, had certain points in mind. Foremost, of course, was the ability of the applicant to use the telegraph code. Obviously, it would be useless, as well as actually dangerous, to issue a license to a man who had an excellent theoretical knowledge of radio communication, but who could not distinguish the characters of the International telegraphic code. He could cause untold damage by operating his equipment in times of distress, thus causing interference with important communication. A vessel in grave peril, sending an SOS, would be greatly hampered in securing aid or might even sink in the event that her distress signals were so interfered with as to prevent their reception ashore. It was therefore decided that amateur radio operators must be familiar with the Continental code to the extent that they could recognize distress signals sent slowly and repeated a number of times.

An arbitrary speed of five words a minute was originally agreed on as sufficient, but experience proved it to be too slow. The rate was accordingly increased to ten words a minute, counting five letters, numerals or other characters to the word. An applicant is really offered five opportunities to demonstrate his ability to translate signals at this speed. Straight, readable matter, containing no numerals or punctuation is sent him during a five minute period. He is required to copy but ten consecutive words (fifty letters) to secure a passing grade, from the fifty words (250 letters) sent him. It is assumed, however, that he will put down a reasonable portion of the balance, in addition to the required number.

Up until a few years ago, no attention had been paid to an operator's ability to *transmit* the code characters. It was assumed that anyone capable of receiving the code, could satisfactorily transmit, for mastering the handling of the key is popularly supposed to be extremely simple. Large numbers of operators, notably at sea, were later found, on observation, to have extremely poor "fists" as their sending hand and style is termed in radio phraseology. Some really good operators fell into the rut and developed what they were pleased to call, "individual style" in their sending. Oldtimers will recognize this as what is often referred to as the "Lake Erie Swing" on the Great Lakes and by similar descriptive names on the coasts.



Underwood & Underwood

A RADIO "COP" CHECKS UP ON RADIO "PIRATES"

If an amateur operates without a license or "jumps" his wavelength, a Federal inspector will catch him with the direction-finding apparatus shown in the picture.

It is true that practically all experienced operators have some individualism in their sending, but it has come with experience, naturally; not through misspent effort to develop a radical style. It does not necessarily mean that the formation of the characters is impaired; rather, it is often an improvement on the mechanical sending of automatic devices which reproduce the characters precisely and automatically.

This practice of purposely chopping up the dots and dashes, as well as lack of training in sending, led the Department of Commerce to inaugurate a transmission test, and now all radio inspection offices are equipped with keys and buzzers, as well as tape recorders, and an applicant must show up equally well in his transmitting ability as in his receiving speed.

It is required, in the case of amateur applicants, that they transmit fifty well formed characters (ten words) consecutively, without error, from a group of two hundred and fifty letters (fifty words) supplied them for copy. A speed of ten words a minute must be maintained throughout. A tape record of their transmission, as well as a copy of their receiving test, is filed with their application as part of their record.

Before you appear for your examination, you should be able to copy from 13 to 15 words a minute under ideal conditions, that is, from your own set at home with no interference, either extraneous noise or radio interference. You are bound to lose your ability slightly, due to a natural nervousness, when you appear for examination. The same applies to your transmission, although not as a rule in the matter of speed. Formation of your characters has a great deal to do with your success, and you should therefore devote much of your time to proper spacing of letters and words, rather than to acquiring great speed; that will come with practice. Learn to grasp your key firmly, and eliminate the tendency to nerve sending, by allowing your entire forearm to rest on the table.

The majority of amateurs use vacuum-tube transmitters and oscillating receivers. The forms are wide and varied, but the underlying principles and the theory of operation are identical. But to just the same extent do they differ from commercial types of transmitters; marine and shore stations. The theory involved is the same, but beyond that the two have nothing in common unless it be the use of vacuum tubes. Naturally, in appearing for your examination, for an amateur class of license, the Government is not interested in what you may know of commercial installations. It wants to be assured that you know enough about *your own* equipment to handle it intelligently, and to determine this point, the entire series of questions is based on your own transmitter; not on one you've seen on a steamer or in a broadcast station, but the one that is actually *on your own operating table!*

You can hold an operator's license even if you own no transmitter, but in this event, you are required to answer your questions covering the transmitter you *propose* to operate, which may be that of a friend, or one you are now building. The first point in connection with your station which will demonstrate your knowledge of your apparatus, is the method in which it is connected. Just like your more advanced brother, you are required to show a complete diagram of the transmitter, receiver, antenna and source of power. This must be *complete* in every sense of the word; each part being properly named and a brief description of its use lettered *on the diagram!* The examiner can therefore tell by a glance at your first sheet, about your fundamental knowledge of radio circuits.

A brief and sketchy description such as you are permitted to make on the diagram to illustrate the *use* of each device, does not mean that you understand its theory and functioning. In order to determine this, the Government will ask you for a complete description of the operation of your transmitter and receiver. This does not mean that you are to say, "I throw my antenna switch to the transmitting position; cut in my power and work my key." What is wanted is something like this:

"Using the alternating current of the house lighting circuits, through the medium of a step-down transformer, the filament of the vacuum-tube oscillator is brought to incandescence, thus emitting an electronic stream, which is caused to flow to the plate by reason—"

Carry out this description through your entire transmitter and receiver, explaining how oscillations are generated, how controlled and how the circuits are tuned. Do *not* be too brief, for you will be marked in exact accord with knowledge your answers show.

An extremely important requirement of the Federal law is that your transmitting wavelength be maintained within proper limits. General amateurs are at present allotted the wavelengths between 150 and 200 meters for regular use, and if your apparatus has a coupled antenna circuit and is capable of producing what is known as a pure continuous wave unmodulated by voice, buzzer, chopper, commutator ripple or alternating current hum, you can request permission to operate on either 75 to 80 meters, 40 to 43 meters, 20 to 22 meters or 4 to 5 meters. It may be readily seen that is it therefore important that you know how to measure your emitted wave, as well as what apparatus is used to effect such a measurement. You will be questioned on these points, and it is best to gain a rather comprehensive knowledge of these measurements before you

From a photograph made for POPULAR RADIO

"BRASS POUNDERS" TAKING THE GOVERNMENT TEST

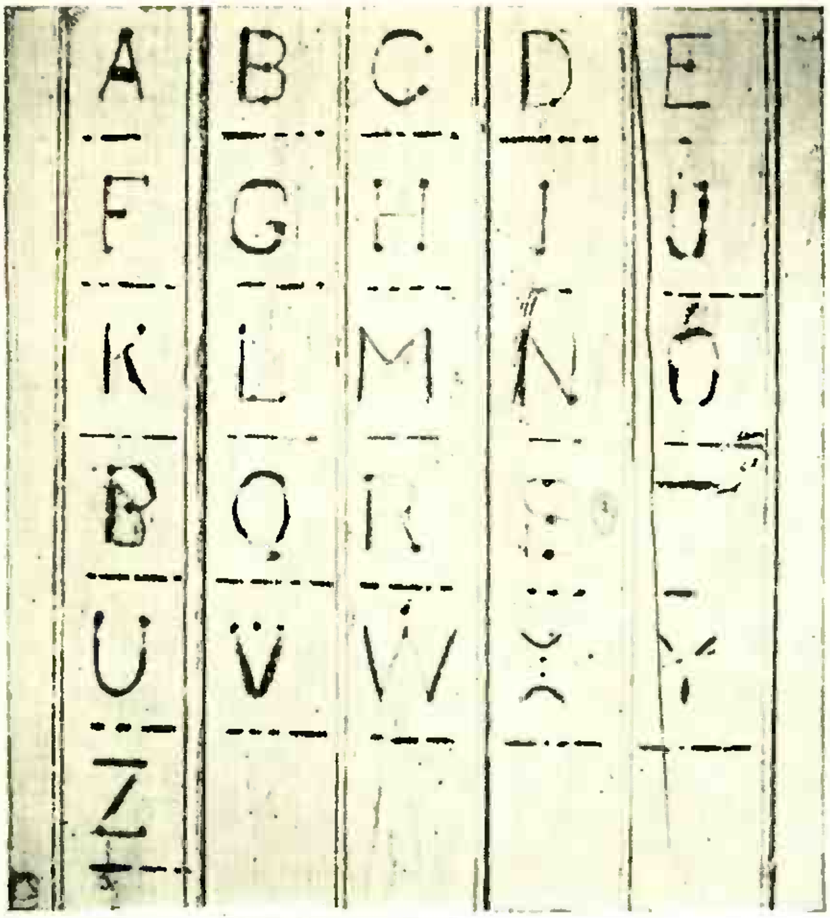
Besides answering technical questions about transmitting, receiving and radio auxiliary apparatus, the "ham" must take down Morse Continental code messages. An examiner in an adjoining room sends the dots and dashes which the license applicant hears in the headphone he wears.

appear before the Federal examiners.

While a knowledge of the Federal wavelength requirements and methods of measurements is essential, there are a number of other laws bearing both directly and indirectly on amateur stations that are extremely important. A good bit of your examination will be based on the essentials of such legislation. Let us consider then, the high lights in the present radio communication laws, where they affect amateur stations and operators.

When you are issued your station license, the Supervisor of Radio will include with it a small card bearing extracts from the law regarding the secrecy of messages and false signalling, with the penalties therefor. You should familiarize yourself with these provisions so that no little detail escapes you.

You will find that *no* message, regardless of its contents or its apparent surface harmlessness, may be divulged other than to the person to whom addressed; a station engaged in relaying such communication, or to a court of competent jurisdiction. Of course, as in all things, there are exceptions. If the message bears the address: "To all ships and stations" as Government weather reports generally do, then the information is meant to be public property. The signal "QST" (meaning, "General call to all stations") has the same meaning, and such information may also be safely dispensed. But *be sure* that the address clearly indicates the message to be public



From a photograph made for POPULAR RADIO

HOW TO LEARN THE CODE IN PICTURES

One amateur memorized the code by painting it on the wall of his bedroom. Each letter in the picture is built up of heavy dots and dashes which are the outline of a particular letter. "A" for instance is dot dash. The dot is at the top of the "A" and the dash is the line that connects the two legs of the letter. Below each letter is the code symbol for the letter. "S," for example, has three dots.

property; otherwise you are subject to a rather heavy fine or imprisonment! Familiarize yourself with these penalties as well as the provisions of the paragraph. False signalling—fraudulent distress calls and similar matter are *extremely serious offenses*. The fine and imprisonment for violation are particularly severe. Be sure that you know this law as well.

You will find, specified in your station license, a clause to the effect that you can use power "—not to exceed one (or one half) kilowatt input." This means that if you are in the general amateur class, which means five or more nautical miles from a military or naval station, that your maximum power consumption in the plate circuit of your transmitter must not exceed one thousand watts. Should you be within the restricted class (or five mile circle) this is reduced to five hundred watts. However, this is specified as the *maximum* power allowed you for *any* communication. It will be found by reference to the communication regulations, that you are required to use the least amount of power to cover the required distance. In other words, if your transmitter has a normal full power range of five hundred miles, you are violating the law if you use such power for local communication. It must be reduced to the least amount necessary to insure the reliable exchange of signals. If every telegraphing amateur followed the law, much interference would be eliminated.

The present radio communication laws were drawn up twelve years ago. They have been amended since, but they are still essentially the same. This is true of both our own laws and the draft of the London Convention, which regulates practically all of the radio activities of the world.

At the time such legislation was enacted, there were few stations, and fewer trained operators. In order to provide the operators with sufficient "practice" to keep them in form, as well as to enable instruction of new men, practice "over the air" was permitted where it did not interfere with other radio communication. Twelve years ago this was easily possible. The law remains the same today, but the effect is entirely different, for there are probably but a scattered few places on the earth where practice carried on in the air would not cause interference with some other station. At any rate, within the territorial limits of the United States, it is safe to say that to follow the strict letter of the law means that practice is really prohibited. The same holds true for superfluous signals and "service talk."

The rest of the "exam" is based on the Radio Communication Laws of the United States and on the International Radio-telegraphic Convention. Complete drafts of both documents will be found in the book entitled "Radio Communication Laws of the United States," which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a cost of fifteen cents in currency (stamps are not accepted). The writer cannot urge too strongly that every prospective amateur secure a copy of this publication and become thoroughly versed in the paragraphs bearing on amateur equipment. There are not many, and it is not necessary to memorize the wording; but satisfy yourself that you have a good understanding of the meat in each paragraph. In addition, learn the abbreviations commonly known as the "Q" signals, which can be obtained from almost any radio book. They will also be found in the rear of the Government publication above mentioned.

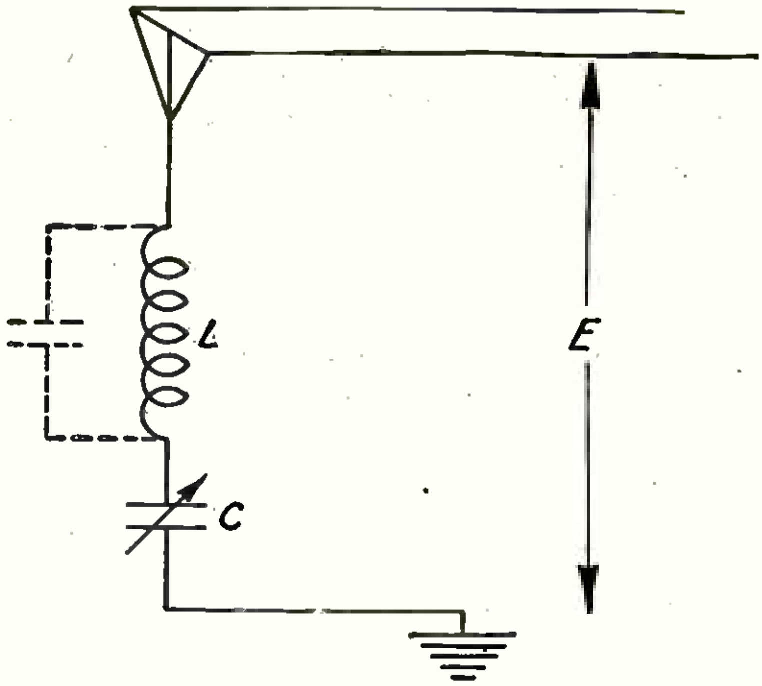
Examinations for the amateur grade of radio operator license are held on regular schedules in the various radio inspection offices throughout the country. Usually each supervisor has a special day set aside for this purpose. In the Eighth District, with headquarters at Detroit, Michigan, for example, "Amateur Day" is Saturday. The examinations are usually scheduled for 10.00 A.M. and it is wise to appear promptly at that time, for the examining officer dislikes to be compelled to run the code test again for late-comers. Should you not be located convenient to one of the district offices, and a fixed day would thereby inconvenience you, a special appointmen can generally be made. Communicate with your supervisor in this respect. To those who are really remote from an inspection office, a temporary permit, in the form of an amateur's second grade license may be issued, upon receipt of answers to a questionnaire accompanied by an affidavit attesting your code ability. The holders of such temporary permits are then required to appear for personal examination when a Radio Inspector conducts such tests in your district.

The amateur game is one of the most satisfying and productive hobbies available. To young men and boys it opens a field for experimentation that cannot be equalled in any other art. It has an excellent influence on a growing boy and tends to keep him from the companionship of questionable characters. Today amateurs are counted in six figures.

Let the aspiring applicants to the "blue ticket" of the full-fledged amateur be encouraged and may the great fraternity remain foremost among the country's youthful experimenters!

"Fifteen Ways to Reduce Static"

—will appear in the next issue of POPULAR RADIO*—for May*



AN ORDINARY TUNED ANTENNA CIRCUIT

FIGURE 1: *This is an example of a tuned circuit which has the voltage introduced in a part of the circuit exterior to the coil. Broadcast receivers generally make use of an untuned antenna circuit.*

What a Straight-line Frequency Condenser Really Is

If you want to know all that goes into the production of a condenser with true straight-line-frequency characteristics, what value a low minimum capacity has—or has not—and what straight-line-frequency really means, read this article by—

HERBERT J. HARRIES

IT isn't so very long ago that the "sacred angle" of the coils in the neutrodyne was the principal subject of discussion whenever two or more dyed-in-the-wool radio enthusiasts met at luncheon. At any rate, each was certain that he had the right "dope" on the exact number of degrees, and tenths of a degree, necessary to make the thing "neut" properly.

But now the sacred angle is forgotten and the straight-line-frequency condenser has become the favorite topic. Opinions concerning its virtues, and vices, seem to be nearly as much at variance as those concerning the proper angle for neutrodyne coils.

One gathers, from what one hears, and reads, that the straight-line-frequency condenser—

(a) is the perfect panacea for all the ills to which a radio set may be subject, not excluding de-thoriated filaments and exhausted "B" batteries;

(b) is "all the bunk," and a darned clever idea to sell more condensers to an unsuspecting public;

(c) theoretically cannot be designed but in practice can be approximated by a cut-and-try process;

(d) can be designed with mathematical exactness and manufactured with any reasonable degree of precision.

Presumably in all these contradictions

there are some whole truths, some half-truths and some un-truths. At any rate, manufacturers are making and selling something they *call* straight-line-frequency condensers.

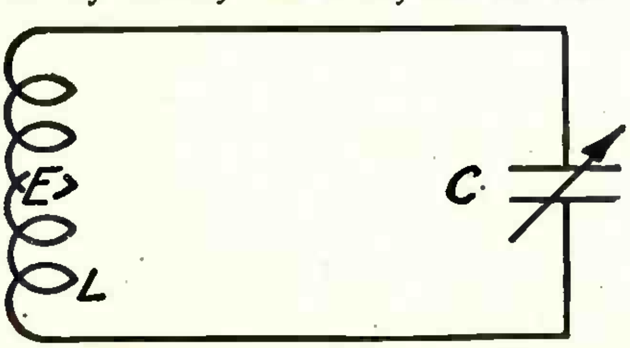
At this point a pertinent question is: *What* and *why* is a straight-line-frequency condenser?

Taking up first the *why* part of this question, we must consider some regulations made by the Department of Commerce.

In the early days of radio communication it was customary to say that a station transmitted on a certain wavelength. This usage was continued when broadcasting was inaugurated, and even to this day stations are listed according to their wavelengths. However, it has been found that wavelength is an inconvenient standard and it is being replaced by another standard, the frequency.

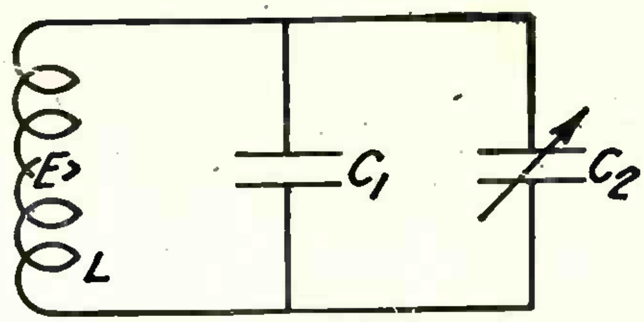
The reason for this is that, to prevent interference between stations, it is necessary to separate them according to a definite rule. This works out in such a manner that KYW (536 meters) must transmit about ten meters below KSD (546 meters) to prevent interference, whereas the separation between WJJD (303 meters) and WPG (300 meters) need be only a third as much for satisfactory transmission. As we go farther down the meter scale the required separation becomes less.

Experiment has shown that if the frequencies of the transmitting stations differ by exactly ten kilocycles no interference is experienced. Consequently, the Department of Commerce has allocated frequency bands to the broadcasting stations. KSD is permitted to use the band between 545 and 555 kilocycles and the frequency of its carrier wave is maintained at 550 kilocycles. KYW is required to maintain its carrier wave at a frequency of 560 kilocycles, just ten kilocycles higher. In a like manner WJJD uses a frequency of 990 kilocycles and WPG uses ten kilocycles more, or 1,000 kilocycles. Thus, it is seen that at every ten kilocycle division along the broadcasting frequency range there is a broadcasting station.



THE MOST COMMONLY USED TUNING CIRCUIT

FIGURE 2: *In this common circuit of the radio receiver the voltage (represented by E) is induced in the coil itself. The coil L will have some distributed capacity.*



A CIRCUIT EQUIVALENT TO THAT OF FIGURE 2

FIGURE 3: *In this circuit L is a pure inductance and its distributed capacity is represented as C1. C2 is the tuning condenser.*

The *what* part of this question now is clear. We wish to have all these stations distributed uniformly over our dials so we use condensers in which the plates are shaped so as to give that uniform distribution. In other words, we wish to get uniform separation of *frequencies*, rather than uniform separation of wavelengths. As a matter of fact, the term wavelength, used in connection with broadcasting stations, is obsolete, and the sooner it is dropped the better.

The next question is: Is it possible to design and manufacture condensers which will give to the circuit in which they are used a perfectly straight-line-frequency tuning characteristic; that is, perfectly uniform separation of the stations on the dials, or are there reasons why such a design is theoretically or commercially impossible and which make it necessary to accept a design only approximately giving the desired characteristic?

It is not necessary to have an elaborately equipped laboratory at one's service to investigate this question, for it is simply a matter of effecting a compromise between a mathematically perfect design and one which is commercially acceptable. Therefore, let us look into it first from the purely mathematical viewpoint, and then from the commercial viewpoint.

As a preliminary measure let us recall some of the facts we know concerning coils and tuned circuits.

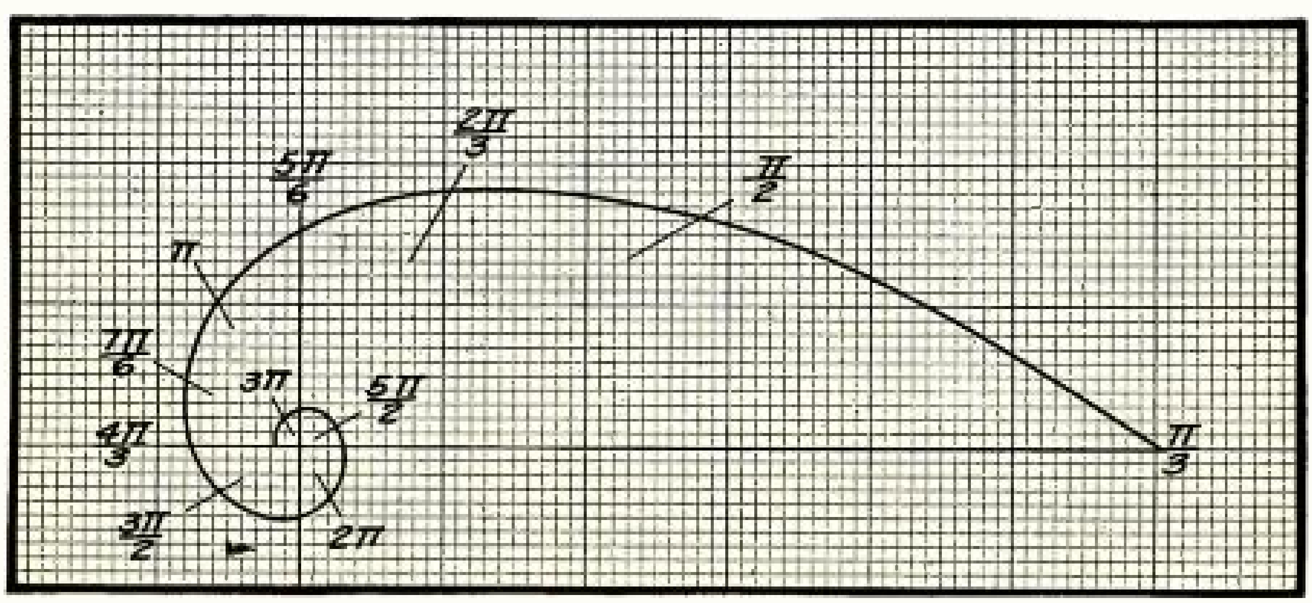
In the first place, we know that a coil has two values of inductance, its *pure* inductance, and its *apparent* inductance. If it were possible to wind coils that had no distributed capacity we should have only the pure inductance to consider. But every coil has some distributed capacity, and under certain conditions that capacity leads us to think the inductance is more than it really is. We call this *observed* value the *apparent* inductance.

Also, we use two kinds of tuned circuits. In one the voltage is induced somewhere in the circuit exterior to the coil. An example is the antenna circuit of Figure 1.

The coil L is in series with the variable condenser C and the source of voltage E. In the other the voltage is induced in the coil itself. An example of this type of circuit is the usual tuned circuit shown in Figure 2 where the voltage is induced within the coil as indicated.

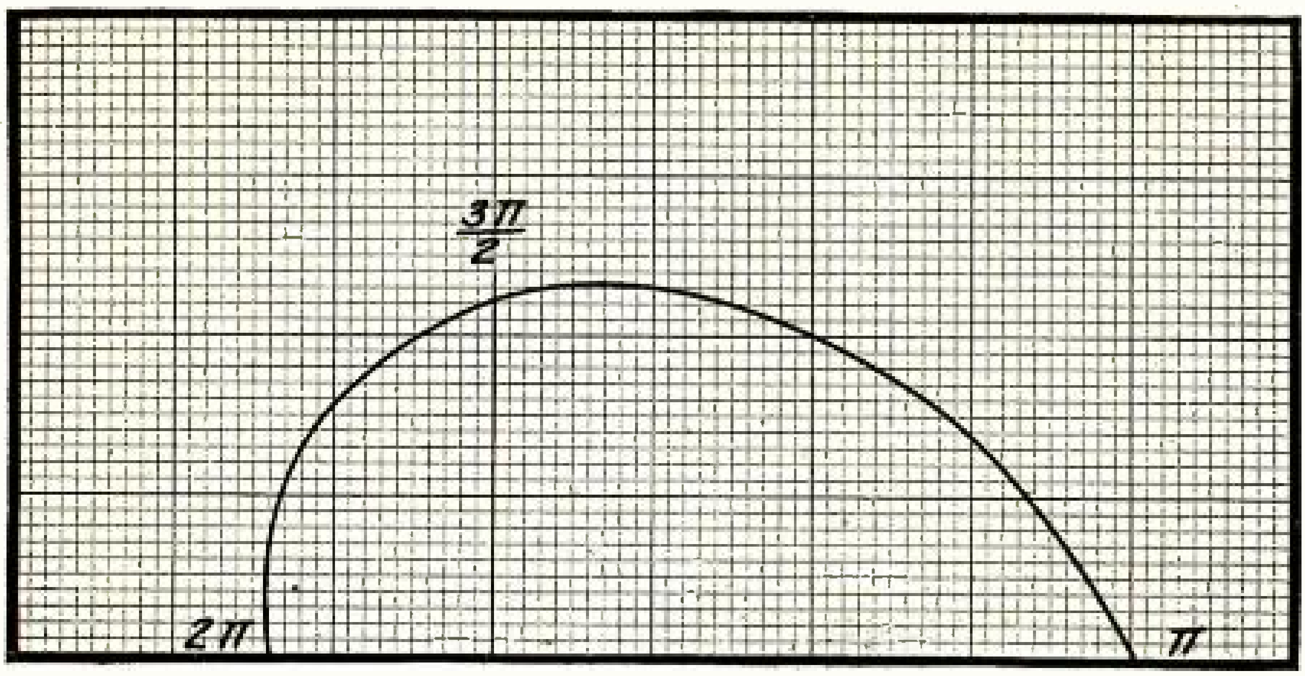
When considering the circuit of Figure 1 it is somewhat simpler to calculate the change in the apparent inductance with the frequency, according to a formula available for that purpose, and use those values in circuit calculations. This is because the coil and its distributed capacity, shown as a dotted condenser in Figure 1, are in series with the variable condenser. When considering the circuit of Figure 2, it is simpler to disregard the apparent inductance entirely. The capacity of the coil is in parallel with the capacity of the variable condenser, so we use the constant value of the pure inductance and add the coil capacity to the condenser capacity to determine the total capacity in the circuit. The equivalent circuit is shown in Figure 3 where L is the constant pure inductance, C_1 the constant distributed capacity of the coil, and C_2 the adjustable capacity of the condenser.

The circuit of Figure 1 is of comparatively little interest to the builder of broadcast receiving sets, since an untuned antenna circuit is in almost universal use.



THE HYPERBOLIC SPIRAL THAT DETERMINES THE SHAPE OF THE PLATES

FIGURE 4: *Such a curve gives the outline of the plates for a straight-line-frequency condenser. A section of this curve which gives a variation in capacity proportional to the frequency range to be covered is chosen.*



A SECTION OF THE HYPERBOLIC SPIRAL

FIGURE 5: *This section of the original curve is correct for tuning in stations that have a 2:1 frequency ratio. That is, it would tune in a series of stations between 500 and 1,000 kilocycles or any other series whose maximum to minimum frequency has the ratio of 2:1.*

So we may confine our study to the circuit of Figure 3.

The frequency to which this circuit is resonant; that is, the frequency at which the reactance of the coil becomes equal and opposite to the reactance of the condenser, and thus neutralizes it, is given by the formula

$$f^2 \doteq \frac{159200^2}{L\,(C_1 + C_2)}$$

Hence, knowing the frequency of any station desired, and the inductance and distributed capacity of the coil, we can calculate the value C_2 must have to tune that station in.

An important point which we must not overlook is that we are not interested in what value of the inductance or capacity of the coil may be, nor in the manner in which the capacity of the condenser varies as the dial is turned. What we are interested in is the result of the combination of those factors; that is, we are interested only in the frequency to which the circuit becomes resonant as the dial is turned.

It is evident, therefore, that in designing a condenser to give the circuit a straight-line-frequency tuning characteristic we must consider, in order, the frequency range we wish to cover, the inductance of the coil we wish to use, and the distributed capacity of that coil.

The problem confronting the condenser manufacturer, therefore, is that of providing a condenser wherein the capacity varies in such a manner that it will tune the circuit to a range or frequencies uniformly distributed over the dial. For example, if the desired frequency range is 500 to 1,500 kilocycles, the condenser capacity should be proportioned so that, using a coil of given inductance and distributed capacity, a 600 kilocycle station will tune in at 10, a 700 kilocycle station at 20, a 1,000 kilocycle station at 50, and so on.

The exact manner in which the condenser capacity varies to accomplish this is not of interest. The only consideration of interest is the variation in the *resonant frequency of the circuit* as the condenser dial is turned.

Neglecting the coil capacity for the moment, and considering the total capacity of the circuit to be concentrated in the condenser, it is apparent that it must vary inversely as the square of the frequency, that is, the outline of the plates must be a hyperbolic spiral. Such a spiral is illustrated in Figure 4.

It is evident we can select a portion of this curve which will give us a variation in capacity proportional to any frequency range we wish to cover. This brings up another consideration, the *frequency ratio,* which is simply the ratio of the highest frequency to which we wish to tune to the lowest.

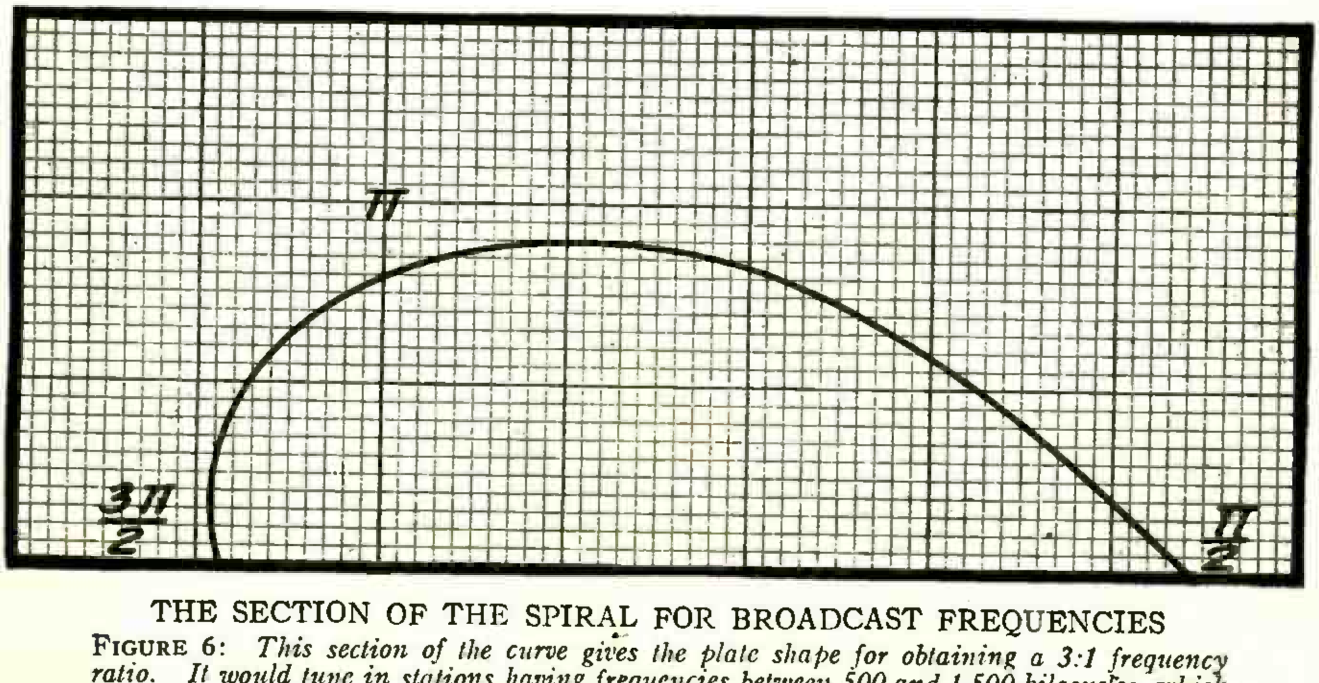
For the range 500 to 1,000 kilocycles, a ratio of 2:1, we would use that part of the curve proportional to that ratio, that is, the portion included between π and 2π, as in Figure 5. For the range 500 to 1,500 kilocycles, a ratio of 3:1, we would use that portion included between $\pi/2$ and $3\pi/2$, as in Figure 6 For the range 500 to 2,000 kilocycles, a ratio of 4:1, we would use that portion included between $\pi/3$ and $4\pi/3$, as in Figure 7. If we wished to cover a very narrow range, such has 500 to 600 kilocycles, a ratio of only 6:5, our plates would be very nearly circular and we would use that portion between 5π and 6π, as in Figure 8.

It is apparent, by this time, that the factor which determines the curvature of the plates, is the frequency ratio. Also, the curvature is different for different ratios, if we do not want the stations concentrated on fifty to seventy-five percent of our dials.

Plates shaped according to these curves would give the circuit a perfectly straight-line-frequency tuning characteristic over the desired frequency range if the coil had no distributed capacity. To compensate for the capacity of the coil, it is necessary to modify the outline of the plates so that, in the final design, the variation in condenser capacity is not in inverse proportion to the square of the frequency. It is such, however, that the variation in the total *circuit capacity* is inversely proportional to the square of the frequency.

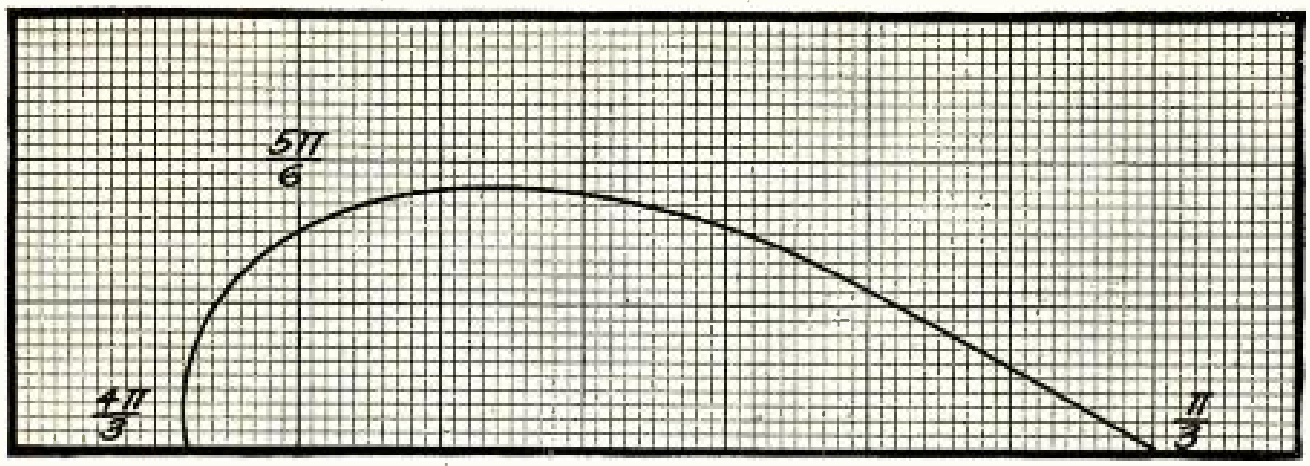
We can consider this question of design from a different angle by considering the circuit of Figure 3. Using the formula given previously it is a simple matter to calculate what values C_2 must have at any setting of the dial to give the circuit a straight-line-frequency tuning characteristic when used in conjunction with a coil.

Suppose, for example, we decide we wish to cover the range 500 to 1,500 kilocycles. Let us assume that the minimum capacity of the condenser is 15 mmfd., which is a fair value, and that the distributed capacity of the coil is 10 mmfd. Then the minimum capacity of the cir-



THE SECTION OF THE SPIRAL FOR BROADCAST FREQUENCIES

FIGURE 6: *This section of the curve gives the plate shape for obtaining a 3:1 frequency ratio. It would tune in stations having frequencies between 500 and 1,500 kilocycles, which is approximately the broadcast range.*



A SECTION FOR COVERING A WIDE FREQUENCY RANGE

FIGURE 7: *This section of the curve has been selected to cover a 4:1 frequency ratio. Plates of this shape would spread a band of stations between 500 and 2,000 kilocycles uniformly over the tuning dial.*

cuit is 25 mmfd. and the inductance required to tune to 1,500 kilocycles is

$$L = \frac{159200^2}{f^2c\,(C_1+C_2)} = \frac{159200^2}{1500^2 \times 25} = 451 \text{ microhenries.}$$

Using this value of inductance we find that to tune to 500 kilocycles

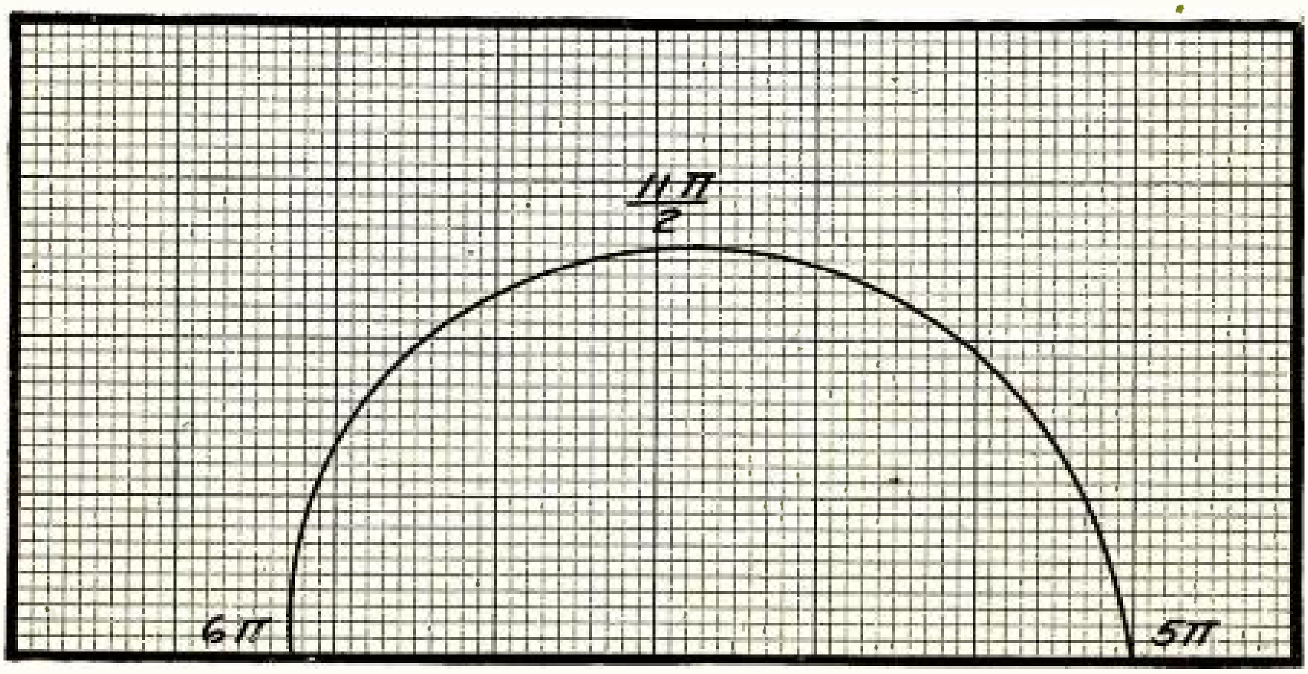
$$(C_1 + C_2) + \frac{159200^2}{f^2\,L} = \frac{159200^2}{500^2 \times 451} + 225 \text{ mmfd.}$$

and $C_2 = 225 - 10 = 215$ mmfd.

We could determine the maximum capacity required in the circuit in another way. The required *capacity ratio* equals the square of the desired *frequency ratio*. We wish to cover a 3:1 frequency ratio so the required capacity ratio is 9:1, that is, the maximum capacity required in the circuit is $9 \times 25 = 225$ mmfd.

Consequently, with a coil of 451 microhenries inductance and 10 mmfd. distributed capacity, and a variable condenser of 215 mmfd. maximum capacity and 15 mmfd. minimum capacity we can cover the desired frequency range, but only under certain conditions.

The formula we have employed presumes an ideal condition, and the pres-



A SECTION OF THE SPIRAL FOR A NARROW FREQUENCY BAND

FIGURE 8: *This section of the curve shows the plate shape for covering a 6:5 frequency ratio. A condenser of this type would place stations between 500 and 600 kilocycles a uniform distance apart on the tuning dial.*

ence of other apparatus may bring about other than that ideal condition. For example, a primary coil coupled rather closely to our secondary would cause a considerable reduction in our frequency range and we should find it necessary to increase the inductance of the coil and the capacity of the condenser.

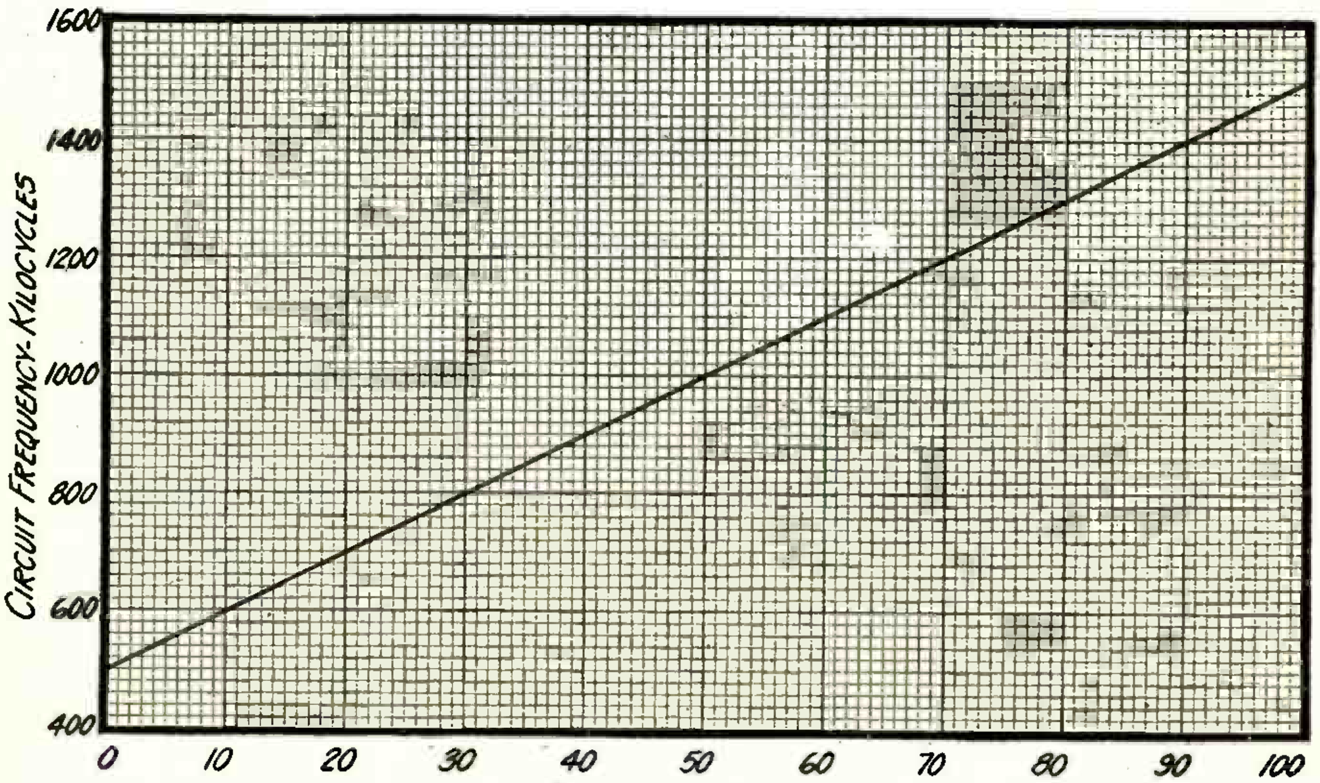
However, we may consider that our coil is a loop excited directly by the broadcast wave and thus consider that the ideal condition exists without affecting the validity of whatever conclusion we may reach.

If our condenser is calibrated into one hundred divisions, the relation of frequency to dial setting is as shown in Figure 9 and it becomes a simple matter to calculate the capacity needed in the circuit at every tenth division, say, to obtain this straight-line-frequency tuning characteristic.

If we plot ($C_1 + C_2$) against the frequency on logarithmic co-ordinates, as in Figure 10, we find that we get a perfectly straight line, that is, the change in *circuit capacity* is a straight-line-frequency variation. But when we plot C_2 against the frequency also, we find the curve is not a straight line, that is, the change in condenser capacity is not a straight-line-frequency variation. What law of variation it actually follows is of no interest, but the variation is different for different frequency ratios.

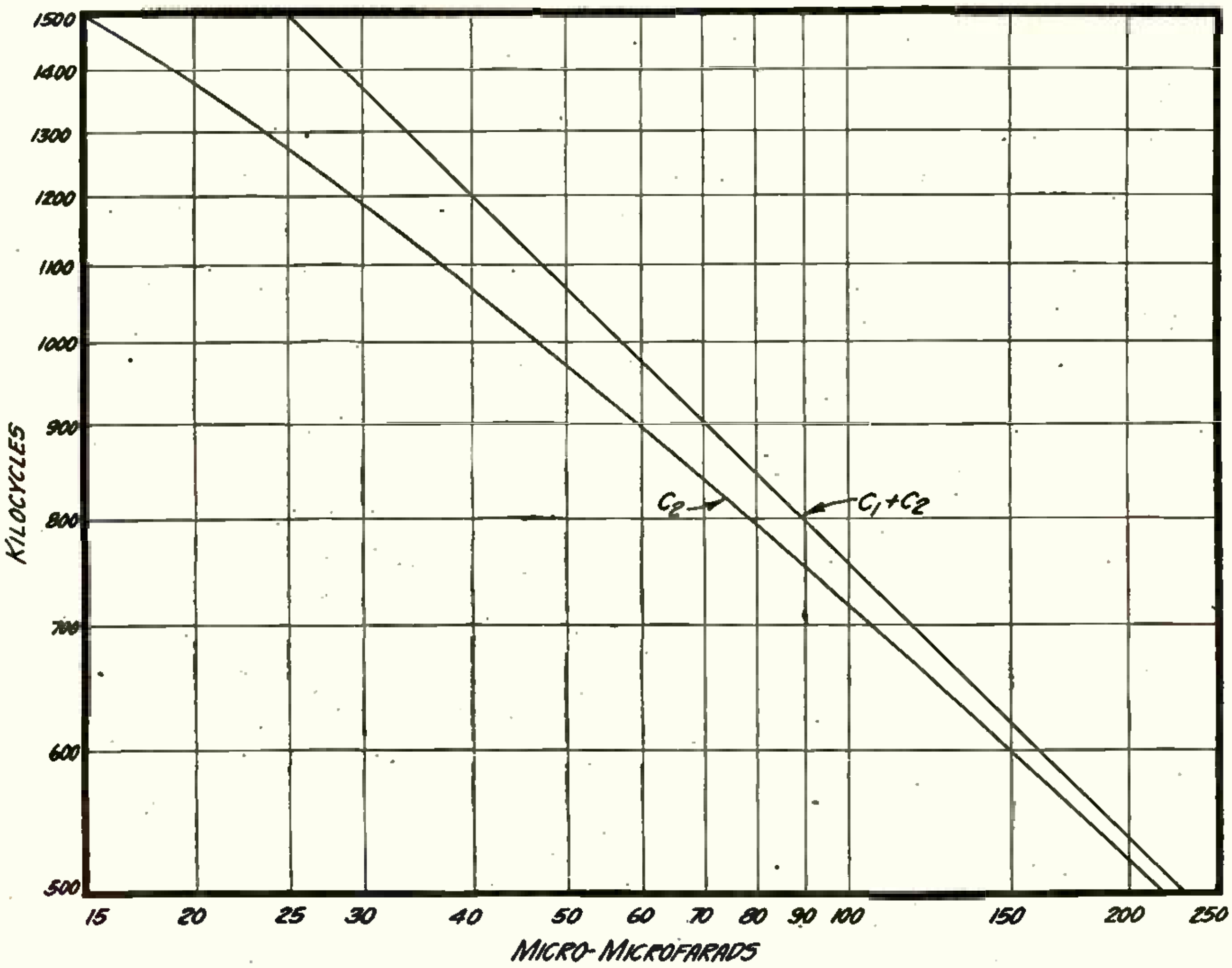
Now let us consider what happens when we attempt to use this condenser over another frequency range with a different frequency ratio. Suppose we wish to cover one of the amateur ranges, 1,500 to 2,000 kilocycles, say, a frequency ratio of 4:3. A little calculation shows that we must use not less than 254 microhenries inductance and further calculation gives us values which, when plotted, give us curve A of Figure 11.

We see that the straight-line-frequency tuning characteristic of the circuit is not impaired, but the frequency range we wished to cover is crowded into the upper thirty-eight divisions of the dial, as indicated by the solid portion of the curve.



THE STRAIGHT-LINE-FREQUENCY TUNING CURVE

FIGURE 9: *This chart shows the curve for a tuned circuit which has the correct capacity to spread the frequency bands uniformly over the one hundred divisions of the condenser dial.*



THE CAPACITY-FREQUENCY CURVE

FIGURE 10: *The total circuit capacity (C1 + C2) has a straight line variation with frequency when plotted on logarithmic paper. But when the distributed capacity of the coil C1 is subtracted from the total circuit capacity we find that the desired tuning capacity C2 does not have a straight line variation with the frequency.*

If we go to the other extreme and use the largest inductance that will permit us to tune to 1,500 kilocycles we get curve B of Figure 11. The straight-line-tuning characteristic of the circuit still is unimpaired but the dial is crowded worse than before and the frequency range we wish to cover is concentrated into only seventeen divisions.

By using any value of inductance between the minimum and the maximum we can place the solid portion of the calibration curve on any sector of the dial we wish, and, depending upon the value of the inductance used, it will include some number of divisions between seventeen and thirty-eight, which represent the maximum and minimum condition of crowding for this particular frequency range.

Also, these curves bring out a fact which is true of any type of condenser but which is sometimes overlooked. That is, the frequency ratio cannot be greater than the square root of the circuit-capacity ratio, assuming a constant value of inductance. In the cases we have been considering the circuit-capacity ratio was 9:1 and the frequency ratio in each case was 3:1 as can be seen by referring to Figure 9 and Figure 11.

Since no tuned circuit is complete without a coil, it seems that we are led logically to the following conclusion:

A condenser intended to afford the circuit in which it is used a straight-line-frequency tuning characteristic, with the stations within the desired frequency range spread *over the whole of the dial, should be designed for a pre-determined frequency ratio, and for use with a coil of known inductance and known distributed capacity.*

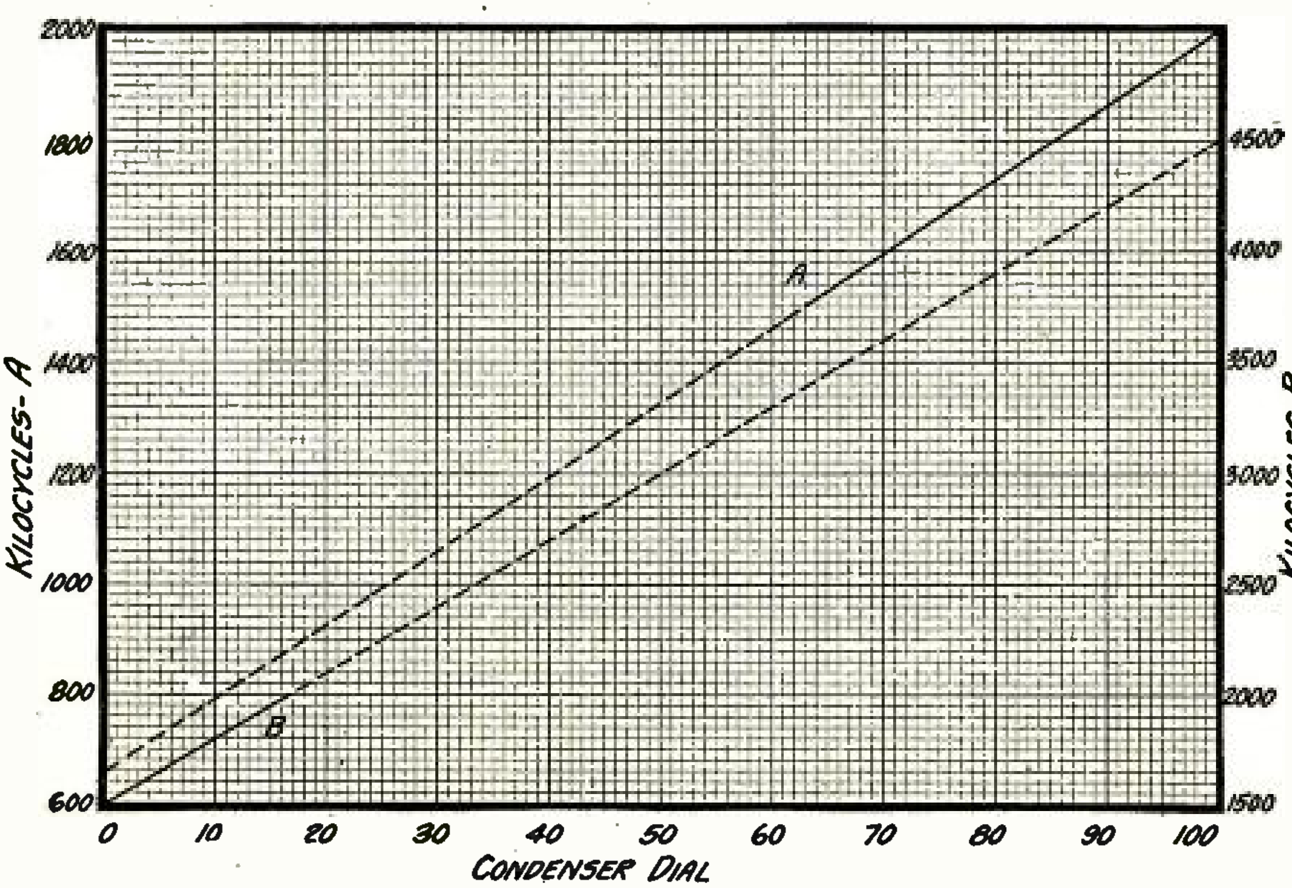
So far we have considered this question only from the mathematically perfect viewpoint. Now let us look at it from the commercial point of view, not forgetting that commercial considerations frequently are just as important, and sometimes more so, than mathematical perfection.

As a manufacturing proposition the 215 mmfd. condenser we have been considering is well within commercial limitations, for 15 mmfd. is a reasonable minimum value. There is no reason why we cannot design dies with which we can punch out plates that will conform to curve C_2 of Figure 10 within very close limits. When used with the coil we considered the tuning characteristic of the circuit would be a perfectly straight line so far as we could determine with any instruments ordinarily available.

The next question is: Would this condenser be satisfactory for use with coils of more, or less, distributed capacity? Upon investigating this phase of the matter for coils of 5 and 15 mmfd. distributed capacity we get the curves of Figure 12.

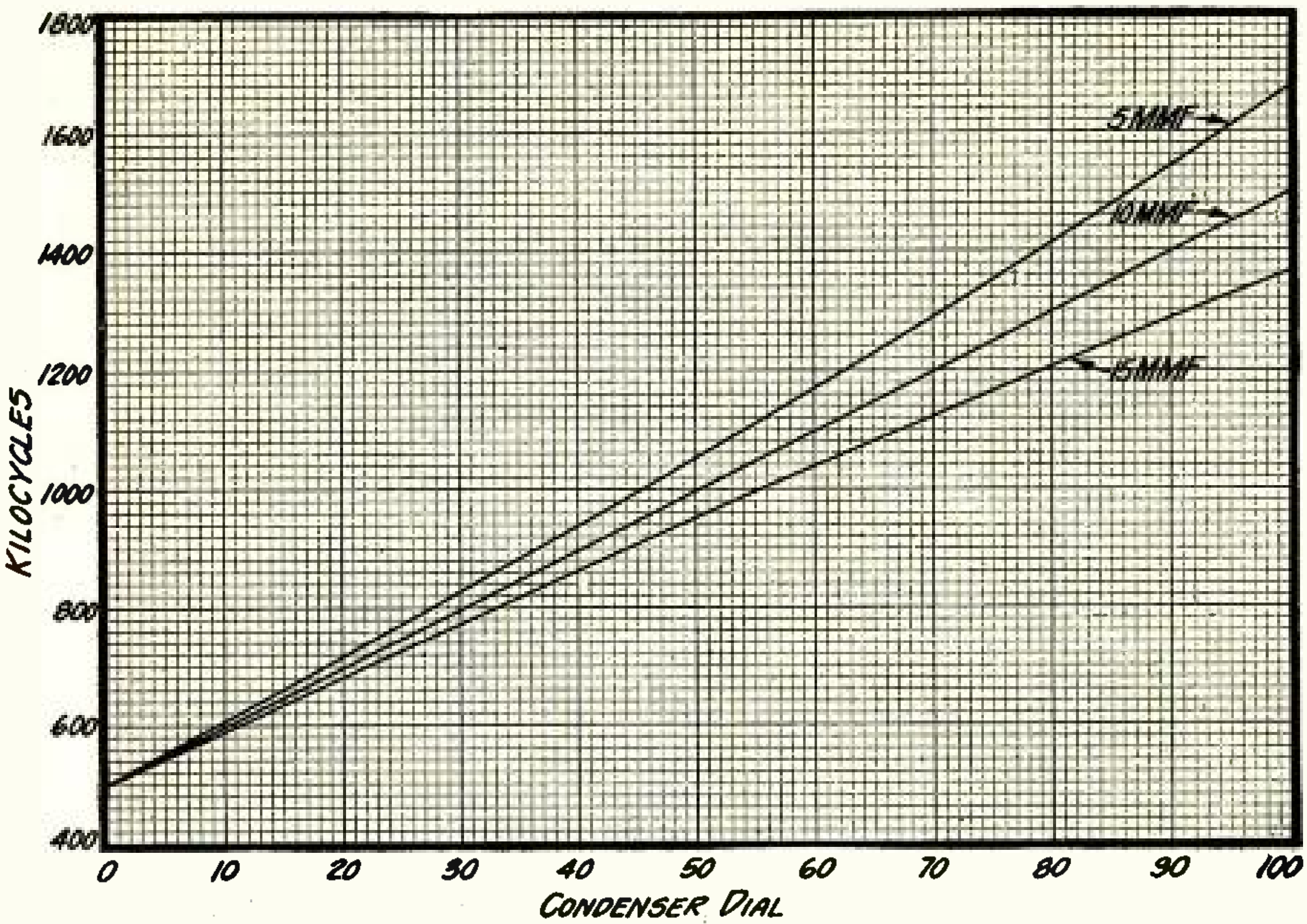
It is plain to be seen that neither the 5 mmfd. nor the 15 mmfd. curve is a straight line. However, the degree of curvature is comparatively slight, and, for all practical purposes, each may be considered to be straight. We may conclude, therefore, that a fifty percent increase, or decrease, in the distributed capacity of the coil does not impair the straight-line-tuning characteristic of the circuit to any material extent.

We should not overlook the fact that



THE RESULT OF USING A 3:1 FREQUENCY RATIO CONDENSER ON A NARROW FREQUENCY BAND

FIGURE 11: *Curve A shows the result when the condenser is used on a 1,500 to 2,000 kilocycle band with minimum inductance to cover this range while curve B shows what happens when the condenser is used with maximum inductance to cover this band. The dotted lines represent the unused parts of the dials.*



THE RESULT OF VARYING THE DISTRIBUTED CAPACITY OF THE COIL

FIGURE 12: *The central curve is for a condenser designed to give straight-line-frequency tuning when used with a coil having a distributed capacity of 10 micro-microfarads. A coil having 5 micro-microfarads capacity will extend the frequency range, while one having 15 micro-microfarads will limit it below the range desired.*

the frequency range changes with a change in coil capacity. In the case of the 5 mmfd. curve the minimum frequency is 505 and the maximum 1,675 kilocycles. In the case of the 15 mmfd. curve the minimum is 495 and the maximum only 1,370 kilocycles. Thus the reduction in coil capacity crowds seventeen percent more stations on the dial, whereas the increase in the coil capacity reduces thhe number of stations by twelve percent.

It is apparent that a condenser of this size would be inadequate to cover the frequency range if the upper broadcasting limit should be raised to 2,000 kilocycles. In that event, the smallest condenser that could be used would have a maximum capacity of somewhere near 375 mmfd. Also, a different portion of the hyperbolic curve would be used to determine the curvature of the plates.

The next consideration of interest is in connection with the design of a 500 mmfd. condenser where we encounter a problem that differs from any we have considered yet.

Let us figure on covering the same frequency range as before, 500 to 1,500 kilocycles. If the maximum condenser capacity is 500 mmfd. and the coil capacity is 10 mmfd., the maximum circuit capacity is 510 mmfd. and the minimum circuit capacity required is one-ninth of this or 57 mmfd. Subtracting the coil capacity, the minimum capacity required in the condenser is 47 mmfd. Also, the required inductance is 200 microhenries.

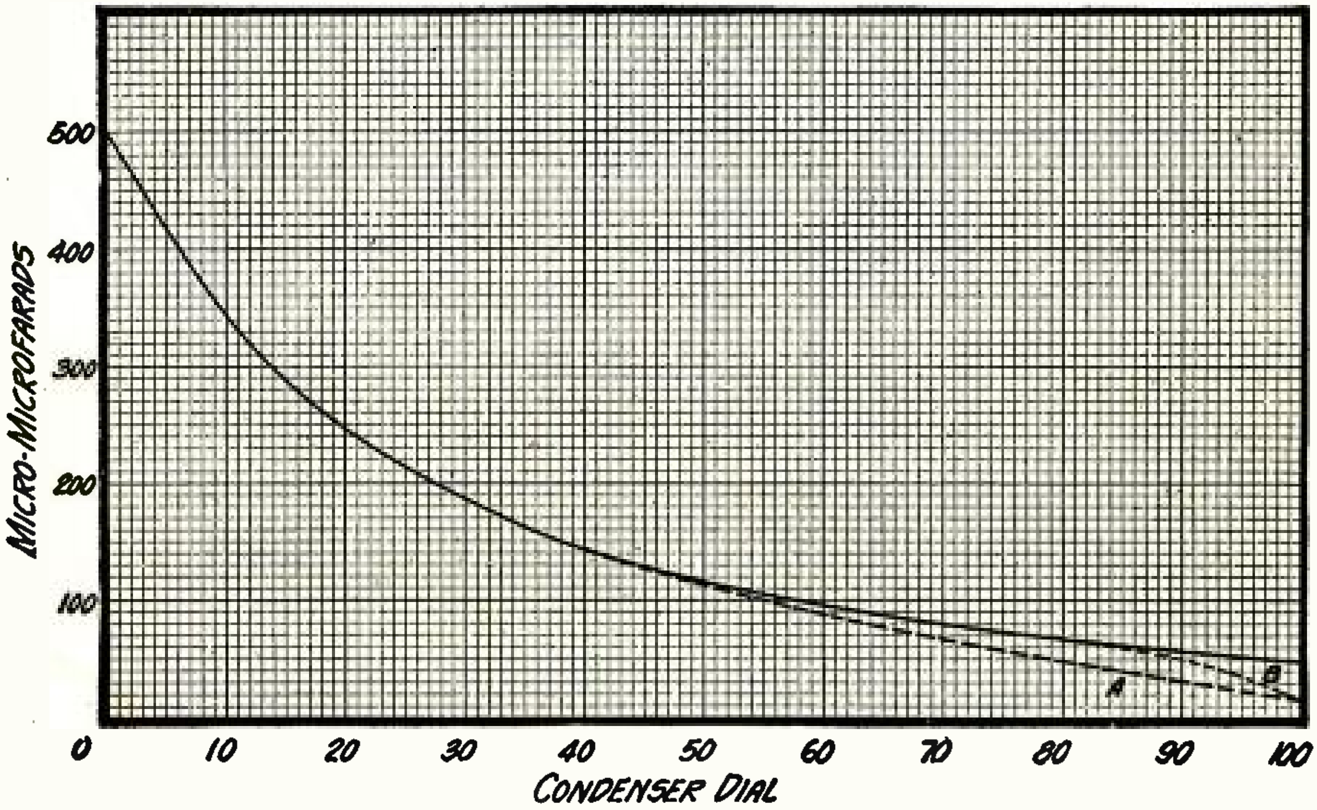
From these values we can calculate the required condenser capacity at each tenth dial division and obtain the solid capacity curve of Figure 13. We note that the minimum condenser capacity is very high, some three or four times the minimum usually found in condensers of this size. If we wish we can build condensers with this high minimum which will afford the solid calibration curve of Figure 14. But if we consider it necessary to cater to the demand for a very low minimum capacity we can modify the curvature of the plates so as to give the capacity curve shown at A in Figure 13, or at B, as we prefer.

If we decide to use curve A, then our calibration curve changes as shown at A in Figure 14, and we find we have rendered twenty percent of the dial useless. If we decide to be conservative and only modify the plates a little so as to correspond with capacity curve B (Figure 13), the calibration curve becomes that at B in Figure 14 and only ten percent of the dial is unused.

The reason for this change in the calibration curve, of course, lies in the fact that the capacity ratio no longer equals the square of the frequency ratio by which the curvature of the plates was determined. Whereas the outline of the plates was such as to correspond to a frequency ratio of 3:1, or a capacity ratio of 9:1, the actual capacity ratio has become (500 + 10) / (15 + 10) or about 20:1. The corresponding frequency ratio is approximately 4.5 ÷ 1, which is the *only* frequency ratio for which a condenser with these maximum and minimum capacities can be designed to give the straight-line-tuning curve shown at D in Figure 14 if we wish to use the whole of the dial range.

Should the upper limit of the broadcasting frequency range be raised to 2,000 kilocycles, it is apparent that a 500 mmfd. condenser modified according to either curve A or curve B would cover the complete frequency range, but the calibration curve would be far from straight and the stations between 1,500 and 2,000 kilocycles would be badly crowded. It would be necessary to shape the plates according to that portion of the hyperbolic spiral (Figure 7) included between $\pi/3$ and $4\pi/3$ to give the straight-line-tuning curve shown at C in Figure 14.

Incidentally, another bad effect of low-



THE CAPACITY CURVES FOR A 500 MICRO-MICROFARAD CONDENSER

FIGURE 13: *The solid line is a curve for a straight-line-frequency condenser having a 3:1 frequency ratio. Note the relatively high minimum capacity. Curves A and B show methods of modifying the capacity curve to get a low minimum, but they only use 80 and 90 percent of the dial respectively.*

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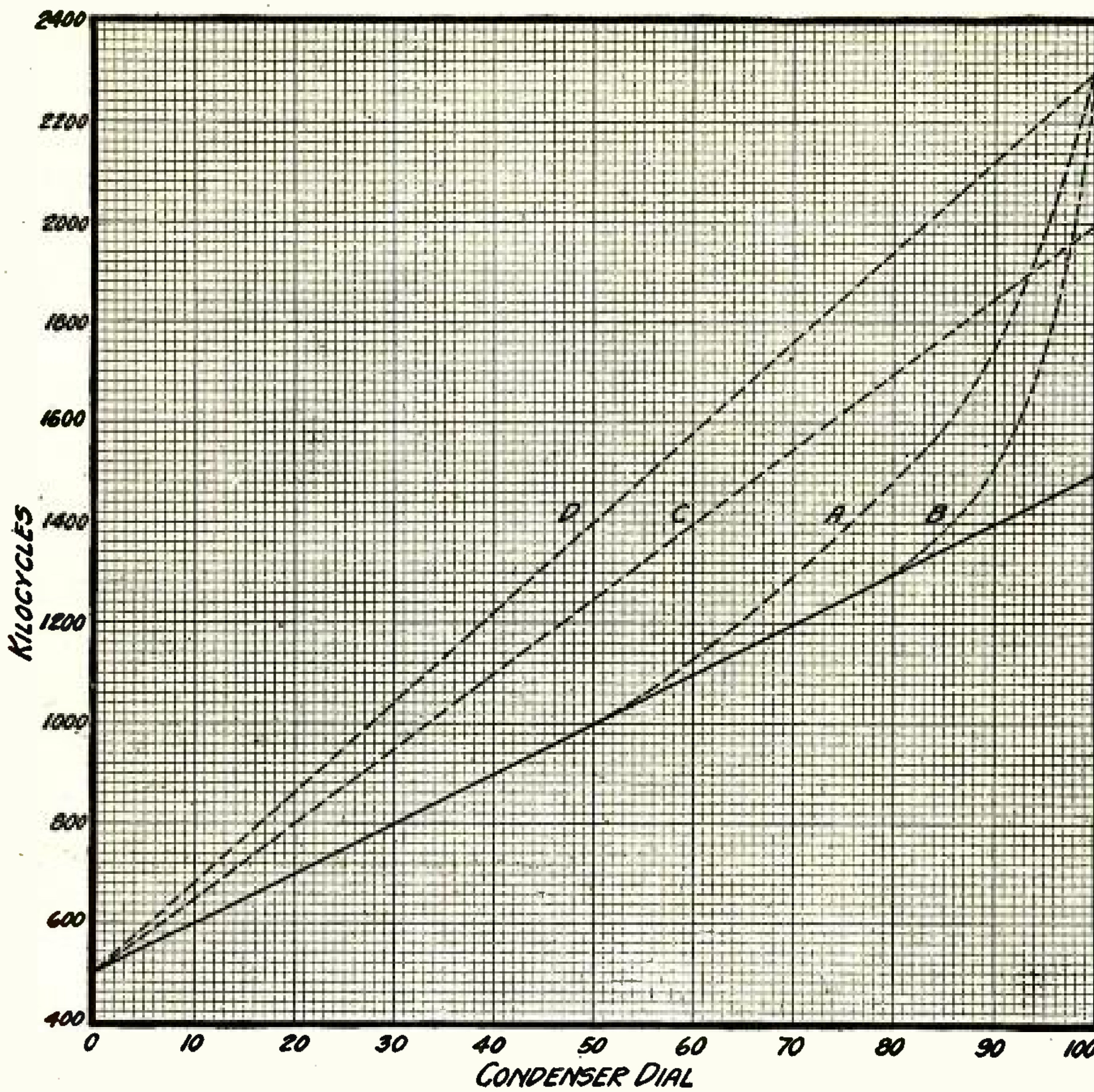


THE TUNING CURVES FOR THE CONDENSERS OF FIGURE 13

FIGURE 14: *The curves A and B show that the capacity curves cover a much greater frequency ratio than 3:1 and that they are no longer straight-line-frequency curves when they are modified to obtain a low minimum capacity. Curve D is the only straight-line-frequency variation between the maximum and the modified minimum.*

ering the minimum capacity in this manner is that the resistance of the condenser at the low capacity settings is increased an astonishing amount over what it would be with a high minimum capacity.

In conclusion, then, it seems that the frequency ratio is the principal factor to be considered in determining the proper curvature of the plates, that the distributed capacity of the coil may vary within reasonable limits without affecting the straight-line-tuning characteristic of the circuit to a serious extent, but that it may reduce the frequency range considerably, and that the inductance of the coil has no effect upon the straightness of tuning curve but determines to what extent the stations desired are crowded into a small sector of the dial. Also, it would appear that the general practice of catering to the demand for a very low minimum condenser capacity serves no useful purpose and is a detriment in that it distorts the tuning curve and increases the condenser resistance at low capacity settings.

Kadel & Herbert

WHERE THE WATCH IS KEPT

Hour after hour during the long broadcasting programs this operator listens in for the call of distress that may come at any moment from the sea.

"S. O. S."

What Happens When a Call for Help Is Picked Up During Broadcasting Hours

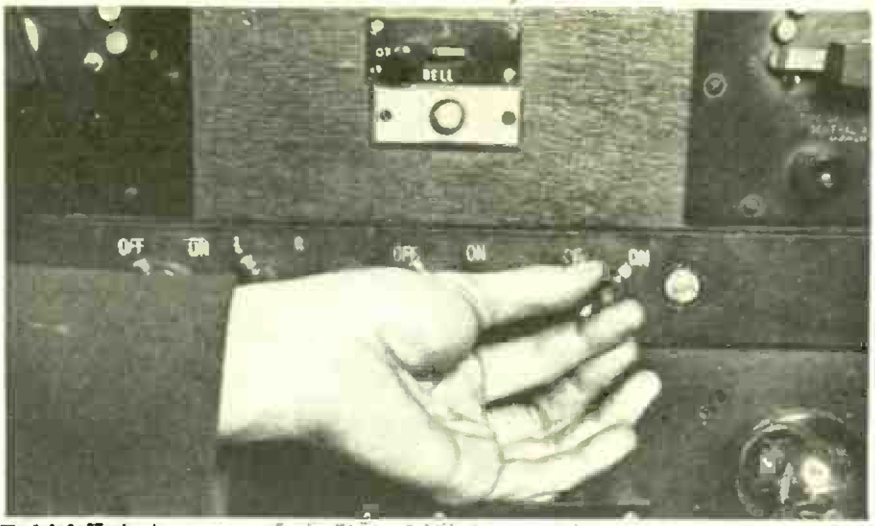
WHEN you hear a sudden "Signing off, account of an S.O.S." come from your loudspeaker in the midst of a program and then find that every other broadcaster has suddenly become silent, what is really happening behind the scenes?

In every broadcasting station there is a receiving set which is constantly tuned to 600 meters. At most stations an operator keeps constant watch for the "S.O.S." call, which means that a ship is in distress and that human lives are in danger.

The moment the listener hears that call he signals to the control room of the station to stop broadcasting. The ether must be cleared at once; there must be no chance that the ship's cry for help may be interfered with.

In the control room, as the listener signals, a tiny light on the panel in front of the operator flashes its warning that an "S.O.S." has been received. In a moment he throws over a switch on the panel which halts all transmission.

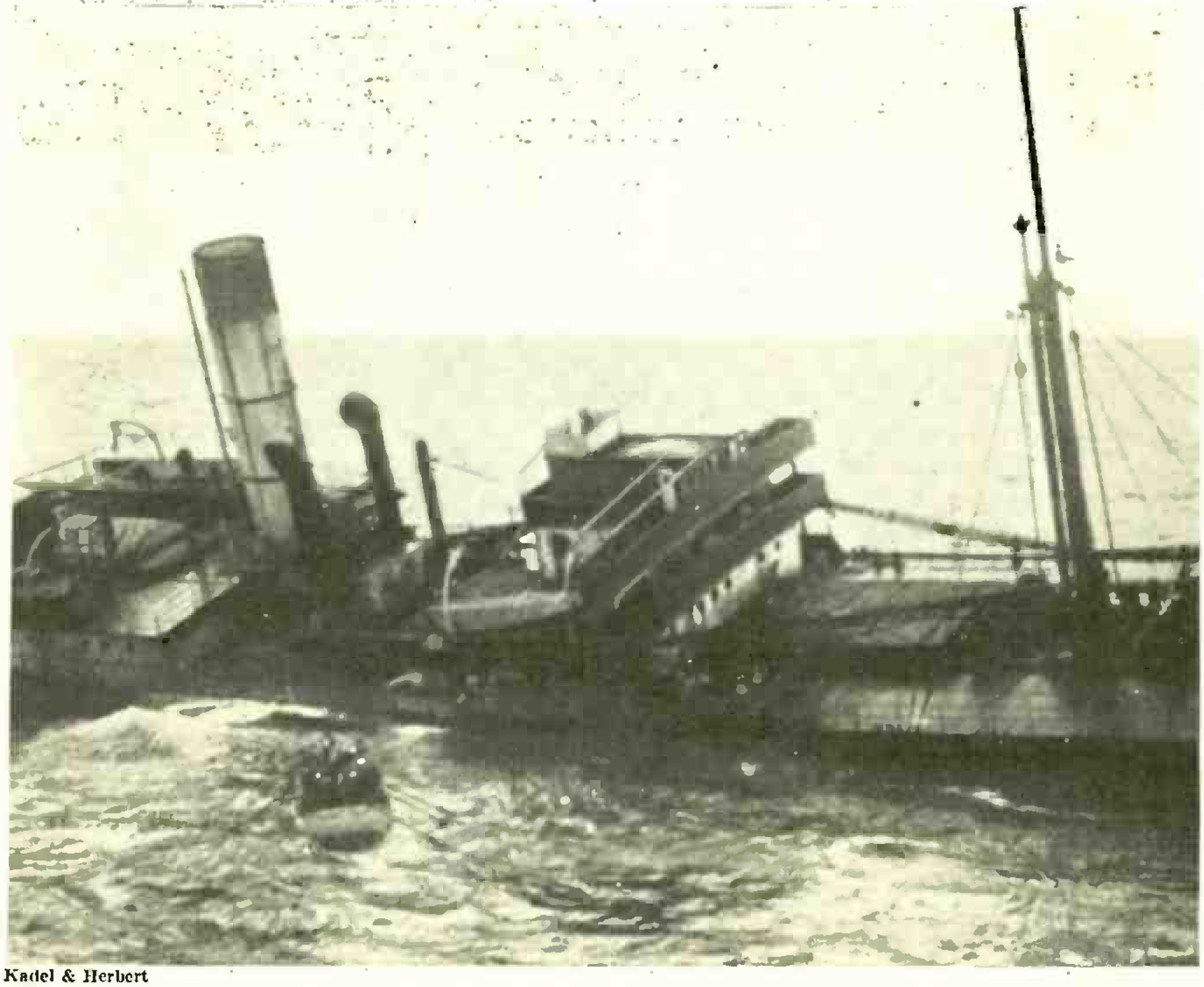
In this way the program is immediately cut off and there is complete silence until the ship's message has gone through to those who can bring aid.



Kadel & Herbert

THE OPERATOR CUTS OFF THE PROGRAM

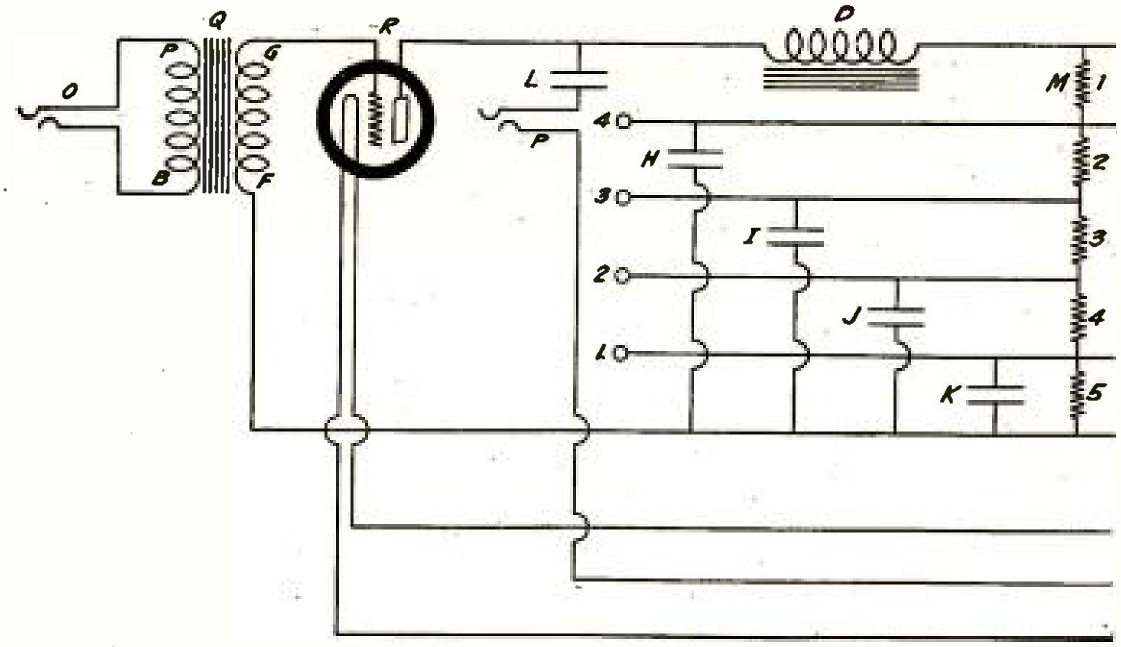
When the tiny light at the right of the panel flashes a warning, the control room operator knows that an "S. O. S." call has been heard by the listener-in and he calls "signing off, account of an S. O. S." and cuts off all transmissions until he knows that the distress call has been heard and answered.



Kadel & Herbert

WHEN THE "S. O. S." CALL IS ANSWERED

Rescue scenes such as this are the rewards of the silent listeners for the fateful call signal. In this instance the entire crew of the Italian freighter "Ignacio Florio" was saved by the crew of the "President Harding," as a result of the vigilance of the little company of men who always sit at the radio receivers—listening.



THE COMPLETE THEORETICAL CIRCUIT DIAGRAM

FIGURE 1: *The hook-up for the "Power-pack" amplifier and "B" current unit. All the symbols for the instruments bear designating letters which are used consistently in the list of parts, text and illustrations.*

HOW TO BUILD THE

POWER-PACK AMPLIFIER

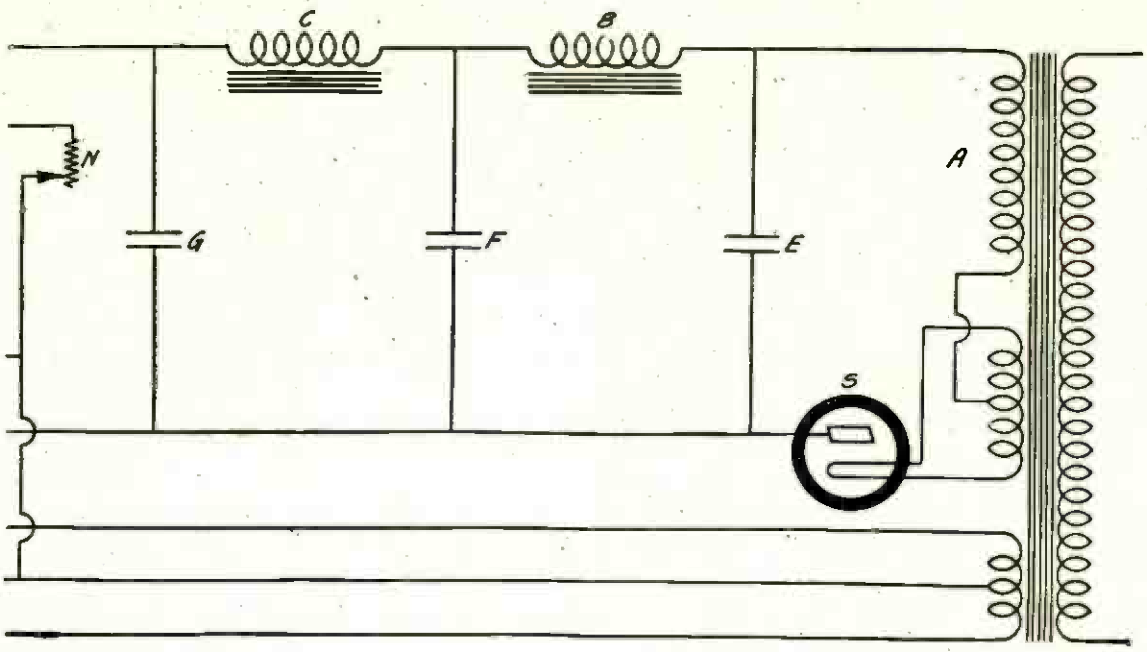
This new unit gives to experimenters and radio fans for the first time a reliable power amplifier that uses a high voltage on a power tube and a plate-supply unit for any radio set that it may be used with. It will give reproduction of a large orchestra with the same quality and strength as that produced by the orchestra itself. It supplies the "A," "B" and "C" voltages to the high power amplification in the last stage direct from the alternating current lighting lines.

By ALBERT G. CRAIG

COST OF PARTS: Not more than $94.00

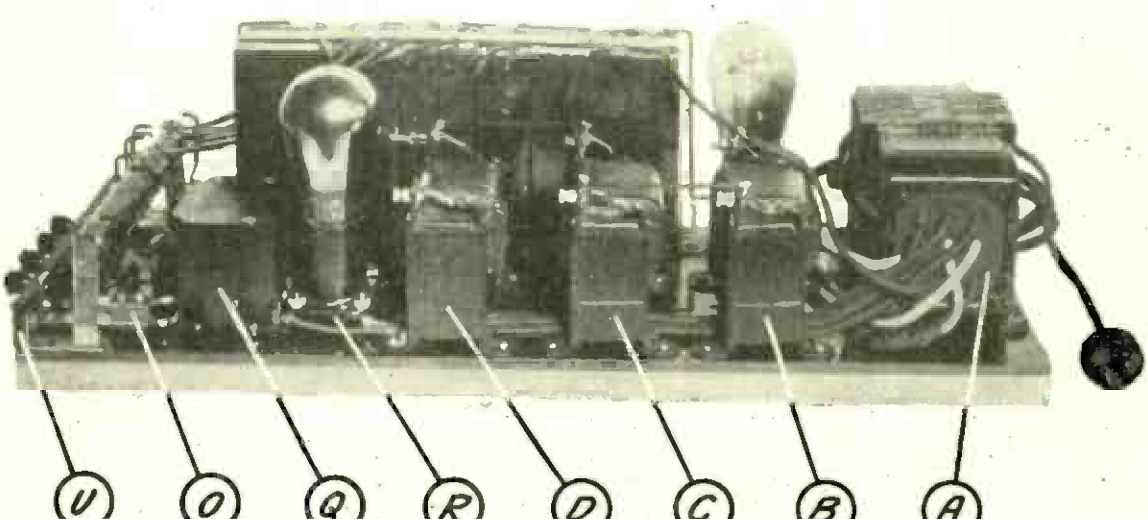
THE PARTS USED IN THE LABORATORY UNIT—

A—Amertran power transformer, type PF-52;
B, C and D—Amerchokes, type 854;
E and G—Dubilier filter condensers, type 769, 2 mfds., (working voltage 400 volts D.C.);
F and L—Dubilier filter condensers, type 770, 4 mfds., (working voltage 400 volts D.C.);
H, I, J and K—Dubilier filter condensers, type 766, 2 mfds., (working voltage 160 volts D.C.);
M—Ward Leonard vitrohm resistor unit, size C or Aerovox Craig resistor, type 980—
Both of these resistance units are tapped as follows: step 1—12000 ohms; step 2—3500 ohms; step 3—1500 ohms; step 4—1500 ohms; step 5—750 ohms.
N—Bradleyohm No. 25, 25,000 to 250,000 ohms;
O and P—Pacent single-circuit jacks, No. 61;
Q—Amertran De Luxe audio-frequency transformer for second stage;
R and S—Benjamin push type sockets, No. 9040;
T—bakelite sub-base, 7 inches by 21 inches by ¼-inch;
U—bakelite binding post strip, 7 inches by 1 inch by ¼-inch;
V—angle brass reinforcement strips for sub-base; (see Figure 6);
W—angle brass for holding binding post strip; (see Figure 6);
X—brass brackets for mounting resistor unit M, (see Figure 6);
Note—These brackets are not required for the Aerovox Craig resistor;
Y—brass strip for mounting filter condensers; (see Figure 6).



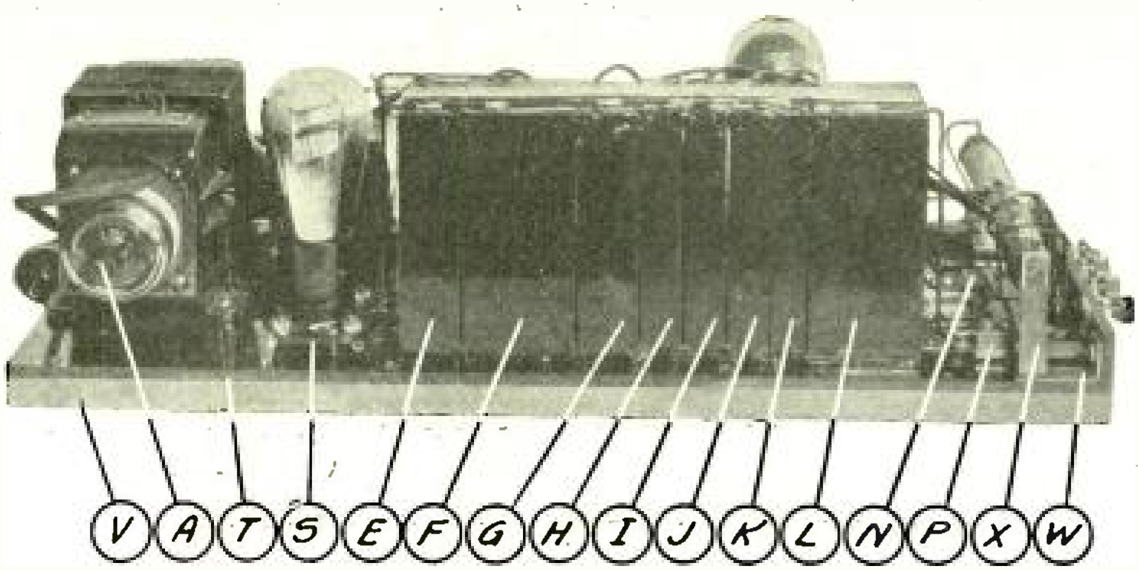
THE first demand of the listener in after the novelty of radio reception has worn off is for a better quality of reproduction. But this desire for good tone quality with reasonable volume has rarely been gratified, largely because of the ease with which the last audio-frequency amplifying tube is overloaded in most present-day receivers.

To remedy this condition and to supply either large or small volume with excellent quality this power amplifier has been designed. The "power-pack" amplifier described in this article uses the UX-210, one of the new power tubes which have recently been placed on the market for the purpose of transmitting a much larger amount of energy to the



A REAR VIEW OF THE DEVICE

FIGURE 2: *This illustration shows the general location of the transformer, tubes, chokes, condensers and resistances.*



A FRONT VIEW OF THE UNIT

FIGURE 3: *The bank of condensers, the rectifier tube and the power transformer with its "on" and "off" switch that also gives three power ranges are shown here.*

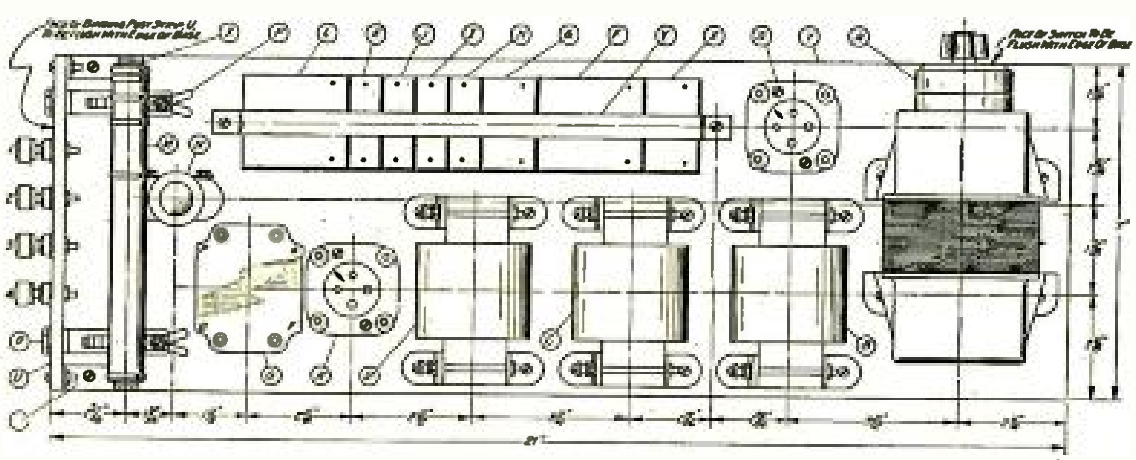
loudspeaker without distortion; and it operates directly from the 110-volt alternating current lighting mains.

This power tube uses several hundred volts on the plate; and this makes the cost of "B" batteries prohibitive. Consequently a plate or "B" current supply has been incorporated in the power unit to furnish this high voltage.

In addition, the plate current supply has been designed to furnish "B" current at several lower voltages for all of the other tubes in the receiver which is used with this unit. This entirely eliminates the "B" batteries.

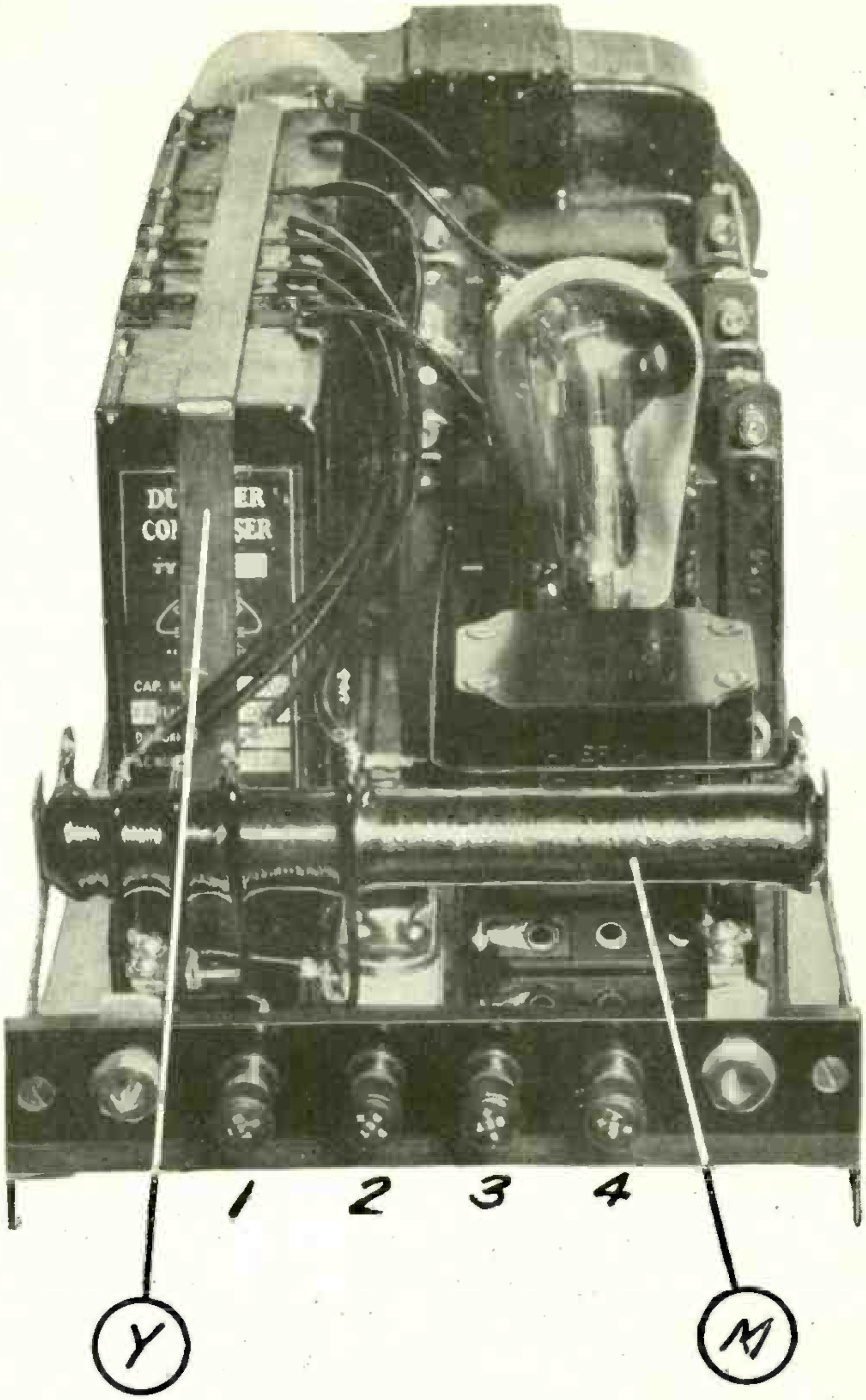
The apparatus available for the construction of "B" eliminators has improved very much in the last year. All of the parts which are used in this power supply, such as the transformer, the rectifying tube, the choke coils and the resistor will handle a direct current output of 60 milliamperes without overload; and the condensers will stand a direct current working voltage of 400. This is quite an advance over the use of 201-a tubes for rectifiers and of audio-frequency transformers for choke coils.

The use of a stage of power amplification on the dry-cell set is worthy of special mention. Ordinarily the dry-cell set will not handle great volume with good quality because of the limitations of the last tube. Now, in practically every case, all of the tubes, except the last audio amplifier, are functioning nor-



THE WORKING DRAWING FOR CONSTRUCTION

FIGURE 4: *This diagram gives the correct dimensions and spacing for mounting all of the component parts of the power-pack amplifier.*



A VIEW OF THE POWER-PACK UNIT FROM THE RIGHT

FIGURE 5: *The unit with the Ward Leonard resistor in place. Notice the input and output jacks and the binding posts which supply the voltages for the set that the unit is used with.*

mally without overload. This means, in short, that the dry-cell set will give as great volume and as fine quality as any other set if the "power-pack" amplifier is plugged in after the first audio-frequency stage of the receiver.

The Theory of Operation

A brief outline of the theory of operation of the power unit may be of interest to the prospective builder. Refer to Figure 1 in tracing through the operation of the unit.

First, note that the power transformer, A, has a secondary winding for lighting the filament of the power tube, R, and another secondary winding for lighting the filament of the rectifier tube, S. Connections to these two filaments are made through center taps of the secondary windings to nullify the effect of the alternating current which is used for filament lighting. For instance, if a connection was made directly to either side of the filament of the power tube, R, a decided hum in the loudspeaker would result.

The third secondary winding of the power transformer furnishes 550 volts of alternating current, which is rectified by the rectifier tube, S, to give a pulsating direct current.

Next, the filter system comprising the choke coils, B and C, and the condensers, E, F and G, smooths out the pulsating current so that at the end of the filter a steady direct current flows through the resistor, M, and also through the choke coil, D, to the plate of the power tube, R.

The extreme lower end of the resistance, M, is negative; and the voltage along it increases to approximately 375 volts at the top. By connecting the grid return of the power tube, R, at the bottom of the resistance and by tapping off the filament of the power tube at the correct distance up on the resistance, as at binding post No. 1, the filament is made positive with respect to the grid or in other words a negative bias is obtained on the grid. Going further up along the resistance, M, to binding posts No. 2 and No. 3, two detector voltages of 18 and 40 volts are obtained. At binding post No. 4 an amplifier voltage of 80 is available; and this may be used to supply the "B" current to all of the remaining tubes of the receiver with which the power amplifier is to be used. The by-pass condensers H, I, J and K are connected across the taps of the resistance, M, to provide lower resistance paths for the audio-frequency currents.

The resistance, N, is shunted across the 80-volt tap of the main resistance, M, to keep the load on this amplifier tap constant. With no amplifier load on tap No. 4 or with a small radio receiver, the resistance, N, can be made low so that it will draw a heavy current. When a large set is connected to tap No. 4 more current will be drawn; but the total load current on this tap may be made the same as before by increasing the value of N and decreasing the current through it.

The direct plate current to the power tube, R, is supplied through the choke coil, D. This direct current is too large and the voltage is too high to apply directly to the loudspeaker, so the audio-frequency current (which produces the sound) is provided with a shunt path from the plate through the condenser, L, and the loudspeaker jack, P, back to the filament of the power tube.

The input to the power unit is made through the jack, O, and the audio-frequency transformer, Q.

Parts Used in Building the Power Unit

In all of the diagrams in this article each part bears a designating letter so that the prospective builder of a set may easily determine how to mount the instruments in the correct places and to connect them properly in the electric circuit.

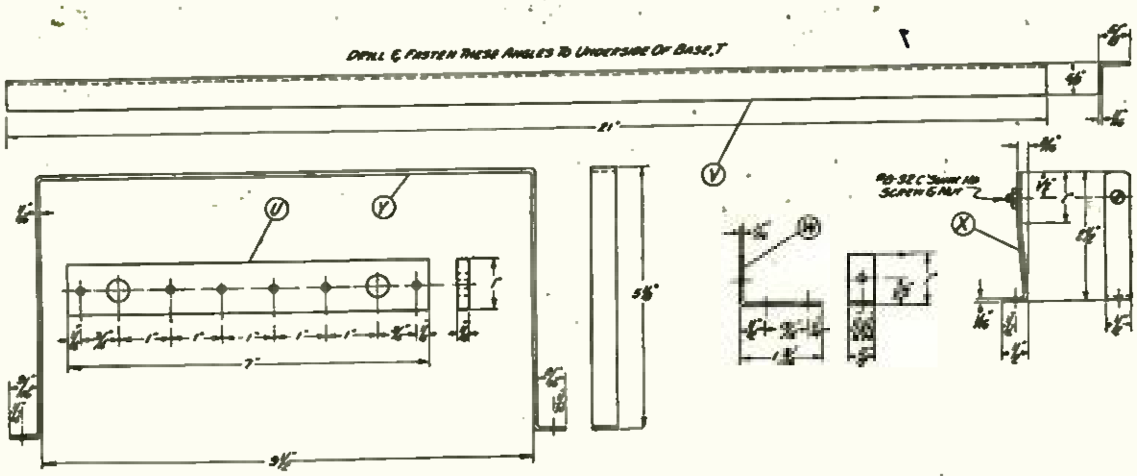
The same designating letters are used in the text and in the list of parts at the beginning of the article.

¶ *The list of parts there given includes the exact instruments used in the set from which these specifications were made up. The experienced amateur, however, will be able to pick out other reliable makes of instruments which may be used with equally good results. But we recommend that the novice follow the list, as the diagrams in this article will tell him exactly where to bore the holes and exactly where to place the connections.*

If instruments other than the ones listed are used, the only change that will be necessary will be the use of different spacings for the holes that are drilled in the sub-base for mounting the instruments.

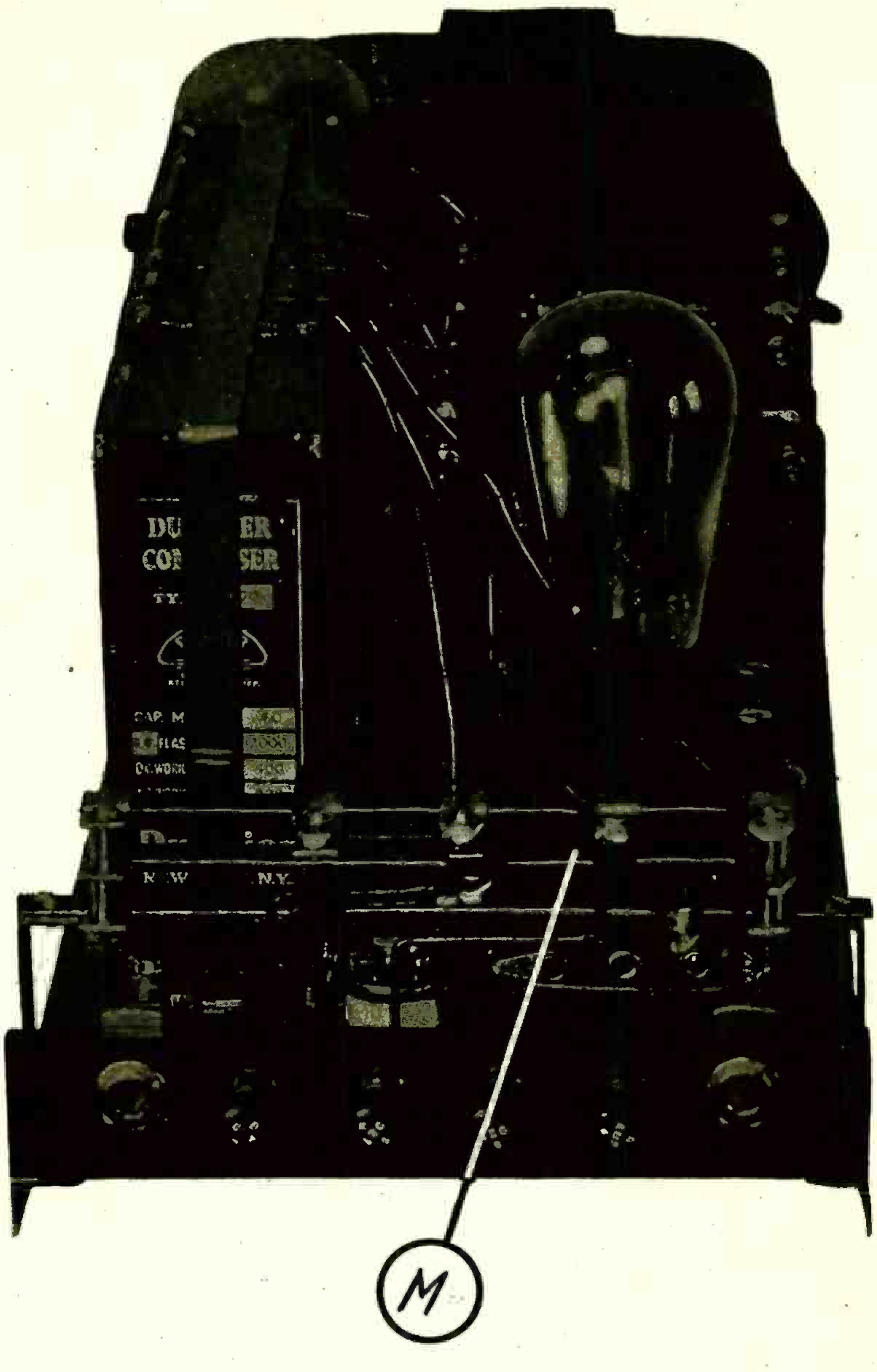
How to Construct the Power Unit

Start the construction work by making the miscellaneous small parts shown in Figure 6.



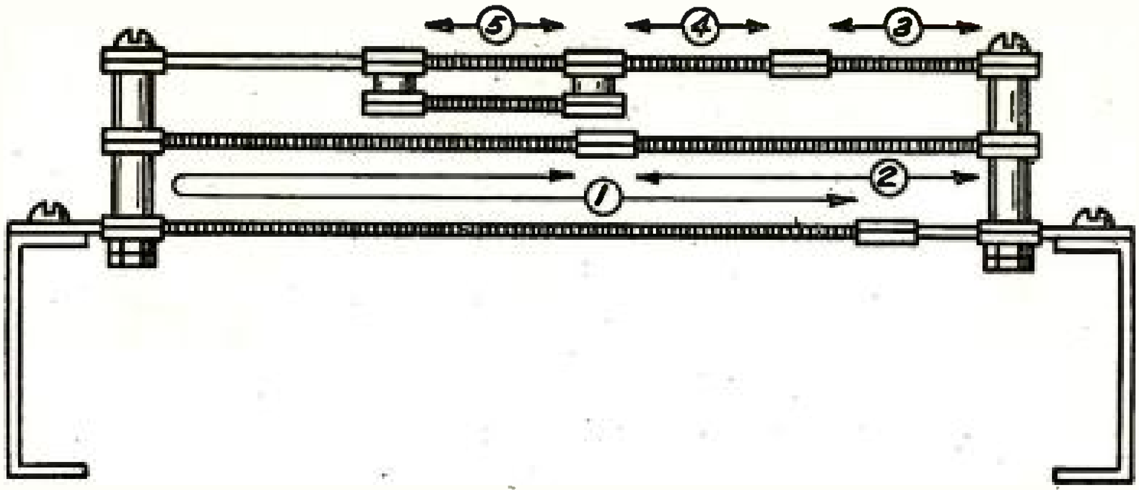
DETAILS OF THE CONNECTION BLOCK, BRASS STRIPS AND BRACKETS

FIGURE 6: *This drawing gives the necessary data for making the insulating strip on which the binding posts are mounted. It also gives the dimensions for the reinforcing angles and the small brass brackets which are used to fasten the condensers, the connection block and the resistance in place.*



ANOTHER RIGHT-END VIEW OF THE UNIT

FIGURE 7: *This picture shows the instrument with the Aerovox resistor installed. This resistor fits in the same place as the one shown in Figure 5 and the connections are brought out to taps with similar resistance steps. The binding posts, as before, supply the voltages for the receiving set that it is used with.*



THE DIAGRAM OF THE RESISTOR

FIGURE 8: *The construction and taps of the special resistor which is shown in Figure 7 with the resistance stages numbered in accordance with the data given in the list of parts at M may be clearly seen in this drawing.*

First, cut to size the bakelite binding post strip, U, and drill holes for two mounting screws, two jacks and four binding posts.

Next, cut the two angle brass reinforcement strips, V, for the sub-base to length.

Make the two brass angles, W, for holding the binding post strip, out of 1/16-inch by 1/2-inch strip brass.

Using the same strip brass material, make the two brackets, X, for mounting the resistor unit, M. If the Aerovox resistor is to be used it will not be necessary to make these brackets as mounting brackets are attached to the resistor.

Finally bend to size the brass strip, Y, for mounting the filter condensers.

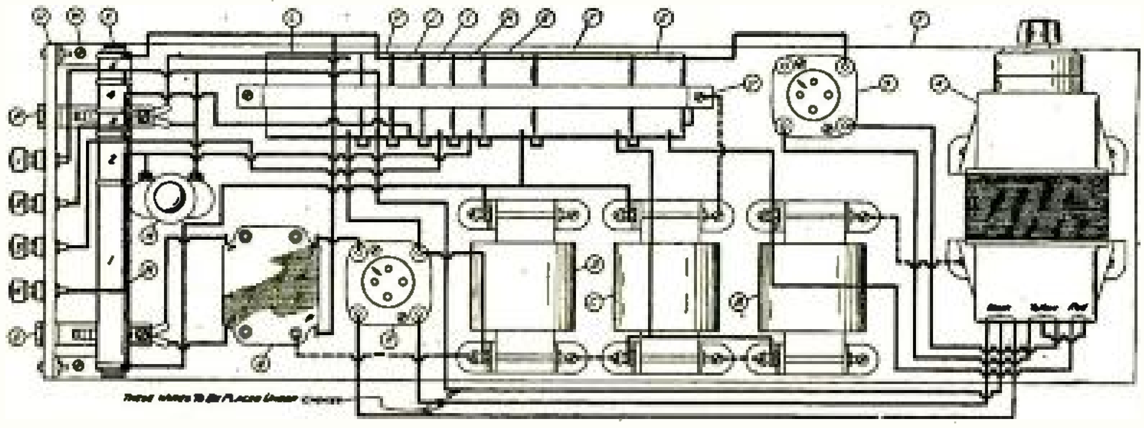
When these small parts are completed begin the mounting of the apparatus by locating the brass angles, W, for the binding post strip, as shown in Figure 4.

The same brass machine screws which hold these brackets may be used to fasten one end of the angle brass reinforcement strips, V, underneath the sub-base.

It should be noted from Figures 2, 3 and 5, that these reinforcement strips are fastened underneath the sub-base with the vertical side flush with the edge of the sub-base. The method of fastening these reinforcement strips was to drill a clearance hole through the sub-base for a flat head 6-32 brass machine screw and to tap the machine screw into the brass strip. One machine screw about an inch from the end of the sub-base and two others spaced centrally should be sufficient.

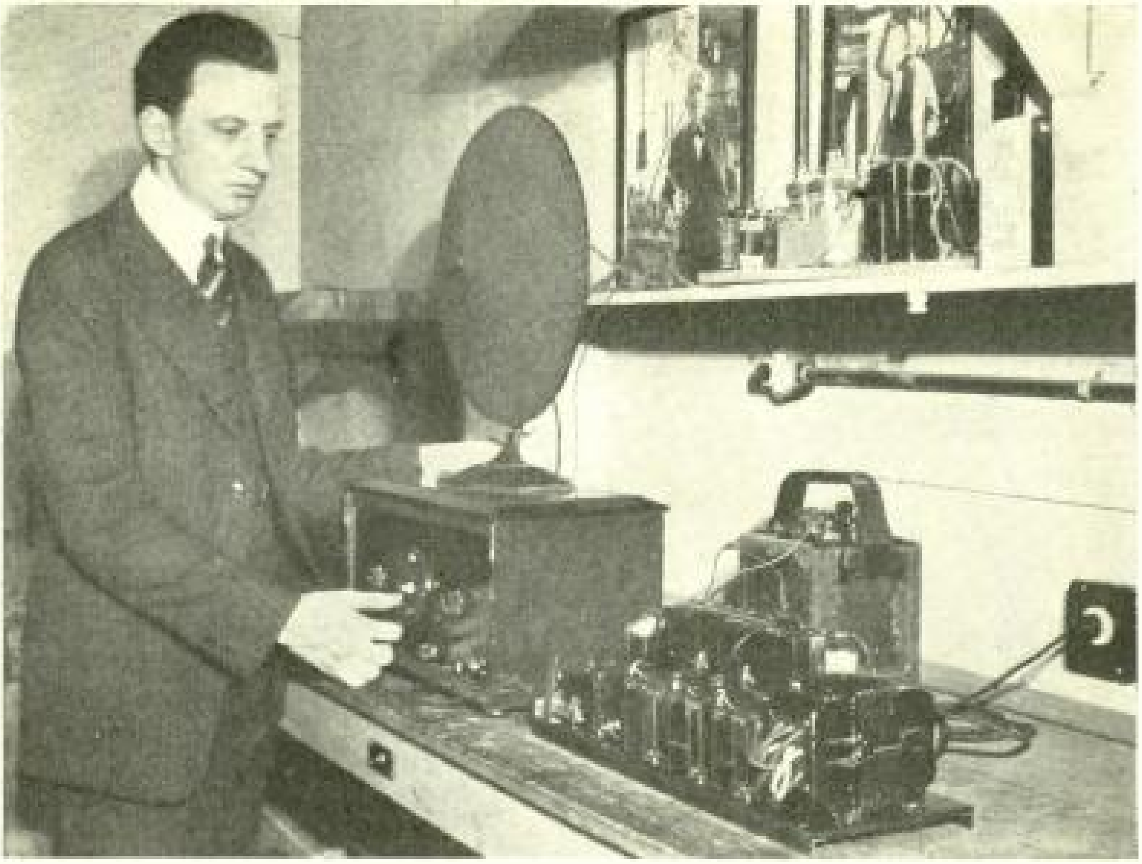
Mount the two jacks, O and P, on the binding post strip, U. Mount the four binding posts from left to right in the following order: B battery minus (—), B detector plus (+), B detector plus (+) and B amplifier plus (+). Then fasten the binding post strip in place on its brackets. (See Figures 4, 5 and 7 for this assembly.)

With two 4-36 brass machine screws fasten the Bradleyohm to the sub-base with the terminals to the rear of the power unit, as in Figure 4. (The front of the power unit is the long side on which the bank of condensers is mounted.)



THE PICTURE WIRING DIAGRAM FOR CONNECTING UP THE INSTRUMENTS

FIGURE 9: *All of the instruments have been drawn in their approximate positions. The heavy black lines show the exact way to run the wires for connecting up the instruments. (Full-scale blueprints for assembling and wiring this device may be obtained by sending in $1.00 to* POPULAR RADIO SERVICE BUREAU.)



THE AUTHOR TESTS OUT THE UNIT

In this picture, Mr. Craig is shown with the unit installed in conjunction with the new S-C receiver. For installation in the home, the unit itself should be placed inside of the radio cabinet in the place generally occupied by the "B" batteries.

Next fasten the two sockets, R and S, to the sub-base with round-head brass machine screws, placing the plate and grid terminals toward the rear of the unit. (See Figures 2, 3 and 4 for the exact locations.)

Fix the audio-frequency transformer, Q, in position, as shown in Figures 2 and 4, with the plate and "B" plus (+) terminals toward the binding post strip.

Now mount the three choke coils, B, C and D, with their terminals toward the binding post strip, as shown in Figures 2 and 4.

Use round-head 8-32 brass machine screws for the heavy power transformer A and locate it according to Figures 2, 3 and 4 with the switch at the rear of the power unit.

Place the condensers E, F, G, H, I, J, K and L in order, beginning near socket S, and secure them to the sub-base with the brass mounting strip, Y.

Using brackets X, mount the Ward Leonard resistance unit, M, with the long untapped portion near the front of the set. (See Figures 4 and 5.)

If the Aerovox resistor, M, is used fasten it in place with the soldering lugs toward the binding post strip, as shown in Figure 7.

This completes the mounting of apparatus for the power unit.

How to Wire the Power Unit

In connecting up the unit, refer to the wiring diagram which is given in Figure 9.

Connect the top terminal of the input jack, O, to the plate terminal of audio-frequency transformer, Q, and the bottom or frame terminal of jack, O, to the B plus (+) terminal of the transformer. Then join the grid terminal of the transformer, Q, to the grid binding post of the socket, R.

Connect the plate binding post of the socket, R, to the near side of the condenser, L, and to the front binding posts of the choke coil, D.

Connect the two outside yellow filament leads of the transformer, A, to the filament binding posts of the socket, S. Join the central yellow filament lead at the transformer to the red high voltage lead below and to the right of it. Run the three black filament leads of the power transformer, A, along underneath the choke coils, B, C and D; and connect the two outside black leads to the filament binding posts of the socket, R.

Connect the plate terminal of the socket, S, to the rear side of the condensers, E, F, G, H, I, J and K; and continue the same wire to the filament terminal of the audio-frequency transformer, Q, and to the outside terminal of step 5 of the resistor, M.

Connect the central black filament lead of the power transformer, A, between step 4 and step 5 of the resistor, M, to one side of the Bradleyohm, N, to the B battery minus (—) binding post, No. 1, to the front terminal of condenser, K, and to the bottom or frame terminal of the output jack, P.

Join the top terminal of the output jack, P, to the rear terminal of the filter condenser, L.

Connect the "B" detector plus (+) binding post, No. 2, between steps 3 and 4 of the resistor, M, and also to the front terminal of the condenser, J. Connect the "B" detector plus (+) binding post No. 3, between steps 2 and 3 of the resistor, M, and also to the front terminal of the condenser, I. Connect the "B" amplifier plus (+) binding post No. 4, between steps 1 and 2 of the resistor, M, to the front terminal of the condenser H, and also to the remaining terminal of the Bradleyohm, N.

Connect the red left-hand high voltage lead of the power transformer, A, and also the front lead of the condenser, E, to the rear binding post of the choke coil B. Join the two front leads of the choke coils, B and C, and connect them to the front terminal of the condenser, F. Join the two rear terminals of the choke coils, C and D, and the front terminal of the condenser, G; and continue this wire to the outside end of step 1 of the resistor, M. For the distribution of the resistance steps of the Aerovox resistor, see Figure 8.

Complete the wiring by grounding the cores of the transformer, A, the choke coils, B, C and D, the audio-frequency transformer, Q, and the metal cases of the condensers, E, F, G, H, I, J, K and L, to the "B" battery minus (−) binding post, No. 1. The ground wires may be conveniently run from one mounting screw to another beneath the sub-base.

How to Install the Power Unit

First find out the voltage of the AC lighting supply with which the unit is to be connected. This may be done by noting the voltage marked on two or three electric light bulbs. Set the switch of the power transformer, A, on tap No. 1 for 120 volts, tap No. 2 for 115 volts or tap No. 3 for 110 volts. This switch should be set once for the correct voltage; and it should not be used for turning the power unit on and off.

Insert a UX-216-b rectifier tube in socket S, and a UX-210 tube in socket R. Then screw the Bradleyohm, N, down tight.

To test the power unit insert the attachment plug in an electric light socket. Both tubes should now light to approximately the same briliancy as those in an ordinary receiving set; and the resistor, M, should heat up noticeably in a few minutes. If all steps on the resistor show some heating effect (even though the amount of heat may vary) the power unit is probably working all right and supplying high voltage direct current.

Disconnect the power unit from the electric light socket. Plug the loud speaker in output jack P and, using a cord with a plug on each end, connect the input jack, O, to the first stage jack of the receiver with which the unit is to be used.

Now reconnect the power unit to the electric light circuit and it should give power amplification of excellent quality. Try reversing the input leads to the jack, O, for the best results.

With these connections the power unit is being used as a stage of power amplification only. To use it also as a "B" battery eliminator first disconnect the unit from the electric light socket, then remove the "B" battery (−) lead of the receiver from the "B" batteries and connect it to the "B" battery (−) binding post, No. 1, of the power unit. Remove the "B" detector (+) lead of the receiver from the "B" batteries and connect it to the "B" detector (+) binding post, No. 2, of the power unit if you are using a soft detector tube or to the "B" detector plus (+) binding post, No. 3, if you are using a hard detector tube. Remove the "B" amplifier plus (+) leads of the receiver (either AF or RF or both) and connect them to the "B" amplifier plus (+) binding post, No. 4, of the power unit. The grid-bias which is used on the amplifier tubes should be 3 to 4½ volts.

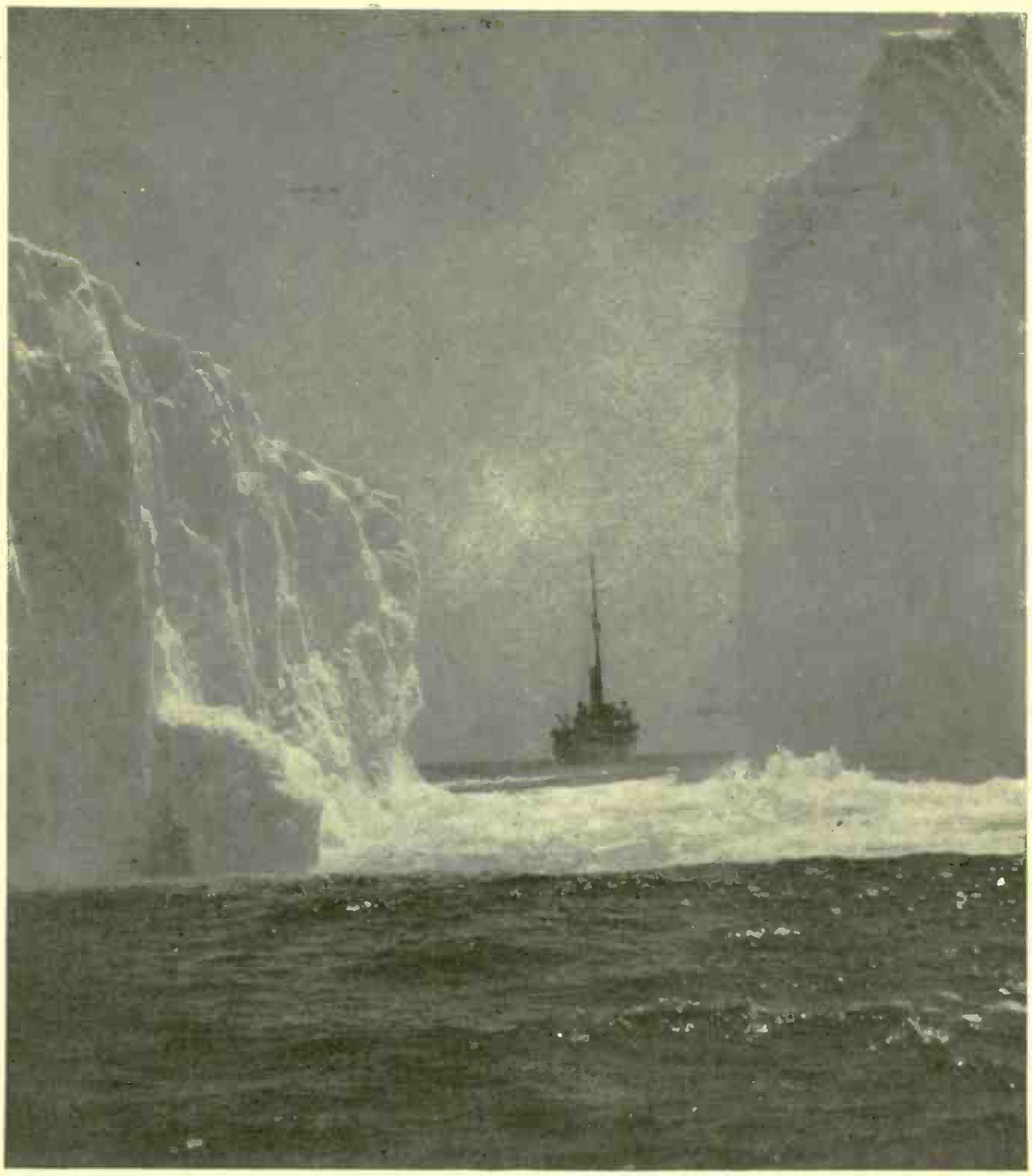
Plug the power unit back in the electric light socket and it will function both as a stage of power amplification and as a "B" battery eliminator.

The Bradleyohm, N, should be adjusted until the detector voltage is correct. In general it will have to be unscrewed further for multi-tube sets.

Always turn off the power unit when making adjustments.

How to Build the New Power-pack

IN POPULAR RADIO *for May—next month—will appear an article that gives complete constructional details on the new Raytheon "Power-pack" that furnishes plate current for any type of radio set now in use for broadcast reception. This Power-pack will supply a plate voltage up to 170 volts for the last stage, and for resistance-coupled amplifiers; it will supply voltages varying between 60 volts and 125 volts for radio-frequency work or for low-power audio amplifiers; and it will supply voltages ranging between 10 and 50 volts for use on the plate circuits of detectors. This new development is a great improvement over the old style of Raytheon Plate-supply Unit, in which only one variable voltage can be obtained. Order your May issue from your newsdealer today.*



A Radio Patrol of the Seas

Over *1,500,000 words were transmitted by radio last year from Uncle Sam's Coast Guard vessels that have been designated as the "International Ice Patrol," to warn shipping of the shifting locations of icebergs. These lonely scouts of the sea are equipped with the latest and most approved type of radio apparatus, as the usefulness of this unique service to mankind rests entirely upon communication that only radio can make possible.*

Westinghouse

A HUGE RADIO TUBE AND THE TINY CRYSTAL WHICH HOLDS THE STATION ON ITS WAVEBAND

Here is one of the large water-cooled transmitting tubes; the small object to the right is a small quartz crystal which is used in a crystal oscillator to control the frequency of the generator current that keeps the station transmitting on its exact wavelength.

The New "Crystal Pilot"

for holding broadcasters to their wavelengths

That peculiar whistle which bothers every radio fan when he tunes in on distant stations that operate on nearly the same wavelengths is caused by the distortion of radio waves that collide with each other—because one of the stations "slides off" the waveband assigned to it. This fault is now being checked with the aid of a tiny crystal oscillator—which thus becomes an object of vast importance to all broadcast listeners.

By THOMAS L. BAYARD.

"THERE'S a good program on XYZ tonight," observes the visitor. "Can you pick up that station well from here?"

"Sure!" replies the confident host. "I often tune in on XYZ." And he turns the dials of his receiving set. "I usually get it right here," he explains.

Whereupon the loudspeaker emits a too-familiar whistle.

The fan makes a further adjustment of a dial. Music can be faintly heard—

but the whistle still remains. He turns another knob—"turning back the tickler," he calls it—but the whistle continues at the same pitch at which it was first heard. The music is a queer medley of sounds; it appears to be a mixture of two selections from different stations.

"They come in that way sometimes," the radio fan mutters apologetically as he works at the dials. "I can't understand it."

And in spite of all the fan can do, the whistle stays at the same unbroken pitch.

The Whistle and Its Cause

The fan "can't understand it" because he believes his receiving set is at fault. But the whistle in this case is caused not by the receiving set; it is caused by interference between the two stations. This interference in turn is caused by one of the stations—or possibly by both—because they are off their assigned wavelengths.

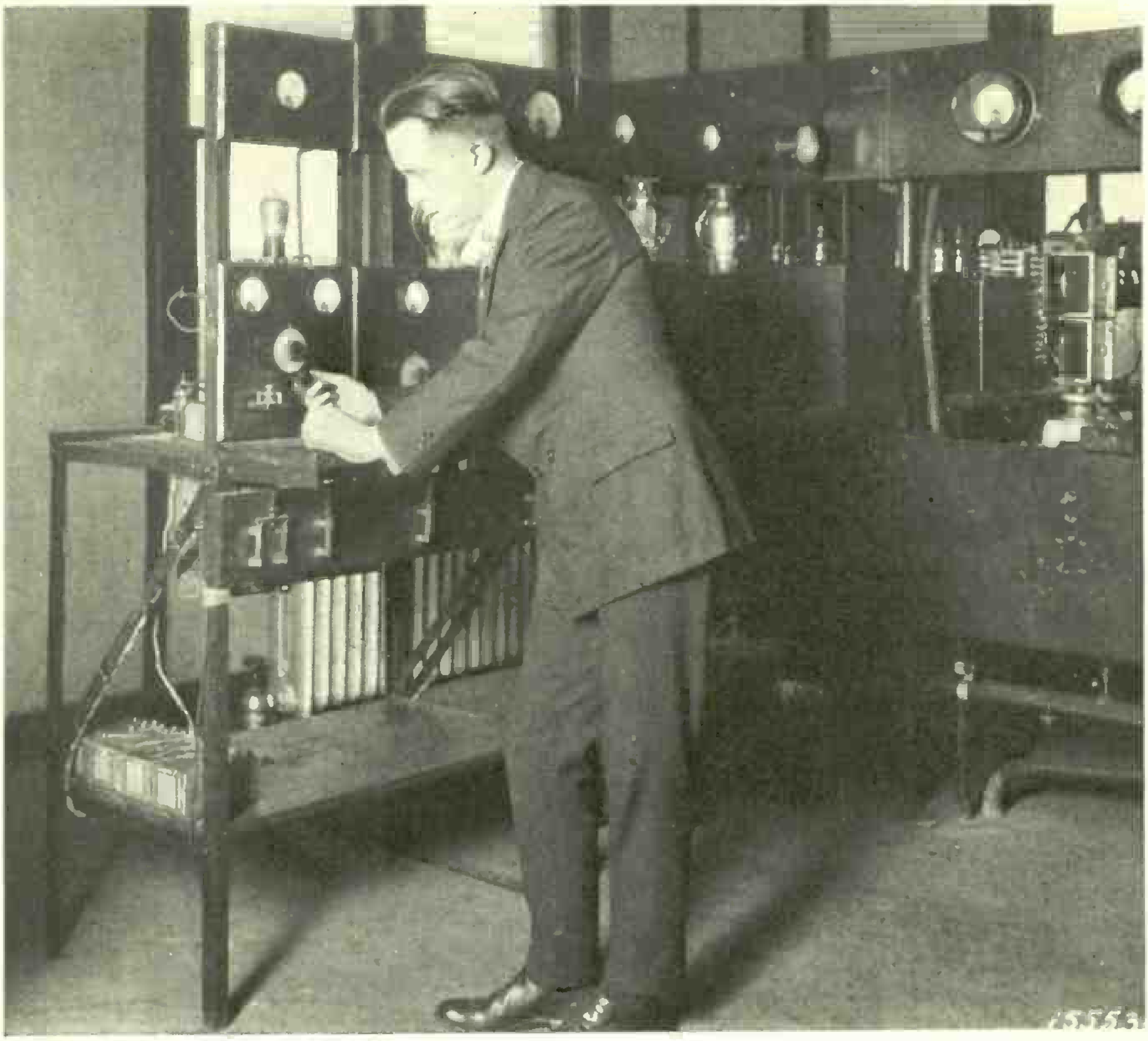
The American broadcasting stations now are assigned wavelengths or frequencies that are separated from each other by exactly 10 kilocycles. That is, there is a difference of 10,000 cycles a second between the frequencies of the different stations. These two stations, which are being received at the same time by the fan, instead of being separated by the 10 kilocycles which is presumed to intervene between them, actually may be separated at the moment by only half or a third of that number.

The oil condenser used by one of the stations, for instance, may have become hot. This condition often results in a wide shift in the frequency of the wave that is transmitted. If the oil used for filling the condensers of this type—a type

Underwood & Underwood

HOW QUARTZ CRYSTALS ARE STANDARDIZED

The exact frequency at which quartz crystals of different sizes will oscillate is here being determined in the Bureau of Standards by means of a sonometer. When the exact point of oscillation has been determined these crystals may serve as frequency standards for broadcasting stations.


Westinghouse

A CRYSTAL OSCILLATOR IN OPERATION

The operating panel of the crystal control circuit that keeps the whole transmitter of a broadcasting station functioning at the proper frequency is shown above. The quartz crystal is mounted on the panel just to the left of the hands of the chief operator of the station, who is adjusting the control.

that is used on many of the American transmitting sets—is not of exactly the right quality, it is apt to become hot under operation and cause the frequency of the transmitted wave to rise as much as three or four kilocycles. If the wavemeter used by the station is not accurate —many of them are not—and the operating staff is not especially alert, it is possible for as great a shift as three or four kilocycles to occur without being noticed by the staff. Other factors may cause the shift, a detail as seemingly trivial as a fluctuation in the plate voltage supplied to the transmitting set, or the swaying of the antenna in the wind.

Whatever the cause, the frequency of station XYZ has shifted and is heterodyning the wave of the station which is next to it in the broadcasting band. This heterodyning is causing, in the receiving set of the listener-in, a whistle. The pitch of the whistle is constant and is established by the difference in frequency between the two stations.

How the Whistle Is Produced

The radio amateur understands what this heterodyning is because it involves a principle used in one of the most widely known and most selective radio receiving sets.

For those who do not know what heterodyning is an analogy may be drawn of a man and a boy walking together across a bridge. If the man takes six steps to cross the bridge while the boy requires nine, they will be out of step part of the time and in step part of the time. If another person is under the bridge listening to their footsteps, he will hear a patter of light footfalls when the two pedestrians are out of step. But he will hear, when the pedestrians tread on the bridge at the same instant, a single footfall approximately twice as loud as the others.

This loud footfall will occur three times while the men are crossing the bridge, which, it should be noted, is the difference between the man's six steps and the boy's nine. If the man and boy are running instead of walking these three loud footfalls will be heard by the person under the bridge as a sharp "rat-tat-tat" that is independently of the rest of the footfalls.

This serves to illustrate how the beat note is caused when two transmitted radio waves are picked up in a receiver at the same time. When the waves are in step or "in phase," their strength is combined and when they are "out of phase" they tend to neutralize each other.

So when radio waves are in step and their strength is combined, the resulting signal is considerably stronger than when they are out of step and therefore neutralizing each other.

This quick rise and fall in the strength of the radio signals as the two waves alternately are in phase and out of phase may be several hundred times a second—so rapid that it sets up in the receiving set an audible tone or whistle that has its own pitch.

The frequency or pitch of this tone is the difference between the frequencies of the two original waves. The pitch of this tone, it also should be noted, is constant, and it cannot be made to vary by any manipulation of the receiver, as can another kind of whistle which will be noted later.

It commonly happens that when the listener-in hears this interfering beat note or heterodyne whistle, he may also hear the music or speech from two different stations jumbled together, with the sounds from one station perhaps louder than those from the other. Or if the two stations cannot be heard at the same dial setting, the listener-in may find that while he hears only one station, he is troubled by the interfering beat note caused by the wavelength of a neighboring station which is too close to the one he hears.

The listener-in who is getting this interference whistle in his set can tell, if he cares to do so, whether the two interfering stations are as close together as four kilocycles. He can do this by comparing the pitch of the whistle with the notes of a piano. If the stations are four kilocycles apart (4,000 cycles a second) it is about the frequency of the last key to the right C, in an 88-key piano. If the stations are three kilocycles apart, the beat note frequency, 3,000 cycles, will be about that of the highest G of the piano. If the stations are as close as two kilocycles the pitch of the whistle will be about that of the C which is next below the highest C and which vibrates 2069 times a second. If they are separated by only one kilocycle the pitch of the whistle will be approximately that of the next C below the one just mentioned.

The Hunt for a Remedy by Means of Crystals

Radio engineers and the United States Bureau of Standards have been working to eliminate this interference. The Bureau of Standards has been helping the stations keep to their assigned wavelength by checking their wavelengths periodically, as it has been a difficult matter for the stations to measure accurately a wavelength that is radiated at perhaps as high a frequency as a million cycles a second. To assist the stations to gauge this

Underwood & Underwood

ANOTHER USE OF THE PIEZO-CRYSTAL AS A FREQUENCY STANDARD

A set-up for a piezo-crystal oscillator and an auxiliary generator design for the standardization of wavemeters which is in use at the Bureau of Standards in Washington. Great accuracy may be obtained by the use of the crystal itself in a wavemeter.

frequency, the Bureau also has devised a wavemeter to be used by the station. Constant vigilance on the part of the staff of a station that uses one of these wavemeters may reduce this frequency fluctuation very materially, yet the station that stays within two or three kilocycles of its assigned frequency is doing very well.

The engineers of the Westinghouse Electric & Manufacturing Company, in their search for ways of maintaining a constant frequency in the company's broadcasting stations, investigated the possibilities of an automatic control of this frequency. They had known that certain crystals, called piezo-crystals, had the property of vibrating when electrically excited. So they investigated the possibility of using these crystals to control the frequency of a transmitting set.

It was known that the vibrations of any given piece of piezo-crystal were remarkably constant and that the size and shape of the crystal governed the frequency of these vibrations. Several month's experimental work on the KDKA short-wave transmitting set established the fact that the vibrations of the crystal could be amplified and radiated by the powerful short-wave transmitting set, at its normal energy output, without a change in frequency.

The short wave set has been constantly operated under crystal control since July and shows none of the shifts in wavelength to which the American broadcasting stations as a rule are subject. Not only will the ordinary causes fail to produce a change in the frequency of this set, but even deliberate efforts on the part of the operating staff will not cause it to change. The amount of energy radiated will drop if the transmitting circuit is thrown out of tune, but the frequency will remain constant.

So satisfactory has the crystal control

proven under the exacting conditions on the KDKA short wave set that the company is equipping all of its broadcasting stations, (KDKA, KYW, WBZ, and KFKX), with the crystal control. One of the specially designed transmitting circuits has been built for the KDKA assigned wavelength set, and it is now being used during all of the regular broadcasting periods. A few other stations have also adopted the crystal control.

How to Tell If a Station Employs the "Crystal Control"

The listener-in who has a regenerative receiver of the coupled circuit type will be able, by means of a simple test, to tell whether any given station has adopted crystal control of its transmitting set.

In this test a whistle is produced—a whistle that sounds something like the one caused by interference between two stations but which must not be confused with it. This new whistle is the one that is caused by an oscillating receiving set that is heterodyning a broadcasting station, and its pitch may be changed by turning the tuning dial. To produce it, the amplification dial or "tickler" must be turned on until the set begins to oscillate, and the set tuned very closely to the station which is being tested. When this is done, the whistle will be produced.

If the listener-in is not certain whether he has the right whistle, let him turn his tuning dial slightly; if the pitch of the whistle changes as the dial is turned, he has the right one.

Now let the listener-in take his hands away from his set and listen to this whistle.

If the whistle is a steady, even, unvarying tone, it is safe to assume that the station is using crystal control. If, however, there is a change or drift in the tone, it is safe to assume that no crystal is being used.

This change or drift in tone, if one occurs, will be easy to recognize. The change may be so rapid and regular that the whistle will sound like the siren on a fire engine that is answering an alarm, or it may be slow, like a singer warbling irregularly up and down the musical scale, a tone at a time.

The change in this tone is caused by a change in frequency of the broadcasting station, which is impossible when the station which is transmitting is controlled by means of a piezo-crystal.

Changes in the List of Broadcasting Stations in the U. S.

These corrections and additions to the list which was published in the March, 1926, issue of POPULAR RADIO *make it correct as of February 20, 1926. Further changes will be published each month in this magazine.*

STATIONS ADDED

KFYO	Texarkana, Tex.	209.7
KWUC	Le Mars, Ia.	252
WABB	Harrisburg, Pa.	204
WATT	Boston, Mass.	243.8
WCOA	Pensacola, Fla.	222.1
WHBY	West de Pere, Wis.	250
WJBR	Omro, Wis.	227.1
WQAC	Amarillo, Tex.	234.2
WSAU	Chesham, N. H.	229

CHANGES IN CALL LETTERS

KFCF	Walla Walla, Wash., *should be changed to*	KOWW
KFDJ	Corvallis, Ore., *should be changed to*	KOAC
KFMQ	Fayetteville, Ark., *should be changed to*	KUOA
KFXC	Santa Maria, Cal., *should be changed to*	KSMR
WDBR	Boston, Mass., *should be changed to*	WSSH
WEBK	Grand Rapids, Mich., *should be changed to*	WOOD
WEPI	Newark, N. J., *should be changed to*	WBPI
WJBP	Buffalo, N. Y., *should be changed to*	WSVS
WJBQ	Lewisburg, Pa., *should be changed to*	WJBU

STATIONS DELETED

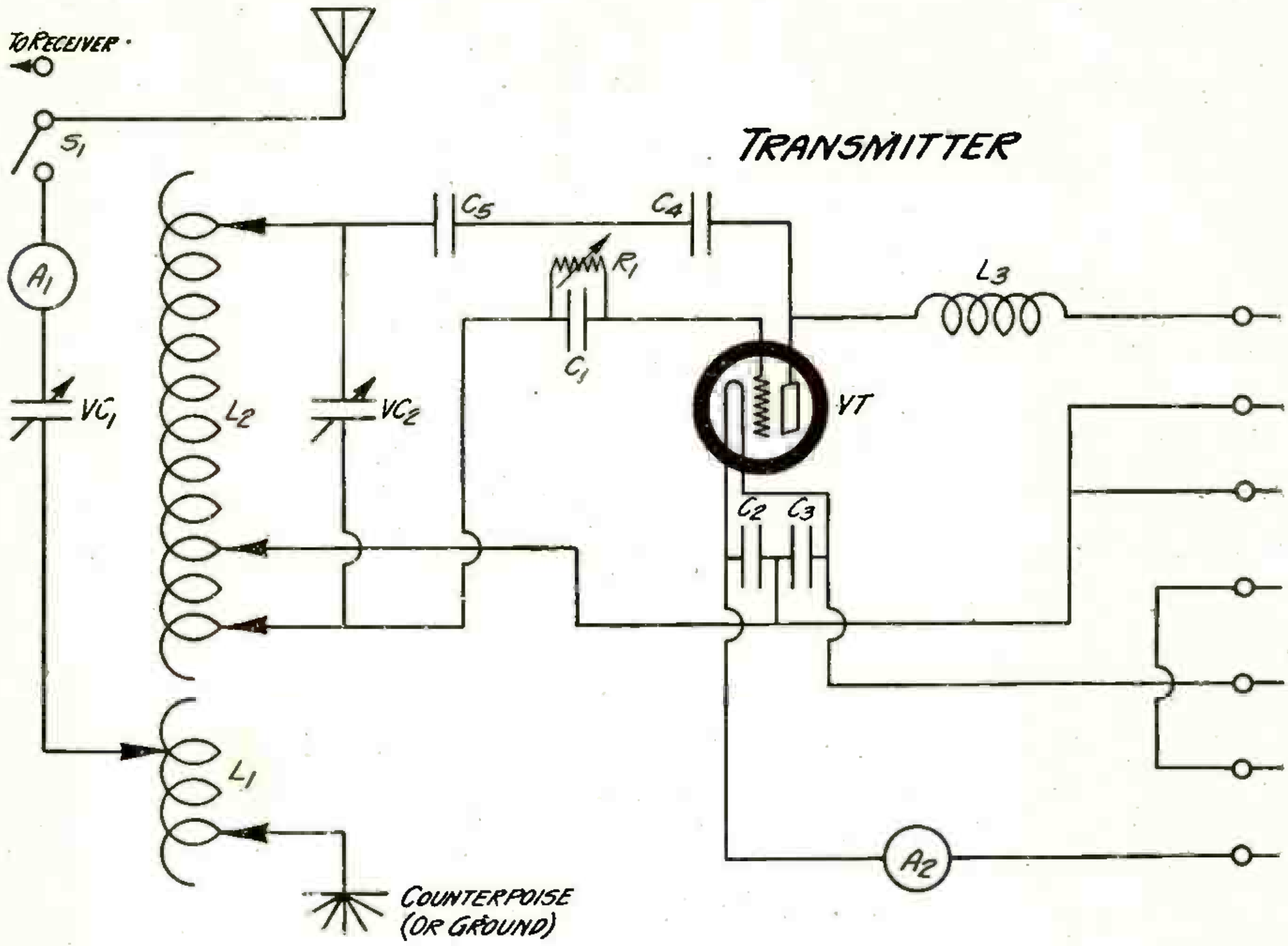
KFGH	Stanford University, Cal.	270
KFOJ	Moberly, Mo.	242
WDCH	Hanover, N. H.	256
WGBK	Johnstown, Pa.	248
WIBC	St. Petersburg, Fla.	222
WJBN	Sycamore, Ill.	256
WRAK	Escanaba, Mich.	256
WTAC	Johnstown, Pa.	268

CHANGES IN WAVELENGTHS

KFAU	Boise, Ida., 282.8, *should be changed to*	280.2
KFBC	San Diego, Cal., 224, *should be changed to*	215.7
KGTT	San Francisco, Cal. 234, *should be changed to*	206.8
KOAC	Corvallis, Ore., 282.8, *should be changed to*	280.2

CHANGES IN LOCATIONS

KMOX	St. Louis, Mo., *should be changed to*	Kirkwood, Mo.
WHBL	Logansport, Ill., *should be changed to*	Chicago, Ill.
WIOD	West Palm Beach, Fla., *should be changed to*	Miami Beach, Fla.



HOW TO BUILD AND OPERATE

A Low-power Transmitter

For the radio experimenter who has reached the stage when he feels the urge to step from the listener class into the exclusive transmitter class, this low-power transmitter is recommended—not only because it is easy to build and because the parts may be obtained for only about $25.00, but also because the set has a daylight range of about 500 miles.

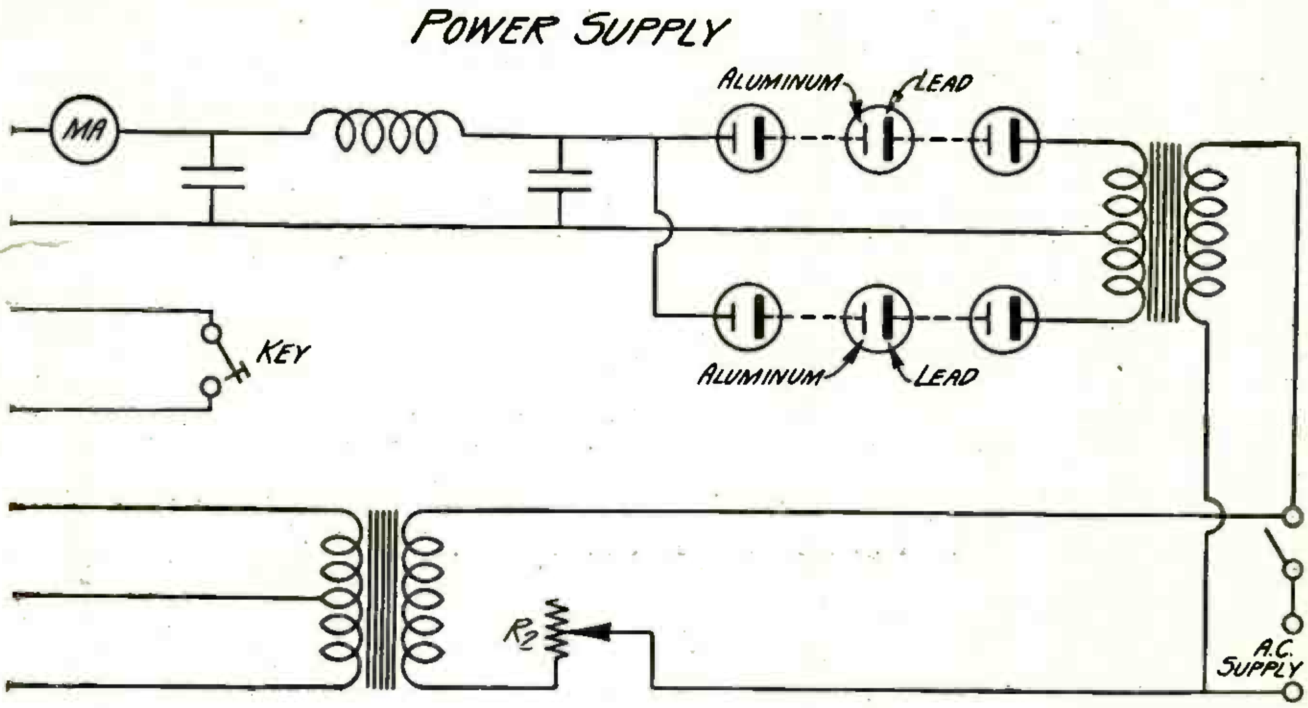
By GORDON FRASER

List of Parts Used in the Laboratory Set

*A1—General Radio Model 127C hot wire ammeter, range 0 to 1 ampere;
*A2—General Radio Model 127A hot wire ammeter, range 0 to 1.5 amperes;
C1—Sangamo fixed condenser, .0015 mfd. capacity;
C2 and C3—Sangamo fixed condensers, .003 mfd. capacity;
C4 and C5—Sangamo fixed condensers, .002 mfd. capacity;
L1—20 turn coil (see text for constructional details);
L2—15 turn coil (see text for constructional details);
L3—Choke coil (see text for constructional details);
*MA—Weston Model 301 DC milliammeter, range 0 to 100 milliamperes;
R1—Bradleyohm No. 25 variable resistance, range 25,000 to 250,000 ohms;
S1—Barkelew antenna switch, single pole, double throw;
VC1—Cardwell variable receiving condenser, with a capacity between .00025 and .0005 mfd.

THE SCHEMATIC DIAGRAM OF THE TRANSMITTER

FIGURE 1: *This drawing shows the complete hook-up of the low-power transmitter, together with the power supply equipment which was described in the January issue of* POPULAR RADIO. *The circuit employed here is the coupled Hartley with shunt feed.*



VC2—Cardwell variable receiving condenser, .00025 mfd. capacity;

VT—Pacent Universal Isolantite socket.

*These meters may be all the same make. In the model of this transmitter the author used the meters that happened to be at hand at the time. The important considerations in selecting the meters to use are that they have the proper range, as given above, and that they be of the type mentioned, i.e., hot wire meters in the case of A1 and A2, and DC meter in the case of MA.

¶ *The list of parts here given includes the exact instruments used in the unit from which these specifications were made up. The experienced amateur, however, will be able to pick out other reliable makes of instruments which may be used with equally good results. But we recommend that the novice follow the list, as the exact arrangement of instruments as shown in the illustrations may then be used. If any substitutions are made it is well to remember that high voltages are being dealt with and that the substitute instruments which are used must be selected accordingly.*

WITH the popularization of short-wave reception many radio fans, whose knowledge of the subject has previously been confined to broadcast reception, are beginning to evince a decided interest in amateur short-wave transmission. This is natural enough since it is a short step from experimental reception to the field of transmission.

There is no better way to obtain a thorough practical knowledge of radio than by "going on the air" with a low power transmitter. High power broadcasting has to some extent eliminated the necessity for high efficiency in broadcast receivers and caused, perhaps, a certain amount of carelessness in construction; but in the case of a transmitter using low power the utmost efficiency is absolutely necessary. And it is this necessity that forces upon the experimenter a better understanding of the fundamental principles of radio and what constitutes real efficiency.

The transmitter that is here described is truly a low power transmitter inasmuch as the total power input to the transmitter is considerably lower than that which is put into a single electric light bulb. Using a UX-210 power tube, which has a rated output of 7½ watts, the power input is between 20 and 25 watts.

To the non-transmitting amateur it may seem almost unbelievable that a transmitter using such low power can actually provide a reliable means of communication with other amateurs half way across the country. As a matter of fact, such transmitters have been heard thousands of miles away, and it is not uncommon for an American amateur, using power as low as this to be heard in European countries, although these feats are usually the result of exceptionally favorable conditions.

The small transmitter described here has a reliable night-time range of somewhat in excess of a thousand miles. Greater distances have been covered, but not consistently.

This transmitter was designed for use on the short-wave amateur bands around 40 and 80 meters, because these are considered to be the most practical working bands for amateurs. Daylight transmission on 40 meters compares favorably with night transmission on the higher wavelengths. It has a consistent daylight range of over 500 miles on a 40 meter wavelength. Two-way communication between this transmitter in New York City and amateurs in Chicago has proven to be quite consistent during the forenoon.

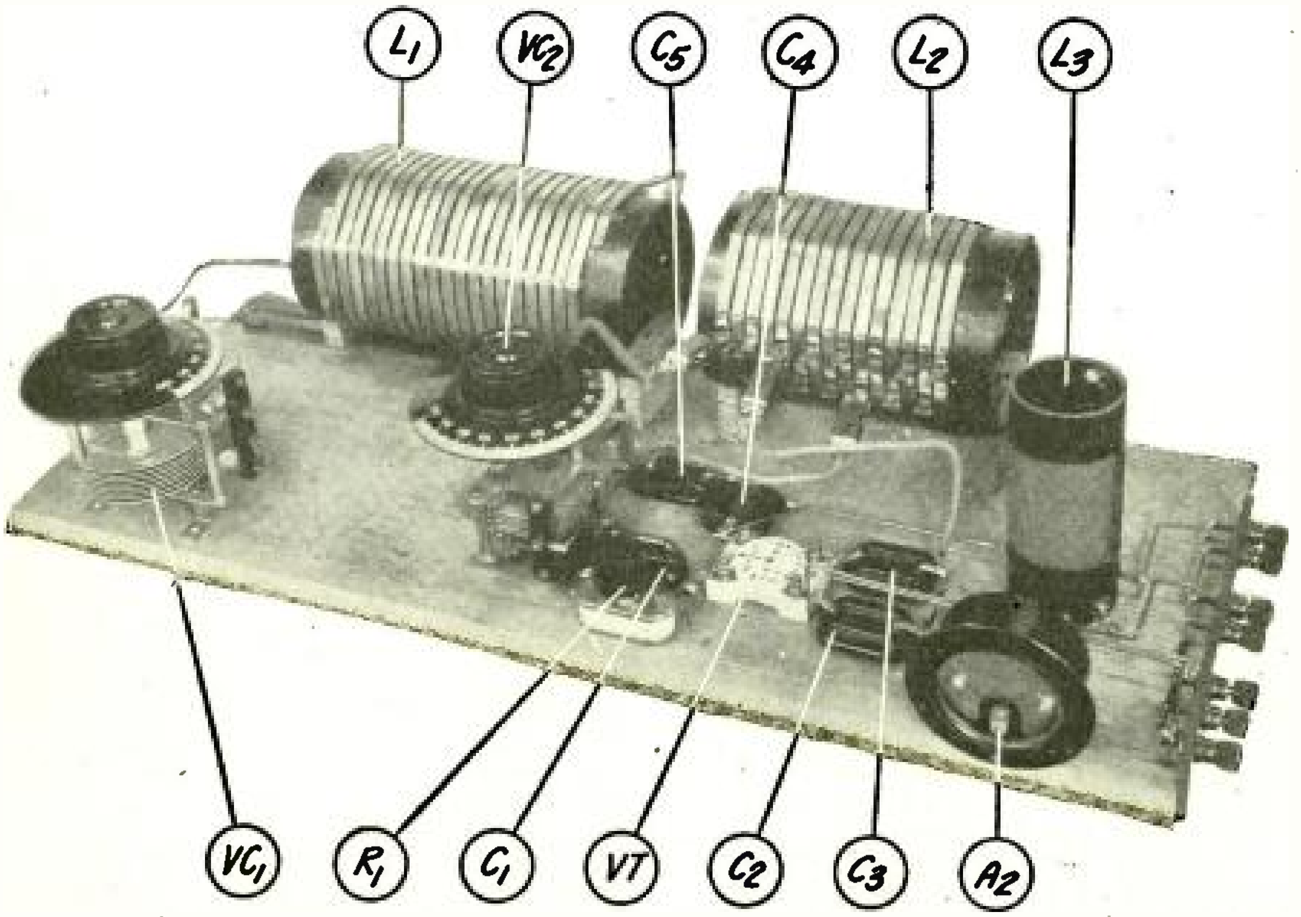
It will be noted from Figure 1 that the circuit and construction of this transmitter are much like that of an ordinary regenerative short-wave receiver. More than this, a number of the instruments used, such as the variable and fixed condensers, are the same as those which are used in receivers.

The coils, in which lies the main difference between this transmitter and a receiver, are homemade. The constructional details are shown in Figure 4. The foundation for the two necessary coils consists of radion tubing 4 inches in diameter and ⅛ of an inch thick. On this tubing 8 strips of radion of the same length and 3/16 of an inch square are laid lengthwise, equidistant around the circumference of the tube.

It is well to fasten these strips to the tube to hold them in place during the winding process. This may be done by drilling small holes through the ends of the strips and tubing and twisting pieces of wire through these holes. The coils, which consist of 25 gauge copper ribbon ¼ of an inch wide by 1/64 of an inch in thickness, are wound on top of these square strips.

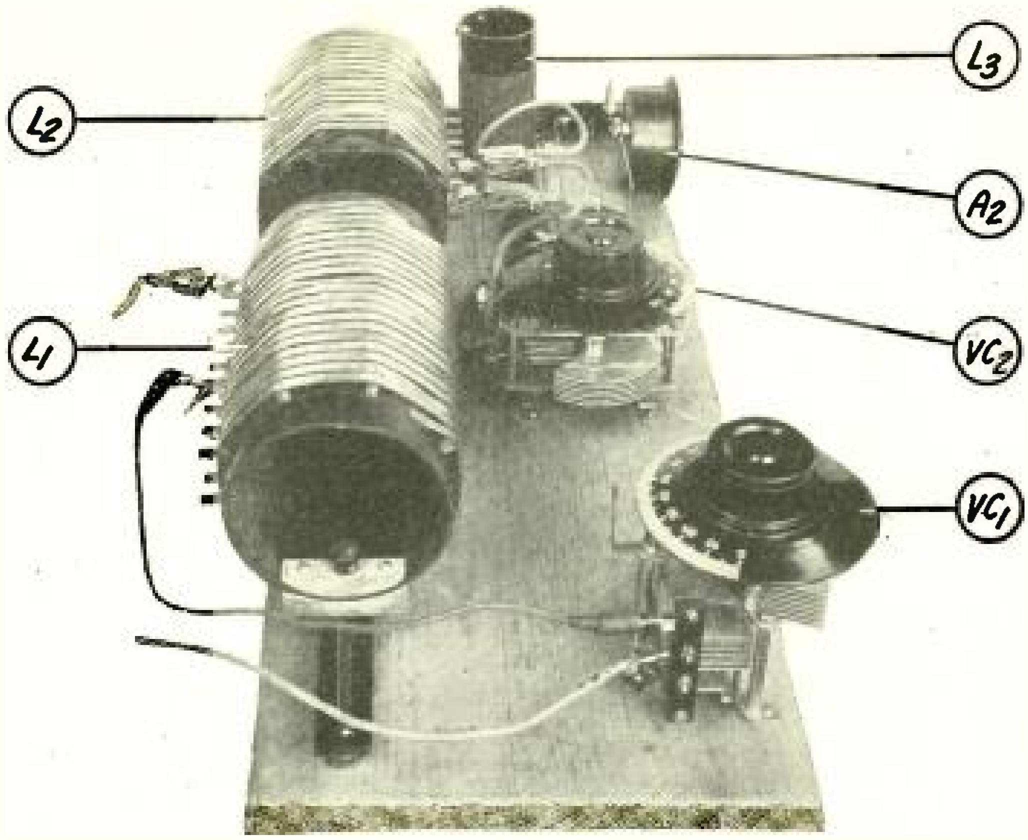
Thus each turn is supported at 8 points but between points is in contact only with the air. To prevent turns from slipping indentations may be made, as illustrated, through the copper ribbon and into the rubber strips with a center punch. After completion of the windings the superfluous ends of the rubber strips may be cut off.

The closed circuit coil L2, which is shown in Figure 4, consists of 15 turns spaced 1/16 of an inch apart. L1 has 20 turns. Used in conjunction with the variable condenser VC2, coil L2 will easily cover the 80 meter amateur band, and of course may be tuned down by means of the clips and the condenser to the 40 meter band.



A FRONT VIEW OF THE TRANSMITTER

FIGURE 2: *This illustration gives a good idea of the layout and spacing of the instruments. The designating symbols shown correspond exactly with those in the other figures and in the list of parts given above. The coil L2 is fastened to the baseboard by means of screws run through from the bottom of the baseboard into the coil mounting blocks.*



AN END VIEW THAT
SHOWS THE COIL MOUNTING

FIGURE 3: *The method used to mount the outer end of coil L1 is illustrated here. By means of the slide on which it is placed coil L1 may be moved towards or away from L2 to provide the necessary degree of coupling. Complete details are shown in Figure 5.*

It is the antenna inductance that presents the main problem inasmuch as its size will depend a good deal upon the antenna with which it is used. However, 20 turns should be ample.

After the coils are wound, a lug is soldered on each turn so that contacts may be made by means of flexible leads and clips. See Figure 4 for details. The mounting blocks are then also attached.

The only other item of the equipment to be constructed by the builder is the choke coil, L3, which consists of 146 turns of No. 28 wire wound in a single layer on composition tubing 2 inches in outside diameter. It is important that this coil should not be larger than specified because the choke coil should have a natural period somewhat lower than 40 meters if the transmitter is to be worked on that wavelength. Otherwise its effectiveness will be decreased.

The blocking condensers C4 and C5 really serve as a single condenser. The voltage to which they are subjected is somewhat in excess of the rating of the small type of receiving condenser, and for that reason two of these condensers were used in series in constructing this transmitter. If desired, a single transmitting condenser of .0015 may be used in place of the two specified. For the grid condenser, C1, and the filament by-pass condensers, C2 and C3, the ordinary receiving condensers are entirely satisfactory.

Space does not permit a detailed description of the layout of the baseboard and instruments. However, the illustrations give sufficient information to permit the builder to follow this without trouble.

The hot wire ammeter, A2, is used to indicate the current flow in the filament circuit of the tube. A meter with a range of 1.5 amperes is suitable because the UX-210 or VT2 type of tube filament current requirements are within this range. In addition to this meter two others are used as indicated at A1 and MA in Figure 1. The former is used to measure the current flow in the antenna circuit so that it indicates when the antenna circuit is tuned to resonance with the closed circuit.

The reading of this meter, however, gives no final indication of the operating efficiency of a transmitter. In general, the best antenna current reading that can be obtained *at a given wavelength* indicates the greatest efficiency. And differing antenna current readings at different wavelengths do not necessarily indicate that the operating efficiency of the transmitter has risen or fallen. The fact is that a change in the characteristics of the antenna circuit is reflected in a change in the antenna ammeter reading just as readily as a change in the efficiency of the transmitter.

The meter MA measures the current flow in the plate circuit of the tube. This meter is not essential but its use is advised since it helps to indicate the efficiency of the transmitter on a given wavelength. This efficiency increases as the plate current, needed to maintain the antenna current reading at the highest obtainable, decreases.

The meters A1 and MA may be permanently mounted in the transmitter if desired. However, most amateurs do not have many spare meters and it is a good plan to arrange things so that the meters can be quickly removed for other temporary use if desired. Thus these two meters are not mounted in the model described here.

The Antenna

The transmitting antenna should, of course, be as efficient as possible. It should be kept clear of trees and buildings in so far as this is possible. If iron pipe masts are used to support the antenna, the antenna wire should be not closer than 10 feet to the masts or guy wires. It is advisable to insert insulators in the guy wires about every 15 feet. Otherwise it is possible that these wires might have a natural wavelength near that of the transmitter, in which case the guys would absorb some of the transmitted energy. Excellent insulation for the antenna is quite essential.

Pyrex insulators serve very well for this purpose, but at least two should be used in series at each end of the antenna and at any other points where insulation is needed. Glass towel bars about 18 inches long and having a glass knob on each end are inexpensive and make first-class insulators for this purpose.

The antenna should be as high as possible, and should be higher at the end farthest from the transmitter. A single wire is all that is needed, and this may well be single strand enamel insulated wire of No. 12 size. The lead-in is taken off at the end nearest the transmitter.

The counterpoise if one is used should be just as carefully constructed as the antenna. It is usually placed directly under the antenna, but if this is inconvenient may be placed almost anywhere. In any event, it should be kept as far below the antenna as possible. It is best to construct it with two or more wires which either radiate in the form of a fan from the transmitter or are spaced at least four feet apart on spreaders. In a pinch a single wire may be used for the counterpoise. In any case the counterpoise should be at least as long as the antenna, or longer if it can be conveniently arranged.

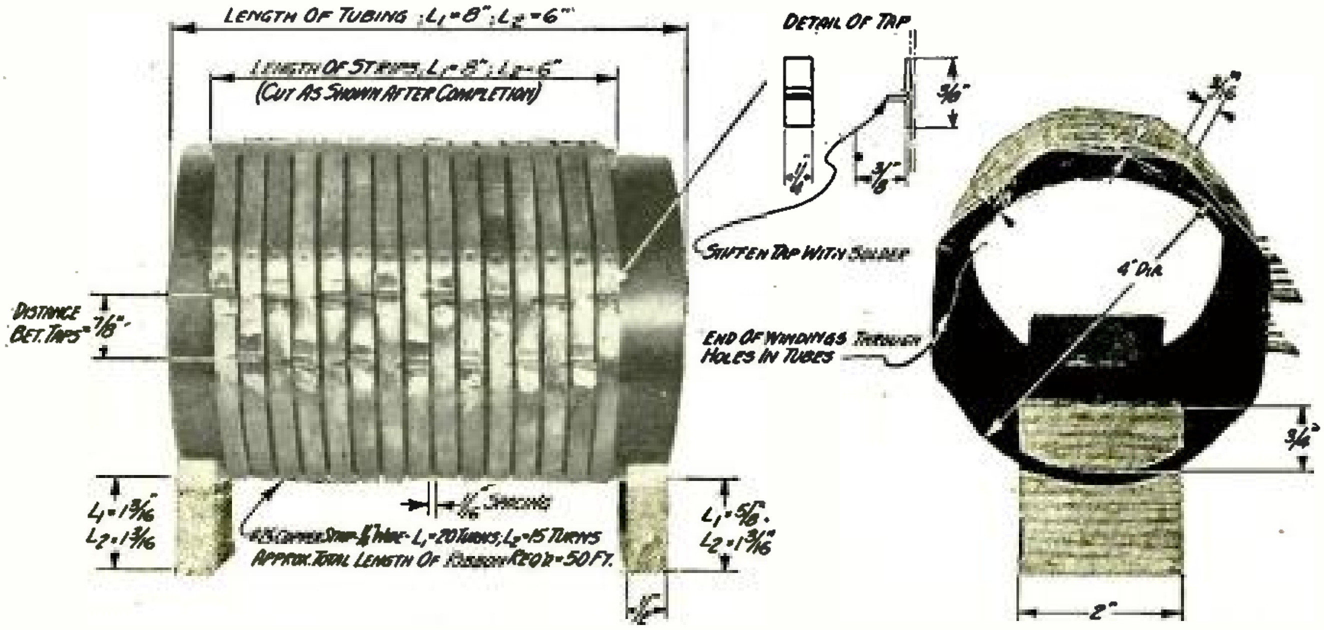
The antenna, counterpoise and lead-in wires should all be stretched taut. This is imperative, for if it is not done the transmitted signals will swing badly during windy weather—so badly as to make it impossible for anyone to read them.

The usual practice at the experimental station, where this transmitter was in use, is to tune the closed circuit of the transmitter to 40 meters and to tune the antenna circuit to 120 meters. Thus in transmitting on 40 meters use is made of the third harmonic of the antenna circuit.

The results obtained, using this method, seem to be somewhat superior to those obtained with a smaller antenna tuned to 40 meters. In this same way it is possible to use the fifth harmonic of the antenna. In that case of course the antenna will be tuned to 200 meters.

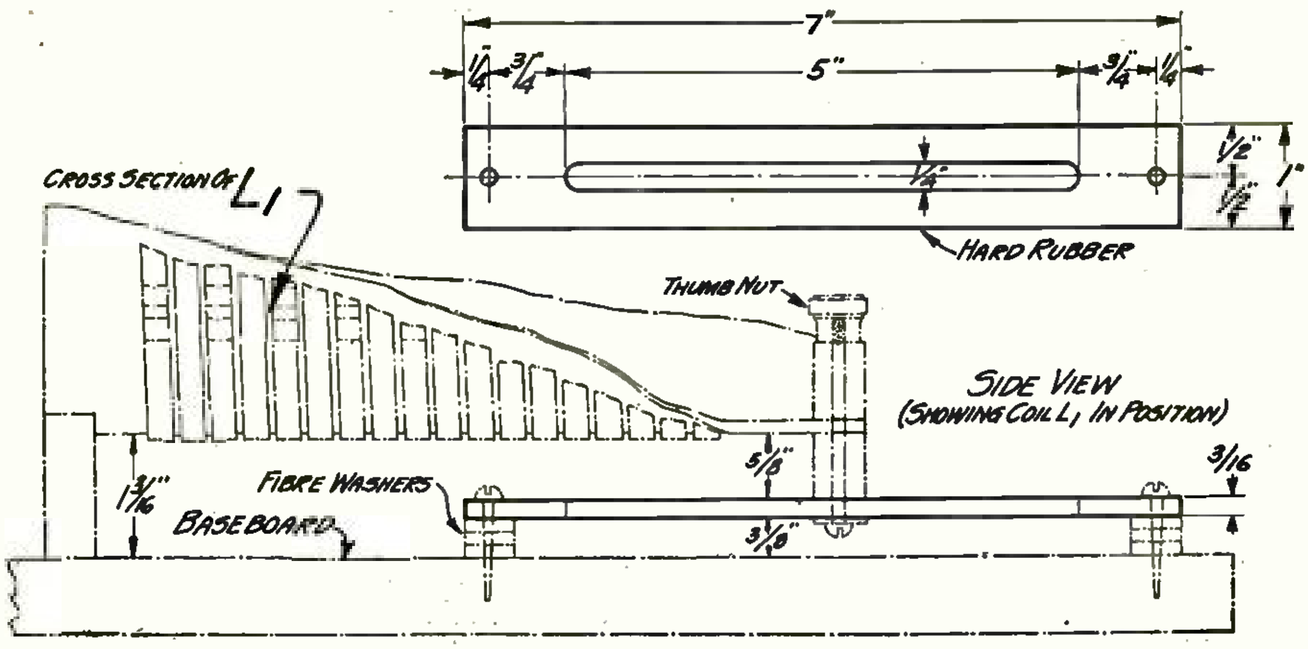
The use of the even harmonic of an antenna has not, however, been found practical. In other words, it is not advisable to tune an antenna to 80 or 160 meters if transmission is to be carried on at 40 meters.

If the antenna system is sufficiently small to have a natural wavelength in the neighborhood of 40 meters it would be necessary to use a



HOW THE COILS ARE WOUND

Figure 4: *Coil L2 with its winding and mounting blocks is shown in this illustration, which gives the constructional details of the coils. Note that each turn of ribbon is punched to prevent it from sliding along the strips. The ends of the windings are secured by bending them through slots in the tube. These slots may be conveniently made by drilling several small holes as close together as possible and then cutting out the material between by means of a knife or small rat-tail file.*



THE CONSTRUCTIONAL DETAILS OF COIL L1

FIGURE 5: *The outer end of the coil L1 rests on a slotted strip of hard rubber. When the thumb nut is loosened it permits the coil to slide freely along the entire length of the slot. This provides a wide range of coupling between the two coils. The slot is cut by drilling four 3-16-inch holes as close together as possible 1 inch from the end of the strip. The material between the holes should then be cut out. A hack saw blade may then be inserted to finish the slot.*

large loading coil in the antenna circuit if it were desired at times to transmit on 80 meters. Inasmuch as such a large loading coil is not considered practical the better plan is to put up an antenna with a natural wavelength somewhere in the neighborhood of 80 meters. If this is done 80 meter transmission can be carried on using the antenna series condenser VC1 and only a few turns of the antenna inductance L1.

To transmit on 40 meters with such an antenna, the antenna series condenser is cut out of the circuit and one of the clips moved along L1 to provide the necessary inductance to bring the antenna circuit up to 120 meters. Further information on this is given later.

The two inductance coils described here were found to be a good practical size for use in conjunction with an antenna system consisting of a single wire antenna 65 feet long and 30 feet high, and a single wire counterpoise of the same length placed directly under the antenna and 20 feet below it.

Connecting up the Transmitter

The power supply equipment, key, antenna and counterpoise are connected to the transmitter as shown in Figure 1. If the meters MA and A1 are not mounted in the transmitter they should be connected in the leads from the positive high voltage supply and the antenna, respectively.

A complete description with constructional data for the power supply equipment was published in the "In the Experimenter's Laboratory" department of the January, 1926, issue of POPULAR RADIO.

The rectifier and filter for the high voltage plate supply are not absolutely essential, but their use is strongly advised for the reasons explained in the January issue.

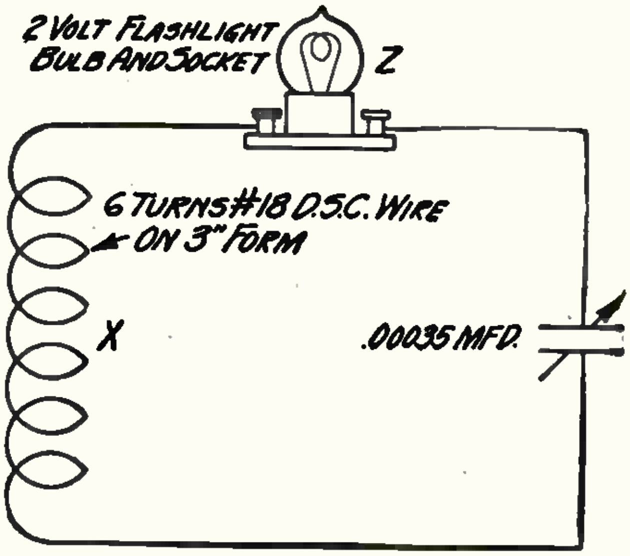
It will be noted that in Figure 1 the antenna is connected to L1 through the antenna ammeter A1, the antenna switch S1 and the variable condenser VC1. It is important that S1 be connected between the antenna and the meter and that the meter be between S1 and the condenser. In other words these instruments should appear in the circuit in the order shown in Figure 1.

All of the leads to the coils should be of flexible wire with clips at one end to facilitate connection to the coil taps. All other connecting wires in the transmitter should be plain copper wire or bus wire, anywhere from No. 18 to No. 12 in size. No. 12 bare, single strand copper wire was used in wiring up the model transmitter for the sake of greater rigidity. The connecting wires of the power supply equipment, and the wires from this equipment to the set should all be insulated wire such as is used for house wiring.

Operation of the Transmitter

Unless one has had previous experience with transmitters, it is suggested that a more advanced enthusiast be called in to help get the set started. This will save much time and experimentation. If one is not acquainted with an amateur who owns a transmitter he can probably get in touch with one through the nearest radio club. If even this is out of the question the builder will have to go his own way. This is not particularly difficult and in the end will be good experience.

A wavemeter consisting of a variable condenser, a coil and a small flashlight lamp will be extremely useful not only in putting the



A SIMPLE RESONANCE INDICATOR OR WAVEMETER

FIGURE 6: *This device works on the energy absorption principle. If it is tuned to resonance with a nearby oscillating circuit it will absorb energy from the oscillator. Thus if headphones are attached to a receiver which is tuned to a given wavelength, and the wavemeter is brought close by and tuned to the same wavelength, it will absorb enough energy to stop the oscillation in the receiver. This will be indicated by a click which may be heard in the phones. A wavemeter may be calibrated by means of this method from a calibrated receiver.*

transmitter into operation, but later. The hook-up of a suitable wavemeter is shown in Figure 6.

The leads from the grid, plate and filament center tap to the closed circuit coil should all be flexible and equipped with clips to slip on the lugs on the coil winding. Connect the grid lead to the first tap (nearest the antenna coil) of the coil L2. The plate lead is connected to the tenth turn and the filament lead to about the fourth turn. For the time being the two leads to the antenna coil should be left unconnected.

The power switch may be turned on. If everything is properly connected the tube filament will light up when the rheostat R2 is turned on (if one is used).

The rheostat should next be adjusted to provide the proper filament current specified by the manufacturer's instructions which accompanied the tube. This current flow will be indicated by the meter A2. When the key is pressed, the high voltage plate current will flow and will be registered on the meter MA.

However, the transmitter may not be oscillating. This may be checked by means of the wavemeter. With the transmitter key depressed the wavemeter coil is placed about five inches or perhaps less from the coil L2 and the wavemeter dial is rotated slowly. When the wavemeter is tuned to resonance with the closed circuit of the transmitter the flashlight bulb will light up, because of the energy absorbed by the wavemeter coil when in resonance with the oscillating circuit.

If the transmitter is not oscillating, the flashlight bulb will not light up. In that case the filament lead to the coil L2 should be moved around one turn at a time until oscillation is secured. The wavelength to which the closed circuit of the transmitter is tuned can be determined by the setting of the wavemeter dial when the two are tuned to resonance.

By means of the variable condenser VC2 vary the wavelength of the closed circuit until it is somewhere in either the 40 or 80 meter bands. In making this change it may be necessary to move the filament clip again. When this circuit is tuned to a suitable wavelength connect the antenna coil into its proper place with, say, 10 turns in the antenna circuit.

Then vary VC1 until there is a deflection of the needle of meter A1. If no deflection occurs place the clips to the antenna coil closer together, leaving fewer turns in the antenna circuit. Again rotate VC1 until a deflection of the meter is obtained. During all this time the two coils should be placed fairly close together —perhaps an inch apart.

Now with the two circuits tuned to resonance and current flowing in the antenna as indicated by the antenna ammeter try readjusting the various parts of the circuit in an effort to obtain a higher antenna current reading. Try using more turns of L2 and a lower setting of VC2, moving the filament lead as needed. Also try more or fewer turns of L1, readjusting VC1 to keep this circuit in resonance with the closed circuit.

The amount of coupling between L1 and L2, regulated by sliding L1 toward or away from L2, is an important factor as well. If these coils are too close together it is probable that oscillation will be unstable.

As resonance between the two circuits is approached the antenna ammeter needle will climb and then may suddenly drop to zero. This indicates that oscillation has stopped. Or the needle may climb to a certain maximum point while the key is held down but when the key is released and again pressed the meter reading will be lower. In either of these cases, coupling between the two coils should be decreased by moving them farther apart. The antenna reading may then be lower but oscillation will at least be steady, and stability of oscillation is absolutely essential if your signals are to be heard and understood. When proper coupling has been obtained the thumb nut on the mounting of L1 is tightened to hold this coil firmly in place.

So far, so good, but it is not known definitely whether the closed circuit is tuned to resonance with the antenna circuit or with one of the harmonics of the latter. If tuned to the second harmonic of the antenna, for instance, efficiency would be low. It is important, therefore, that the operator familiarize himself with the approximate adjustment of each circuit for a given wavelength. This can be done by tuning the closed circuit to somewhere around 100 meters. This wavelength is sufficiently high so that when the antenna is tuned to resonance you will know that it must be the fundamental of the antenna circuit that is in resonance, not one of its harmonics.

If the antenna circuit cannot be brought to resonance, set the antenna circuit adjustments for maximum wavelength (using all turns of coil L1). Then vary the wavelength of the closed circuit until it is in resonance with the antenna.

When the two circuits are in resonance tune the closed circuit down to one half of this wavelength. There may or may not be a deflection of the antenna ammeter at this setting. Readjust both circuits slightly if there is no antenna current reading. In most cases a slight deflection of the antenna ammeter needle can be obtained at this second harmonic of the antenna.

Then go on down to one third of the wavelength with the closed circuit, leaving the antenna circuit tuned to 100 meters as before. At this setting a fairly substantial current flow should be indicated by the antenna ammeter. Now, if the transmitter is to be operated on 40 meters, using the third harmonic of the antenna system, tune both circuits up gradually keeping them in resonance as you go along. When the closed circuit wavelength reaches 40 meters then the antenna circuit will, of course, be tuned to 120 meters.

If the antenna is too small to be tuned as high as 120 meters it may perhaps be tuned as low as 40 meters. In that case the use of harmonics for 40 meter transmission will be unnecessary. However, it may not be possible to tune such an antenna up as high as 80 meters without considerable loading inductance in the antenna circuit.

It will be seen that there a little experimentation may be required before the right length for the antenna is found. It would be a good plan to try out a small antenna of about 30 feet in length which can be tuned down to 40 meters or up to 80 meters, and then to try a longer antenna such as the one mentioned earlier in this article, which can be tuned to 80 meters and up to 120 meters so that its third harmonic may be used for 40 meter transmission. Then for the permanent installation the antenna which proves to be best for the wavelengths on which it is desired to work may be used.

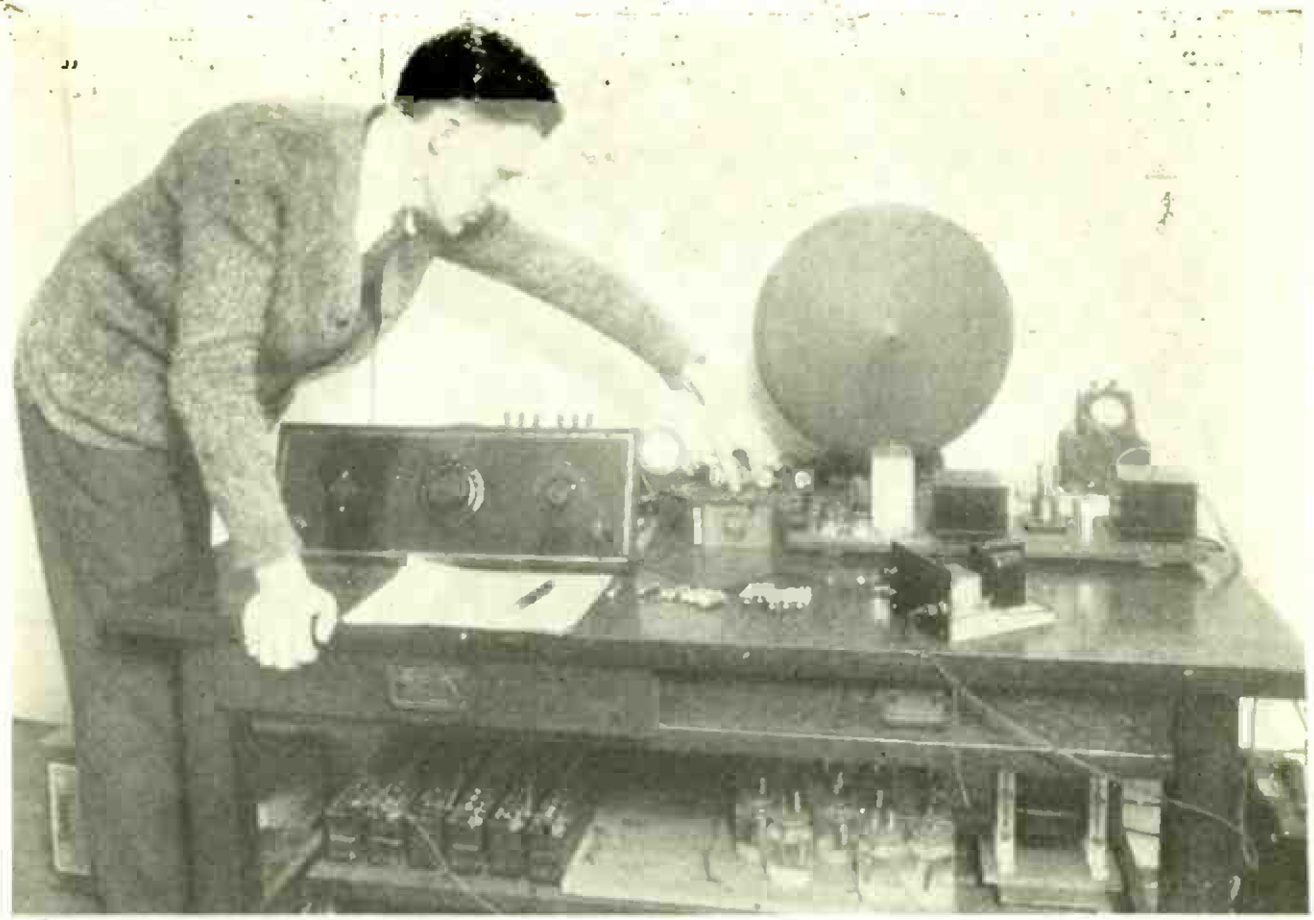
After the antenna and counterpoise are erected and the transmitter is in operation, it is well to try a water pipe or other form of ground in place of the counterpoise. In some cases the use of antenna and ground will give superior results, while in others the antenna and counterpoise will prove better. It is even found best in some installations to use both the counterpoise and ground, connecting them together at the transmitter.

Before a station is put into operation it is imperative that the government rules and regulations on amateur transmission be learned. For instance, the use of radiotelephony on wavelengths lower than 150 meters is prohibited at all times. So is the use of any modulated form of transmission, as when buzzer modulation is used. If raw AC is used for the plate supply or if half-wave rectification is used transmission is not permitted between the hours of 8 P.M and 10.30 P.M. daily, or during the broadcasting of regular church services on Sunday. Where the power supply is put through a full-wave rectifier, such as the one described in the January issue, transmission is permitted at any time desired providing no interference is suffered by neighboring broadcast fans. If your transmitter does cause interference, the quiet hours mentioned above must be observed regardless of the type of rectification used.

Above all, *it is necessary that an amateur station license be obtained from the Department of Commerce before any amateur transmitter can be put into operation. And an amateur operator's license is also required.* Full information regarding these licenses and how to obtain them may be had by writing to the radio inspector of your district, or to the Department of Commerce, Washington, D. C.

ONE OF THE WORLD'S LOVELIEST BROADCASTING STATIONS

No wonder this tiny strip of land off Miami, Florida, is called "The Wonderful Isle of Dreams." On it is located station WIOD.



From a photograph made for POPULAR RADIO

EXPERIMENTING WITH A "C" BATTERY IN THE LC-26 RECEIVER

FIGURE 1: *The effect of a "C" battery connected in the grid circuit of the last stage of the LC-26 receiver was carefully studied. An improvement in tone quality and greater economy in "B" battery consumption were obtained, as explained in this article.*

Helpful Hints for Operating the LC-26 Receiver

This additional information on the proper operation of the LC-26 receiver, together with some new data on methods of reducing plate current and improving tone quality on exceptionally loud signals, is of special interest to those radio fans who have installed this type of receiver in their homes.

By S. GORDON TAYLOR

IT was the intention of the author to call this article "Trouble Shooting in the LC-26 Receiver," but so few troubles seem to have been encountered by readers in constructing and operating the receiver that there seems to be little to "shoot."

A number of cases in which readers have reported trouble with their LC-26 receivers have been investigated personally by the author; and in every case but one the trouble was found to be outside of the receiver itself, or else in the method of operating the set. The one exception was a case where the owner had taken one of the instruments apart to see what it looked like inside and had reassembled it incorrectly.

In several of the cases which were investigated defective batteries caused the trouble; in one the loudspeaker was at fault; in another a defective tube prevented reception of distant stations with satisfactory loudspeaker volume

Two pointers were picked up, however, which may be of interest to owners of this receiver.

The first is that it is not absolutely essential that the detector "B" battery voltage be limited to 16½ or 18 volts. Some of the so called "soft" detector tubes, such as the UV-200, UX-200 and C-300 require 19½, 21 or even 22½ volts for proper operation in this receiver. If the detector voltage is too low the tube will not oscillate and the receiver will therefore not provide maximum volume, especially in receiving distant stations.

The test for oscillation is to turn the rheostat about two-thirds on, in a clockwise direction, and then to rotate the main tuning dial from zero to 100. Whistles should be heard as this dial moves past the settings for the broadcasting stations which are in operation at the time. In other words the "carrier waves" of the stations should be heard. If none are heard it is an indication that the detector is not oscillating and the process should be repeated again, this time with the detector rheostat moved about three-quarters on. In making these tests be sure that the knob of the Bradleyleak is turned in only part way, or to a point where no pressure is felt. To find this adjustment turn this knob to the right until a slight pressure is felt, then turn it back about half a turn.

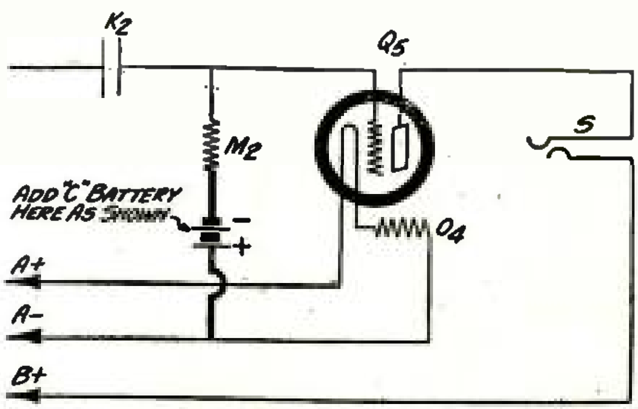
A slight click should be heard at the correct adjustment.

If the whistles are still audible, the detector tap on the small "B" battery should be moved from 16½ to 18 volts, and if there are still no results, on up to 19½ or 21 volts. These higher voltages should certainly give results unless the tube is defective. 22½ volts are rarely needed, and higher voltages never.

Several cases have appeared where builders have complained that they were unable to obtain the volume and distance which they expected, although locals were received with excellent quality and the more powerful stations were received with good volume. Investigation disclosed the fact that these fans were afraid to turn their rheostats more than half way on for fear the detector tube filament would burn out. There is no danger in turning the rheostat two-thirds "on," or even three-quarters. Where it is necessary to do this to make the detector oscillate it is probable that the Bradleyleak knob is screwed down too far or else that the detector "B" battery voltage is too low.

Turning the detector rheostat on two-thirds does not mean turning it until the arrow points to 66 on the panel. *It means turning the knob until the spring contact lever at the rear of the rheostat has traversed two-thirds of the rheostat winding.* Incidentally, it is well to attach the knob to this instrument in such a way that its arrow is parallel with the spring lever. Then the operator can tell at a glance just where the lever is in relation to the winding.

The second point is that the receiver is designed to use the UV-200 or C-300 (the "X" tubes of the same numbers are the same as the "UV" and "C" except that they have the new standard bases) as the detector in this circuit. Other tubes such as the 201-a may be used but they will not produce as good a tone



THE PROPER ELECTRICAL LOCATION OF THE "C" BATTERY

FIGURE 2: *This drawing shows only the circuit of the last tube as no advantage is gained by the use of a "C" battery in the preceding stages. The symbols used here are the same as those in the original diagram on page 497 of the December, 1925, issue of* POPULAR RADIO.

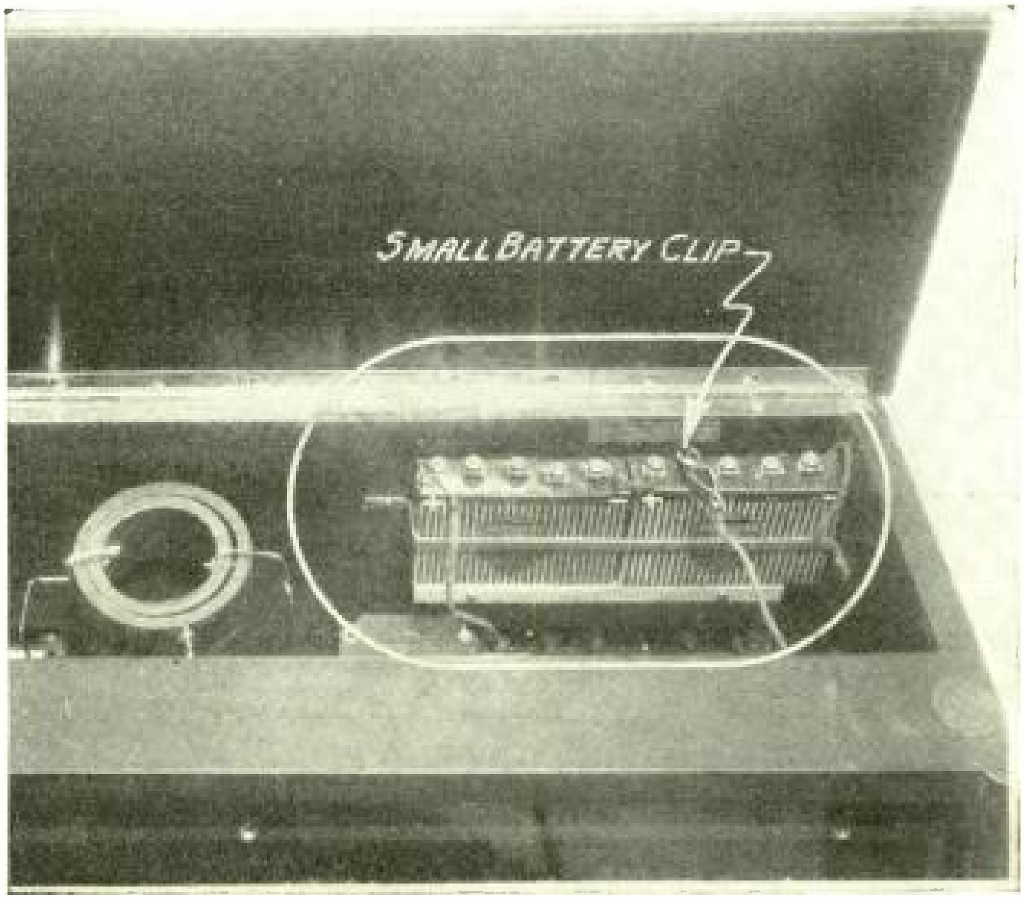
quality; and detector oscillation will be hard to control. In an emergency, a tube of this type may be used; but in such a case the detector "B" battery voltage should be reduced to probably as low as 4½ or 6 volts. Even then there will be distortion caused by too much oscillation. *By all means use a soft detector tube regardless of any advice to the contrary.*

Body Capacity in Tuning

There is no noticeable body capacity effect in tuning this receiver. The hands may be placed on the dials or anywhere on the cabinet or panel without affecting reception in the least. In every case where this complaint has been investigated it has been found that the trouble has been caused by having the loudspeaker or the loudspeaker cord within a few inches of the operator. In that case there will be a shrill whistle or hissing when the hand is placed on the tuning dial. The obvious remedy is to keep the loudspeaker and cord a few feet away from the body of the operator.

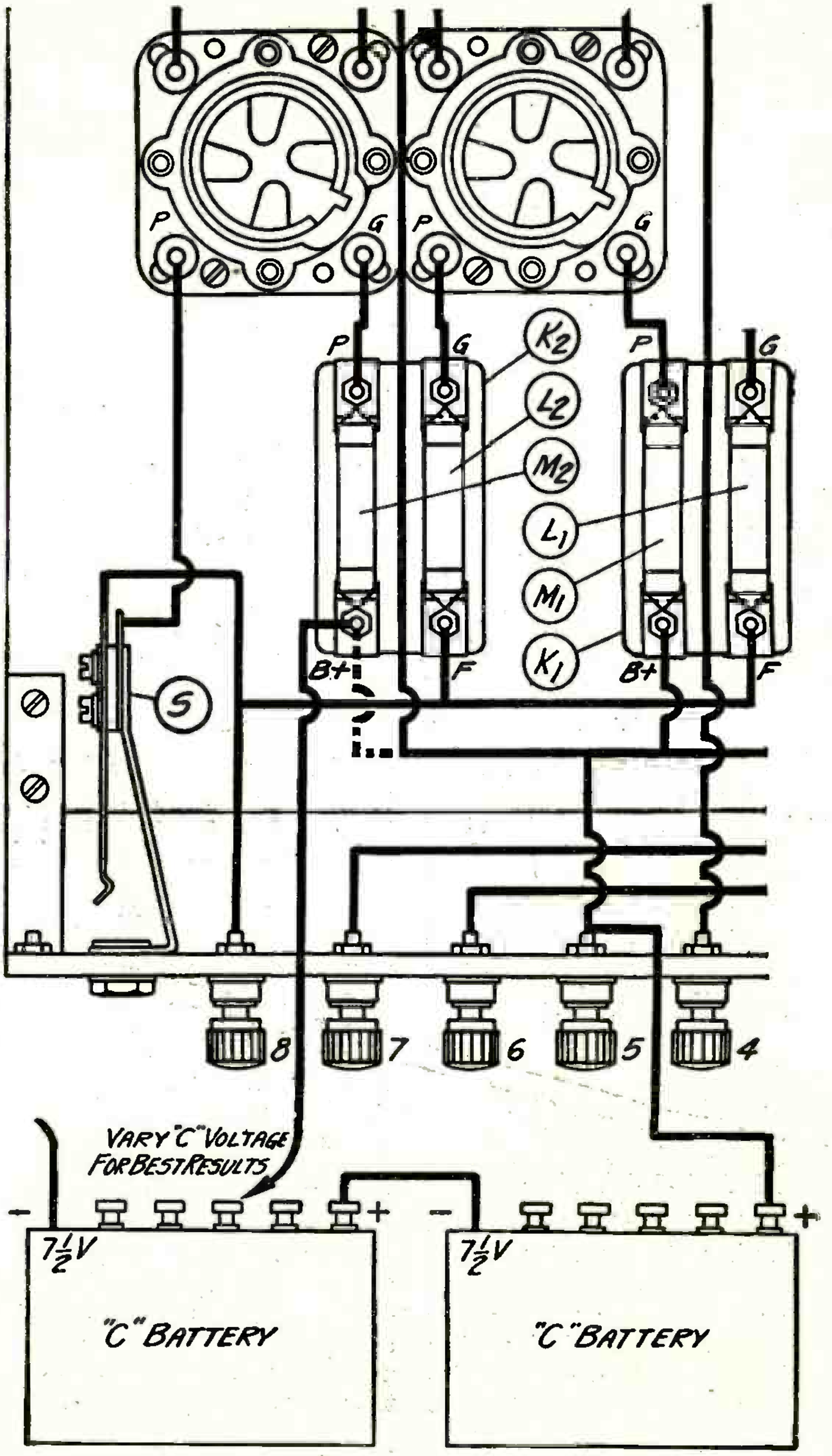
The above suggestions seem to clear up all of the "trouble shooting" data to date. More irregularities may develop in time; and in that case they, together with their remedies, will be brought to readers' attention in a later article, or in the "Experimenter's Laboratory" department of later issues.

Constant experimental work on the LC-26 receiver has been carried on by Mr. Cockaday and by the author in an effort to attain an even higher degree of perfection than that reached by the original model as described in the December, 1925, issue of POPULAR RADIO. Much of this work has been confined to the receiver itself while some has also been devoted to the accessories. The suggestions which are offered in this



THE "C" BATTERIES INSTALLED IN THE CABINET

FIGURE 3: *A small wood shelf is mounted directly on the rear wall of the cabinet. The batteries are placed on this and are held in place by a piece of 1⁄16 by ½-inch brass strip, bent to proper shape. A small battery clip may be used conveniently to make an easily adjustable negative connection.*



A PICTURIZATION OF THE CHANGE SHOWN IN FIGURE 2

FIGURE 4: *A section of the original diagram which was printed on page 505 of the December, 1925, issue of* POPULAR RADIO, *showing the changes which must be made in connecting the "C" battery into the circuit.*

article are a result of these experiments; and each one offers some advantage in improved reception, added convenience or greater economy.

The Addition of a "C" Battery

The use of a "C" battery of proper voltage with the LC-26 receiver has been found to provide advantages in added economy of operation and in improved tone quality on loud signals. The universal comment on this receiver since its introduction last December has laid especial emphasis upon its exceptional tone quality. In this respect there seemed little hope for further improvement.

However, in carrying on experimental work in the Laboratory in an effort to reduce "B" battery consumption by means of "C" batteries, it was found that the "C" battery not only reduced "B" battery consumption considerably but actually improved the tone quality of loud signals to a noticeable degree.

When no "C" battery is used, the "B" battery current consumption of the LC-26 receiver is no higher than that of other five-tube receivers, in spite of the fact that the total "B" battery voltage used is 157½ volts. Ordinarily the amount of current drawn from the "B" batteries increases with an increase in battery voltage but the use of resistance-coupled amplification in this receiver keeps the current drain well down.

It is assumed here that a 201-a type of tube is used in the last audio stage of the receiver. If a 112 type of tube is used the current drain from the "B" batteries will be higher; but this is to be expected in view of the greater volume produced by this tube.

The use of the proper "C" battery voltage when the UX-112 tube is used in the last stage more than compensates for the added drain on the "B" batteries which results from the use of this tube. In fact the total current drain of the receiver can be cut in half. Actual measurements which have been made show a current drain of 20.5 milliamperes per hour for this receiver with a 112 tube in the last stage, but without a "C" battery. Using 9 volts of "C" battery, connected as shown in Figure 2, the current consumption is cut to 10 milliamperes. In terms of "B" battery life this means that without the "C" battery a set of "B" batteries would last approximately 170 hours if the receiver were used an average of two hours daily. With the 9-volt "C" battery in the circuit the life of the "B" batteries is extended to approximately 400 hours under the same conditions of use.

Where a 201-a tube was used in the last audio stage the average "B" battery current drawn by the receiver was 14 milliamperes. A 6-volt "C" battery reduced this drain to 9.5 milliamperes. The life of the "B" batteries without a "C" battery would, in this case, be approximately 286 hours as compared with a life of 420 hours if a 6-volt "C" battery were used.

The exact voltage for the "C" battery will vary somewhat, depending on variations in tubes and other factors in each receiver. For this reason it is impractical to recommend the exact voltage to use. In general it should be about the same as mentioned in the preceding paragraphs. If a milliammeter is available it may be connected in the negative lead to the "B" battery and used to determine the correct "C" battery voltage. With no "C" battery it will be noted that the hand of the meter fluctuates downward with modulations of the received signals. When a "C" battery is inserted in its proper place in the circuit this downward fluctuation ceases. If the "C" battery voltage is too high the fluctuation will be up instead of down. The most efficient action of the audio amplifier is that obtained with practically no fluctuation of the hand of the meter.

If no milliammeter is available it will be necessary to judge the proper "C" battery voltage by the sound of the signals. Starting with 1½ volts of

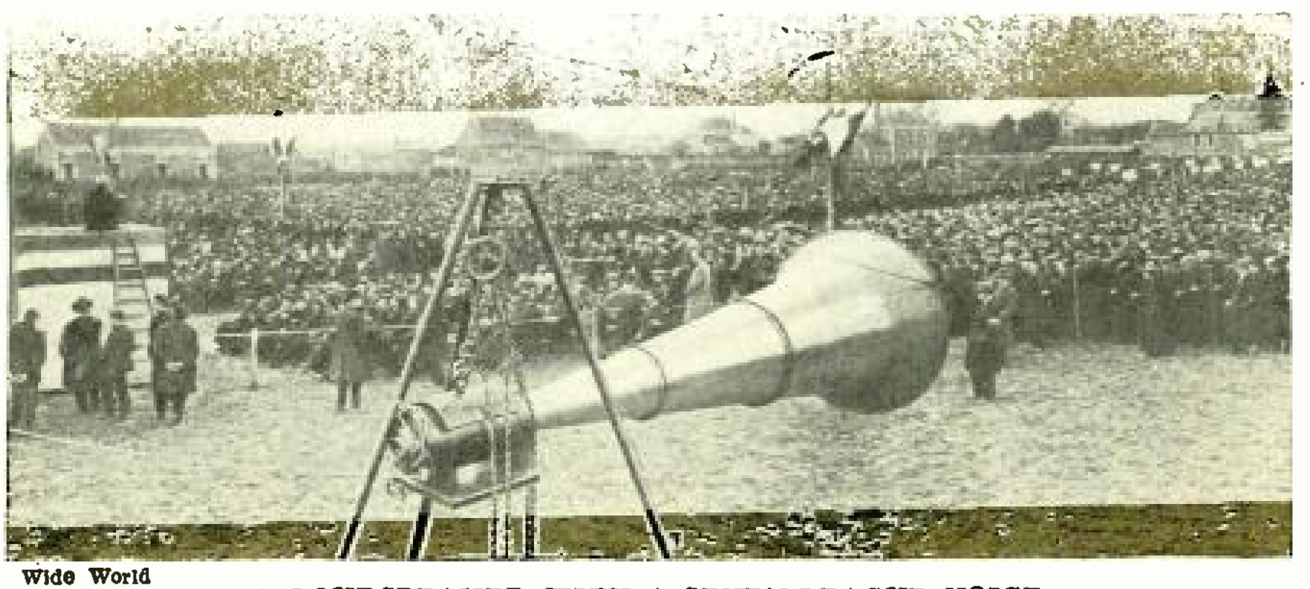
"C" battery, a broadcasting station should be tuned in with moderate strength. The "C" battery voltage should be added, 1½ volts at a time, until a point is reached where the volume starts to decrease, or the tone quality becomes impaired. It is advisable to use the highest "C" battery voltage which will still maintain the best tone quality and volume.

After the set has been operating for some time the voltage of the "B" battery will drop; and when this occurs the "C" battery voltage should be decreased also. For this reason it is well to experiment with the voltage of the "C" battery from time to time to make sure that it is being kept at the best value at all times. It might be said here that there is practically no current consumed from the "C" battery and its life should therefore be somewhere in the neighborhood of a year.

The diagram in Figure 2 shows how the "C" battery is connected in the circuit of the last tube only. Nothing is to be gained by connecting it into the other circuits. This is convenient as it requires only one changed connection in the receiver to install this additional battery whereas a good deal of rewiring would be required if the "C" battery were to be connected in the circuits of the other tubes.

Probably the most convenient location for the "C" battery is in the receiver itself as shown in Figure 3. The Burgess No. 5540 "C" battery shown in Figure 3 is handy for this use because of its compact size. Each of the small batteries shown has a voltage of 7½, tapped at every 1½ volts. Thus with two of these blocks secured on the inside of the cabinet it is possible to obtain a biasing voltage of anywhere from 1½ to 15 volts, in steps of 1½ volts.

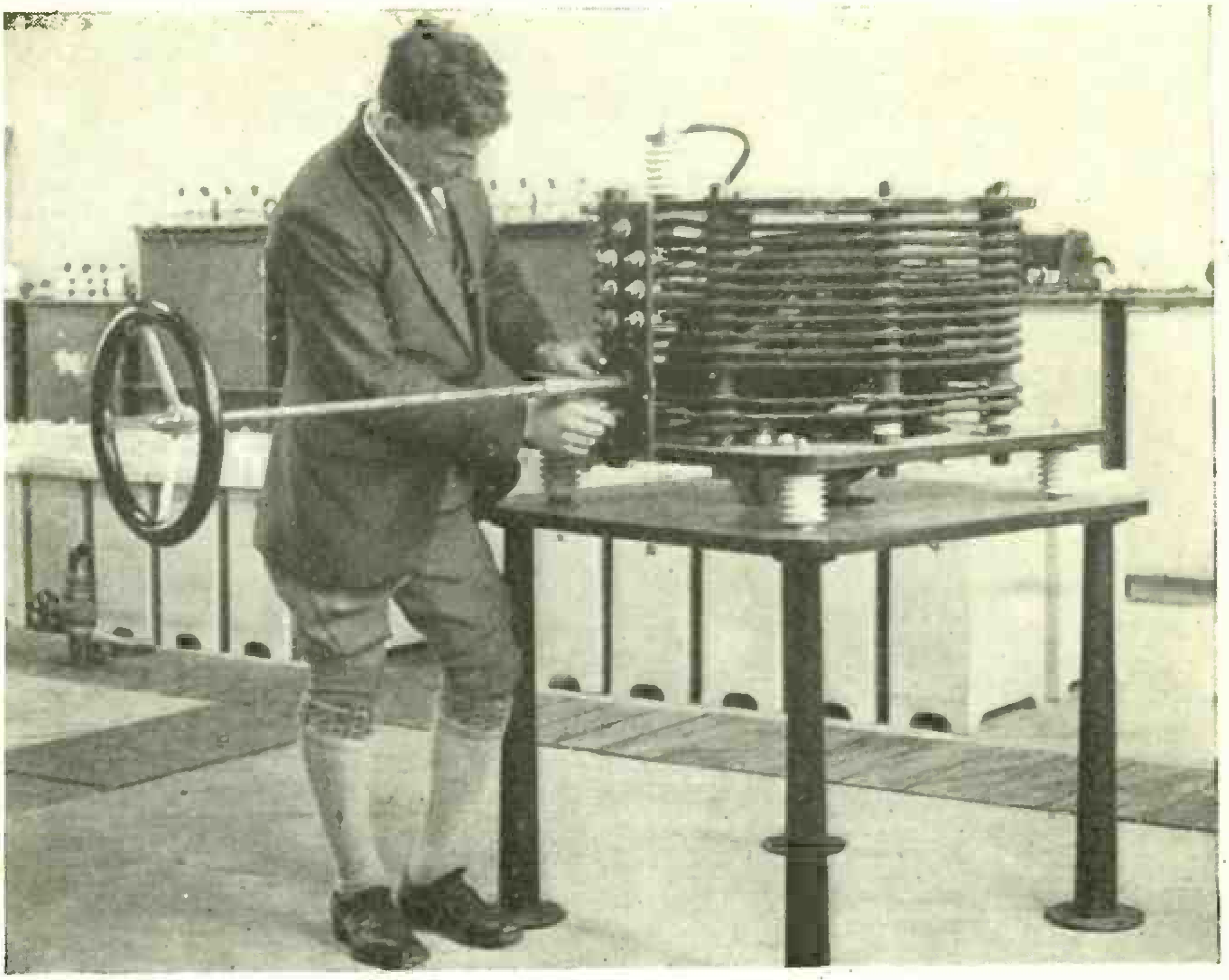
The electrical location of the "C" battery is in the grid return of the last tube, between the grid resistance, M2 (see Figure 1, page 497, December, 1925, issue of POPULAR RADIO) and the "A" (negative "A") line. The wire which connected these two points is removed and the "C" battery is inserted in its place, with the negative terminal of the "C" battery connected to the resistance, M2, and the positive terminal connected to the "A"-line. This change is indicated in Figure 4. It is a good plan to fasten a small battery clip on the end of the connecting wire which leads to the negative terminal of the "C" battery. This will make it easier to vary the voltage.



Wide World

A LOUDSPEAKER WITH A SEVEN-LEAGUE VOICE

One of the indirect effects that radio is having upon our civilization lies in the use that is being made in other fields of apparatus developed by radio. Here, for example, is a giant loudspeaker that was heard by a crowd of 50,000 people assembled in a stadium in France.



Barratt's, London

AN OVERSIZE VARIOMETER

The steering wheel of a motor car has been appropriated to operate the huge variable coupling of this large antenna coil.

Two Unique Features of a New Station

ANTENNA coils which are so huge that they must be tuned with the steering wheel of an automobile and ground systems so extensive that they surround acres of meadow are two of the unique features of the new super-power broadcaster at Daventry, England.

The coupling of the antenna inductance coil (shown above) is operated by means of a shaft to which is attached a large wheel. A small dial which indicates the position of the coils encircles the shaft at the panel.

The large zinc plate shown at the right is only a small part of the comprehensive ground system devised by Captain Round, the well-known English radio engineer. Twenty-four plates, each approximately a yard square, are embedded in the earth in a circle about the buildings which house the apparatus. From each of these plates insulated wires are led to posts standing behind them. From insulators on the tops of the posts the wires converge to the transmitter house.

Barratt's, London

BURYING AN UNUSUAL "ROUND" GROUND

A zinc ground plate, over a yard square, being placed in position; it forms part of the ground system designed by Captain Round for the new high power station at Daventry.

The obverse of the medal; this original is two-and-one-half inches in diameter.

The reverse; the name of each recipient will be engraved in the space provided.

THE POPULAR RADIO

Medal for Conspicuous Service

TO every radio amateur; to every amateur experimenter and broadcast listener, who is instrumental in alleviating human suffering or saving human life, directly or indirectly through the medium of radio, recognition will hereafter be extended in the form of a medal that shall be known as "The Popular Radio Medal for Conspicuous Service."

This medal is unique within the realms of radio in that it shall be awarded, not for scientific achievement or invention, but for service to humanity; for bringing aid in time of peril, within the territorial confines of the United States and its possessions and in its waters.

It shall be awarded without discrimination to all amateurs—men, women or children, of any race, nationality, color or creed—through whose prompt and efficient action radio is utilized to perform an essential part in rescue work. The awards shall be restricted to non-professionals only.

To insure a fair and unbiased consideration of all claims, a Committee of Awards has been appointed that includes five distinguished citizens of international fame.

To assist this Committee of Awards, an Advisory Committee has been appointed that numbers among its members some of the most eminent citizens of the United States, including representatives of many of our most distinguished institutions. These gentlemen have been carefully selected not only because they themselves are interested in public service, but also because many of them represent important bodies and are consequently in positions to know of the activities of individuals within their spheres and to make recommendations that are based upon personal knowledge of the achievements of candidates for the medal.

The Popular Radio Medal for Conspicuous Service has been designed by the well-known artist, Walter D. Teague. It is two and a half inches in diameter in size, and is cast in monumental bronze.

The conditions under which the medal will be awarded are here specified:

1. The medal shall be known as the Popular Radio Medal for Conspicuous Service.

2. The medal shall be awarded, without discrimination as to sex, age, race, nationality, color or creed, to those radio amateurs, radio experimenters, broadcast listeners and other non-professionals through whose prompt and efficient action radio is utilized to perform an essential part in the alleviation of human suffering or in the saving of human life within the territorial confines of the United States and its possessions, or in the waters thereof.

3. The medal shall be awarded by a Committee of Awards that shall not exceed five in number. No member of this Committee shall be an employee, officer or stock holder of POPULAR RADIO, INC., nor shall any such employee, officer or stockholder have a vote in the deliberations of the Committee.

4. An Advisory Committee, which shall co-operate with the Committee of Awards and which shall be particularly charged with the responsibility of making recommendations for awards of this medal, shall be made up of men and women who, because of their interest in the public welfare or because of their connection with institutions that are consecrated to public service, are in positions to bring to the attention of the Committee of Awards the exploits of candidates who are within their own special fields of activity.

5. The medal will be awarded for services rendered since Armistice Day, November 11, 1918.

6. Recommendations for awards may be submitted to the Committee of Awards at any time and by any person. Every recommendation must contain the full name and address of the candidate, together with a detailed account of the accomplishment on which the proposed award is based, and must be accompanied by corroboratory evidence from persons who have first-hand knowledge of the circumstances and whose statements may be verified to the satisfaction of the Committee of Awards.

7. The medal will be awarded to as many individuals as qualify for it and at such times as the Committee of Awards may authorize.

8. All considerations not specified herein shall be left to the discretion of the Committee of Awards.

All communications to the Committee of Awards may be addressed to—

THE SECRETARY OF THE COMMITTEE OF AWARDS, POPULAR RADIO MEDAL FOR CONSPICUOUS SERVICE, 627 WEST 43rd STREET, NEW YORK.

The Committee of Awards

of the Popular Radio Medal for Conspicuous Service

HIRAM PERCY MAXIM, *President of the American Radio Relay League.*

E. F. W. ALEXANDERSON, *Chief Consulting Engineer of the Radio Corporation of America.*

MAJOR GENERAL CHARLES McK. SALTZMAN, *Chief Signal Officer of the Army.*

REAR ADMIRAL W. A. MOFFETT, *Chief of the Bureau of Aeronautics, U. S. Navy.*

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WILLIAM L. SAUNDERS, *President, United Engineering Societies.*
BRIG. GEN. J. R. QUIGG, *Commander, the American Legion.*
JOHN H. MOSS, *President of Kiwanis International.*

From a photograph made by Borgens, Oslo, Norway, especially for POPULAR RADIO

WHAT EFFECT DOES THE AURORA BOREALIS HAVE ON RADIO RECEPTION?

Among the distinguished physicists who are seeking the answer to this important question is Prof. Lars Vegard of Norway, who is shown above with the apparatus used to obtain the green spectro line of the aurora from frozen nitrogen gas. What has already been learned about this subject of interest to all radio fans will be told in POPULAR RADIO *for May.*

CONDUCTED BY DR. E. E. FREE

Have "Brain Waves" Been Discovered?

THE scientific world, to say nothing of that part of the world which remains blissfully unconscious of science, continues to nurse the hope of identifying some kind of human radiation, some "ray" which may be correlated with the mysterious phenomenon of thought and which may be used, perchance, to provide a reasonable basis for the supposed and cherished instances of thought transference or "telepathy." Radio has been invoked many times as the medium of this transference. But, as the properties of radio waves become better understood, this continues to seem less and less probable. The current idea, nowadays, seems to be that there is some unknown kind of radiation lurking somewhere in the less explored parts of the ether-wave spectrum. Even this, it must be concluded, is extremely doubtful.

In a recent series of papers, M. Francis Marre, of Paris, summarizes the claims made for the reality of some such human radiation.* In England, Mr. C. Russ (not to be confused with Dr. Sidney Russ, the well-known biophysicist of London) has made some stir by announcing his supposed (but very doubtful) discovery of an instrument which can be deflected by the power of the human eye. Much more important than this is the fact that Dr. Ferdinando Cazzamalli, Professor of Nervous Pathology in the University of Milan, Italy, has obtained what he believes to be experimental evidence of the "broadcasting" of radio impulses by the human brain, especially in states of extreme emotion and in abnormalities of the "psychic" variety.†

Whether or not one agrees with the conclusions reached by Dr. Cazzamalli, it is necessary to applaud the care and seriousness with which he has attempted to obtain unmistakable experimental evidence of radio emanations from the brain. The experiments were conducted inside an airtight room, built of carefully soldered sheets of tern plate (sheet iron covered with a lead alloy). This room contained a cot for the patient, a chair and the radio detecting apparatus. Air was provided through filters composed of iron filings and grounded. The metal sides of the room were thoroughly grounded also. If necessary, food could be introduced through a two-compartment metal trap, also grounded. These precautions were necessary in order to keep out stray electromagnetic disturbances. That they were successful was indicated by the fact that a radio receiver inside the sealed room picked up no disturbance whatsoever, not even any static.

The radio devices used in the experiments were of several types, ranging from a simple crystal detector to vacuum-tube receivers provided with two stages of audio-frequency amplification. From the viewpoint of the radio engineer, Dr. Cazzamalli's descriptions are not very complete; but it appears that none of the receivers employed would have possessed extreme sensitivity. Nevertheless, sounds were heard in the receivers whenever the patient, inside the metal room, entered any abnormal or emotional mental state. There seemed to be certain correspondences between the nature of the mental state and the character of the sounds, although Dr. Cazzamalli is properly conservative in asserting this as a definite conclusion.

This is, undoubtedly, an important and valuable experiment. It appears to be the first time that a human being and a radio receiver have been isolated together inside a thoroughly

*"Essays on the Radiation of the Organism" (in French), by Francis Marre. *Radio-Electricité* (Paris), vol. 6, pages 306-307 (August 25, 1925), pages 322-323 (September 10, 1925), and pages 342-343 (September 25, 1925). See also an earlier contribution by M. Paul Lambert, under the same title, to which M. Marre acknowledges indebtedness, which was published originally in *L'Electricité pour Tous* (*Brussels*), January 15, 1925, and republished by *Radio-Electricité*, vol. 6, pages 463-464 (December 25, 1925).

†Dr. Cazzamalli's experiments were announced last summer in the *Revue Metapsychique* (Paris) and were noted in the American newspapers during the week beginning August 16, 1925. His paper has now been translated into English by Mr. J. Malcolm Bird, assisted by Mr. Austin C. Lescarboura, as radio expert. It appears as: "Telepsychic Phenomena and Cerebral Radiations," by Ferdinando Cazzamalli. *Journal of the Society for Psychical Research* (New York), vol. 20, pages 1-17 (January, 1926). POPULAR RADIO is indebted to Dr. Cazzamalli for some additional information concerning his experiments.

grounded cage. There is now no doubt that under these circumstances disturbances of some kind can be picked up by the receiver. Dr. Cazzamalli has indubitably done this. But can we be so sure that the disturbances are "brain waves?"

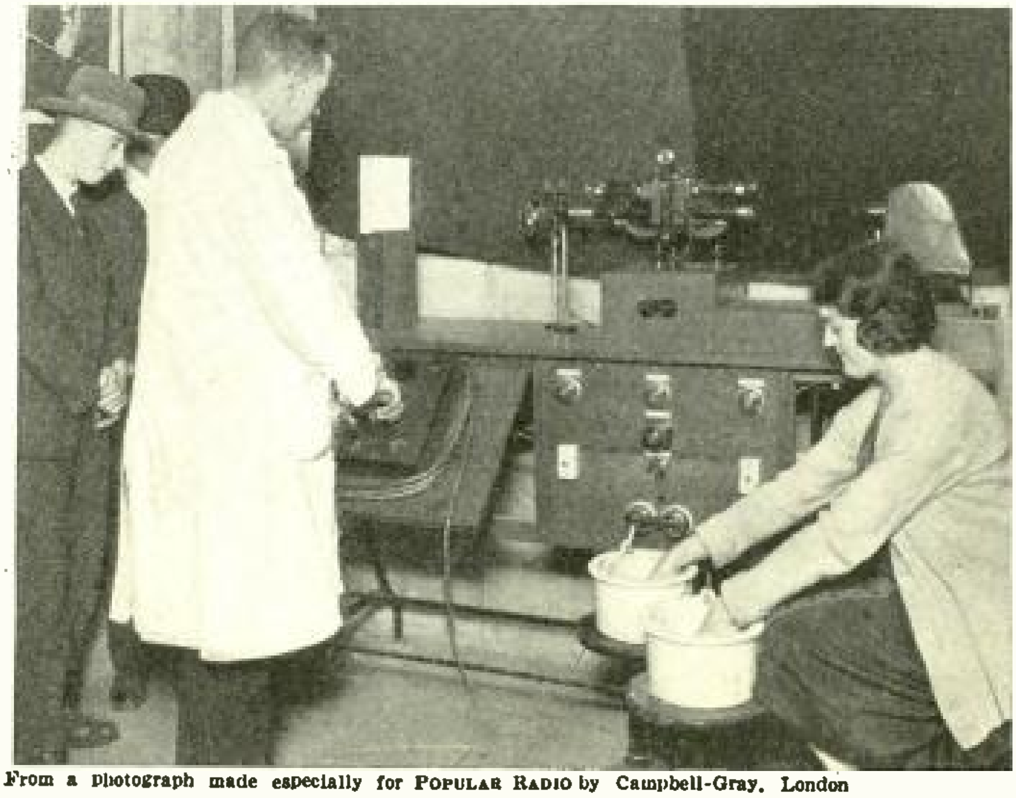
All nerve action, it is true, is certainly of electric character. It is probable that it sends out, as do all electric changes, some variety of ether-impulse; possibly some kind of wave, possibly some quickly-damped impulse more like that created by a sharp and transient electric spark. With these conclusions all physicists and physiologists will agree. But, unfortunately, these electric reactions in the nervous tissues, including the brain, are not the only electric changes which go on in the living human body. Every beat of the heart causes an electric change. That is how the familiar medical instrument, the electro-cardiograph, operates. The corpuscles of the blood are electrically charged. Every time that a muscle contracts, including the involuntary and unconscious contractions of the muscles of the stomach and of other internal organs, an electric change occurs. An ether impulse of some kind is sent out, undoubtedly, into the surrounding space. It seems quite possible that it was some of these bodily reactions which Dr. Cazzamalli's apparatus detected, not any "thought wave" from his patient's brain.

The difficulty in detecting the possible "human radiation" by radio is not that none exists, it is that too much exists; too many kinds of impulses are coming out all the time from the living, active human body. This is no criticism of Dr. Cazzamalli. He has taken an important first step. It is to be hoped that the experiments will be continued and extended as rapidly as possible, both by Dr. Cazzamalli and by others.

What is needed, of course, is not more sensitive receivers but more selective ones. Probably any good radio receiver, properly shielded from outside interference, will duplicate what Dr. Cazzamalli has observed. The problem is to sort out the impulses of different kinds, to separate the heart-waves and the stomach-waves and the muscle-waves and so on, from any possible brain-wave that may be there. The plight of the present brain-wave searcher is like that of a man with an untunable crystal receiver set up in some radio bedlam such as our great cities have now become.

Radio Ills from Sunspots

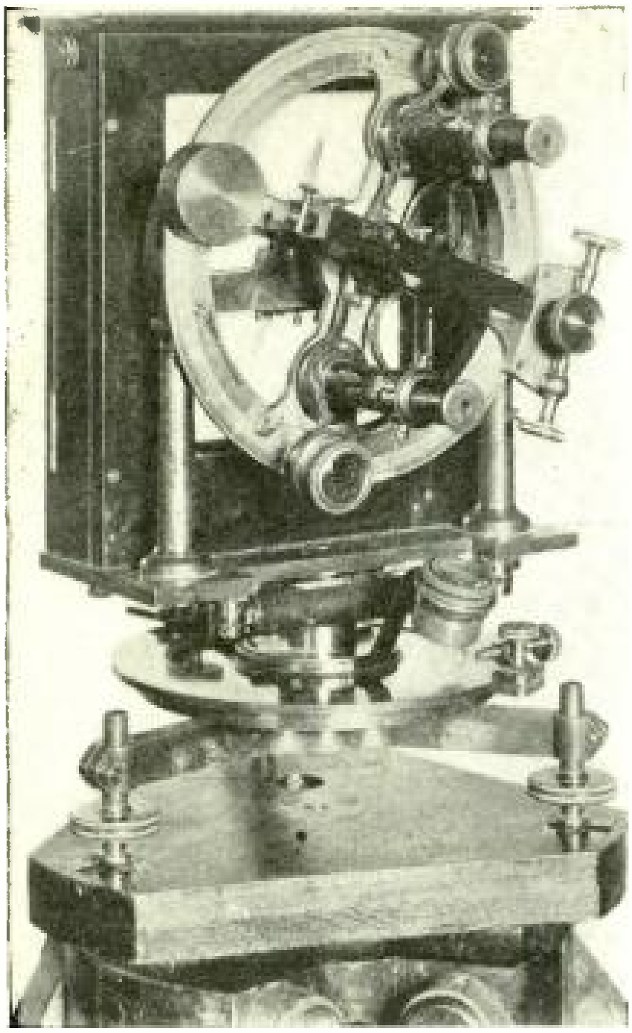
If there remained any radio experts who doubted the effects of the condition of our sun on terrestrial radio, they must have been convinced during the International Radio Tests of the week of January 24, 1926. It happened that at that time there were two active groups of spots on the sun. These were easily large enough to be seen by the naked eye, protected, of course, by a bit of smoked glass. During that same week the aurora was unusually active



From a photograph made especially for POPULAR RADIO by Campbell-Gray, London

MEASURING ELECTRIC CURRENTS FROM THE HEART BEAT

One of the chief difficulties about detecting electric waves from the brain is that every muscle in the body, including that of the beating heart, produces electric changes. The instrument shown here is the electro-cardiograph, used to detect these changes. The girl's hands, dipped into bowls of salt water, make the contacts by which the heart's electricity is communicated to the recorder on the table. This photograph is published by special permission of the British Empire Exhibition Committee of the Royal Society.



U. S. Coast and Geodetic Survey

A DIP CIRCLE

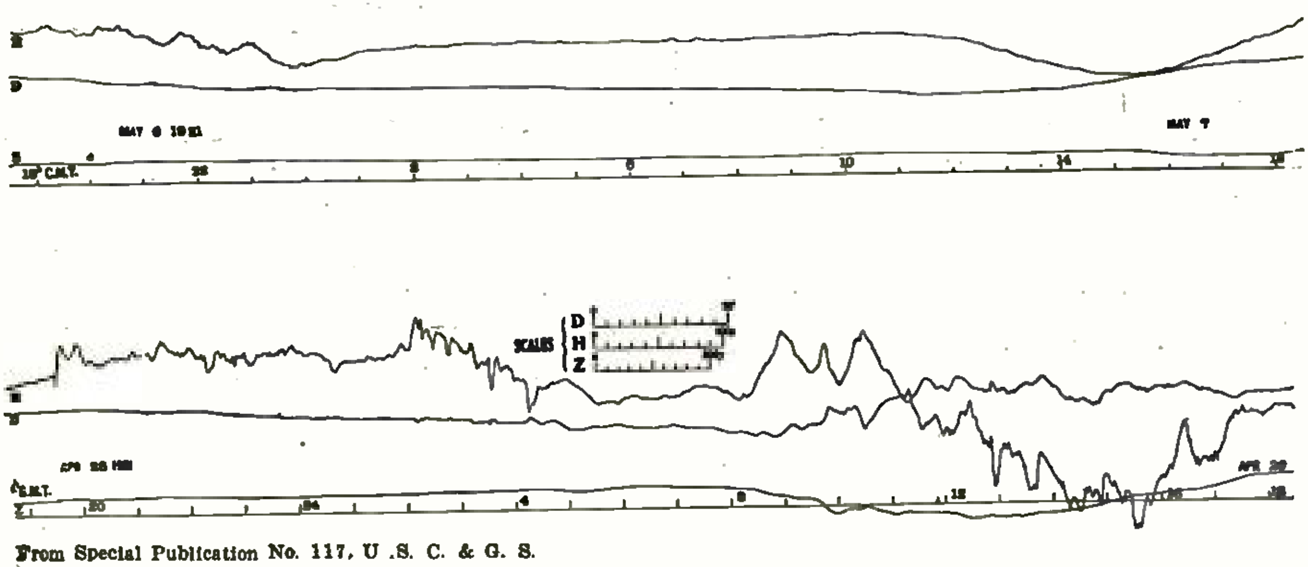
This is a delicate magnetic compass, so arranged that its needle measures the inclination of the earth's magnetism to the horizontal. This inclination, called the "dip," changes during the magnetic storms which so disturb radio.

and severe magnetic storms occurred. That week marked, also, the practical failure of the International tests. Radio transmission across the Atlantic was consistently worse than in many weeks in the spring and fall.

The fact that an unusual number of spots was appearing on the sun became obvious in the first week of November. The group then visible disappeared around the edge of the sun on November 20 and did not reappear. By mid-December, however, another large group had appeared and the sun remained unusually bespeckled after that time. At the time of the total eclipse, on January 14, the observers in Sumatra reported both sunspots and prominences as unusually and unexpectedly numerous. Terrestrial symptoms began on December 27 and 28, both of these dates being marked by magnetic disturbances of moderate intensity. These disturbances continued at intervals until January 26, on which day occurred one of the most violent magnetic storms on record, with corresponding deterioration of radio communication.

By "magnetic storm" is meant an occasion on which the elements of the earth's magnetism show sudden and relatively violent alterations. The direction in which the compass needle points may swing to the east or to the west by a whole degree, or even more. The angle of "dip," which means the normal inclination of the magnetic lines of force to the surface of the ground, may alter also. The intensity of the earth-magnetism, as measured by a magnetometer, suffers simultaneously from the same disturbances.* That these magnetic symptoms

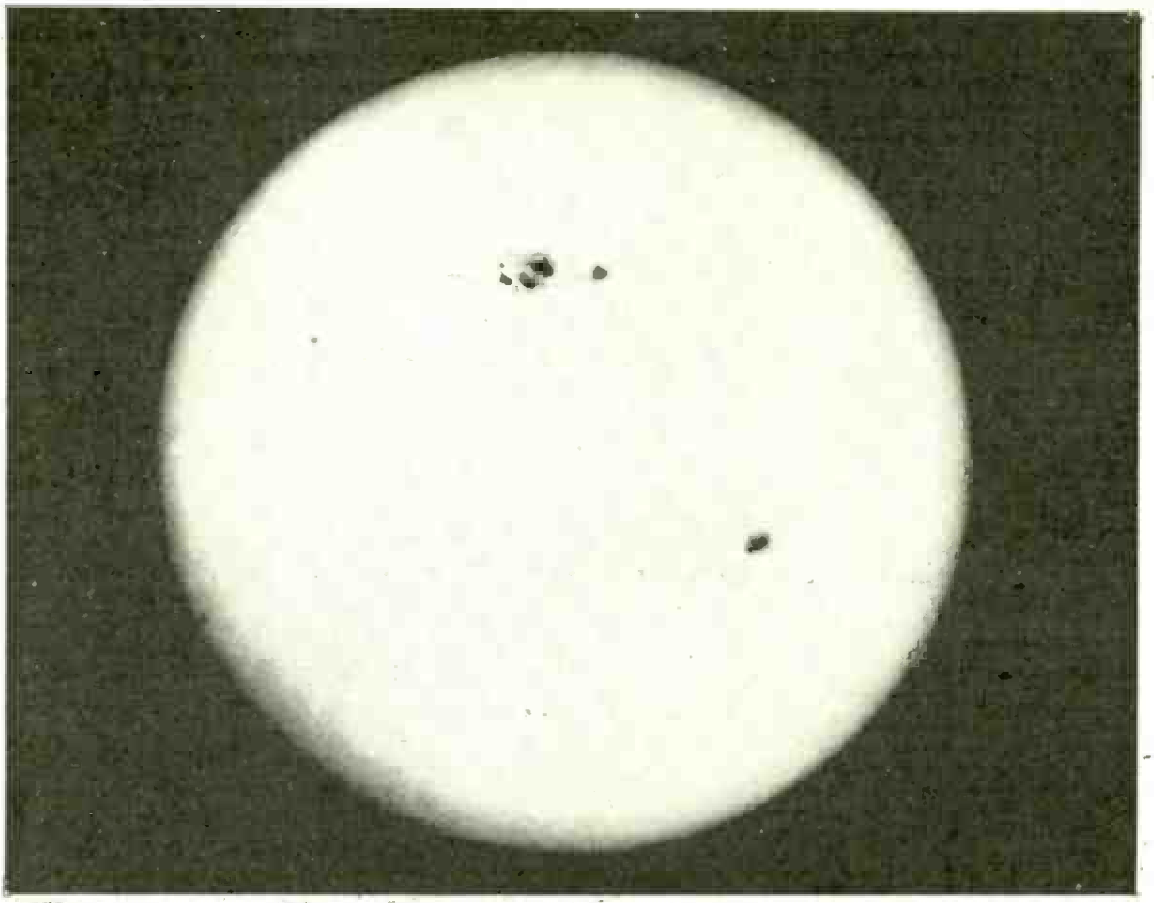
*An admirable general discussion of the earth's magnetic field, its variations and the means of measuring its elements is contained in "The Earth's Magnetism," by Daniel L. Hazard, 52 pages, 1925, published as Special Publication number 117 of the United States Coast and Geodetic Survey and obtainable for fifteen cents from the Superintendent of Documents, Washington, D. C. Every radio fan interested in the effects of earth magnetism on radio should obtain and read this document.



From Special Publication No. 117, U. S. C. & G. S.

A MAGNETICALLY QUIET DAY AND A STORMY ONE

Curves are given for two days, a quiet day above and a disturbed day below. The three curves for each day indicate, respectively, the magnetic declination, the intensity of the magnetic force and the inclination of this force to the earth's surface.



William Henry

DISTURBERS OF THE INTERNATIONAL RADIO TESTS

This picture shows the remarkable sun spots of January 24, 1926. The larger spot was vast enough to have ingulfed a dozen whole earths. Magnetic disturbances connected with the violent solar storms creating these spots caused severe interferences with the international broadcasting tests late in January.

are merely results of a more widespread electromagnetic disturbance as indicated by the simultaneous occurrence of powerful stray currents in long telegraph lines and similar wires, sufficient, in many instances, to paralyze telegraphic communication for minutes or even for hours.

Just how these terrestrial magnetic effects are related to what is going on in the sun is not known, although a general correspondence in time between the terrestrial magnetic storms and an unusual frequency of sun spots has been recognized for many years and is universally admitted. A sun spot consists, the astronomer's believe, of a vast whirling storm in the sun. It is much like a terrestrial cyclone, although far larger. We know, too, by actual observation of the light from sun spots, that vast magnetic forces are at work in them, forces great enough to modify the light-giving power of the atoms caught therein. Possibly these magnetic (and undoubtedly electric) forces in the spots send out electromagnetic waves of some kind which affect the magnetic field of the earth. Or perhaps the messengers are streams of electrons or ions, shot out from the solar atmosphere when this atmosphere is so tremendously disturbed as it is by a vast sun-spot storm perhaps a hundred thousand miles in diameter.

Whatever the mechanism, it is beyond question that spots on the sun mean trouble for telegraphers and for radio listeners here on earth. Radio transmission is dependent, we now know, upon the electric condition of the atmosphere and upon the nature and intensity of the earth's magnetic forces.* Both of these are affected, very powerfully, by the disturbances, whether electronic or radiant, which are sent out from a stormy sun. Our dependence upon the sun for light and heat and power and food is well known. It is now apparent that we are dependent on it, also, for the good or bad quality of radio.

*For the effects of the magnetic forces of the earth on radio transmission see: "How Earth Magnetism Affects Radio Waves," by H. W. Nichols and J. C. Schelleng, POPULAR RADIO for October, 1925, pages 309-316; also, "Alexanderson's Theory of Twisting Waves," POPULAR RADIO for November, 1925, pages 461-463.

Trailing Noises With a Radio Apparatus

ONE of the latest services of radio science to other scientific inquiries is the apparatus, recently developed and applied, by which the loudness of noises of any kind may be measured and reduced to definite quantitative units. This apparatus was applied some months ago to the measurement of the amount of noise produced by a moving automobile. More recently, the apparatus has been used to make a "noise survey" of the streets of Manhattan and of Brooklyn.

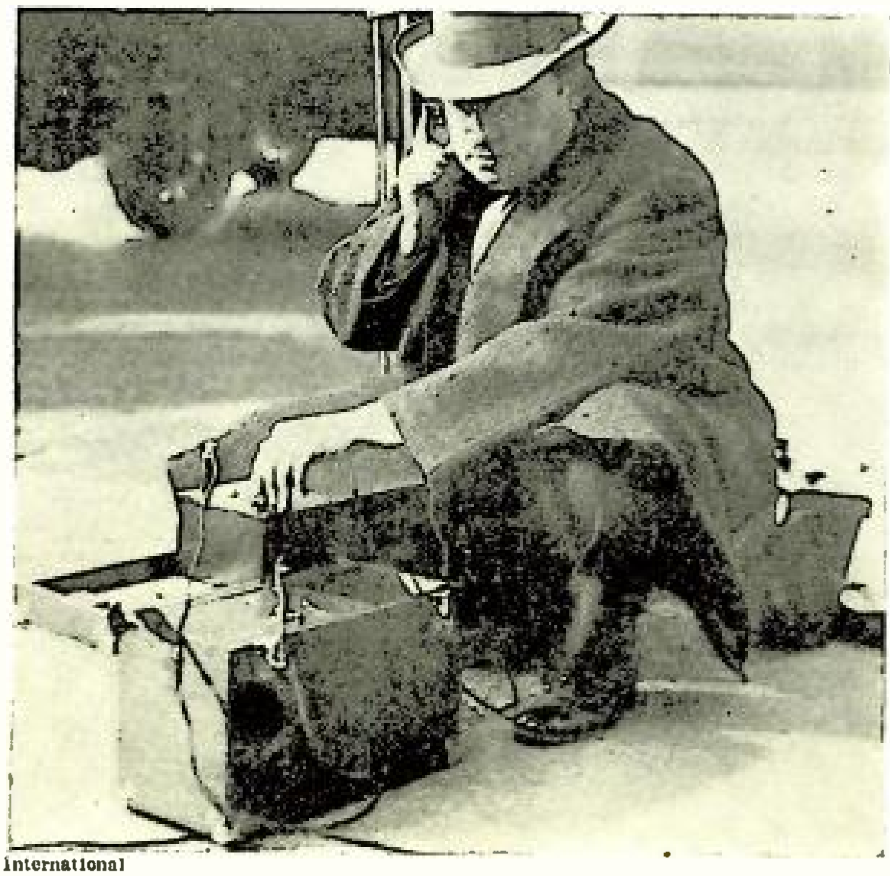
The development began with the audiometer, an instrument devised by Dr. Harvey Fletcher, of the Bell Telephone Laboratories, for the purpose of measuring the hearing abilities of the human ear, especially in cases of partial deafness.* This audiometer consists of a combination of vacuum-tube circuits capable of feeding into a telephone receiver notes of certain given audio frequencies and with any desired intensity, from zero to a tone which is louder than most people can bear. Having perfected this instrument, Dr. Fletcher then devised a smaller, portable form, which does not produce pure tones each of a definite frequency, but merely a single buzzer note, designed to contain most of the audio frequencies present in ordinary sounds and important in hearing. This buzzer note may be attenuated, by a potentiometer, so that any desired intensity, over a considerable range, may be fed into a standardized telephone receiver and thence into the ear which is under test.

For the testing of the percentage of hearing remaining to a person who is partially deaf, all that is necessary is to determine the attenuation of the buzzer note which can be introduced without making the note inaudible. If even the loudest note is unheard, the deafness is considered complete. If the note can be heard at its lowest intensity—the most complete attenuation—hearing is considered perfect.

To measure noise with this device a modification is introduced. Instead of an ordinary telephone receiver, fitting closely against the ear, a receiver is employed which has an offset, so that there is a small space between the receiver and the side of the head. Noise from the surroundings enters the ear through this space. Simultaneously, the tone from the receiver enters the ear. The latter tone may be adjusted in intensity, as just explained. The operation consists, therefore, in adjusting this buzzer-note intensity until the noise from the surroundings just masks it; that is until the buzzer note just cannot be heard against the noise. The note and the noise are then assumed to have the same intensity, an assumption which is found correct by actual test, provided only that the noise being measured is substantially similar in character (as to its component frequencies) to the tone supplied from the buzzer.

This method of measuring the intensity of noise has been applied to automobile noise by B. J. Lemon and H. Clyde Snook and to the general street noise of New York City, in the investigation already mentioned, which was made by the

*See POPULAR RADIO for December, 1924, pages 620-622. For a full account of the audiometers, their theory and uses see: "Audiometric Measurements and their Uses," by Harvey Fletcher, *Transactions of the College of Physicians of Philadelphia*, 1923, 13 pages; and "Physical Measurements of Audition and their Bearing on the Theory of Hearing," by Harvey Fletcher, *Journal of the Franklin Institute* (Philadelphia), vol. 196, number 3, (September, 1923), 38 pages; both reprinted by The Bell Telephone Laboratories, Inc., New York.



International

HOW STREET NOISE WAS MEASURED IN NEW YORK

The buzzer circuit of the audiometer is inside the larger wooden box. The smaller box, resting on the lid of the larger one, is the potentiometer, used to attenuate the buzzer note, as in an audibility meter. The telephone receiver, pressed to the operator's ear, permits the street noise to enter the ear together with a note of known intensity from the buzzer circuit.

Bell Telephone Laboratories

THE MOST COMPLETE FORM OF AUDIOMETER

This instrument, devised for the testing of hearing, uses vacuum-tube oscillating circuits to produce tones of fixed pitch and known intensity. The patient, seated at the right, records the intensity which she can just hear. Thus the sensitivity of the ear for various pitches is determined. Standing behind the patient is Dr. Harvey Fletcher, of the Bell Telephone Laboratories, who perfected the audiometers, including the one used for noise measurement.

Forum, a magazine of that city.*† The apparatus and its use for noise measurement were described by Mr. Snook before the Society of Automotive Engineers in June, 1923, and again before the New York Electrical Society, February 3, 1926.

The most striking conclusion from the noise survey of New York City is that practically all of the city noise is produced by the traffic on the streets, with the automobile truck ranking as the greatest contributor. As might have been expected, the noise is local in distribution; the back rooms of a house may be very quiet, even though the house fronts on a very noisy street. In terms of physical units, the quietest places in the city have an average noise intensity of approximately .001 dyne per square centimeter; the noisiest places reach an average of about 20 dynes per square centimeter, a variation of twenty thousand times. The noise of 20 dynes per square centimeter means, in terms of human hearing, that about half the normal sensitivity of the human ear is lost where that level of noise prevails.

The most interesting feature of these new methods and tests (for the radio engineer, at least) is what they suggest for the future. Noise is increasing in our cities; it is increasingly annoying. There is more and more demand for noiseless automobiles, noiseless offices, quieter houses, machinery that is less ear-splitting. One can scarcely doubt that there will be, before many more months, a new profession of noise engineer. The tools of this profession will be radio tools; its technique will be, essentially, the technique of the radio engineer. It will merely be audio-frequency work instead of radio-frequency work. The path blazed by the Bell Telephone Laboratories, in the persons of Mr. Snook and Dr. Fletcher, will be followed, we may be sure, by many of the radio fraternity.

We must not forget, however, an important caution. The science of sound has been a backward one for a generation. Other sciences have outstripped it. Many of its basic facts are unknown or are known only imperfectly. These facts are being discovered or corrected quite rapidly. They will soon be available, just as the facts about city noise have become available. In the meantime, guessing is dangerous. The fact that acoustic engineering is likely to call for

*See the important paper "Automobile Noise Measurement," by H. Clyde Snook. *Journal of the Society of Automotive Engineers*, vol. 17, number 1 (July, 1925), 29 pages, reprinted by Bell Telephone Laboratories, Inc., New York City.

†"How Noisy is New York," by E. E. Free. *The Forum* (New York), vol. 75, number 2, pages xxi, xxii and xxiv of the illustrated section (February, 1926). Newspaper accounts, with some additional data, were published in the New York Herald-Tribune for January 15, 1926, and in the Brooklyn (New York) Eagle for January 21, 1926.

men and for answers should not induce ill-prepared enthusiasts to rush into it too rapidly or to promise or attempt too much.

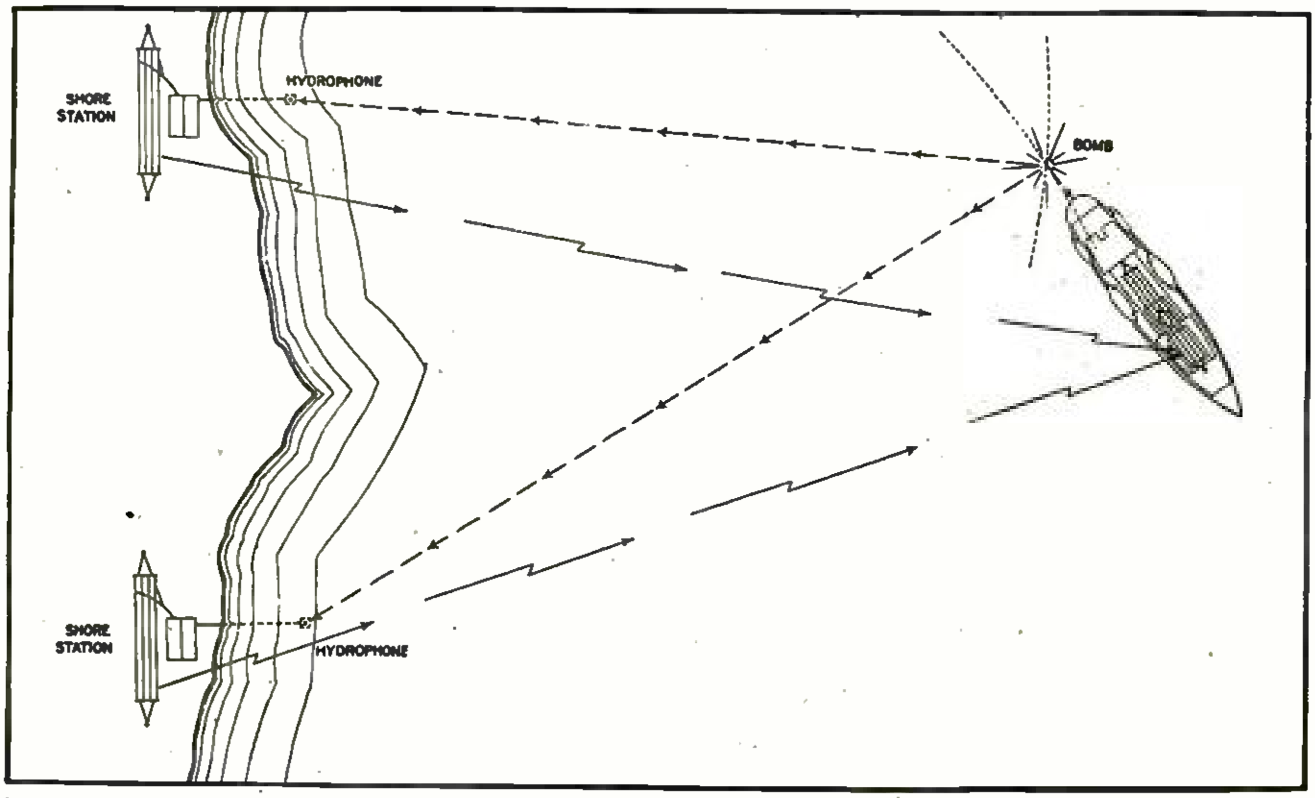
A New Radio System for Locating Ships

An ingenious combination of sound waves and radio waves has been perfected by the United States Coast and Geodetic Survey in order to locate the exact position of a survey ship off the coast, even when the coast line is hidden by fog, haze or the smoke of forest fires ashore.* Under normal conditions the location of a vessel engaged, for example, in making precise soundings for shoals and reefs, is determined by taking the direction of two or more visible points on the shore, so that the ship's position may be fixed on the chart by what surveyors call "triangulation." This requires good vision of the shore stations. When they cannot be seen the use of this method is impossible.

The new method obviates this difficulty. Visibility of points on shore from the surveying ship is not necessary and only a stiff gale will cause the suspension of the survey work. "The measurement is made," says the Survey, "by recording the speed of a sound wave from ship to shore and then converting it into distance," a conversion which is quite easy when the speed of sound in sea water is known. "The sound is produced," the Survey's statement continues, "by the detonation of a time-fuse bomb of T. N. T., which is dropped from the vessel while under way. The sound of the explosion is picked up on board ship by a hydrophone (a microphone for under-water service) which converts the pressure variations of sound waves into variations of electric current. These variations are amplified to operate a relay, through which the instant of explosion is registered on a strip of moving paper. The ticks of a chronometer are also recorded on this strip.

"The sound wave from the explosion is also picked up on shore by a hydrophone planted on the bottom of the sea and connected to the shore station. The sound impulse is amplified to operate a relay, which, after a predetermined interval, starts a radio transmitter to sending out a code message for that particular station. Reception of this message on the vessel is recorded on the chronograph strip. After the known lag at the shore station is subtracted, the travel time [for the sound wave in the water] is converted into distance. * * * * Coast and Geodetic Survey vessels have worked successfully 206 miles off shore by this method." If

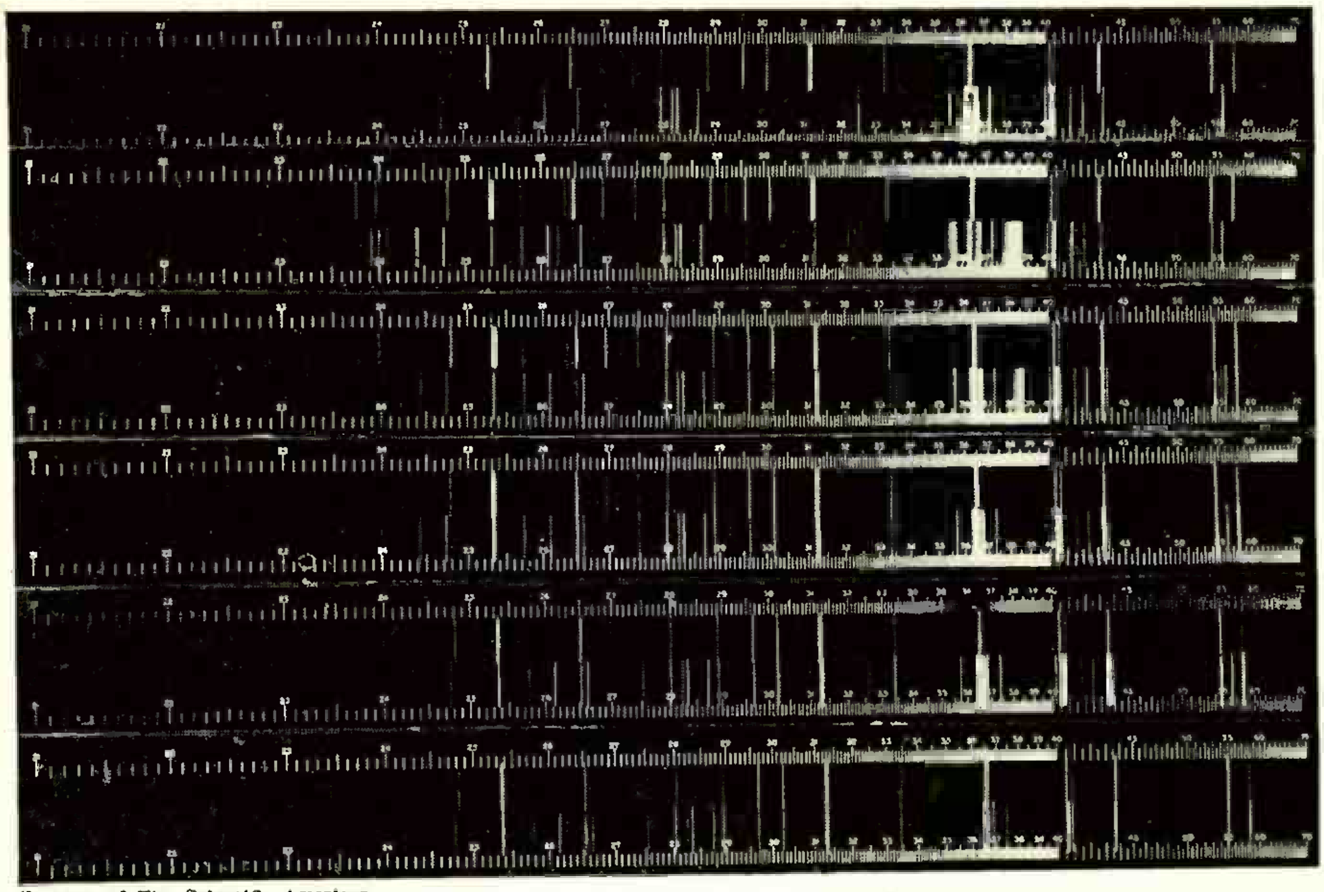
*The method was mentioned by Commander N. H. Heck, of that Survey, in an address before the American Association for the Advancement of Science, at Kansas City, Missouri, on December 29, 1925. Information for the present note has been kindly supplied especially to Popular Radio by Director E. Lester Jones, of the U. S. Coast and Geodetic Survey, Washington, D. C.



U. S. Coast and Geodetic Survey

HOW RADIO AND SOUND WAVES FIX A SHIP'S POSITION

A bomb is dropped from the ship and explodes under water. Sound waves travel through the water, affecting the hydrophones on the sea bottom near shore. This starts the radio transmitter at the shore stations. Their signals are picked up on the ship, thus fixing the time needed for the sound wave to travel from ship to shore. The distance can be calculated from this time.



Courtesy of The Scientific American

THE RECORD OF A SUPPOSED CREATION OF MERCURY

In this series of spectra, photographed by Professor Smits, the lines due to lead become weaker and the lines due to mercury become stronger from the top of the series downward, this corresponding to the length of time that the molten lead had been exposed to electric action in the lamp. Professor Smits believes that this change indicates a transmutation of the atoms of lead into atoms of mercury.

desired, the velocity of the sound wave in the sea water of that particular locality may be determined by exploding bombs and taking the radio records at times of clear weather, when visual checks on shore stations are possible.

Another Alchemist Appears

READERS of POPULAR RADIO will remember the claims made two years ago by Professor Adolf Miethe, of Berlin, that he had succeeded in the age-old quest of the alchemists and had transmuted the element mercury—common quicksilver—into gold. A little later, Professor Hantaro Nagaoka, of Japan, claimed to have accomplished the same feat. Unfortunately, these claims did not stand unchallenged. Some of Professor Miethe's own colleagues, in Berlin, reported against his claim. Professor H. H. Sheldon and Mr. R. S. Estey, of New York University, repeated the experiments, exactly as described by Miethe, but obtained no gold.* Nagaoka's experiments do not seem to have been repeated critically; but they are similarly under suspicion in well-informed scientific circles.

Now appears another scientist who believes that he has accomplished the transmutation of one atom into another. Gold is not involved, the transmutation being of lead atoms into thallium atoms and, ultimately, into mercury atoms. The scientist is Dr. Arthur Smits, well-known and respected Professor of Chemistry in the University of Amsterdam, Holland.† The method is similar to that used by Miethe. Pure lead is put into a quartz tube and heated. Through the vapor of lead thus produced in the tube powerful electric currents are passed, usually in the form of intermittent heavy sparks. The spectrum of the light is photographed. In the beginning, this spectrum shows the lines of lead. As the sparking goes on, the lead lines grow weaker, while lines of thallium and of mercury appear and grow stronger. It is assumed that lead atoms are being converted into thallium or mercury atoms.

Professor Smits' report is straightforward and impressive. However, the scientific world, once bit (however unintentionally) by Professor Miethe, is twice shy. The Amsterdam claim does not seem to have met with very general acceptance. Except for one rather doubtful chemical test, the evidence of the formation of mercury is purely spectrographic, and spectra have a way of performing unexpected tricks.

*See "The New Alchemy Fails to Make Gold," this Department of POPULAR RADIO for December, 1925, pages 577-578.

†"Transmutation of Elements" by A. Smits. *Nature* (London), vol. 117, pages 13-15 (January 2, 1926), and "The Transmutation of Elements," by A. Smits and A. Karssen. *The Scientific American* (New York), vol. 134, pages 80-81 (February, 1926).

CONDUCTED BY HUGH S. KNOWLES

IN *justice to our regular subscribers a nominal fee of $1.00 per question is charged to non-subscribers to cover the cost of this service, and this sum must be inclosed with the letter of inquiry. Subscribers' inquiries should be limited to one question or one subject.*

The Use of Silver Wire for Bus Wiring

QUESTION: I am rebuilding my receiver and want to make it as efficient as possible. I have used the best parts available throughout and want to spare nothing to make it as fine a set as may be built. I understand that sterling silver is a better conductor than copper. Would you advise me to use it in connecting up the set?

SAMUEL BIRD.

ANSWER: This is a common question; it indicates that some set builders have consulted a table of specific resistances. The conductivity of annealed electrolytic copper is about 95 percent that of *pure* silver. Sterling silver is not pure silver but an alloy that contains considerable copper. Its conductivity therefore, is less than that of pure silver. Aside from this consideration however, and even assuming that pure silver is used, the difference in conductivity does not warrant the additional expense. It would be just as logical to use silver wire in the loop and this would be very expensive. The slight difference in conductivity can be compensated for by using wire a size larger.

The Use of a Wave-trap with Loop Receivers

QUESTION: There is a powerful station about two miles from my house that is very hard to tune out. I am using a standard type eight-tube superheterodyne with a loop. Can a wave-trap be used with a loop antenna? Would it help to eliminate this interference?

HAROLD FIELDING

ANSWER: When the received wave differs sufficiently from the interfering wave, a wave-trap may be used advantageously with any type of antenna. The wave-trap is nothing but a parallel resonant circuit designed to offer a verv high impedance to the frequency to which it is tuned. Increasing the resistance of this circuit *decreases* the impedance to this resonant frequency so a good coil and condenser should be used.

As in the case of an outdoor antenna the wave-trap may be used either by connecting it directly in series with the loop or by coupling it to a small coil connected in the loop circuit. In practice this latter arrangement is generally to be recommended since its reaction on the loop circuit may be controlled more easily.

How to Test Large Condensers

QUESTION: I have a few bypass condensers ranging in capacity from .1 to 1 mfd., which I use in making up sets. I have tried testing them with a headset and battery but they all give a pronounced click which I understand should indicate that they are defective. Is there any more accurate method of comparing any two condensers to determine which has the higher resistance, that is, which is the better to use in a set?

WILLIAM CLARK.

ANSWER: The usual phone and battery test is unsatisfactory for condensers of this type. This is due both to the high capacity and to the relatively low resistance of this type of condenser.

High capacity condensers possess a large initial current which will produce a loud click in the phones, while condensers with a low resistance will discharge rapidly enough so that subsequent tests also give a click in the phones.

There is a simple method which may be used to get a relative idea of the resistance of several condensers.

Charge the condensers with fairly large capacities by means of a single dry cell. For small capacities of the order of .0005 mfd. more voltage should be used. (The charge on a condenser is equal to the product of the capacity and the applied voltage.)

The battery should be connected directly across the condenser for a period of from five to thirty seconds or possibly even longer. The reason for this is that the charging time should be the same for all of the condensers compared, and it is somewhat easier to measure a long period of time accurately than a short one.

Wait a few minutes (which should be timed not estimated) and connect the phones across the condenser. Unless the condenser is a poor one there should be a pronounced click, thus showing that the condenser is not completely discharged.

Charge the condensers again and increase the time before testing until there is a barely perceptible click. The condenser that requires the longer time to discharge to this point is the better one, as it has the higher resistance.

It must be remembered that this system is satisfactory only when condensers of the same capacity are to be tested or compared. The relation between the time required to discharge and the resistance is a complicated one and the fact that one condenser takes twice as long to discharge as another does not necessarily indicate that it has half the resistance.

How to Insert a Crystal Detector in the Four-circuit Receiver

QUESTION: I have a Cockaday four-circuit receiver which was built from the description given in the October, 1924 issue of POPULAR RADIO. I have heard that a crystal detector gives better quality than a tube detector, so I should like to experiment with it, even though this set gives very good quality. If I could use it on local stations it might operate satisfactorily and save the heavy "A" battery drain of the UV-200.

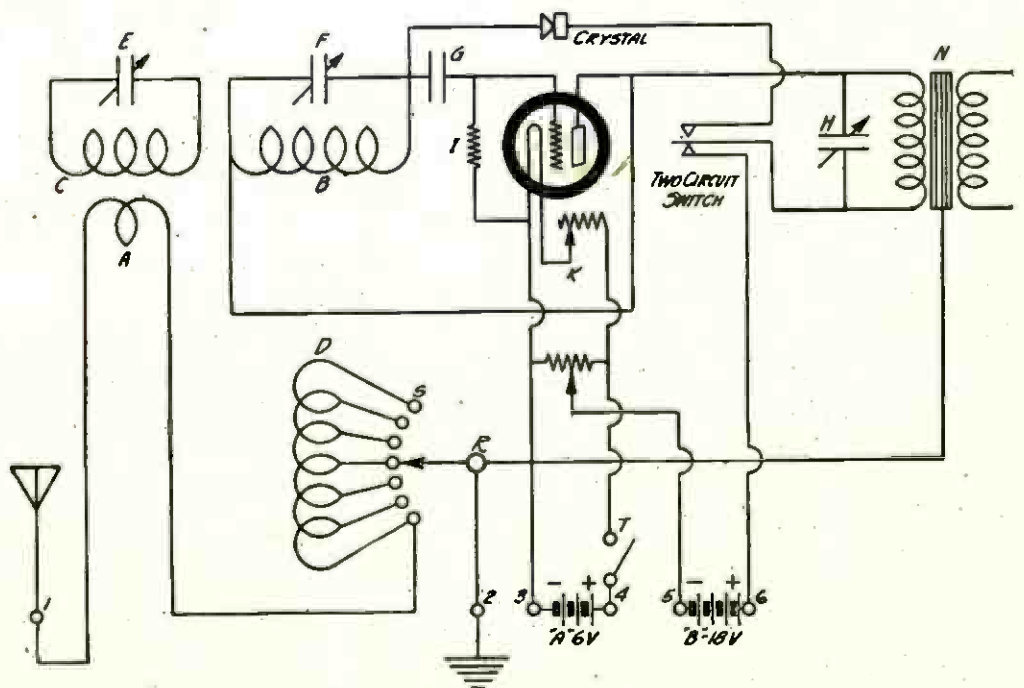
EDWARD CARSON.

ANSWER: This change may be readily made as may be seen from Figure 1.

You will need a single pole double throw switch such as the Yaxley No. 30. Disconnect the "B" plus lead to the audio-frequency transformer from the transformer and connect it to one of the stationary springs of the switch. Connect the transformer binding post just disconnected to the moving spring of the switch. Connect the other lead of the switch to one side of the cyrstal detector and the other side of the detector to the outside lead of coil B as shown.

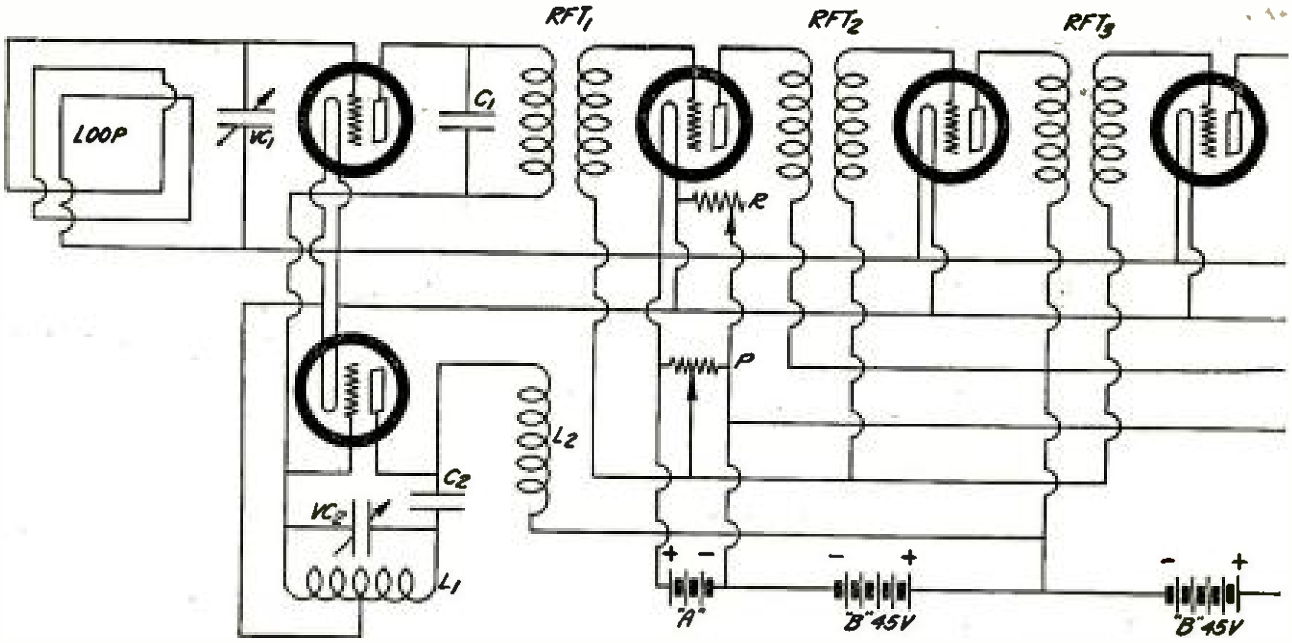
Make the leads to the crystal detector as short and direct as possible and space them as far as possible from the plate leads. If the change from one type of detector to the other is to be made frequently you may find it convenient to put the switch on the panel over the Dublwundr. This necessitates rather long leads and we suggest you mount it on a small brass bracket on the baseboard just back of the first socket.

The letters on the various parts are those used on the original diagram of this receiver.



THE FOUR-CIRCUIT RECEIVER WITH A CRYSTAL DETECTOR

FIGURE 1: *This schematic diagram shows how the change from a vacuum tube to a crystal detector may be made in the Four-circuit receiver. All the lettering in the drawing is identical with that employed in the original diagram of the receiver.*



A SCHEMATIC DIAGRAM OF THE ULTRADYNE

FIGURE 2: *The detailed hook-up of the Ultradyne superheterodyne receiver which is described below. The lettering of the apparatus in the drawing corresponds with that in the printed list of parts.*

How to Build the Ultradyne Superheterodyne

QUESTION: I have heard a great deal lately about the Ultradyne, and as I still have a set of intermediate frequency transformers together with most of the other parts I once used in a nine-tube superheterodyne, I want to build a set using this circuit. Since coils for this receiver cannot be bought locally I would appreciate your giving me the specifications for them as well as the circuit of the set. Will you kindly give me the necessary information as well as a complete diagram that will help me in wiring up?

HENRY BAINBRIDGE.

ANSWER: The circuit of this receiver is given in Figure 2.

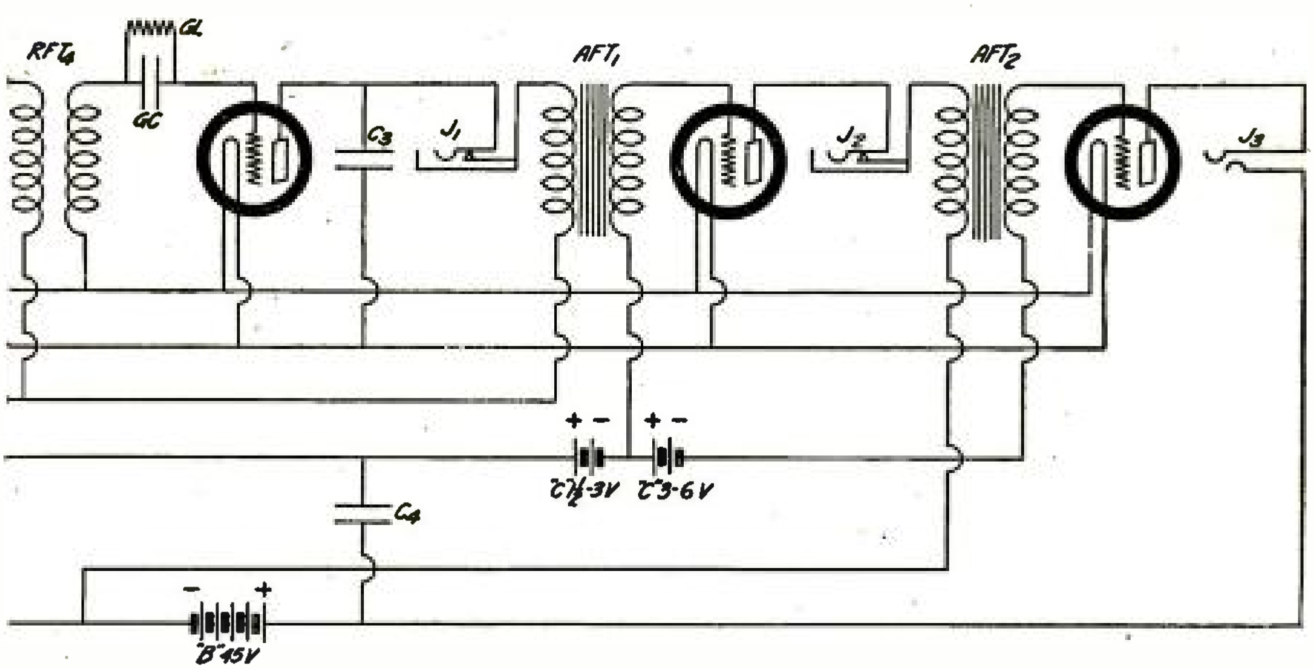
You will need the following parts:

RFT1—Intermediate frequency transformer, tuned input;
RFT2, RFT3 and RFT4—Intermediate frequency transformers, untuned;
VC1—Variable condenser, .0005 mfd.;
VC2—Variable condenser, .0005 mfd. vernier;
C1—Condenser, fixed, .0005 mfd.;
C2—Condenser, fixed, .006 mfd.;
C3—Condenser, fixed, .002 mfd.;
C4—Condenser, fixed, .5 mfd.;
GC—Condenser, grid, .00025 mfd.;
GL—Grid-leak, 2 megohm;
P—Potentiometer, 300 to 400 ohm;
R—Rheostat, 2 ohm, 2 to 2.5 ampere capacity;
AFT1 and AFT2—Audio-frequency transformers, first and second stage respectively;
J1 and J2—Double circuit jacks;
L1—Oscillator inductance (57 turns of No. 22 DSC or DCC wire on a 3-inch tube tapped at 28½ turns);
L2—150 to 300 mili-henry choke, small and connected close to plate;
Loop—This should be made by winding 15 or 16 turns of No. 18 wire (preferably stranded or fixture wire for mechanical reasons) on two slotted cross arms. The outside turn should be two feet square with turns spaced about ¼-inch.

The necessary battery voltages are indicated in the diagram.

As the first tube has no plate voltage other than the alternating current voltage supplied by the oscillator, the oscillator must be operated so as to give a larger output than is usually necessary. You may find that the voltage of the first "B" battery block shown in the diagram will have to be as high as 90 volts. As this voltage is also applied to the intermediate frequency amplifier, in this way considerably increasing the "B" battery drain, it may be advisable to connect the oscillator plate to the second block in order to secure the necessary voltage without increasing the amount applied to the intermediate frequency amplifier.

When an oscillator is operated at large outputs there is considerable wave form distortion; that is, considerable energy is present at harmonic frequencies. This is due to the tube characteristic. Consequently you may have trouble with harmonics from the oscillator as well as a few repeat points, particularly on local stations. This trouble may be minimized by using a larger tube of the semi-power type and by employing some negative bias on the grid.



The Use of a Loop or an Antenna Coupler

QUESTION: I have just built one of the McLaughlin single control super-heterodynes. I have been unable to obtain one of the loops specified for this receiver. I have been using a Korach loop and the results have been very satisfactory, but I would like to dispense with loops altogether if possible and use my antenna. Can you suggest a means of doing this?

ARTHUR WILLIAMS

ANSWER: Although this can be done rather easily it is not altogether satisfactory and should not be resorted to except when a loop cannot be used. The loop has the advantage of giving a higher signal to static ratio, directional properties, greater selectivity (due partly to the former) and of more nearly giving a straight-line-frequency curve over the portion of the condenser that is used. This last characteristic is important where single control is used, due to the fact that there has to be a constant frequency difference between the oscillator and loop or input circuit.

Where an antenna coupler is used the curve deviates from that obtained with the loop due to the reaction of the antenna circuit on the secondary circuit through the coupling which must necessarily exist between the two. To minimize this effect and to improve selectivity the coupling between the primary and secondary should be loose.

To make an antenna coupler to use with this receiver sixty turns of number 20 DCC or DSC wire should be wound on a 3 or 3¼ inch composition tube. Space an inch and wind eight turns of the same wire for the primary. The four binding posts for the primary and secondary can be mounted directly on the tube. To improve the looks of the unit it can be mounted in a small cabinet and the binding posts mounted on the panel. The two phone tips supplied with the "Imp" jacks should be soldered to two short leads and connected to the secondary of the coupler.

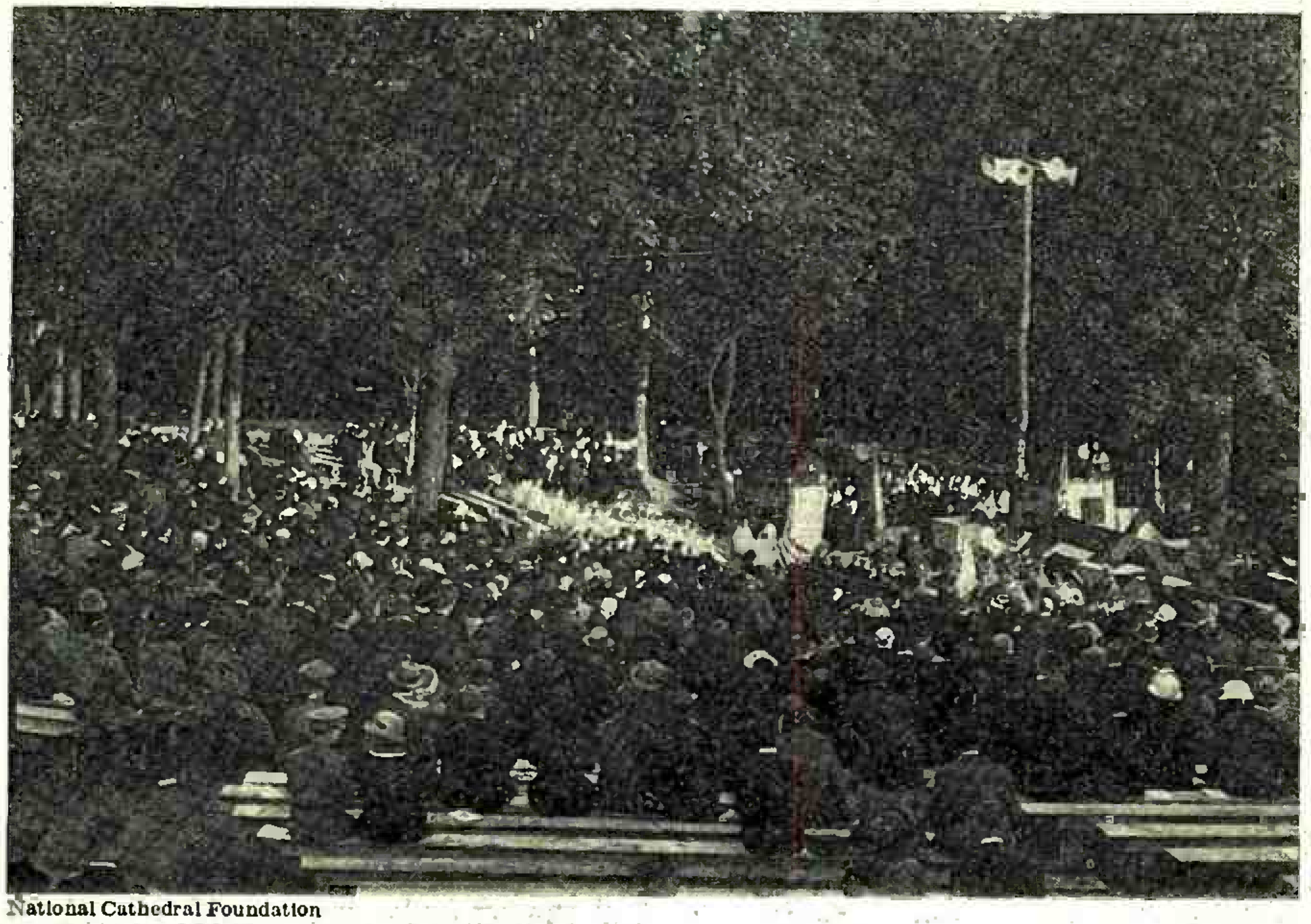
If the antenna is large it may be necessary to connect a .00025 fixed condenser in series with one of the primary leads. Where necessary the selectivity may also be improved by removing turns from the primary.

To place the unit in operation connect the antenna and ground leads to the primary and the two leads from the loop jacks to the secondary binding posts. This should be done while the lid of the set is open so the condensers can be adjusted. Set the midget condenser so that half of the rotor plates are engaged. Tune the receiver while using the headphones until a station is heard. One of the set screws on the coupling connecting the two variable condensers should then be loosened and the oscillator condenser (the rear one) should be rotated slightly until the signal is loudest. The set-screw should then be tightened. The capacity variation which can be gotten through adjusting the midget condenser will compensate for any frequency difference between the oscillator and the loop circuits.

The Menace of the Radio "Press Notice"

"Dreaded censorship will certainly come unless the broadcasters wake up to the realization that only clean, wholesome material has any right in God's air. National advertisers will learn that they are causing a feeling of antagonism only when they force their sales talk into the homes of the people."

—DR. LEE DE FOREST



National Cathedral Foundation

BROADCASTING AN OUT-DOOR CHURCH SERVICE

Not only does the Reverend Microphone appear in the pulpit during divine worship held on on the grounds of the Cathedral of St. Peter and St. Paul in Washington, D. C., but amplifiers are employed (as shown above) for carrying words and music to the assembled multitudes which constitute but a tiny fraction of those who listen in.

The BROADCAST LISTENER

Comments on radio programs, methods and technique —from the point of view of the average fan

By RAYMOND FRANCIS YATES

The Squealing Receiver Is a Social Nuisance

OUR international tests have been the subject of splendid newspaper articles; but the results have been far from satisfying. As a matter of fact, they have been so bad as to bring the whole thing pretty close to a downright fiasco. Each night at the appointed hour the air was found writhing like a mass of worm squeals and howls of every imaginable degree of frequency. To tune into a mess like that in hope of enmeshing a foreign wave was nothing but the shearest folly. Yet thousands upon thousands who, ordinarily could not get beyond the bounds of their state line, strained and struggled to catch one fleeting note of the foreign stations. It was all very sad and very disappointing.

In our rash judgment of the thing, we must not overlook the loads and loads of real sport had by the Radio Boy Scouts. The distance-eaters were as happy as Elks at a carnival. So after all, the trans-Atlantic tests were not the dismal failure they might have been.

In reviewing this trans-Atlantic test business, it is interesting to note that the only thing that prevented complete and glorious success was the presence of the squealing receivers. The carrier waves of all of the British broadcasters were easily heard and it was only the wild shrieks of the unsatisfied tickler coils that made of the whole thing a somewhat grotesque display of the evil spirits of the air.

Is there not some way of making the owner and user of a squealing receiver realize his obligation to his fellow listener? Is there not some way of impressing him with the fact that he is a social nuisance? Then, too, we often wonder if the manufacturers who supplied such contraptions to the public in the early days, do not feel just a little sting of compunction? If they don't, they should.

* * *

How To Listen In

WE came to thinking the other day that we had in a measure failed to fulfill our obligation to the hundreds of thousands of our faithful readers who mob the newsstands on the 20th of each month that they may share the wisdom of this philosopher. Here we have been whittling out these clever little items for over a year now and not once have we given the listening public the real inside dope on radio reception. It's a pretty raw deal when you come to think it over; but we hasten to make amends; and now, for the first time, our faithful followers will be given full instructions, which, if followed, will turn every evening at the radio into a period of Alice-In-Wonderland pleasure.

In giving out these secrets of reception, we are naturally assuming that you are that type of body who would much rather listen to a harmonica solo from a local station than to listen to Paderewski at distance of 2,500 miles. Some very dear friends of ours would, strange as it may seem, much rather listen to a harmonica solo at a distance of 2,500 miles than to listen to Paderewski at a distance one mile. That, of course, is one of the great mistakes of listening in and we want to warn you against it right now. The real secret of radio broadcast reception is to keep in your own back yard as far as possible.

And what is the second great secret of perfect reception? Perhaps we shouldn't tell you, but we feel that we owe it to posterity and once you convince yourself that you owe anything to posterity, you ought really to give it up. The second great secret of perfect reception (clearing of the throat) is the simple matter of planning your own program from the material listed at the several nearby stations that supply your nightly entertainment. If you will cultivate the habit of reading the programs with a No. 2 reading glass and if you put your ear right down close to the page of the newspaper, you will be able to detect the best items on each bill. The mere application of a red pencil finishes the job and then you are ready to sit down and enjoy a program that you have in a measure planned yourself. As a practical example of this scheme we are having printed below a copy of a New York program. The features bearing the X were marked at the beginning of the evening. They afforded us not only variety but practically uninterrupted entertainment:

NEW YORK

492—WEAF—610.

6:45-7:45 A. M.—Setting-up exercises.
7:45 A. M.—Morning prayer service.
10:45 A. M.—Home service talk.
11:05 A. M.—Anna Frevola, piano; talk.
11:30 A. M.—Columbia Univerity lecture.
12:00 M.—Market and weather reports.
2:30 P. M.—Government Club meeting; Mrs. George Owens, President.
4:30 P. M.—B. Gorden, tenor; talk.
5:00-6:00 P. M.—Ritz-Carlton Orchestra.
x6:00 P. M.—Waldorf-Astoria dinner music.
7:00 P. M.—Columbia University lecture.
x7:20 P. M.—Iris Torn, piano.
7:30 P. M.—"Lullaby Lady"; songs.
8-00 P. M.—"Pop Concert."
x8:30 P. M.—"Coal Miners' Trio."
x8:45 P. M.—Talk, "Louis Pasteur."
9:00 P. M.—Gypsy Entertainers.
10:00 P. M.—"Norma."
x11:00-12:00 P. M.—Bernie's Orchestra.

455—WJZ—660.

1:00 P. M.—Park Lane Orchestra.
2:00 P. M.—News.
3:30-4:30 P. M.—Helpful talks.
4:32 P. M.—Sherry's Trio.
5:32 P. M.—Market closings and summary.
x7:00 P. M.—Commodore dinner concert.
7:55 P. M.—Talk, John B. Kennedy.
8:00 P. M.—Arion Male Chorus.
x9:00 P. M.—F. F. French dinner: Hadley's Philharmonic Orchestra; Fred F. French, speaker; Mary Garden, soloist.
10:30 P. M.—Waldorf-Astoria Orchestra.

316—WGBS—950.

10:00-11:00 A. M.—Timely talks; music.
1:30 P. M.—Scripture reading.

Kadel & Herbert

THE FIRST RADIOPHONE BOOTH ON A GERMAN EXPRESS TRAIN

Uninterrupted telephone service while you travel along at a rate of sixty miles an hour is the latest convenience which is offered to travellers on the Berlin-Hamburg express in Germany.

1:35 P. M.—Interview, Helen MacKellar.
1:45 P. M.—Piano duets; songs.
3:00 P. M.—Interview, William Harrigan.
3:10 P. M.—Virgil Forrest, piano; Adele Herman, recitations; Women Voter's hour.
6:00 P. M.—Uncle Geebee.
6:30 P. M.—Royal Balalaika Orchestra.
7:00 P. M.—Bankers' Association talk.
7:10 P. M.—Premier Club Orchestra.

341—WMCA—880.

6:00 P. M.—Vail's String Ensemble.
6:30 P. M.—Golden's Orchestra.
x7:30 P. M.—Karnival Kings.
8:00 P. M.—Terminal musicale.
9:00 P. M.—Christian Science lecture.
10:15 P. M.—Messner Quintet.
10:45 P. M.—Barclay musicale.
11:00 P. M.—Manhattan Serenaders.
11:30 P. M.—Frivolity Orchestra.

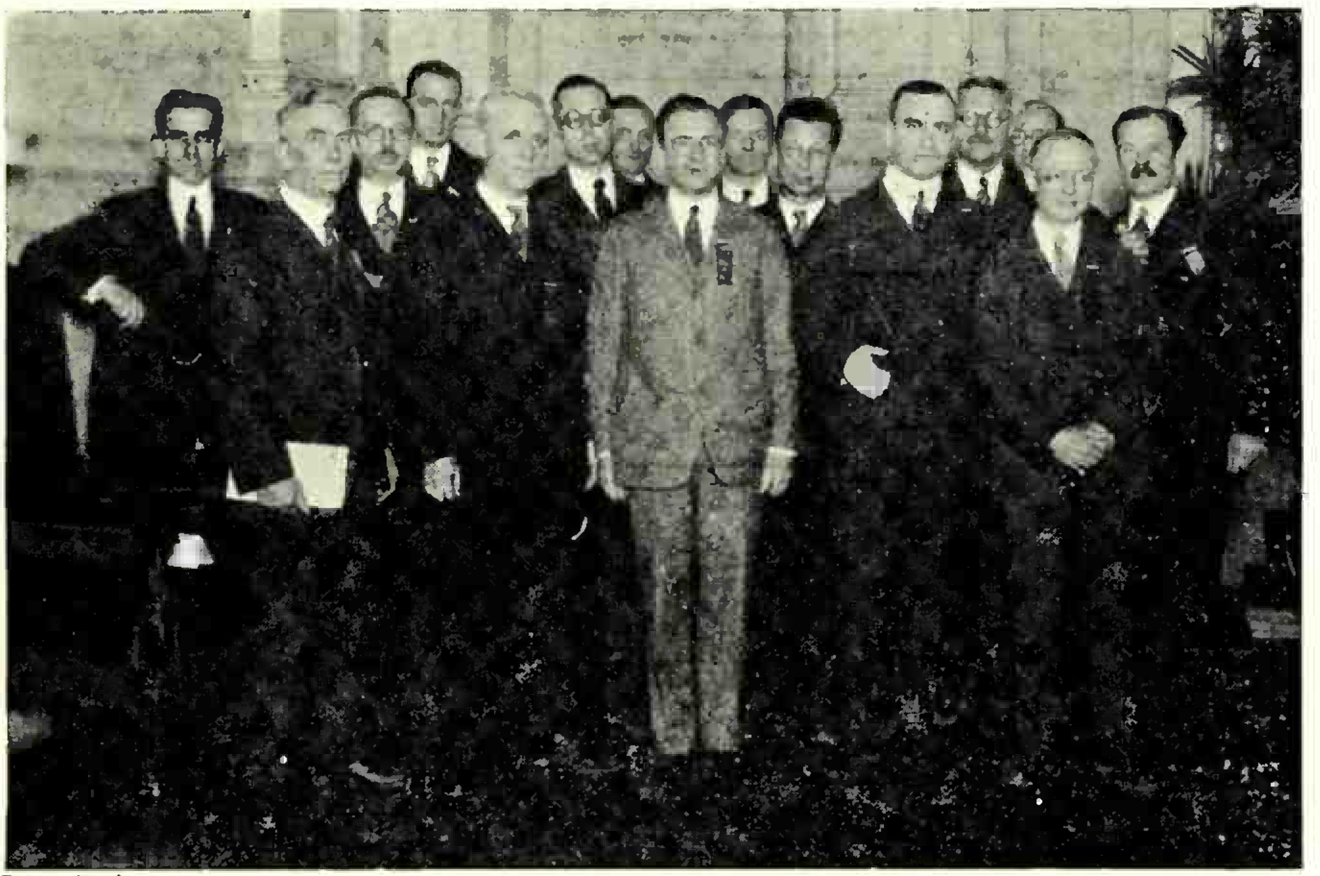
259—WRNY—160.

12:00 M.—Piano; songs.
1:30 P. M.—Studio recital talks.
4:00 P. M.—Studio recital.
7:00 P. M.—Biography sports; commerce.
7:15 P. M.—Songs; entertainers.
x7:45 P. M.—Studio recital; talks.
9:00 P. M.—Piano recital; poems.
9:55 P. M.—Ferrucci's Orchestra.

Temperament in The Studios

THE stories of the temperamental displays of some of our radio artists (and others) are all but incredible. Some of them match the classical example of Mme. Blank who, falling in swoon near the wings at the Metropolitan, required that an attendant be present with a large and effervescent schooner of beer. Madame absolutely and flatly refused to go through this particular opera unless she was permitted to take on liquid refreshment at this particular moment.

Something that comes pretty close to this high record of subnormal tommyrot occurred some time ago at WEAF. A young lady who had evidently made a very close study of temperament and who felt that she could duplicate the performance of the best of them, decided, at the last moment, that she could not sing unless she was standing squarely upon a piece of sheet metal about half the size of a box car door. Not being much of a metallurgist, she left the choice of the metal to the house, but it had to be about half the size of a box car door. Now, setting out to find a piece of metal about half the size of a box car door, with one minute to work in is no easy job. It happened on this occasion that such a piece of metal was found in the control room. It was not exactly half the size of a box car door so the studio boys really put one over on



Brown Brothers

MEN WHO MAKE RADIO

This picture, which shows perhaps the most distinguished body of radio experts ever assembled in one group, was taken especially for POPULAR RADIO *at the Convention of the Institute of Radio Engineers which was recently held in New York. Reading from left to right, this picture shows Messrs. W. H. Hubley, F. C. Conrad, J. V. L. Hogan, C. W. Horn, D. McNicholl, A. H. Grebe, J. H. Dellinger, J. H. Morecroft, A. N. Goldsmith, G. W. Pickard, R. H. Marriott and E. F. W. Alexanderson.*

Henry Miller

STATION JOAK WELCOMES A PRINCESS WITH A BRASS BAND

The sound of saxophone and clarinet broadcast from the radio station in Tokyo by the band of the Toyama Military Academy recently announced to the waiting people of Japan that a daughter—instead of a son—had been born to their Crown Princess.

the young lady. She might have gone into hysterics had she known that she had sung on a piece of metal that was not exactly half the size of a box car door.

There is another story told about one of Roxy's pianists who insisted that the studio temperature be exactly 70 degrees and that he should be screened off from the rest of the gang while doing his stuff.

Still, that is not so bad when one recalls that even Paderewski carries on tour a woman who is purported to be the only laundress who can starch his cuffs to right degree of hardness.

* * *

$25,000 for One Radio Performance

It was rumored a few weeks ago that the great fiddler Mr. Fritz Kreisler had asked for $25,000 for a single radio performance. That Mr. Kreisler should ask such a large sum for so small an effort is none of this department's business and consequently we shall refrain from expressing our private opinion in the matter.

We often wonder how long it will be before our musical artists will, like the literary aspirants who storm the editors of the *Saturday Evening Post*, be eager and happy to perform for nothing. There are but two important factors in the making of an artist. Genius, or at least what the public recognizes as genius, must be present. Once a musician masters his art he must introduce himself to the world. What greater opportunity for lasting and quick introduction could one ask for compared with the radio? What other medium with one majestic sweep can please the ears of a whole nation in an insignificant fifteen minutes of time? Within a few years' time the concert tour will become a waste of time and effort; radio will find its own geniuses, train them and introduce them. Those haughty *virtuosi* of the present—the younger of them—may some day be on the waiting list of our second-grade studios.

Radio must simply bide its time. The activities of many thousands of ambitious home tinkers to say nothing of work of dozens of hinky-dinky manufacturers of radio receivers has kept radio from being a real serious rival of the concert stage. Eighty percent of the receivers in use today are just about on a par with the early American phonograph with the morning glory horn. Before radio can dominate in music it must do justice to the work of those who entertain. And when it does?—well here's a little prayer for the Fritz Kreislers!

¶ *In the next number will appear the first announcement of the* Popular Radio Medal for Conspicuous Service.

LISTENING IN

PRACTICAL *pointers from experimenters and broadcast listeners. What helpful hints can* YOU *offer to your fellow fan? Readers are invited to address their letters to the editor of this Department.*

CONDUCTED BY LLOYD JACQUET

How I Marked My Battery Terminals

INSTEAD of the usual color scheme of wiring, I have devised a simple and inexpensive way of marking the battery terminals of a radio set.

First, it is necessary to obtain from a stationery store some metal-edge cardboard tags, either of the round or square variety. The round ones are about one inch in diameter.

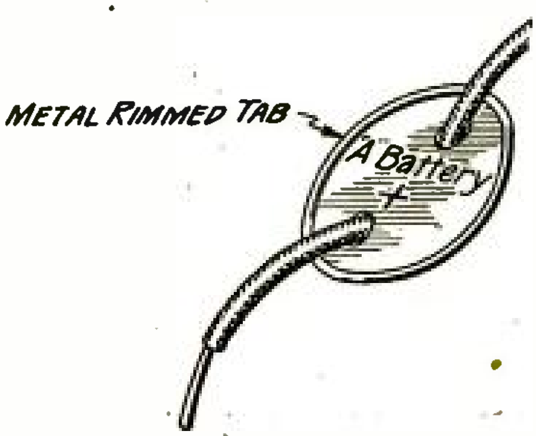
Then print on both sides of the tags, with india ink, the various indications, such as "A" BATT; "B" BATT; GND; ANT; and any others which may be required.

A hole should be punched below these markings, in line with the top hole which is already provided. This lower hole should be so located that it will not obliterate the printing.

As soon as the ink is dry, the tags should be thoroughly shellacked, so as to be moisture and acid-proof. One coat of shellac will be sufficient; and it will dry very quickly.

Then, the wires which have been previously cut to the correct length for the various connections should be passed through the two holes of the tag as shown in Figure 1. The tags should be retained at the ends from which changes in connections will be made. For instance, they should be placed at the very end of the battery wires, so that they may be handy when batteries are changed.

—PETER STEVENS, *Brooklyn, N. Y.*



A MARKER FOR BATTERY WIRES

FIGURE 1: *How the small metal-rimmed tab is slipped over your battery terminals. This will help to prevent costly errors in wiring.*

* * *

How a Community Radio Service Is Maintained

IN this community there is only one receiving set. This is in charge of a competent radio operator, who is somewhat of an artist as well. He has installed a powerful radio receiving set of his own construction, in which some 20 vacuum tubes are utilized.

By means of a master wire, which is a No. 9 galvanized iron wire running over fences, trees and buildings, and under a sewer, the railroad right of way and bridges, to every section of our hilly little city, this receiver serves about 200 homes.

None of the "subscribers" to this service have any receiving set, batteries, or horns. The only attachment is a unit which may be placed on the phonograph tone arm, and which connects to the line and to the ground. This is the only equipment necessary at the home of any listener in.

We have no tuning to do; and we get our programs entirely without interruption. The best programs and the finest stations from coast to coast are tuned in by our operator, who knows what to listen for, and gives us the best.

The service is continuous from 8 A.M. till late in the evening. When special events are broadcast, such as baseball games, operas, presidential speeches or Sunday services, all we need to do is to listen, for it will have been tuned in for us on the instant.

There is a slight initial installation charge and a monthly fee which is also small in comparison with the service given. The city council has passed the idea. Although we welcome newcomers on the air, there are very few of them, because this service is satisfactory. We have no squeals or noises; and the radiation nuisance is automatically taken care of. With all the mess and care of radio taken out, we find that it is an ideal way to listen in.

We believe that this community is the first one in the country to work out this idea, which is beyond an experiment at the present stage.

—JESSE SHIMP, *Mannington, W. Va.*

* * *

How I Am Able to Use Either Dry-Cell or Storage Batteries with My Neutrodyne Receiver

WITH the idea of making my neutrodyne receiver a semi-portable proposition during the summer months, I installed dry-cell tubes in it in place of the standard tubes which operate on storage batteries.

This did not work well, mainly because the internal capacity of the small dry-cell tubes is less than that of the standard type of tube. As the tubes make up a part of the neutralizing circuit, this circuit is unbalanced as soon as the tube capacity becomes smaller or greater.

To take care of this change in capacity I converted my neutralizing condensers, which are of the usual construction, into semi-variable ones, which are so conceived that it is easy to shift from dry-cell to storage battery operation and vice versa in an instant.

To accomplish this the proper point for the setting of the movable rod (shown in Figure 2) which slides into the glass tube is first found for both types of tubes, and marked. Then, the end of the rod is bent upward and the point nicked so that it may be automatically set by a spring when it is withdrawn. In this way the conversion of the neutralizing condenser for dry-cell or storage battery tubes is simply done.

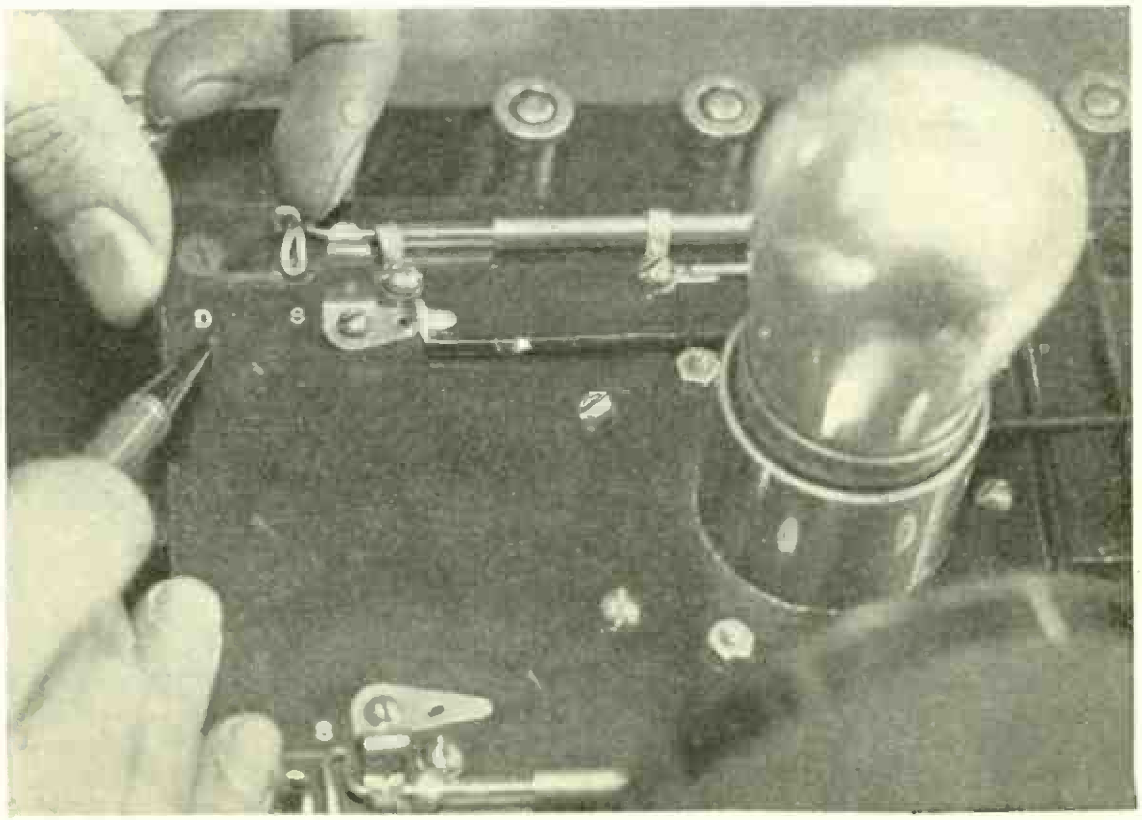
As more capacity will have to be added to the circuit when storage tubes are used and as less will be needed for the dry-cell type, the rod is correspondingly pressed all the way in, or driven all the way out to the stopping point.

—MORTIMER TREADWELL, *New York*

* * *

How to Check Your Wavelength

AMATEURS who would like to check-up the wavelengths of their sets with which they use more than one antenna or in which they hook in or out several coils or condensers will find an innovation of the Bureau of Standards useful to them. The Bureau's announcement (given below) tells how the wavelength check-up is conducted:



F. A. D. Andrea

HOW ONE FAN MARKED HIS NEUTRALIZING CONDENSERS

FIGURE 2: *This picture shows the movable rod about to be slipped from the proper position for the storage battery tubes, as denoted by the letter S, over to the correct position for the neutralization of dry-cell tubes, as denoted by the letter D.*

"The Bureau of Standards transmits, twice a month, radio signals of definitely announced frequencies, for use by the public in standardizing wavemeters and transmitting and receiving apparatus. The signals are transmitted from the Bureau's station, WWV, at Washington, D. C., and from station 6XBM, Stanford University, California.

"The transmissions are by unmodulated continuous-wave telegraphy. A complete frequency transmission includes a 'general call,' a 'standard frequency signal,' and 'announcements.' The 'general call' is given at the beginning of the 8-minute period and continues for about 2 minutes. This includes a statement of the frequency. The 'standard frequency signal' is a series of very long dashes with the call letters (WWV or 6XBM) intervening. This signal continues for about 4 minutes. The 'announcements' are on the same frequency as the 'standard frequency signal' just transmitted and contain a statement of the measured frequency. An announcement of the next frequency to be transmitted is then given. There is then a 4-minute interval while the transmitting set is adjusted for the next frequency."

The schedule of standard frequency signals may be obtained from both the Bureau of Standards and Stanford Univeristy.

—JAMES BUSH, *Washington, D. C.*

* * *

How the Position of Loudspeakers Affects Reception

BY properly locating my loudspeaker I succeeded in greatly improving the quality of reception.

At first, I used a horn type of speaker. By locating this instrument in such a way that the opening of the horn was at about the same height as the ear of the auditor, noticeably better results were had than if it is was placed on a high piece of furniture above his head.

Similarly, I have obtained better results by placing my horn in one of the corners of the room, rather than with its back to one of the walls. If the wall opposite the horn was covered with drapery, the tones were softened. If the horn was not properly placed in a big room, echoes which marred the quality resulted.

The cone type of loud speaker may be used anywhere, and in any position. I found it best, however, to place it in front of a wall covered with drapery.

—LAWRENCE NEALS, *Dayton, O.*

* * *

How a Swedish Amateur Built His Radio Receiver

IT will probably interest my fellow readers of this department to see how a Swedish amateur built his set. In the picture (Figure 3) is shown a back view of a receiver which I constructed from one of the "How to Build" articles published in POPULAR RADIO for April, 1924.

With a few exceptions, the parts of the receiver, such as the condensers, rheostats, sockets, binding posts, coils and so forth are all homemade. The tubes were purchased, of course. The radio-frequency stage is equipped with a UV-201-a, while the detector and audio stages have Phillips a-310 tubes.

With this receiver I have heard most of the broadcasting stations in Europe; and it has been a welcome successor to my former, a whistling, single-circuit receiver. Unfortunately, this latter is the most popular type of set here at the present time.

Needless to say, we watch with interest the progress of American amateurs, who are well equipped with parts and apparatus, and who have the best magazines published.

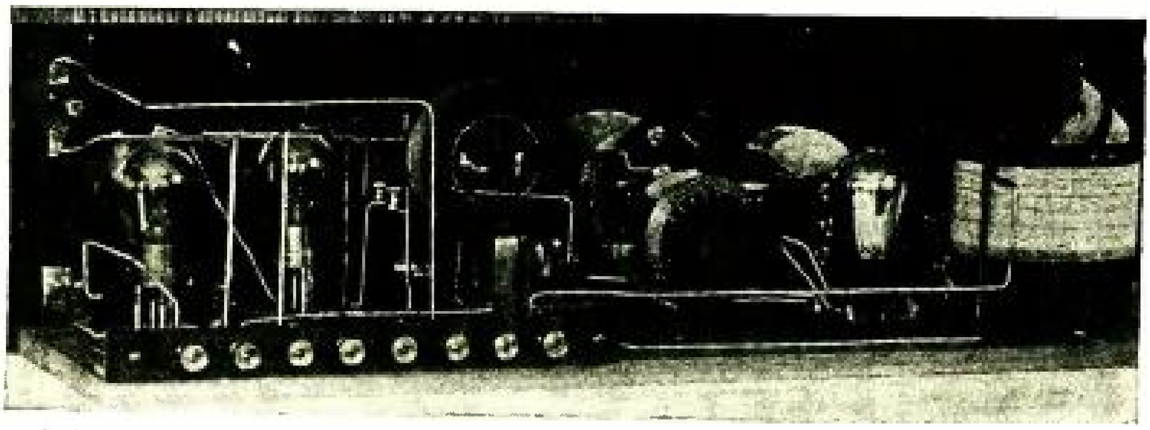
—K. A. SVENSSON, *Vigge, Juntland, Sweden*

* * *

What the L-C 26 Receiver Brought In

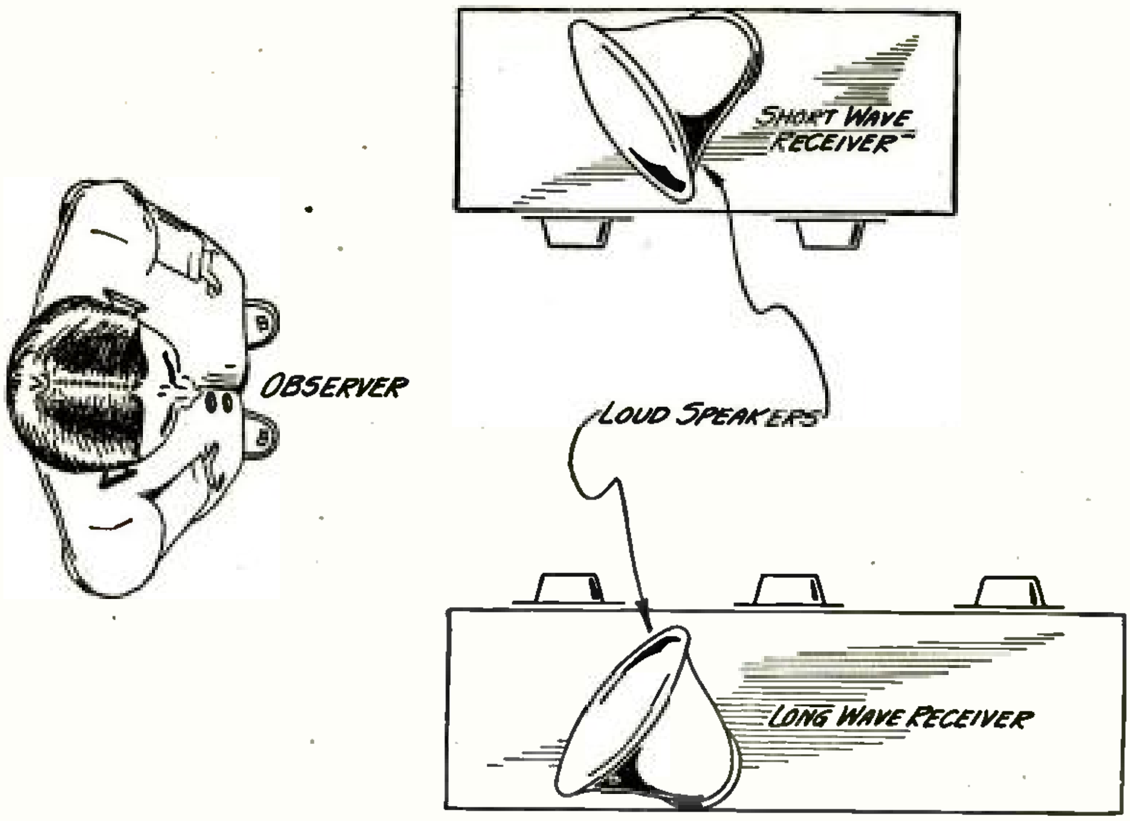
THE reference in the February issue of POPULAR RADIO to the results which were obtained in different sections of the country with the LC-26 Receiver has prompted me to express to you my great satisfaction in the results which I have obtained with this receiver which I built shortly after the publication of the article.

I have been able to receive with loudspeaker volume nearly all of the principal broadcasting stations in the country, including Pacific Coast



A "POPULAR RADIO" RECEIVER BUILT BY A SWEDISH AMATEUR

FIGURE 3: *Although this radio experimenter had to build most of the parts for this receiver he got the results he wanted. It is the Craig receiver, the details of which were published in the April, 1924, issue of this magazine.*



THE DOUBLE RECEPTION SYSTEM

FIGURE 4: *This stereoscopic receiving system is designed to operate on short-wave and long-wave signals transmitted by the same station with one receiver especially designed to bring in the high notes and the other one designed to bring in the low notes.*

stations. On one occasion, the experience was so unusual that I believe it is worthy of special mention.

From two to three o'clock, daytime, I tuned in with loudspeaker volume thirteen stations, including Davenport and Omaha, and WJZ, New York. This represents real daylight DX for this receiver for this location.

It has been possible for me to tune in the setting up exercises of WLW in the morning. I held Mexico City during an entire evening with loudspeaker volume. It is a pleasure to operate such a set as the LC-26.

—LEROY H. HABENICHT, *Kershaw, S. C.*

* * *

Have You Ever Tried Stereoscopic Reception?

EVERYONE is familiar with the stereoscope, the device by means of which two similar photographs which have been taken simultaneously, but at a different angle, are made to give one the illusion of relief.

In a similar way a broadcast listener may obtain the idea of tones and overtones as though he were sitting in the auditorium itself by means of what I call stereoscopic reception.

Two loudspeakers are connected to two receiving sets which are tuned to a station which is broadcasting one program, on two different wavelengths. There are several stations which are doing this today, such as KDKA and WGY.

One of the receivers is tuned to the long wave while the other set is receiving the short wave which is simultaneously broadcast. By placing the two loudspeakers in one room, about five to six feet apart, and with both cones or horns facing a spot which is equally distant from each an unusual result will be experienced by the listener, who should be at the spot where the lines from the loudspeakers converge, as shown in Figure 4.

By designing the radio sets so that one of them will bring in the low wave lengths with good low notes, and so that the long wave set will specially amplify the high notes, the entire scale will be covered and practically perfect reproduction will result.

—JACK HALY, *Brooklyn, N. Y.*

* * *

It's Easy to Simplify Your Panel Arrangement

As the general trend is towards simplification, I decided to simplify the front panel of my radio receiver by eliminating some of the controls.

The first ones to go were the rheostats. I did not do away with rheostats altogether; but by removing them from the panel and placing them behind the panel on a conveniently located strip, I removed three controls from the front of the panel.

The rheostats, when they are once adjusted, need not be regulated for a long period of time; and if a trickle charger is used, it will hardly be necessary to change the settings even over a period of months.

With the straight-line frequency converters which are equipped with fine verniers, I retained my old variable condensers, but did away with the smaller vernier control knobs.

—PAUL MARTON, *Cleveland, O.*

THIS *department is conducted by* POPULAR RADIO LABORATORY *for the purpose of keeping the radio experimenter and the broadcast listener informed concerning the newest inventions and the approved developments in radio equipment. Only such apparatus as has been tested and endorsed by the Laboratory is noted in these columns.*

Apparatus Approved by Popular Radio

This list of apparatus approved by the POPULAR RADIO LABORATORY will be continued as a part of the WHAT'S NEW IN RADIO APPARATUS department until all instruments, parts and complete sets have been included. The listing is alphabetical by manufacturer's name and the installment in this issue includes only the letters F through G.

AERIALS

Antenella; Chas. Freshman Co., Inc.

AUDIO-FREQUENCY TRANSFORMERS

Federal transformer; Federal Telephone Mfg. Corp.
Supertron A. F. transformer; Ford Mica Co.
Audio-frequency transformer; General Radio Co.
Audio-frequency transformer; Gilfillan Bros., Inc.

BATTERIES

Ray-O-Vac "B" and "C" batteries; French Battery & Carbon Co.

BATTERY CHARGERS AND RECTIFIERS

Balkite trickle charger; Fansteel Products Co., Inc.
Fore battery charger; Fore Electrical Mfg. Co.
Unitron battery charger; Forest Electric Co.
"FF" battery charger; France Mfg. Co.
France super-charger; France Mfg. Co.
Tungar battery charger; General Electric Co.
"Unipower"; Gould Storage Battery Co.

BATTERY ELIMINATORS

Fansteel Balkite "B" plate current supply; Fansteel Products Co., Inc.
Freshman Master "B" eliminator; Chas. Freshman Co., Inc.

BINDING POSTS

G-K spring binding post; Ganio-Kramer Co., Inc.
Binding posts; General Radio Co.
Jack binding post; Globe Phone Mfg. Co.

CRYSTAL DETECTORS

Variotector; Foote Radio Co.
Giant crystal; Foote Radio Co.
Adjustable crystal detector; Chas. Freshman Co., Inc.
Fixed reflex detector; Grewol Mfg. Co.
Grewol 2 in 1 crystal; Grewol Mfg. Co.

DIALS

Dial; Chas. Freshman Co., Inc.
Knobs and dials; General Radio Co.
Knobs and dials; Gilfillan Bros., Inc.
Gee-Haw vernier dial; Otto R. Gischow Co., Inc.
Fynur vernier control; August Goertz & Co., Inc.

FIXED CONDENSERS

Micadenser; Ben Franklin Radio Mfg. Co.
Fixed condenser; Chas. Freshman Co., Inc.

GRID-LEAKS AND RESISTANCES

Fixed grid-leak; Chas. Freshman Co., Inc.

HEADPHONES

Frost Fones; Herbert H. Frost, Inc.
Globe phones; Globe Phone Mfg. Co.
"N & K" phones; Goldschmidt Corp.

INSULATORS

Porcelain; stand-off, and glass insulators; M. M. Fleron & Son, Inc.
Insulators; General Radio Co.

JACKS

Federal jacks; Federal Telephone Mfg. Corp.
Frost Pan-Tab jack; Herbert H. Frost, Inc.

KITS

Freshman tuned-radio-frequency kit; Chas. Freshman Co., Inc.

LIGHTNING ARRESTORS

Refillable lightning arrestor; M. M. Fleron & Son, Inc.
Gray lightning arrestor; Gray Products, Inc.

LOOPS

Hand-D-Tena; Frost Radio Specialty Co.
Effarsee portable antennae; Fishwick Radio Co.

LOUDSPEAKERS

Farrand-Godley speaker; Farrand Mfg. Co., Inc.
Fibertone horn and base; Fiber Products Co.
"Town crier" loudspeaker; Gale Radio Laboratories
"N & K" imported loudspeaker; Th. Goldschmidt Corp.
"G. G. H. Majestic" loudspeaker; Grigsby-Grunow-Hinds Co.

MISCELLANEOUS ACCESSORIES

Reddy Hot soldering kit; E. D. Fahlberg Mfg. Co.
Fahnestock antenna connector; Fahnestock Electric Co.
Fahnestock ground clamp; Fahnestock Electric Co.
Fahnestock clips; Fahnestock Electric Co.
Soldercake; C. de P. Field Co.
"Perfecto" soldering fluid; John Firth
Fleming jiffy connector unit; Fleming Mfg. Co.
Vernier adjuster; M. M. Fleron & Son, Inc.
Lead-in bushing; M. M. Fleron & Son, Inc.
Loudspeaker extension unit; Four Way Co.
"Fits-all" head cushion; Francisco Mfg. Co.
Radio aerial mast fittings; Freidag Mfg. Co.
Frost radio jac-box; Herbert H. Frost, Inc.
Frost ground clamp; Herbert H. Frost, Inc.
Frost radio protector; Herbert H. Frost, Inc.
Frost extension cord; Herbert H. Frost, Inc.
Kant-Blo signals; Ganio-Kramer Co., Inc.
Filter; General Radio Co.
Giant ground clamp; Giant Clamp Works.
Battery mats, spaghetti tubing, hard rubber tube, radiophone ear cushion; B. F. Goodrich Rubber Co.

PANELS

Fibroc bakelite panel; Fibroc Insulation Co.
Electrosote radio panel; M. M. Fleron & Son, Inc.
Formica panels; Formica Insulation Co.
Hard rubber radio panel; B. F. Goodrich Rubber Co.

PHONE PLUGS

Federal plug; Federal Telephone Mfg. Corp.
"4-Way" switch plug; Four Way Co.
Frost plug and jack; Herbert H. Frost, Inc.
Frost plugs; Herbert H. Frost, Inc.
Comsco automatic "Bull Dog Grip" plug; General Instrument Corp.

PHONOGRAPH ATTACHMENTS

"N & K" phonograph unit; Th. Goldschmidt Corp.

POTENTIOMETERS

Potentiometer; Gilfillan Bros., Inc.

POWER AMPLIFIERS

Power amplifier; General Radio Co.

RADIO-FREQUENCY TRANSFORMERS

Farrand-Godley transformer No. 301; Farrand Mfg. Co., Inc.
Federal transformer; Federal Telephone Mfg. Corp.
"Gen-Win" tuned air-core transformer; General Radio Winding Co.

RECEIVING SETS

Faraway radio sets; Faraway Radio Co.
Federal receivers; Federal Telephone Mfg. Corp.
Ferguson "Six" and "Eight" receivers; J. B. Ferguson, Inc.
Flash vest pocket radio; Flash Radio Corp.
Freed-Eiseman neutrodyne receiver; Freed-Eiseman Radio Corp.
Freed-Eiseman NR-6 receiver; Freed-Eiseman Radio Corp.
Masterpiece receivers; Chas. Freshman Co., Inc.
"Garod" broadcast receivers; Garod Corp.
"Voceleste" portable receiver; General American Radio Corp.
Gilfillan neutrodyne; Gilfillan Bros., Inc.
Gold Medal receiver; Gold Medal Radio Corp.
Pliodyne receivers; Golden-Leutz, Inc.
Grebe broadcast receiver; A. H. Grebe & Co., Inc.
Nightingale Six Speaker set; Guthrie Co.
American Crest receiver; Guthrie Co.
Hansel receivers; Guthrie Co.

RHEOSTATS

Rheostat; Framingham Co.
Frost tube control unit; Herbert H. Frost, Inc.
Frost bakelite rheostat; Herbert H. Frost, Inc.
Frost metal frame rheostat; Herbert H. Frost, Inc.
Rheostat; General Instrument Corp.
Rheostats; General Radio Co.
Rheostat; Gilfillan Bros., Inc.

SOCKETS AND ADAPTERS

Federal socket; Federal Telephone Mfg. Corp.
Porcelain socket; M. M. Fleron & Son, Inc.
Phonograph adapter; M. M. Fleron & Son, Inc.
Frost sockets; Herbert H. Frost, Inc.
Frost adapter; Herbert H. Frost, Inc.
General Radio sockets; General Radio Co.
Sockets and adapters; Gilfillan Bros., Inc.
V. T. socket; B. F. Goodrich Rubber Co.

SWITCHES

Anti-capacity switch; Federal Telephone Mfg. Corp.
Frost radio battery switch; Herbert H. Frost, Inc.
Frost bakelite toggle switch; Herbert H. Frost, Inc.
Panel switches; General Radio Co.

A VARIABLE RATIO VERNIER DIAL

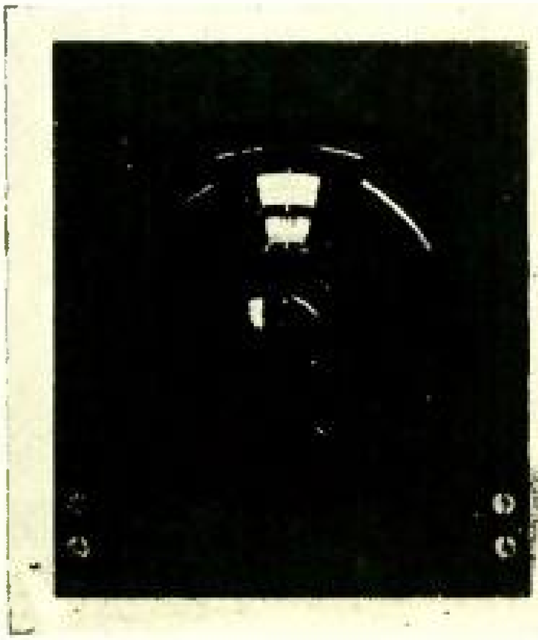
Name of instrument: SLF tuning dial.

Description: This dial is designed to operate with an ordinary straight-line-capacity condenser for obtaining straight-line-frequency tuning. It accomplishes the same results as using a straight-line-frequency condenser with an ordinary dial. The condenser shaft is fastened to a plate in which is cut a straight slot which engages a ball bearing operating in a spiral cam slot mounted directly on the moving part of the dial. Throughout the first lower settings of the dial, the condenser revolves much slower than the dial itself, but this ratio of movement of the condenser and the dial increases until at the upper settings of the dial the condenser is moving at an increased rate. The rate of change of capacity with dial setting is of course correct for producing straight-line-frequency tuning when used in connection with the proper coil and condenser.

Usage: In any radio-frequency circuit for controlling the tuning apparatus.

Outstanding features: Converts old sets to the new style of tuning. Equipped with space for writing in station call letters directly on the moving dial.

(*Further details furnished on request*)



Switch; Gilfillan Bros., Inc.
Double-pole, double-throw switch; Globe Phone Mfg. Co.
Single-pole, double-throw switch; Globe Phone Mfg. Co.

TESTING INSTRUMENTS

No. 1 hydrometer set; Francis L. Freas Glass Works
Clearview hydrometer set; Francis L. Freas Glass Works
Radio "B" hydrometer set; Francis L. Freas Glass Works.
Battery tester; Francis L. Freas Glass Works.
Laboratory instruments; General Radio Co.
Ammeter; General Radio Co.
Wavemeter; General Radio Co.

TOOLS AND EQUIPMENT

Franklin coil winder; Franklin Coil Winder
Windham wire former; Goyer Co.

TUBES

Magic-Tron Vacuum tube, type 201-a; F. & C. Corp.
Gem 201-a tube; Gem Tube Co.
Gold Seal tubes; Gold Seal Products Co.

TUNING INDUCTANCE UNITS

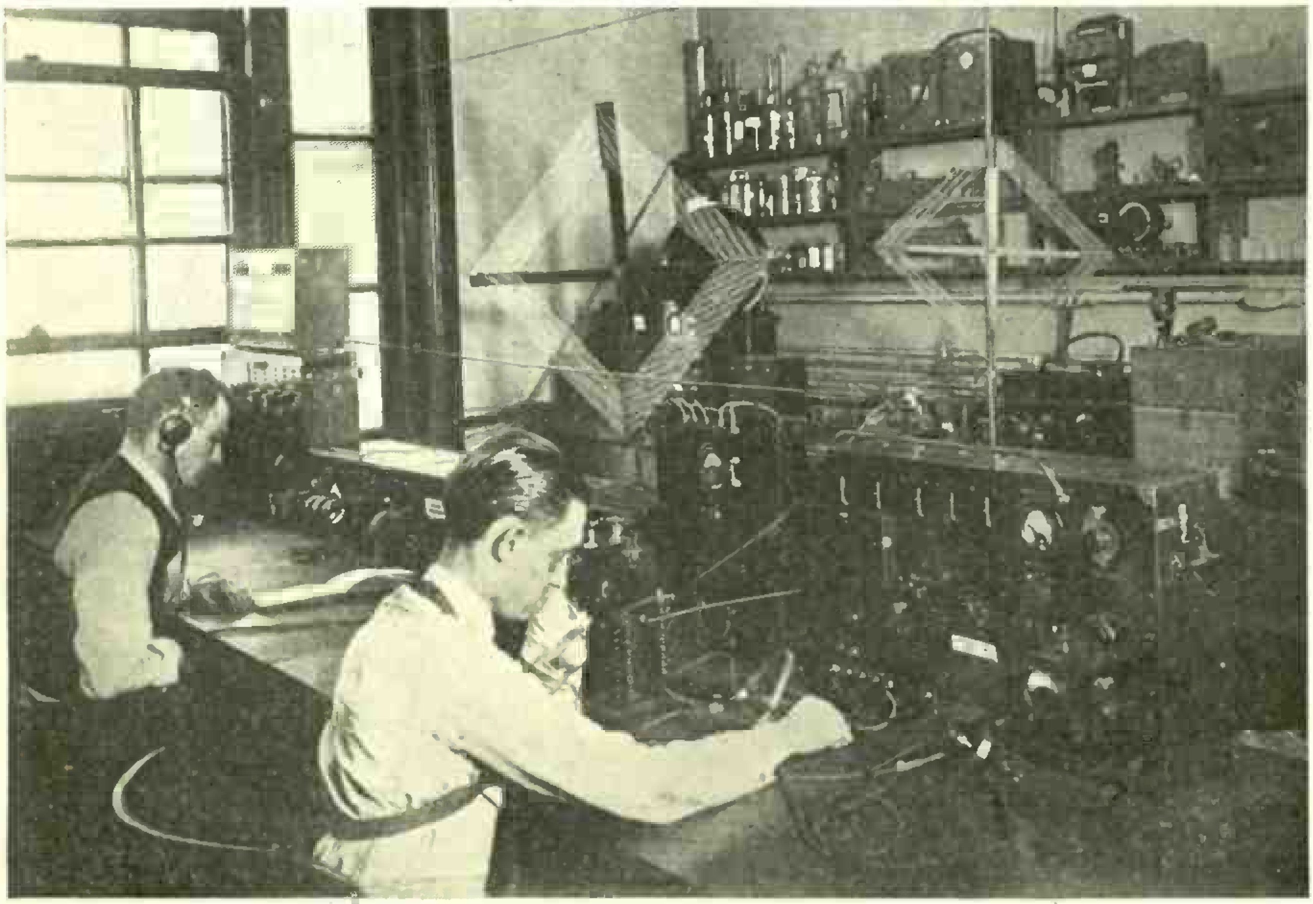
Variocoupler; Federal Telephone Mfg. Corp.
Ferbend wave-trap; Ferbend Electric Co.
Fischer coupler; G. H. Fischer & Co.
Variometer; G. H. Fischer & Co.
Coast coil: Foote Radio Co.
Heliotor (toroid coil); Geo. A. Freeburg Co.
Masterpiece coil and condenser; Chas. Freshman Co., Inc.
Variometer; General Radio Co.
Variocoupler; General Radio Co.
Low-loss coils; General Radio Co.
"Gen-Win" low-loss tuner; General Radio Winding Co
"Gen-Win" variometer, variocoupler, reflex coil, Master tuning coil, neutorflex coil; General Radio Winding Co.
"Gen-Win" Cockaday unit; General Radio Winding Co.
Variocoupler; Gilfillan Bros., Inc.
Variometer; Gilfillan Bros., Inc.
Globe low-loss tuner; Globe Radio Equip. Co.
Short-Wave tuner; L. W. Goodman
Variometer forms; B. F. Goodrich Rubber Co.
Grebe clarifier; A. H. Grebe & Co., Inc.

VARIABLE CONDENSERS

Variable condenser; Federal Telephone Mfg. Corp.
Craftsman condenser; Pett & Kimmel.
Variable condenser; Chas. Freshman Co., Inc.
Furnell taper coil condenser; Furnell Mfg. Corp.
"Continental" vernier condenser; Gardiner & Hepburn Co., Inc.
"Unitrol" condenser; Gardiner & Hepburn, Inc.
Separator; Gardiner & Hepburn, Inc.
Garod straightline condenser; Garod Corp.
Allen dial vernier; General Eng. & Model Works.
Concentric S. L. F. condenser; General Instrument Corp.
Multiple condenser; General Instrument Corp.
Tandem condenser; General Radio Co.
General Radio straight-line wavelength condenser; General Radio Co.
Air condenser; Gilfillan Bros., Inc.
Vari-grid; Grewol Mfg. Co.
"Nol-loss" variable condenser; B. Grosser Sons Co., Inc.

WIRE

Rubber covered wire, metal shielded; Herbert H. Frost, Inc.



Henry Miller

RADIO SETS FOR COMMUNICATING UNDERGROUND

While miners pursue their work far beneath the earth's surface, radio apparatus such as this is employed to maintain constant communication with the outside world. The apparatus shown here is employed by the Bureau of Mines in tests which aim to perfect this type of communication.

IN THE EXPERIMENTER'S LABORATORY

CONDUCTED BY LAURENCE M. COCKADAY

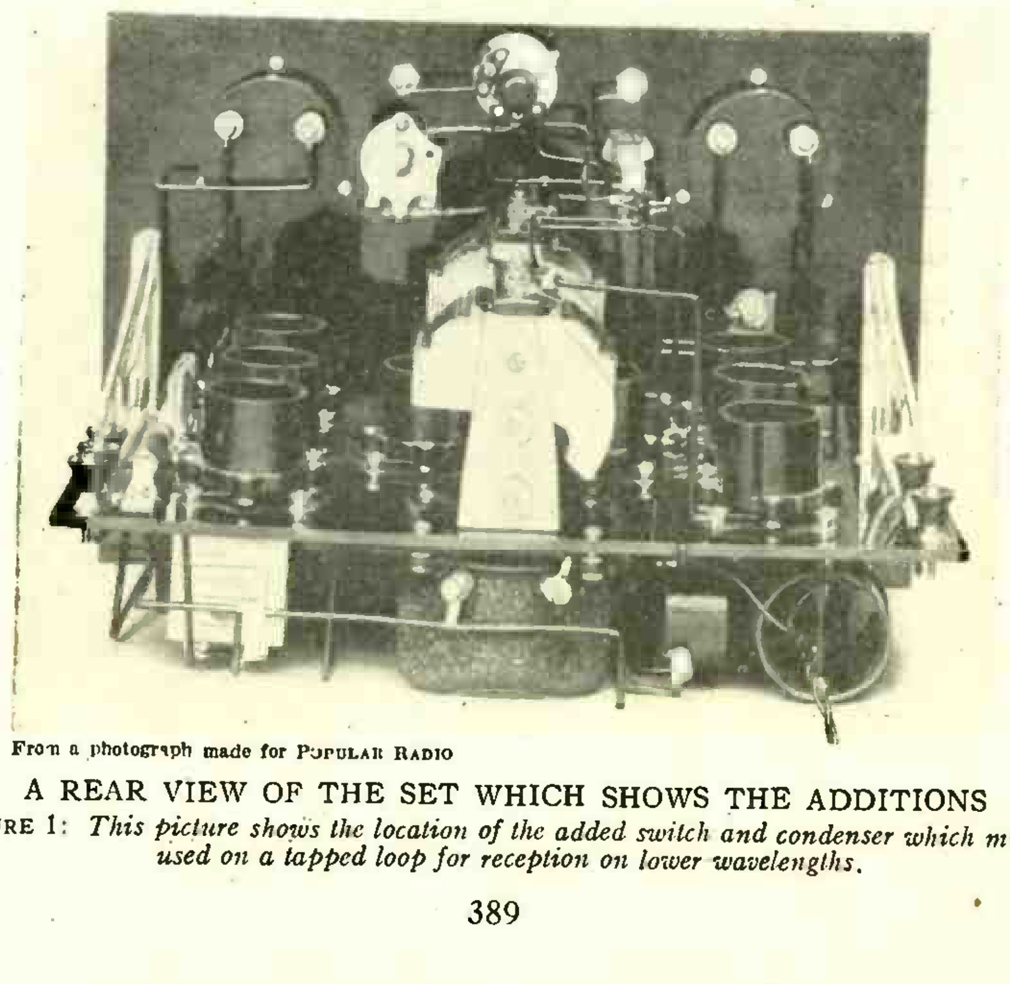
"More About the McLaughlin Superheterodyne"

ONE of the questions most frequently asked in regard to the single-control superheterodyne receiver (described in the October issue of POPULAR RADIO) is "Do I absolutely have to use the D.T.W. loop with my single-control?"

Yes, it is absolutely necessary to use the D.T.W. loop with this set. This is so because of the balance which should exist between the oscillator and the first detector circuit (frequency-changer).

The inductance of this particular loop, with its distributed capacity, has a fundamental equal to the oscillator coil with approximately half the capacity of the midget condenser. If another make of loop is substituted, this balance is destroyed, thus forfeiting all possibility of the complete synchronization of the tunable circuits. Differently designed loops possess distinct and varying electrical characteristics.

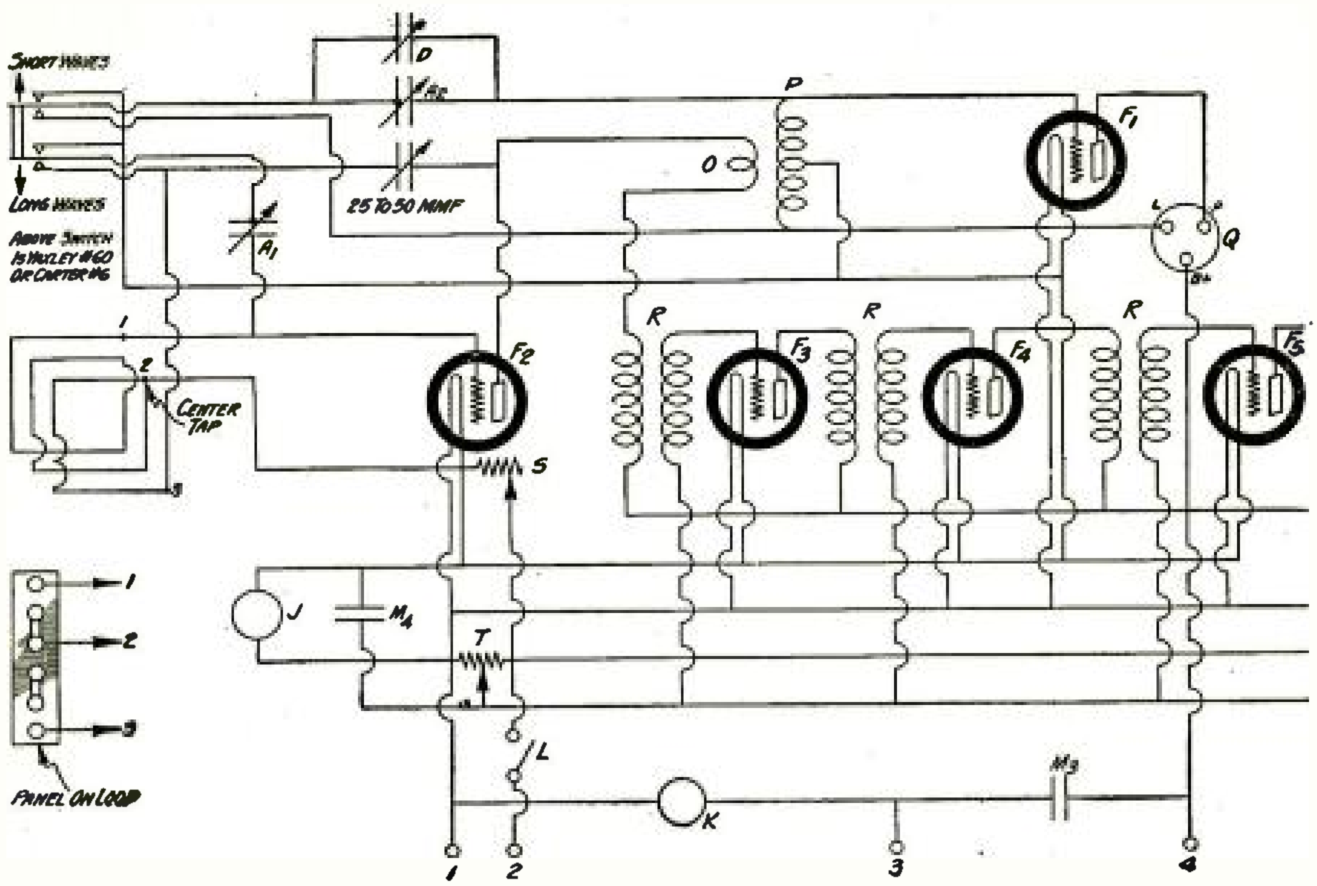
The Litzendraht (high-frequency cable) has not proven satisfactory in coil design due to the breaking of strands generally caused by undue haste in production. In the face of this, it is noteworthy that when two loops of the same physical dimensions and electrical characteristics, one the D.T.W. loop (using Litzendraht), the



From a photograph made for POPULAR RADIO

A REAR VIEW OF THE SET WHICH SHOWS THE ADDITIONS

FIGURE 1: *This picture shows the location of the added switch and condenser which must be used on a tapped loop for reception on lower wavelengths.*



other wound with ordinary loop wire, were successively connected to the identical receiver, the D.T.W. loop produced a considerable increase in signal strength over that of the other loop. Laboratory tests are now being conducted to ascertain what percentage of increase the D.T.W. loop accomplishes over that of the loop using the so-called loop wire. This increase proves itself on reception from both local and distant stations.

Many persons deplore the fact that the set will not tune below 250 meters and write to ask whether or not they have made some mistake in construction or whether the design was intentional in this respect. The guiding motive in the design of this receiver was to perfect an instrument which would receive good broadcasting and accomplish realistic reproduction.

To every individual who listens to a class A station one will find a hundred or more who will choose a class B station when they want an honest-to-goodness program. Be it understood, however, that poor reception below 250 meters is not always due to poor transmitting equipment or to unwisely selected programs, but is generally caused by the congestion which exists in this frequency range and by harmonics of stations operating at lower frequencies whose fundamentals are twice or three times that of the stations whose programs are being received.

A loop receiver can be made to function more efficiently over the class B range than over the two ranges together. In this set the loop used has considerably more inductance than common practice permits. A loop that has higher inductance exposes more area to incoming oscillations, which results in more current being collected by the loop, *i.e.*, greater signal strength.

But in cutting down the turns of the loop or inductance, we will reach those lower wavelength stations which we do not want after we have them. In other words, we sacrifice reception on the lower wavelengths for better receptio on the higher ones.

Inasmuch as we have intimated that it would be far better not to listen to broadcasting on the lower wavelengths, we feel sure that there will be many fans who will go exploring. To them the following information is offered:

If the tuning condenser across the loop is connected across but half the loop the tuning range on this circuit would be changed. So in the oscillating circuit; if we connect the tuning condenser across half the coil, its tuning range will also be changed. This change is of the same value as the change in the loop circuit. If such is the case, then in order to get to our lower wavelength stations, we need only to change the positions of our condensers electrically.

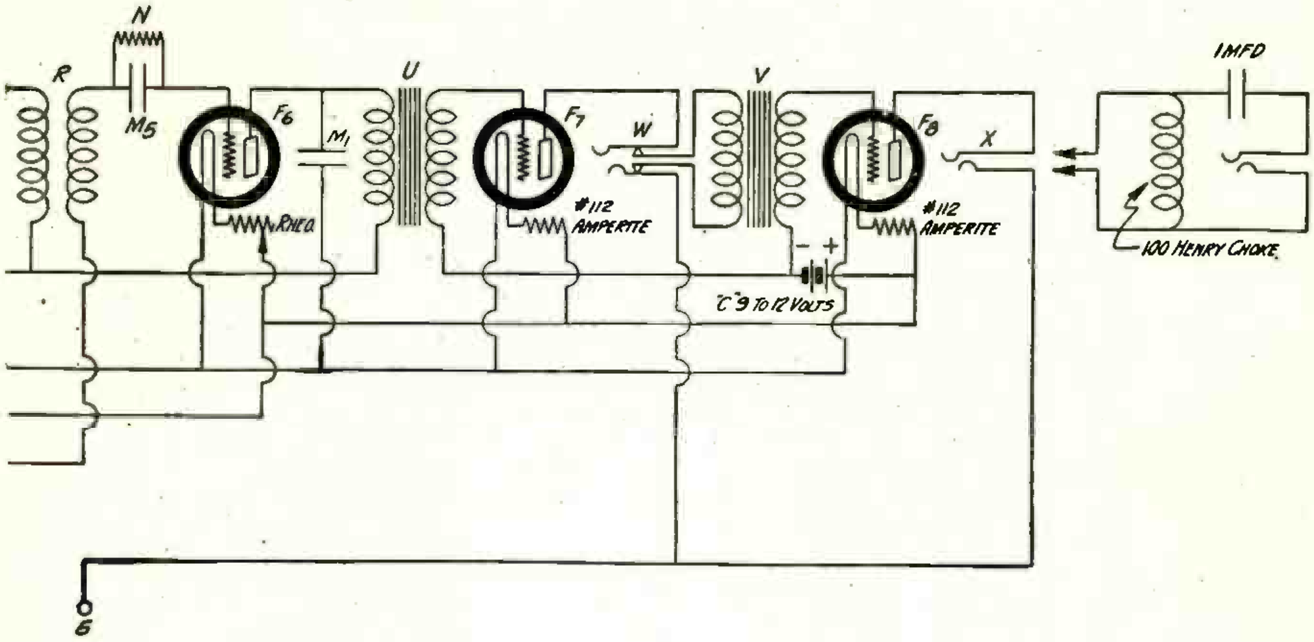
This is shown in Figures 1 and 2.

A Yaxley No. 60 or a Carter No. 6 panel-switch is necessary. This may be mounted on the panel as is shown in Figure 3. The function of this switch is to change the position of both condensers across either half the coil and loop or across all the coil and loop. When the switch is turned one way the tuning range of the set will be from 175 meters to approximately 500 meters, and when the switch is thrown in the reverse position it will be from 250 meters up to approximately 700 meters. The insertion of this switch in the circuit will by no means impair the general efficiency of the set.

An easy way to obtain higher amplification and better selectivity on distant stations is to add regeneration to the first detector. This may be

THE WIRING DIAGRAM FOR THE COMPLETE McLAUGHLIN SINGLE-CONTROL SUPERHETERODYNE

FIGURE 2: *The changes in the electrical circuit which must be made in adding the tapped loop and the vernier condensers and the way in which the "C" battery and the filter unit for the loudspeaker should be included are shown here.*



effected by connecting one side of a small midget condenser to the plate terminal of the detector tube, and the other side to the lower terminal of the loop.

Figure 2 shows just how this may be accomplished. Condenser M2 must be disconnected from the circuit in order to obtain the most satisfactory results. When the best position for this condenser has been found, it should be undisturbed by further adjustments. Changing this will slightly vary the balance between the oscillator and loop circuits.

Many have inquired as to the proper way of coupling the first detector to the oscillator. One complete turn, in either direction, is looped around the oscillator coil, near the end of the windings, with a piece of flexible wire of any convenient size between 20 and 16.

Distortion may be noticed on especially loud stations because the 201-a type tubes, in the audio stages, are not large enough to properly amplify the energy received. In order to remedy this condition the UX-112 Radiotron may be used in the last audio stage and the No. 112 Amperite inserted in the negative filament lead to properly control the filament temperature.

When using the UX-112 tube, slight changes will be necessary in the filament wiring, and in the "C" and "B" battery voltages; such changes being clearly illustrated in Figure 2. The small "C" battery must be taken out of the set and two flexible wires, approximately 12 inches long or more, must be connected to the terminals which previously connected the "C" battery. These connections will go to an external "C" battery consisting of three of the larger type "C" batteries connected in series.

To distinguish correct polarity it is advisable to connect a knot in the positive "C" battery lead as shown in Figure 4.

Practically no results will be had in reception unless the receiver is properly balanced. Consequently it is highly desirable to have an intelligent comprehension of the oscillator and frequency-changer circuits.

The function of these contained circuits is to change the incoming signal to a lower frequency, at which frequency it is amplified. The frequency to be amplified, in general practice, is the difference between the frequency of the broadcasting station and that of the oscillator. So to have a one-control superheterodyne, the tuning circuit of the frequency changing tube (first detector) and that of the oscillator must be so designed as to produce a constant difference in frequency at any setting of the controlling mechanism.

In this arrangement, when both the variable condensers are disconnected from the circuit, the design is such that the LC values of both circuits approximate each other. That is, the inductance (L) and distributed capacity (C) of the loop equals the inductance (L) and distributed capacity, plus half the capacity of the midget condenser (C).

When the condensers are again connected to the circuit and set at exactly the same capacity on the controlling mechanism, there should be exact resonance between the two circuits, from the minimum to the maximum range. Now, in order to obtain the desired frequency difference between the two circuits, the capacity of the midget condenser is increased which automatically lowers the frequency of the oscillator circuit.

There is a general opinion that meters on the panel of a radio receiver are in no-wise necessary to intelligent operation; but that they are employed merely as mechanical embellishments to give an appearance of intricacy. The opinion is erroneous.

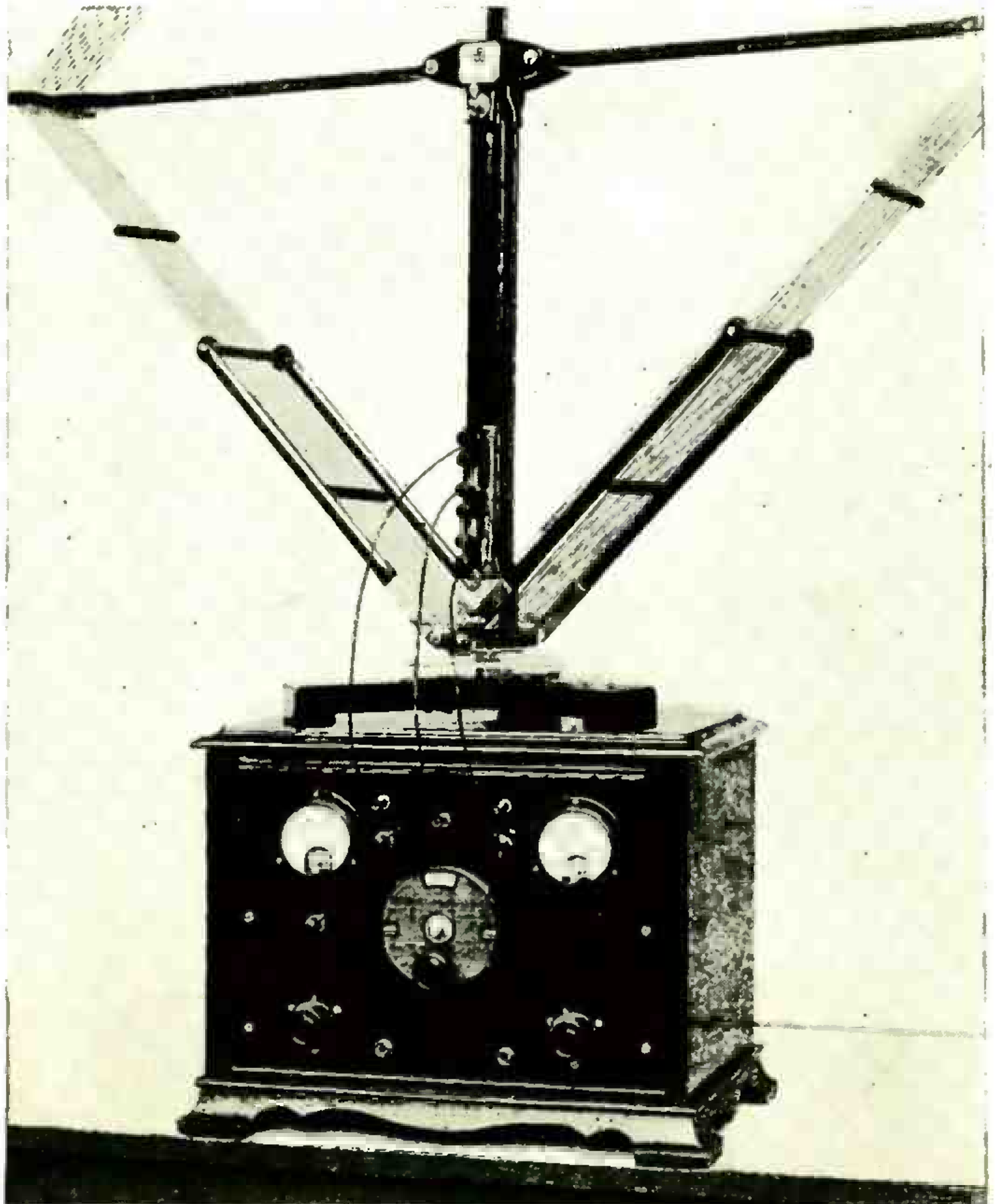
A slight increase above normal filament voltage, which increase may be detected only by a voltmeter, will produce a rapid deterioration of tube life. Going further, there is always a particular filament voltage for each receiver, which likewise can be determined only by the use of voltmeters or lucky guesses. Guesses may be relied upon if they have sufficed in the past. Voltmeters are accurate indicators. While the voltmeter detects an overloading of the filament, the milliammeter detects an overloading of the grid-plate circuits.

To obtain reception void of distortion the needle of the milliammeter should not vary from its normal settings. An overloading of one or more tubes may thus be detected by a fluctuation in plate-current of the milliammeter. To obtain satisfactory reception, watch your meters.

When high plate voltage is used, it is desirable to keep the DC current out of the loudspeaker windings by using a good make of output transformer, or an arrangement, illustrated in Figure 2 which consists of a 100 henry choke-coil and a 1 microfarad by-pass condenser.

It would be useless to build such a receiver as described and then connect it to an inferior loudspeaker.

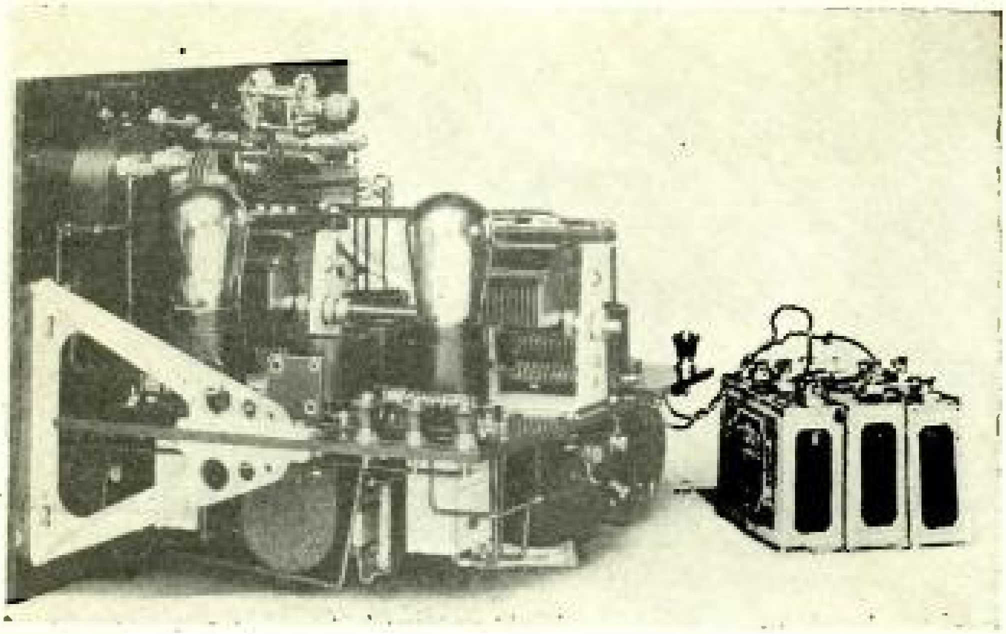
The owner of such a receiver, or any good make of receiver for that matter, should use a cone-type of speaker.



From a photograph made for POPULAR RADIO

THE NEW APPEARANCE OF THE RECEIVER

FIGURE 3: *Instead of the usual two terminals to the loop there are three now; and they terminate in small panel jacks on the set. An extra switch has been installed for changing the connections to the loop circuit. These are the only changes which are noticeable from the front of the receiver.*



A VIEW OF THE SET WITH THE CABINET REMOVED

FIGURE 4: *The "C" batteries which are connected with the flexible leads have been added to accomplish a saving in total "B" battery drain and also to improve quality on strong signals.*

How to Increase the Life of Your "B" Batteries

IN almost any type of multi-tube receiver, which uses dry-cell "B" batteries for the high-voltage plate supply, considerable saving can be made by adjusting the filament rheostats or "B" battery voltage to provide only the needed sensitivity and volume.

A superheterodyne receiver, for instance, usually places a heavy drain on the "B" batteries, and of course provides great sensitivity and volume. However, when it is desired to tune in local stations there is no need for this great sensitivity and it is usually necessary to cut down volume by means of the potentiometer which controls the grid potential of the intermediate amplifier, or by cutting down the current supply to one or more of the tube filaments.

When volume reduction is accomplished by turning the potentiometer back from the oscillating point, the "B" battery consumption is greatly increased; therefore to cut down volume in this manner may increase "B" battery current as much as 25 percent. This is certainly not a logical procedure. To cut down volume by reducing the filament current is much more logical because this also reduces the drain on the "B" batteries, although not in proportion to the reduced signal strength. Moreover, it is necessary to cut the filament current to at least four of the tubes if any noticeable saving in "B" battery current is to be effected.

In the majority of cases the most advantageous way to cut down the "B" battery consumption is to reduce the voltage supplied to the plates of the amplifier tubes, especially the intermediate-frequency amplifier tubes. Actual measurements taken on one superheterodyne receiver show astonishing prolongation of "B" battery life resulting from reducing the detector and intermediate-frequency amplifier, plate voltages by 22½ volts. This particular receiver was designed to use 45 volts on the two detectors, 67½ volts on the four intermediate-amplifier tubes, and 90 volts on the two audio tubes. When used with 22½ volts on the detectors and 45 volts on the intermediate-frequency amplifier tubes, still retaining 90 volts on the audio-amplifier tubes, the "B" battery current consumption dropped to 74 percent of the original drain, which means that the life of "heavy duty" "B" batteries would be more than twice as great as when the original voltages were used.

In receivers of this type a "C" battery is usually used in connection with the audio amplifier, and for that reason the battery drain is comparatively small and little would be gained by reducing the plate voltage on the audio-amplifier tubes.

For long-distance reception results are not as good with the reduced voltage as with the original voltages. On local and semi-distant reception, however, results may be found better with the lower voltages because the volume of the output is reduced to more suitable proportions without the usual necessity for toning the receiver down, as is usually the case with local reception with superheterodyne receivers. Because of the somewhat decreased sensitivity when the lower voltages are used, the receiver is less noisy; it picks up less of the stray electrical disturbance in the neighborhood.

To put this plan into operation the "B—" leads from the receiver should be connected to lower taps on the "B" battery as shown in Figure 5. Try moving one lead at a time, to a point 22½ volts lower on the battery. It is best to do this while a fairly powerful local station is tuned in so that the effect on local reception can best be judged. During these tests it is well to keep the potentiometer adjusted fairly close up to the point of oscillation.

—S. GORDON TAYLOR

A Glossary of Practical Electrical Units

By William Fenwick

AMPERE, (am'pēr). The unit of current. It is defined as the unvarying current which will deposit silver at the rate of 0.001118 gram per second when it is passed through a solution of silver nitrate of standard specifications.

AMPERE-HOUR (am'pēr our). A unit of quantity. The amount of electricity transferred by a current of 1 ampere in 1 hour = 3600 coulombs.

AMPERE-HOURS PER KILOGRAM (am'pēr ours per kĭl'o-grăm). The ratio of the ampere-hour capacity of a storage battery to the weight of its plates expressed in kilograms.

AMPERE-TURN (am'pēr tûrn.) A unit of magnetomotive-force). The magnetomotive-force exerted by a current of 1 ampere flowing through 1 turn.

COULOMB (cụ-lŏm'). The quantity of electricity transferred in 1 second by a current of 1 ampere.

COULOMB PER CENTIMETRE (cụ-lŏm' per çĕn'ti-mē"-ter). The unit of electric displacement.

FARAD (făr'ăd). The unit of capacity. The capacity of a condenser charged to a potential of 1 volt by 1 coulomb of electricity.

GILBERT (gĭl'bert). The cgs unit of mangetomotive-force = 0.7958 ampere-turns.

GILBERT PER CENTIMETRE (gĭl'bert per çĕn'ti-mē"-ter). The unit of magnetising force.

HENRY (hĕn-ry). The unit of inductance. The inductance in which a variation of current at the rate of 1 ampere per second produces a counter electromotive-force of 1 volt.

HORSEPOWER (hôrs'pow-er). A unit of work or power, equal to 746 watts.

JOULE (joul). The unit of electrical energy. The energy expended in 1 second by a current flow of 1 ampere at an electrical pressure of 1 volt.

MAXWELL (măks'-wĕl). The unit of magnetic flux.

MAXWELL PER SQUARE CENTIMETRE (măks'-wĕl per skwâr çĕn'-ti-mē"-ter). The unit of magnetic inductance.

MHO (mō). The unit of conductance. It is defined a the facility for current flow offered by a circuit of 1 ohm resistance.

OERSTED (ō'ersted). The unit of magnetic reluctance. The reluctance offered when 1 gilbert micromicrofarad produces 1 maxwell.

OHM (ōm). The unit of resistance, represented by the resistance offered to an unvarying current by a column of mercury 14.4521 grams in weight, of a constant cross-sectional area, of 106.3 centimetres in length, and of a temperature equal to that of melting ice.

VOLT (vōlt). The unit of electromotive-force (electric pressure). It is defined as the electromotive-force which produces a current of 1 ampere when it is steadily applied to a conductor whose resistance is 1 ohm.

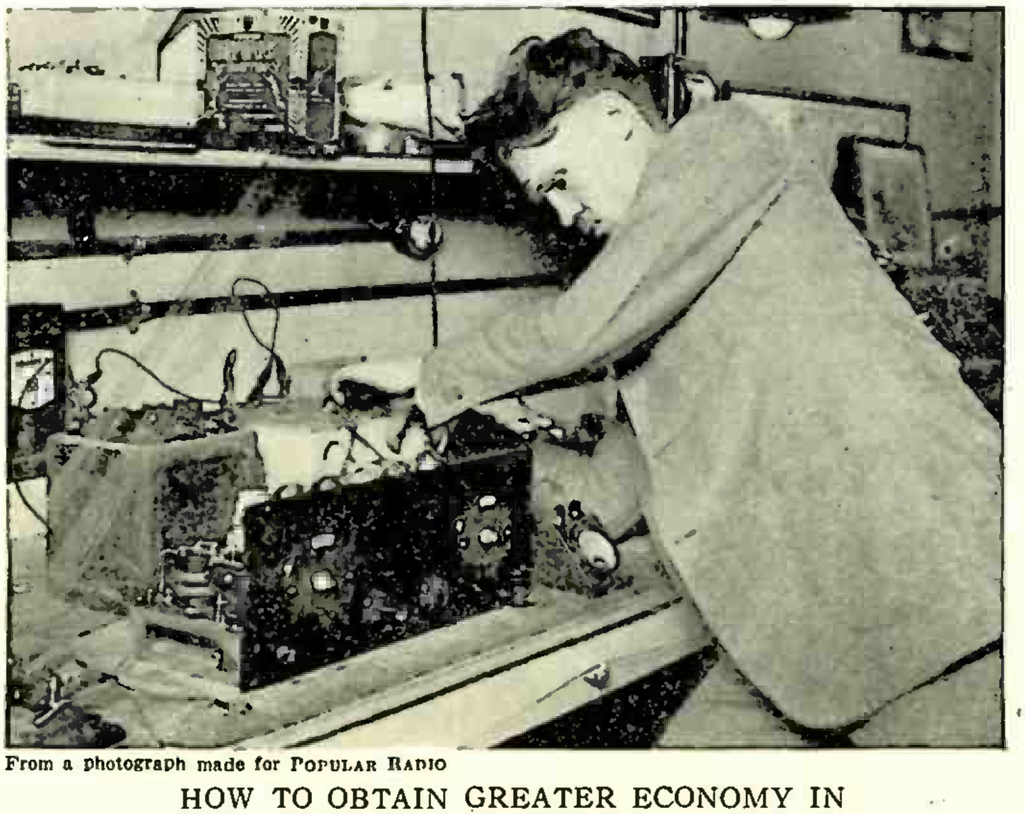
VOLTS PER CENTIMETRE (vōlts per çĕn'ti-mē"ter). The unit of electrostatic field intensity.

WATT (wat). The unit of work or power. It is defined as the expenditure of energy at the rate of 1 joule per second.

WATT-HOUR (wat our). A unit of the quantity of electricity = 1 ampere-hour = 3600 coulombs.

As practically all of the units given above may be prefixed to indicate that they are multiplied by 10, 100, 1000 and so forth, or that they are divided by 10, 100 or 1000, the following prefixes are given. Column 1 gives their names; column 2 contains their abbreviations, and column 3 furnishes their meaning.

pico or micromicro	$\mu\mu$	one million millionth
micro	μ	one millionth
milli	m	one thousandth
centi	c	one hundredth
deci	d	one tenth
deka	dk	ten
hekto	h	one hundred
kilo	k	one thousand
mega	M	one million



From a photograph made for POPULAR RADIO

HOW TO OBTAIN GREATER ECONOMY IN SUPERHETERODYNE OPERATION

FIGURE 5: *It is possible to effect a great saving in "B" battery consumption by reducing the plate voltages of superheterodyne receivers. In many cases such a reduction can be accomplished without in any way reducing the efficiency of the receiver.*

CONDUCTED BY WILLIAM G. H. FINCH

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

A New Variable Condenser for Short Wave Circuits

A NOVEL idea for a variable condenser which is especially adaptable for high frequency or short wave radio circuits is described in Patent No. 1,557,725, which was issued to John A. Proctor of Lexington, Mass.

The ideas contained in this invention are applicable to variable electrical condensers in general, and especially to the high potential condensers, which are used in radio transmitters and in power factor lines. However, the claims of the invention rest more particularly upon a variable condenser of the enclosed casing type which has preferably a vacuum dielectric and which is provided with means for varying the condenser capacity by relative movements of the condenser conductors or armatures of opposite polarity. The condenser may be constructed so as to be suitable for use at any desired voltage.

In condensers of the sheet or jar type now in use, the electrical losses where high voltages are employed are comparatively great. This results in a loss of efficiency and also in the over-heating and ultimate disintegration of the condenser, especially if it is not properly made. This heating is partly due to losses in the dielectric which apparently arise from dielectric hysteresis or frictionally impeded movements of the atoms of the dielectric because of electric flux through the latter, and partly because of brush or corona discharges in the medium surrounding this type of condenser.

An object of the present invention is to provide a condenser construction in which losses are at a minimum. In particular, the invention comprises a variable condenser in which the principal dielectric preferably is a vacuum.

Briefly this condenser comprises a suitable casing, bulb or tube in which is mounted a condenser made up of spaced metallic plates. The air is exhausted from the casing to form between the plates a vacuum dielectric in which there is no appreciable loss in use due to gas ionization or to dielectric hysteresis. Finally, there are means, operable from the exterior of the casing, by which relative movement of the interior condenser conductors may be effected.

The invention is shown, in perspective, in Figure 1.

The condenser contains spaced and fixed metal plates mounted upon and electrically connected to metal rods. These plates are spaced from each other by any suitable means. The rods are in turn secured to metal end plates.

Movable metal plates are fixed at spaced distances on a metal shaft and in such a position as to alternate with the fixed plates. The shaft is journaled in insulators which are fixed in the end plates to insulate the two sets of plates from each other.

The upper portions of the end plates are cut away in order that the movable plates may be sufficiently spaced from them. This allows a wider range of capacity variation, as plates in the position shown will have very little capacity effect.

Two springs made of strips of metal are connected to the end plates and engage the side walls of the enclosing air-tight glass bulb or casing. In this way the condenser is yieldingly supported against any longitudinal movement which might injure the casing. This casing may be a bulb or tube as shown and it should preferably be of glass or some other non-magnetic material.

There are several features of this condenser which may be pointed out as particularly novel. (The numerals mentioned correspond to those which mark the parts in Figure 1.). One terminal (that for the fixed plates, 25) is a conductor, 36, which extends through and is sealed in the casing, 32a. The terminal is thus connected to one of the two metal springs, 32, which is connected to the metal plates, 28, which, in turn, are electrically connected to the fixed plate, 25.

The other terminal of the condenser (that for the movable plates, 29) is a conductor, 38, which extends through and is sealed in the casing, 32a. This terminal is then connected to a spiral conducting coil, 37, which is connected to one end of the metal shaft, 30. This connection is of flexible wire to allow the free rotation of shaft, 30, which carries the movable conductors.

The parts of the terminals, 36 and 38, which extend through the casing, 32a, and are fixedly sealed there should be of platinum when the casing is of glass. Thus these terminal leads are independent of the capacity-varying means which are now to be described.

The left end of the shaft, 30, terminates in a magnet, 39, which is made of some suitable magnetic material such as iron, steel or nickel, and which is supported in a spaced relation to the end of the tube, 32a. This magnet has poles 40 and 41. The encased condenser is supported in any suitable manner on the base, 42.

A horseshoe magnet, 43, is located outside the casing, 32a, is journaled in the support, 42, at 44 and is provided with an actuating knob, 45. This magnet embraces the end of the non-magnetic casing, 32a, which is adjacent to the exterior magnet, 39. As the magnet, 43, is rotated, this rotation will be communicated magnetically to the variable condenser through the co-acting interior magnet, 39.

In this way means are provided for varying the capacity of the condenser without any danger of impairing the high degree of vacuum necessary or, in any instance, without the necessity of extending a mechanically moving part through the casing, 32a.

Either of the magnets may have a soft iron or nickel armature, if this is desired.

The movable plates, 29, are unbalanced on their shaft, 30, and tend (when their axis, 30, is horizontal, as shown) to hang down under the influence of gravity in a position 180 degrees from that shown in the drawing. Therefore, the capacity of this condenser may be varied by rotating the casing, 32a (and consequently the fixed plates, 25) around the longitudinal axis of the casing. The movable plates will hang down by gravity and will remain stationary.

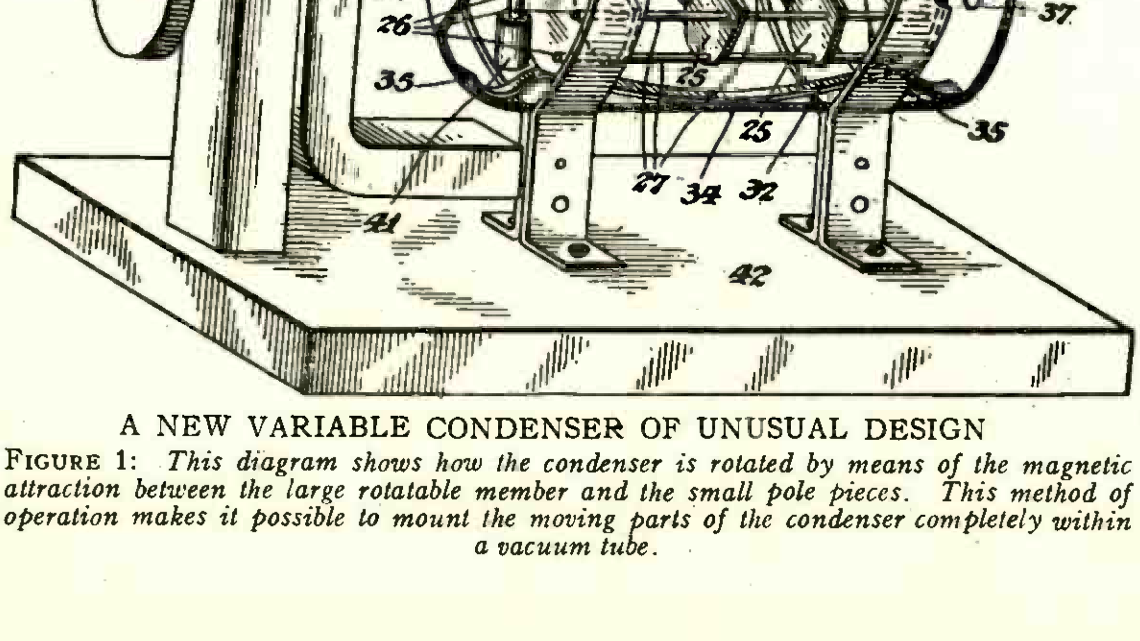
Thus the capacity of the condenser may be varied with or without the operation of a magnetic field, by a rotation of the entire casing, 32a, in its supports; and each of the relatively movable conductors may be moved with respect to the other.

The order of vacuum or exhaustion which exists in a condenser which contains a dielectric such as the one described above should be extremely high so that no appreciable gas ionization may take place to cause losses while the condenser is in operation. This condition may be obtained, for example, by a pressure of the order of a millionth of a millimeter. Exhaustion of this order may be obtained by any well-known means such as a Gaede or molecular pump or by Langmuir's condensation pump.

All of the materials inside of the casing, when a vacuum dielectric is employed, should be treated to remove gases (occluded or otherwise) according to any of the well-known processes in use for the production of high vacuum apparatus. This treatment may consist, for example, in removing gases from these materials before they are assembled in the casing.

In addition, it is advisable to subject the contained materials, after they are assembled in the casing, to further treatment to remove any residual gases. This final treatment may consist of a bombardment of the materials from a heated filament which is temporarily located within the casing.

The gases may best be removed in the first treatment by the use of the Northrup high frequency electrical furnace. If this method is used, the entire condenser is placed in the field



A NEW VARIABLE CONDENSER OF UNUSUAL DESIGN

FIGURE 1: *This diagram shows how the condenser is rotated by means of the magnetic attraction between the large rotatable member and the small pole pieces. This method of operation makes it possible to mount the moving parts of the condenser completely within a vacuum tube.*

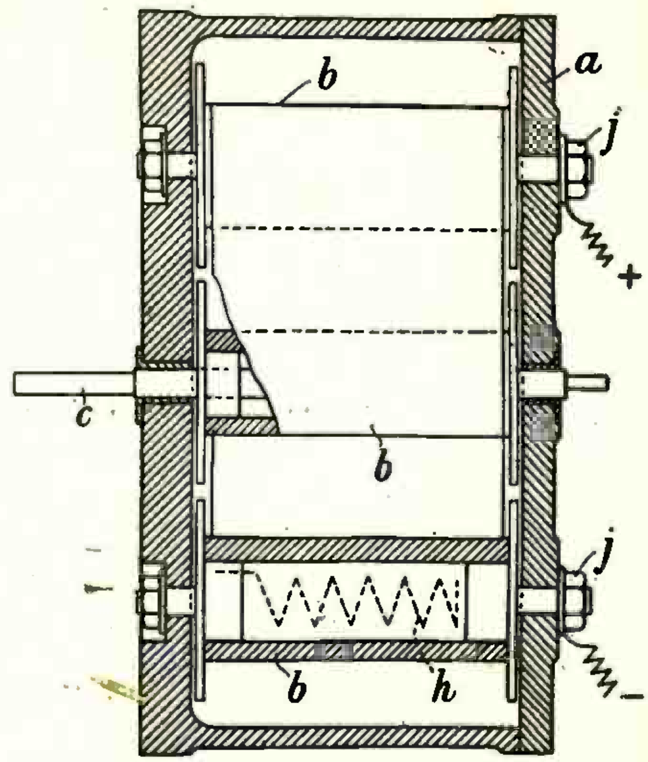
of a coil carrying a high frequency current, while it is undergoing the process of exhaustion. This heats the metal parts inside the condenser casing, and thus drives off all gases which may be in them before the casing is completely exhausted and sealed off.

The materials used in these vacuum condensers should be of such a nature that the gases may be easily removed by the two processes described above. Nickel, tungsten, molybdenum or rolled steel should be used wherever possible in the construction of the condensers.

In the way described above, a condenser in which the plates 1 and 2 are spaced a centimeter apart, may be constructed to stand a million volts. In such a condenser and with a vacuum dielectric of the order specified, the total loss is practically zero as it is limited to the minute Joulean losses in the metal plates and leads, and to the minute losses in the dielectric surrounding the terminals and in the supporting dielectric material.

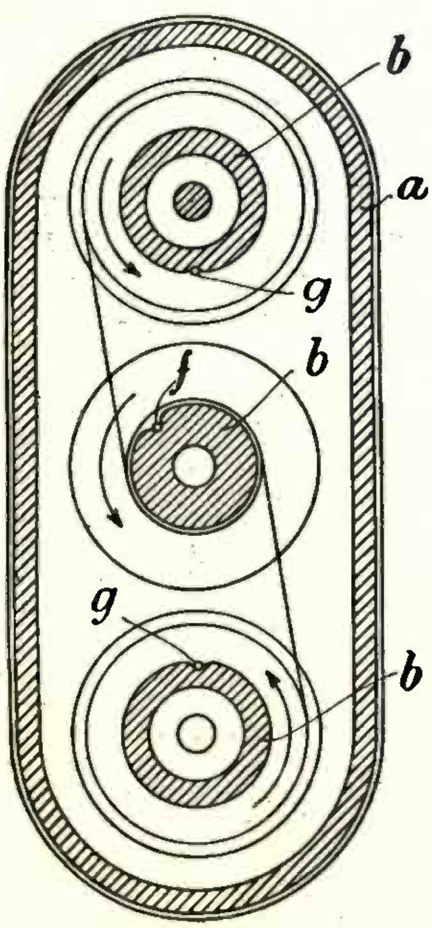
The most important aspect of this invention is that part of its construction and arrangement which involves the variation of the condenser capacity by means of relative movements of the conducting plates inside of the casing where they are separated from one another by any suitable dielectric. Another particularly important aspect of the invention when a vacuum is employed, as the dielectric, or when the relatively movable conductors are wholly supported and enclosed within the casing, is the provision of a means for causing relative movements of the conducting plates which does not affect the vacuum seal or the enclosure of the casing.

Sixteen claims were allowed to Mr. Proctor on this novel and ingenious invention.



A SECTION OF THE SELF-INDUCTANCE

FIGURE 2: *This diagram shows how the convolutions of the coil wind about the three roller cores of this new variable self-inductance.*



A SECTIONAL FRONT VIEW

FIGURE 3: *This view of the self-inductance described, shows how the wires roll on and off of the roller cores.*

A New Variable Self-Inductance

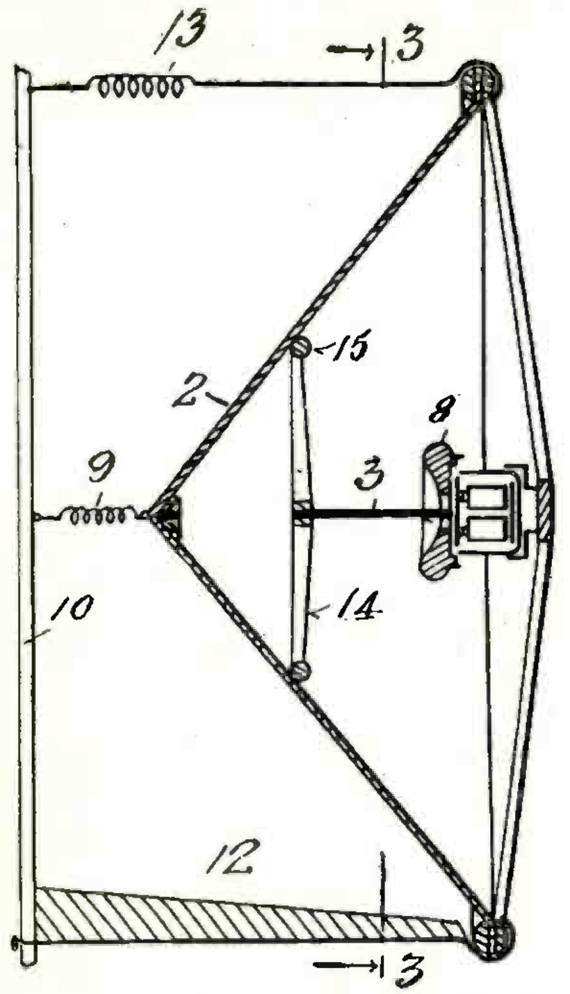
A VARIABLE self-induction apparatus, which is simple in operation and in construction, is described in Patent No. 1,555,509, which was issued to Yves Marrec of London.

In this invention an electrical conductor, which may be a wire or flat metal strip, is fastened at the middle of its length to a winding element which is referred to, in the description, as the middle winding element. The two ends of the wire or strip are adapted to be simultaneously wound on two other winding elements, which are referred to as the end winding elements.

In an arrangement of this sort, the length of the conductor which is coiled on the middle winding element has practically no self-induction, as it is a non-inductive winding, the magnetic fluxes of which, being opposite, neutralize one another. On the other hand, the two separate lengths of single conductor which are coiled on the end winding elements constitute a coil in which the self-induction varies with the length of the conductor wound on these elements.

It is evident that by varying the amount wound on the several winding elements, the self-induction of the conductor may be varied continuously from practically nothing, when almost the whole of the wire is wound on the middle winding element, to a maximum when the wire is entirely unwound from it.

The conductor should usually have a round, square or rectangular cross-section and it should



A NEW CONE-TYPE LOUDSPEAKER

FIGURE 4: *The constructional details of De Forest's new cone-type loudspeaker which may be used in connection with an electrical sound receiving apparatus such as a telephone receiver.*

be wound so as to form helices, in which the diameter and pitch and therefore the self-induction will depend on the shape and size of the winding elements. In this case, the winding elements should be provided with grooves which have been adapted to receive the conductor. The conductor may, however, be flat, and wound so as to form spirals.

The drums which constitute the end winding elements may be of magnetic material, so as to constitute magnetic cores. These cores may be independent.

The faces of the casing in which the spindles of the winding elements are pivoted may also be of magnetic material. If they are, they will form a closed magnetic circuit with the cores.

Figure 2 shows a section of the variable self-induction apparatus described in this patent. Figure 3 shows a sectional front view.

The form of the apparatus which is shown has a case, which may be of any suitable non-conducting material and three drums, which are carried in bearings. The spindle on which the middle drum is carried is extended, as shown in the diagram and an adjusting knob is fitted upon it (the knob is not shown).

The strips are made from thin silk; and each carries the conductor on one side and a more or less coarse woven mesh on the other side.

The conductors may be of metal foil, in which case they are bound and stitched at the edges as shown. However they may be made from sprayed metal, metallic paint or other materials.

There are two strips which are both pinned to the central drum and to the end drums. The non-conducting part of the strip may be continuous and may be carried under an anchoring wire on the middle drum.

The two end drums are hollow and contain springs which keep the strips in tension and unwind them from the middle drum when this is turned in the reverse direction.

The spindles of the end drums carry terminals by means of which a potential difference is applied to the coatings.

A Cone-type Loudspeaker on a New Principle

DR. LEE DE FOREST, the eminent radio pioneer, was recently granted patents No. 1,554,794 and No. 1,552,914 for a cone type of loudspeaker.

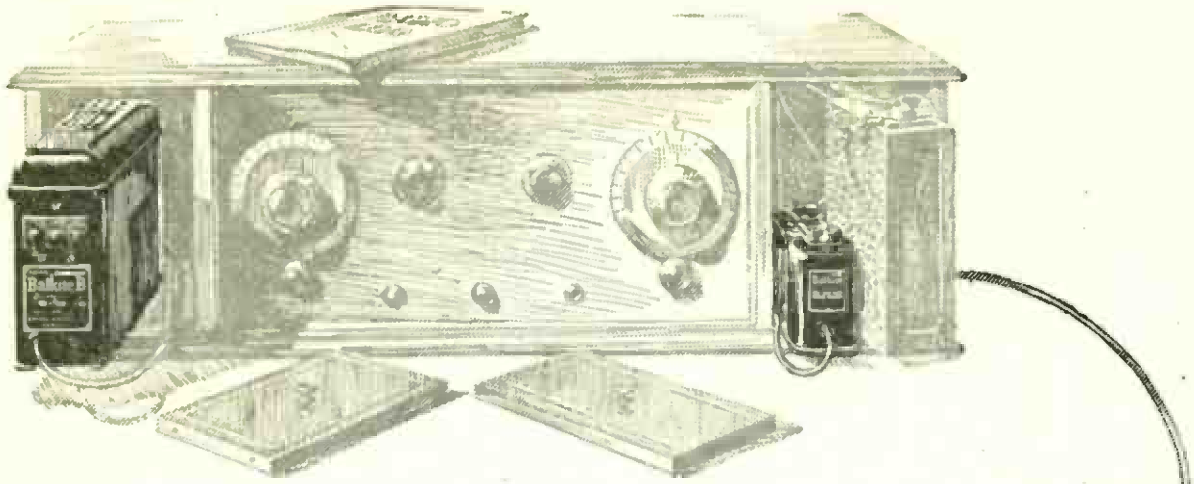
Among loudspeaking devices are those in which the sound is led from its source into a second horn or cone of tightly stretched paper, thin leather or other non-metallic material for transmitting sound waves. Several such horns are being used, in connection with phonographs, in which the phonograph needle is located at the apex of the cone.

It is one of the special purposes of Dr. De Forest's invention to provide a loudspeaking device that uses this type of diaphragm or cone but which operates on a different principle and therefore is made available for use in connection with an electrical sound receiving apparatus—such, for example, as a telephone receiver.

Dr. De Forest employs a cone structure shown in Figure 4. It consists essentially of a spider, preferably with a comparatively heavy rim, between parts of which is clamped a non-metallic diaphragm such as parchment, paper or thin leather. This diaphragm is stretched preferably in the shape of a cone. It may be maintained in a taut position in any suitable manner, for example, by means of a rod terminating at one end in a spider which supports a ring secured to it, which engages it one-half or one-third of the distance from the apex of the cone to the periphery. The rod is provided with screw threads at the opposite end which engage a nut positioned inside of the hub of the spider.

It will be seen that by varying the position of the nut which is on the threaded portion of the rod the tension imparted to the diaphragm may be varied, thus permitting an easy manner of maintaining the diaphragm taut under all conditions of temperature or atmosphere.

The apex of the conical diaphragm is provided with a needle point that projects through the diaphragm. This needle point is placed in contact with the diaphragm of an ordinary telephone receiver. It will be seen that the vibrations imparted to the diaphragm of the telephone receiver are sent directly to the conical diaphragm. In this way, the sound, in a greatly amplified condition, is reproduced in an undistorted non-metallic manner.



Convert your receiver into
A LIGHT SOCKET SET
with Balkite Radio Power Units

Now you need wait no longer for a light socket set. Balkite Radio Power Units—the Balkite Trickle Charger and Balkite "B"—enable you to make a light socket set of your present receiver.

The Balkite Trickle Charger converts your "A" Battery into an automatic "A" power unit that furnishes full "A" current from the light socket at all times. Balkite "B" replaces "B" batteries entirely and furnishes "B" current from the light socket.

This popular light socket installation is extremely simple to install, economical both in initial cost and in operation, and will fit in practically all present battery compartments. It is composed entirely of units that have demonstrated their success over a long period of time.

Noiseless—No bulbs—Permanent

All Balkite Radio Power Units are permanent, entirely noiseless, have no bulbs, no moving parts, nothing to break or get out of order. Their current consumption is very low. All operate from 110-120 volt AC current, with models for 50, 60 and other cycles. *All are tested and listed as standard by the Underwriters' Laboratories.* . . . At your dealer's.

[*The Balkite Railway Signal Rectifier is now standard equipment on over 50 leading American and Canadian Railroads*]

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Balkite
Radio Power Units

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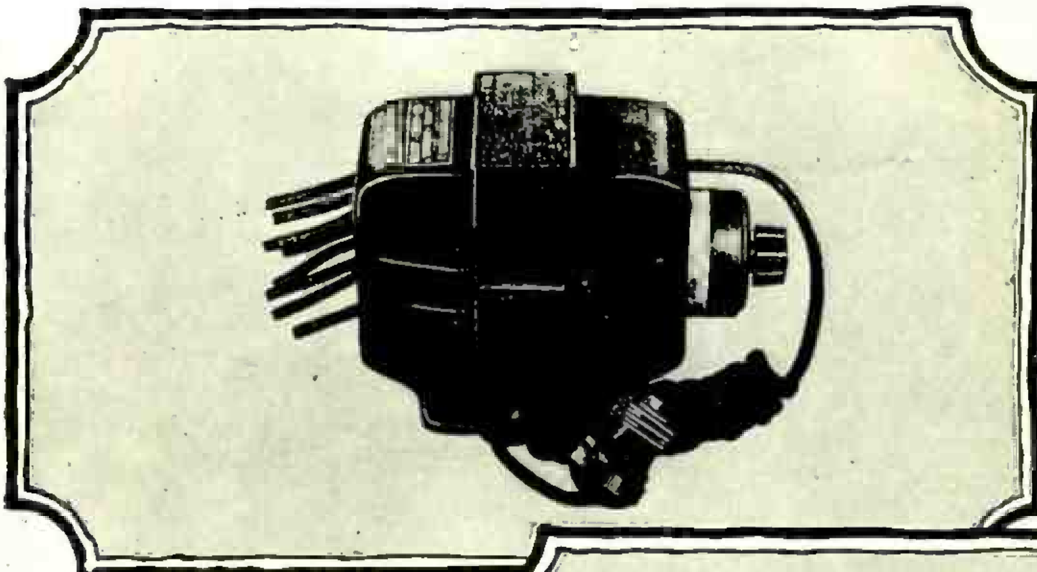
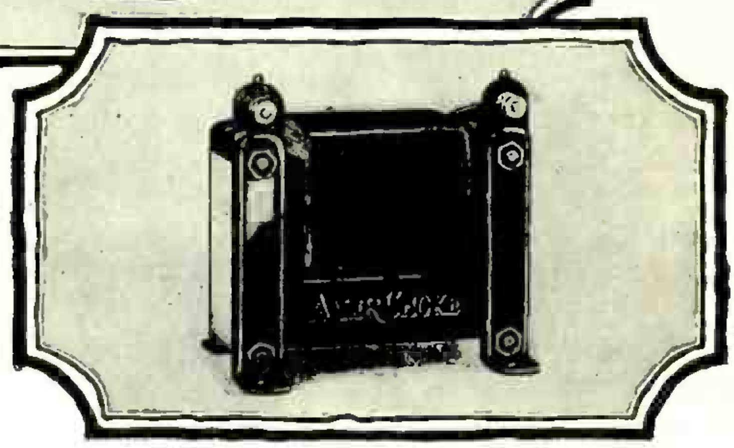
American Transformer Company



AmerTran Power Transformer Type PF-52



AmerChoke. Type 854.

FOR more than twenty-five years, the American Transformer Company has specialized in the manufacture of transformers. The transformers used by Marconi in his first trans-Atlantic tests in 1904 were made by this Company.

Since that time the engineering staff has directed a large share of its resources toward the development of transformers for radio use.

In 1921 the AmerTran Audio Transformer set a definite standard of excellence in its field.

The last five years have seen radio develop rapidly. Better tubes, broadcasting, and acoustical apparatus have brought these phases of reproduction nearer to perfection than ordinary transformer, impedance, or resistance audio amplification.

Transformer Builders

American Transformer Company

When the new AmerTran DeLuxe Audio Transformer was recently introduced it put the "audio side" ahead of broadcasting facilities and reproducing instruments. Faithful amplification with natural quality thus, has again established AmerTran as the mark of a "new standard of excellence." Combined with the new tubes, cone speakers, and clear signals from the detector tube, the AmerTran DeLuxe will reproduce natural volume over the *entire* audible range.

And now, as Radio Reception is further simplified and refined, the American Transformer Company offers a major contribution.

The AmerTran Power Transformer and the AmerChoke make it possible and economical to use the new 7½ volt power tubes in the last audio stage. The filament of this tube is lighted direct from this transformer. The Power Transformer also has a filament supply winding for the rectifying tube and supplies sufficient plate current, after rectification, for the operation of the entire receiving set.

As the receiving set of the future is destined to be power operated—the American Transformer Company offers the above apparatus as units which in quality and design are best adapted for use in the type of audio amplifier required.

For use in building, experimenting and manufacturing these new AmerTran Radio Products assure dependability and satisfaction —and furnish the most advanced construction in practical radio.

AmerTran DeLuxe 1st Stage . . .	**$10.00**
AmerTran DeLuxe 2d Stage . . .	**10.00**
AmerTran AF-7 (3-½-1)	**5.00**
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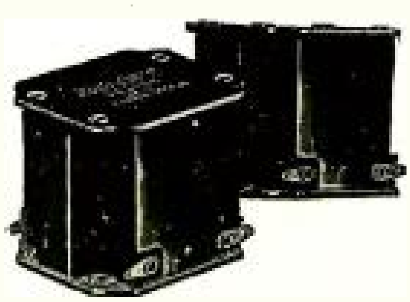
AmerTran Power Trans. PF-45 .	**15.00**
AmerTran Power Trans. PF-52 .	**18.00**
AmerChoke Type 854	**6.00**



AmerTran DeLuxe two types for first and second stages.

Write for booklet entitled "Improving the audio Amplifier." It contains valuable up-to-date information.

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Send coupon below for FREE BOOK—"Rich Rewards in Radio." Read for yourself. No previous experience needed. Common schooling enough. WRITE NOW.

Receiving sets, from simplest kind to thousand mile receiver, included to help you learn. An UNEQUALLED OFFER. Other special features for limited time only, so ACT QUICK!

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Dept. DT-8, Washington, D. C.

MAIL COUPON

National Radio Institute,
Dept. DT-8, Washington, D. C.

Without obligating me in any way please send me your free book, "Rich Rewards in Radio," also complete information on your practical, home-study Radio course.

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

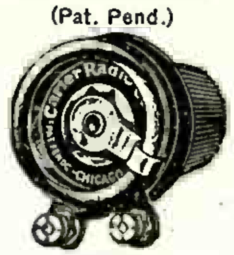
Address...

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

CARTER

All Metal "IMP" Rheostat

(Pat. Pend.)



Half Size

$1 All Resistances 3 to 50 Ohms

No matter what circuit you use, use a Carter "IMP" Rheostat. No moulded parts to crack or break; wire element clamped in place. Will not move. Silent, smooth operation. Potentiometer 200 or 400 Ohms; same size and construction. Price $1.25.

MEMBER R.M.A. See them at your dealers. Write for illustrated folder.

In Canada—Carter Radio Co., Limited, Toronto

Carter Radio Co.
300 S. RACINE AVENUE
CHICAGO, ILL., U.S.A.

Oh boy

KESTER *Rosin Core* *Radio* SOLDER

Sure is Safe and Simple

APPROVED BY RADIO ENGINEERS

A GENUINE SOLDER

CHICAGO SOLDER COMPANY

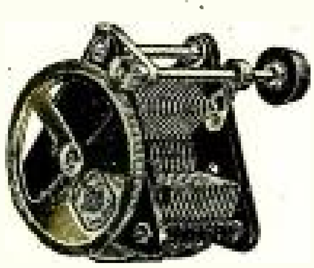
4221 Wrightwood Av., Chicago, U.S.A.

Originators and World's Largest Manufacturers of Self Fluxing Solder

YOUR DEALER CAN SUPPLY YOU

The UNIVERSAL Standards of Quality

Type 277-D
Coupling Coil
Price $1.50



Type 247-H
Geared Condenser
Price $5.00

Type 368
Micro-Condenser
Price $1.25

In building a radio receiver remember that its performance depends primarily upon two things; an efficient circuit, and the use of good parts.

Wherever you find a popular circuit you will invariably find General Radio parts.

The General Radio Company has contributed more in scientific apparatus for laboratory use than any other one Company in the history of radio.

The same outstanding craftsmanship and materials are embodied in General Radio parts for use in the construction of broadcast receivers.

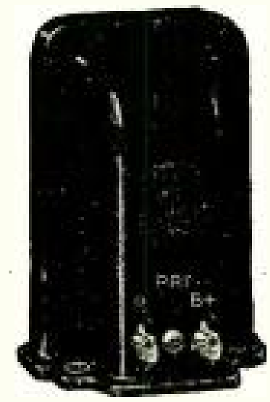
Through the merits of design, performance, and price, General Radio instruments for the scientist or set-builder are universally recognized as the Standards of Quality.

Every instrument made by the General Radio Company is thoroughly guaranteed.

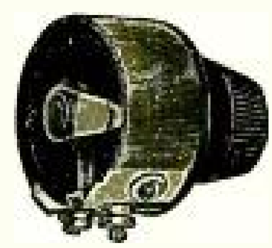
The General Radio Company has endeavored to make it possible for the experimenter to obtain its products with a minimum of effort. A careful selection of distributors and dealers has been made. They are best fitted to serve you. If, however, you are unable to obtain our products in your particular locality they will be delivered to you, postpaid, direct from the factory upon receipt of list price.

Write for our latest parts Catalog 924P

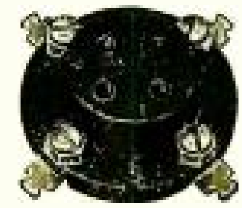
GENERAL RADIO CO.
Cambridge 39, Mass.



Type 285
Audio Transformer
6 to 1 and 2 to 1
Price $6.00



Type 301
Rheostats
12 and 25 ohms

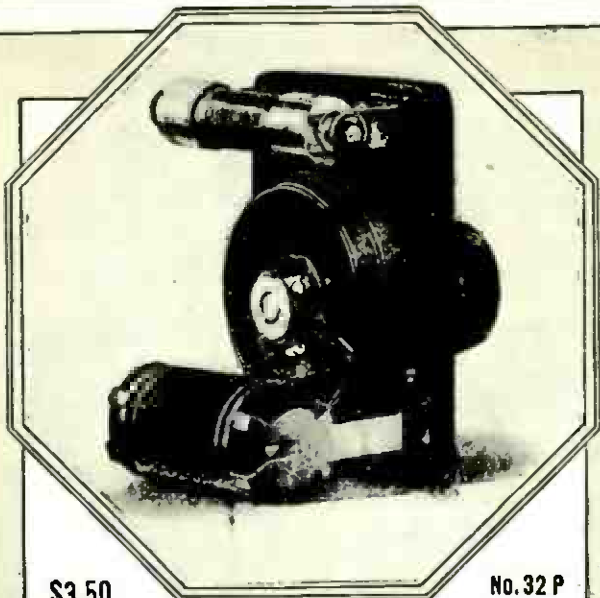


Type 349
Ux Tube Socket
Price 50c.

GENERAL RADIO

INSTRUMENTS

"Behind the Panels of Better Built Sets"



$3.50
IN U. S.
(WITHOUT DRY CELL)

No. 32 P

Banish Detector Troubles with The Carborundum Stabilizing Detector Unit

BY a turn of the knob on the stabilizer you adjust the detector impedance to best suit operating conditions.

You can materially reduce the detector circuit damping, thus giving increased selectivity—sharper tuning.

With this stabilizing unit you get the most efficient rectification—resulting in increased sensitivity—greater volume.

It's a simple device that solves all detector troubles.

Comes equipped with genuine, fixed Carborundum Detector. An ordinary flash-light cell for booster voltage completes the unit.

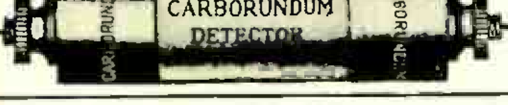
You can get the fixed, permanent Carborundum Detector alone for $1.50

YOUR DEALER OR DIRECT

Send for Descriptive Circular Showing Hookups

THE CARBORUNDUM COMPANY
NIAGARA FALLS, N. Y.

New York Chicago Boston Philadelphia
Cleveland Detroit Cincinnati
Pittsburgh Milwaukee Grand Rapids



Corbett Console for LC-26 Receiver

Five ply mahogany or walnut, with our usual high quality hand rubbed Duo-tone lacquer and varnish finish. Straight or sloping panel front.

The "Corbett Console" is adapted to any of the popular receivers, including McLaughlin, Hammarlund Roberts (Illustrated), G-O and S-C.

WITHOUT HORN.................... $40.00
(as illustrated)

WITH BUILT IN HORN 54.00
(Large Miller hard rubber horn at left of panel with silk backed grill.)
Shipping charges prepaid

WRITE FOR BOOKLET showing attractive models for all sizes of radio cabinets, consoles and tables.

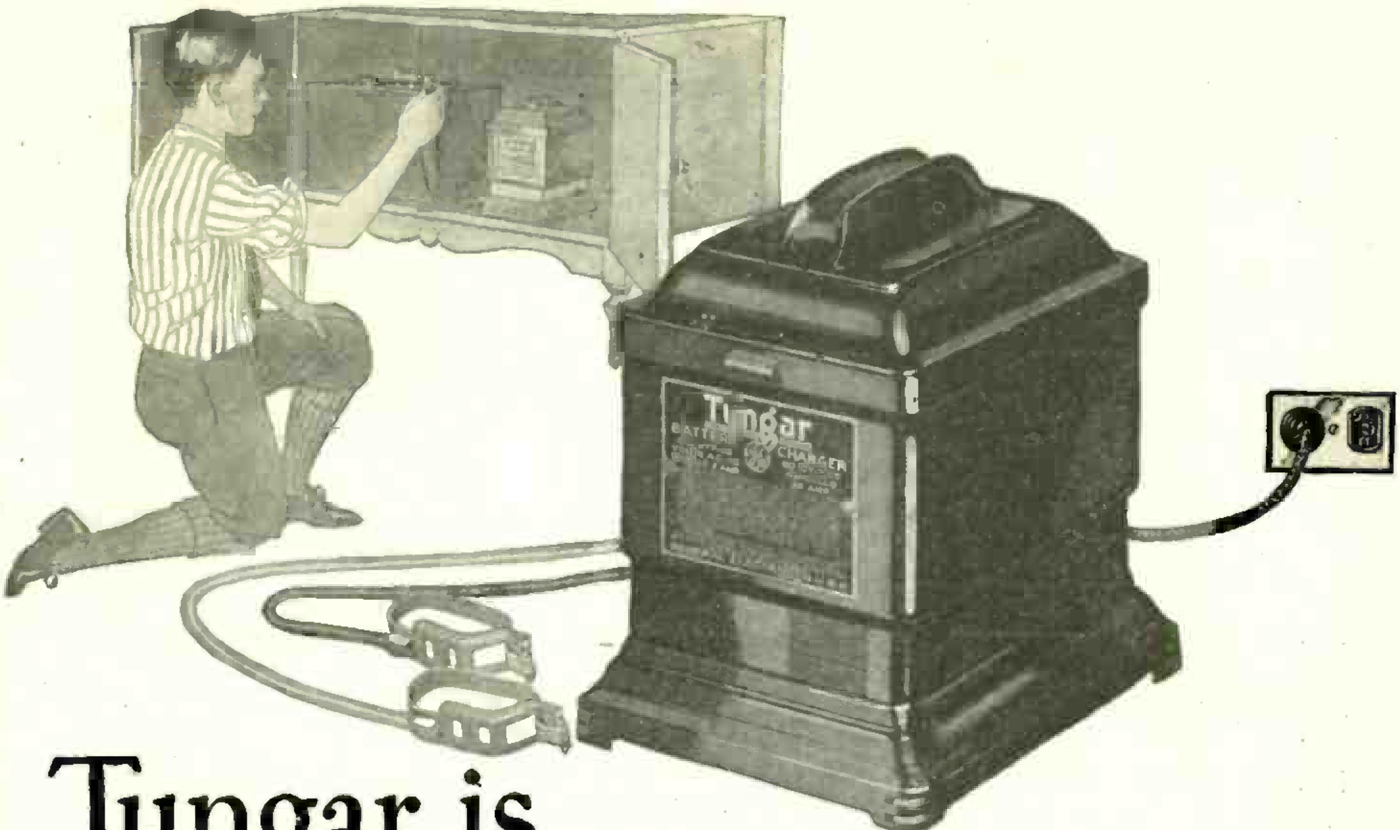
Jobbers & Dealers write for discounts.

CORBETT CABINET MFG. COMPANY
St. Marys, Pennsylvania

screw-machine products —brass

For plugs, jacks, clips, condenser and transformer parts, etc., BRASS assures economy in quantity production. It also gives the right electrical conductivity and the mechanical accuracy essential to proper operation of radio sets and parts.

COPPER & BRASS
RESEARCH ASSOCIATION
25 Broadway, New York



Tungar is the easy-to-use charger

Anyone can clip a Tungar to a battery and plug it in on the house current. That's all there is to it.

Attach a Tungar at night—and have snappy batteries in the morning. It will not blow out Radiotrons.

It needs little attention. Only a dime's worth of current consumed for a charge. No wonder "Tungar" is fast becoming the word for battery charger.

Tungar is the original bulb charger. It is a G-E product developed in the Research Laboratories of General Electric

The new Tungar charges 2, 4 and 6 volt "A" batteries, 24 to 96 volt "B" batteries, in series; and auto batteries, too. No extra attachments needed.

East of Rockies

Two ampere size $18.00
Five ampere size $28.00

60 cycles - 110 volts

Merchandise Department
General Electric Company
Bridgeport, Connecticut

Tungar
REG. U.S. PAT OFF.
BATTERY CHARGER

Tungar—a registered trademark—is found only on the genuine. Look for it on the name plate.

GENERAL ELECTRIC

HAMMARLUND

ROBERTS

FOR a long time to come, there will not be evolved a more efficient circuit than that in the new Hammarlund-Roberts Receiver.

Ten leading radio engineers devised it as their composite ideal. The result is a receiver, operating on only five tubes, which possesses the sensitivity of a standard eight-tube receiver, plus a high degree of selectivity which minimizes interference.

Tuning is simplicity itself. The volume and tone are exceptional, the receiver being designed to operate on the cone type of speaker.

And best of all, you can construct it yourself, from the finest parts known to radio, with results worthy of any professional builder.

The cost, $60.80 (cabinet extra) is only about one-third of the price of a factory-built receiver of similar quality.

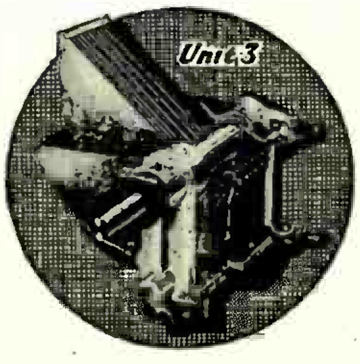
Your dealer sells the famous Hammarlund parts for this receiver and can supply you with all the other parts specified in the "How to Build" book, which will be mailed on receipt of 25 cents.

For Better Radio
Hammarlund
PRECISION
PRODUCTS

HAMMARLUND MFG. CO.

424-438 W. 33d St. New York

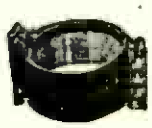
UNIT 2. — "Hammarlund, Jr." The Precision Midget Condenser.
UNIT 3. — The New Hammarlund Straight-line frequency Condenser.
UNIT 4. — The New Hammarlund Low-Loss, Space-Wound Coils.



FOUNDATION UNIT

The Foundation Unit contains all *special* parts needed to build the Hammarlund-Roberts Receiver, including drilled and engraved panels, brackets, wire, screws, etc. $7.90, at your dealers.

UNIT 4



UNIT 4

A. Radio Phan

ANYWHERES, U. S. A.

Mr. Mike Rofone.
Dear Mike:

Just wanted to tell you how wonderful your broadcasting sounded last night.

I heard the program on an Arborphone Set using a Timbretone speaker and never before realized how wonderful Radio really was.

I have since found out that the Timbretone Speaker is one of the few on the market that is really built to reproduce music and speech.

Found it was built to bring out the overtones and harmonics of music with the same fidelity that appeals to lovers of music who really appreciate real "Quality." Being all wood it has a "mellow" tone, unequaled.

I paid thirty dollars for it but, gosh, I have a good set so couldn't afford to spoil it all with a cheaper speaker.

Will write you again next month. Till then,

Sincerely yours,
Tim Bretone

SEE THAT SCREW

A screw driver adjusts an X-L in crowded places.

X-L VARIODENSER

Results in easier tuning, more distance, volume and clarity — greater stability.

Indorsed by leading radio authorities

Model "N" A slight turn obtains correct tube oscillation on all tuned radio frequency circuits. Neutrodyne, Roberts two tube, Browning-Drake, McMurdo Silver's Knockout, etc., capacity range 1.8 to 20 micro-micro farads. Price $1.00.

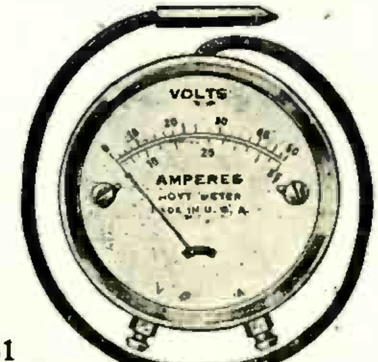
Model "G" with grid clips obtains the proper grid capacity on Cockaday circuits, filter and intermediate frequency tuning in heterodyne and positive grid bias in all sets. Capacity range .00016 to .00055 and .0003 to .001 micro farads. Price $1.50.

X-L PUSH POST

Push it down with your thumb, insert wire, remove pressure and wire is firmly held. Releases instantly. Price 15c.

X-L Radio Laboratories
2422 LINCOLN AVE.,
CHICAGO, ILL.

Hoyt Pocket Meters



Hoyt Type 31 Pocket Meter

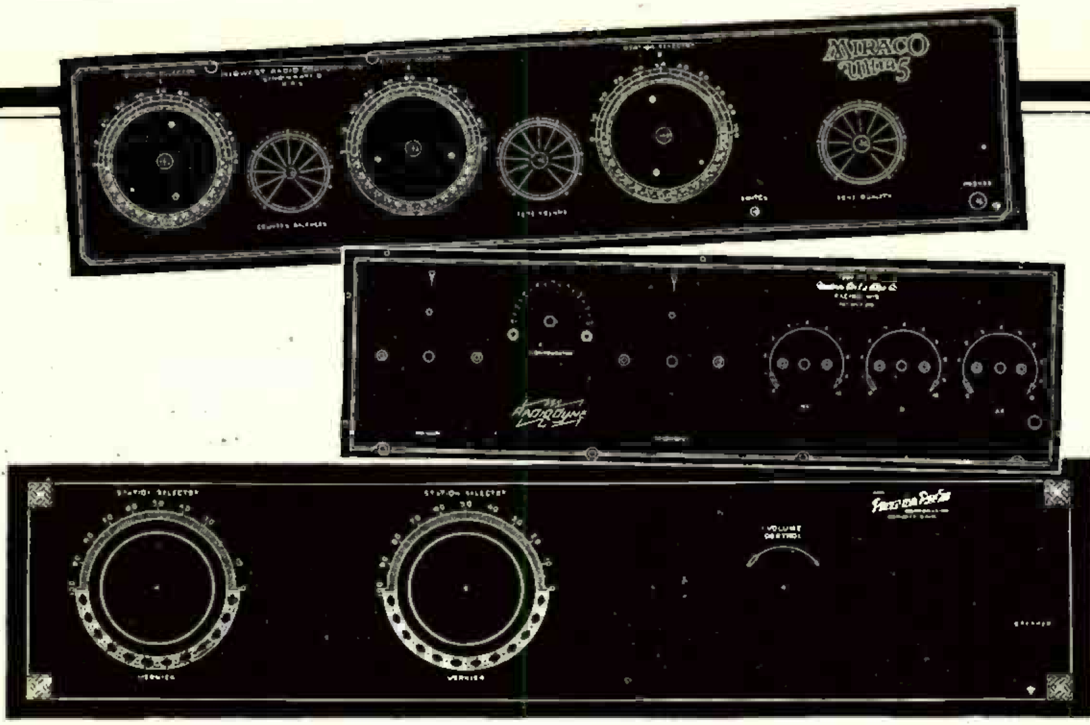
The indispensable pocket instrument for Dealers and Radio-Owners for checking the condition of A and B batteries. Reads up to 50 volts or 35 amperes. All scales are hand-calibrated, resistance of meter is unusually high for this type, accuracy does not vary in extreme heat or cold.

Finished in polished nickel, of small size, convenient for handling.

Price, complete with lead
$3.00

BURTON-ROGERS CO.
26 Brighton Ave. Boston, Mass.
National Distributors

HOYT makes a complete line of Radio Meters. Send for booklet "HOYT Meters for Radio."



Veri Chrome and Formica Provide the Finest Radio Panel

The great variety and beauty of the decorations for radio panels that are possible with Veri Chrome and the remarkable permanence of a Formica panel so decorated, have made sets with Veri Chromed panels very popular.

You will find Veri Chromed panels—some of them decorated with the work of the leading artists—on many of the finest sets this year.

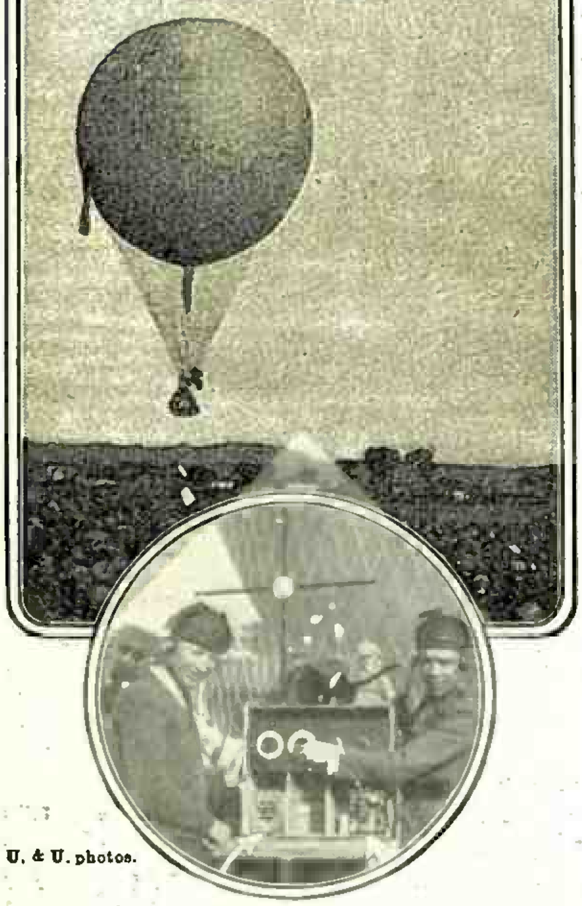
To give kit buyers who assemble their own sets a chance to purchase decorated panels, we have prepared panels for some of the better known kits.

Bremer Tully No. 1, Bremer Tully Counterphase, Bremer Tully Nameless, two sizes of Best's Superheterodyne put out by Remler; the Browning Drake receiver offered by the National Company, The Marco Browning Drake and the Radio Broadcast Universal Receiver are kits for which Veri Chromed panels are now available. See your dealer or jobber or write us direct. Panels of all standard sizes are packed in neat individual envelopes and sold by dealers to home set builders.

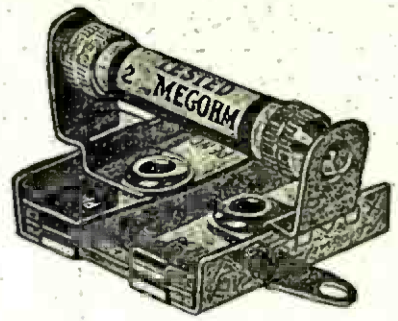
Write for booklet *"What Formica Is"*

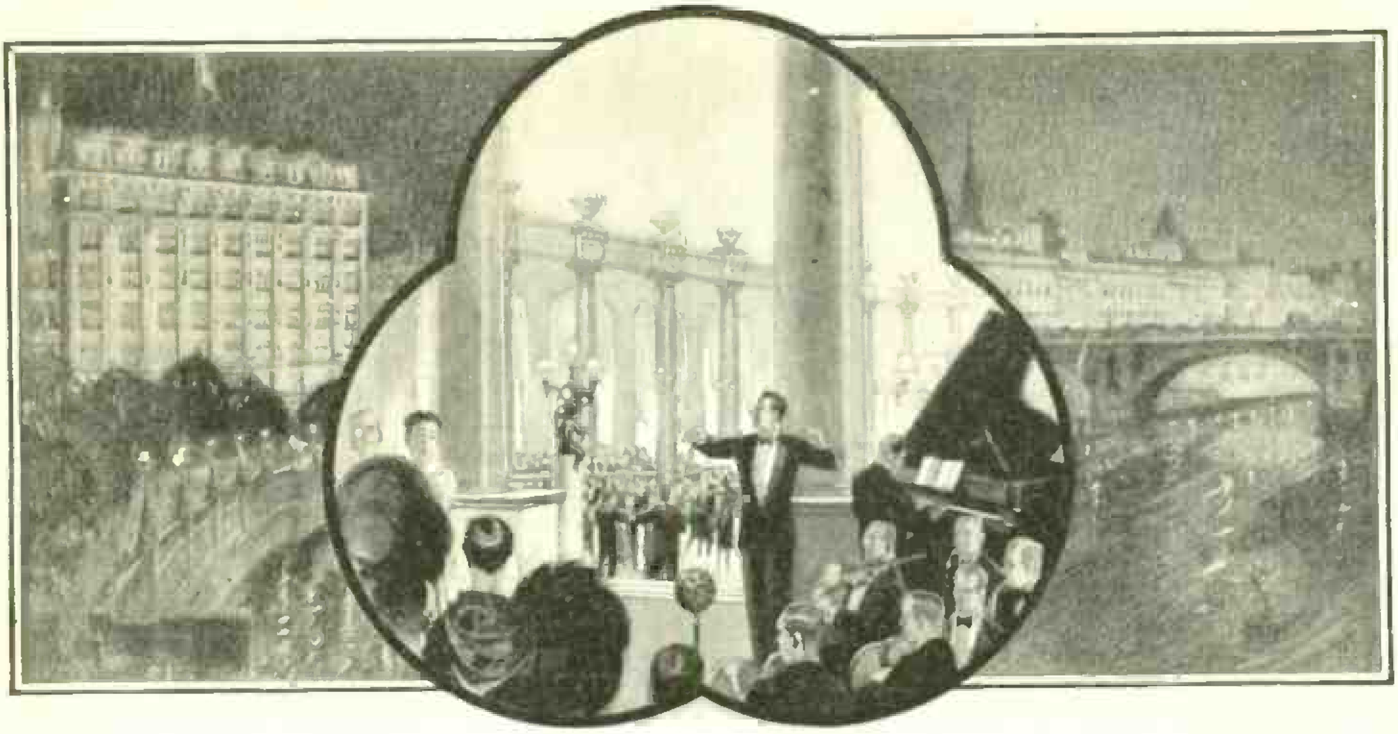
THE FORMICA INSULATION COMPANY
4641 Spring Grove Avenue, Cincinnati, Ohio

FORMICA
Made from Anhydrous Bakelite Resins
SHEETS TUBES RODS

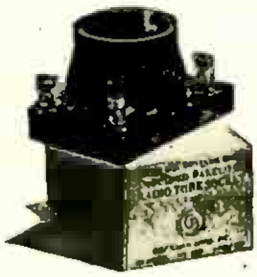


U. & U. photos.





"This is Station 2-L.O. London—12 Midnight"



When listeners-in on this side of the Atlantic first heard the voice of the British announcer, and then a program of music from the famous Savoy in London, they experienced one of the real thrills of radio.

To get everything that is on the air—the faint signals as well as the strong ones—effective insulation of all radio parts is a prime essential. The best way to make sure that a radio set or parts are well insulated, is to buy those in which Bakelite is used.

Bakelite is used by 95% of radio set and parts manufacturers. It is the standard material for front and base panels, dials, knobs, tube sockets and bases, fixed and variable condensers, rheostats, plugs and other radio accessories and parts. Write us for a copy of Booklet, No. 28, "Bakelite in Radio"—it's a helpful guide in buying radio equipment.

BAKELITE CORPORATION
247 Park Avenue, New York, N.Y
Chicago Office: 636 West 22nd St
BAKELITE CORP. OF CANADA Ltd
163 Dufferin St., Toronto, Ontario, Can

BAKELITE

REGISTERED U. S. PAT. OFF.

THE MATERIAL OF A THOUSAND USES

"The registered Trade Mark and Symbol shown above may be used only on products made from materials manufactured by Bakelite Corporation. Under the capital "B" is the numerical sign for infinity, or unlimited quantity. It symbolizes the infinite number of present and future uses of Bakelite Corporation's products."

First in the Field Specializing in Cockaday Kits

S. HAMMER RADIO CO., 303 Atkins Ave. Brooklyn, New York

Cockaday Sets Now Made Easier to Build by Our New "Ready-to-Wire" Plan

50% of Your Time, Work and Worry SAVED!

All you need do is to connect bus-bar according to diagram, solder and your set is finished.
These Kits are sent to you completely mounted, and assembled on a Veneered Mahogany baseboard and genuine bakelite panel, drilled and engraved. Genuine parts used as listed below; exactly as used in Mr. Cockaday's Laboratory Model. COMPARE OUR OFFER!

"POWER UNIT"

These are the exact parts, used in building the Laboratory Model of the "POWER UNIT"

1 Amertran power transformer, type PF-52..$18.00
1 Amertran De Luxe A. F. transformer for second stage...... 10.00
3 Amerchokes, type 854. 18.00
2 Dubilier filter condensers, type 769, 2 mfd. (working voltage 400 volts D. C.)........ 7.00
2 Dubilier filter condensers, type 770, 4 mfd. (working voltage 400 volts D. C.). 14.00
4 Dubilier filter condensers, type 766, 2 mfd. (working voltage 160 volts D. C.). 8.00
1 Aerovox Craig resister, type 980........... 4.00
1 Bradleyohm No. 25—25,000 to 250,000 ohms............... $2.00
2 Pacent single-circuit jacks, No. 61....... 1.00
2 Benjamin push-type sockets, No. 9040... 1.50
Bakelite sub-base, 7x21x ¼ inch Drilled........ 4.45
Bakelite binding-post strip, 7x1x¼ inch... .35
Angle brass reinforcement strips for sub-base pr. .75
Angle brass for holding binding post strip, pr. .10
Brass brackets for mounting resistor unit M, pr. .35
Brass strip for mounting filter condensers.... .35

COMPLETE KIT **$89.85**

The Following UNASSEMBLED and READY-TO-WIRE KITS IN STOCK

S-C RECEIVER Raytheon Plate Supply Unit; McLaughlin Single Control Superheterodyne; Hammarlund Roberts Kits.

Cockaday's New LC-26 Receiver

1 General Radio Variometer type 269 with rheostat knob.................. $5.30
1 General Radio Rheostat type 214-a, 7 ohms, with rheostat knob.............. 2.25
1 Precision Octaform coil set 5.50
1 Amsco Double Unit Condenser No. 1814......... 6.25
1 Micamold fixed Condenser .00015 mfd.............. .35
1 Micamold fixed Condenser .00025 mfd.............. .35
2 Daven resisto-couplers (new type).................. 3.00
1 Amertran DeLuxe transformer, first stage.......... 10.00
Bradleyleak ¼ to 10 meg. 1.85
3 Bradleyunits, ¼ megohm... $2.25
1 Bradleyunit ½ megohm.... .75
3 Amperites No. 1a.......... 3.30
1 Amperite No. 112.......... 1.10
5 Benjamin standard "Cle-ra-tone" sockets........... 5.00
1 Carter single-circuit jack No. 101................ .70
2 Carter Jack switches No. 2 2.00
8 Eby binding posts......... 1.20
1 Fynur vernier control knob and dial................ 3.50
1 Universal decorated panel, 8 x 22 inches........... 7.50
4 Small brass brackets.....
2 Bakelite Connection Blocks 1 x 2 plus 1 x 9.....
2 Large Brass Brackets.... .35

READY-TO-WIRE KIT, PRICE, . $62.50
WIRED COMPLETE In Genuine Mahogany Cabinet ***$77.00***

UNASSEMBLED KITS IN STOCK

BEST 5 TUBE SUPERHETERODYNE

Send for Free Radio Catalog and Complete Information about our Parts and Kits.

WRITE FOR BOOKLET about these Parts and Kits

Transportation Prepaid. One-third must accompany all C. O. D. orders. Not insured unless insurance charges included

Premier B Battery Cabinet

Our Premier B Battery Cabinet is a beautiful piece of furniture. The B battery compartment will take any type B battery. The space of each B battery compartment is 4½" wide, 8½" high and 10" deep.

No.	For Panel	Deep	Genuine Walnut
718-10	7 x 18	10"	$18.50
721-10	7 x 21	10"	19.00
724-10	7 x 24	10"	19.50
726-10	7 x 26	10"	20.00
728-10	7 x 28	10"	21.00
730-10	7 x 30	10"	22.00

F.O.B. Waukesha, Wis.

The tops of these cabinets are figured walnut, the ends and B battery panels are select walnut, all 5 ply veneer. The bases are built up of massive molding. Nickel plated piano hinges and lid holders. The material and finish in these cabinets will equal the best furniture obtainable.

WE MAKE 9 STYLES OF CABINETS FOR 14 SIZES OF PANELS. Send for our 1925-26 line of cabinets at "Factory to User" prices.

Utility Cabinet Company

Phone 721 **Waukesha, Wisconsin**

22½ Volt un-acid everlasting rechargeable "B" Storage Battery

$2.95

includes chemical

45 volts $5.25, 90 volts $10.00, 112½ volts $12.50, 135 volts $14.75, 157½ volts $16.80. Truly the biggest buy today. Easily charged on any current including 32 volt systems. Any special detector plate voltage had. Tested and approved by leading authorities such as POPULAR RADIO laboratories. Over 3 years sold on a non-red tape 30 day trial offer with complete refund if not thoroughly satisfied. Further guaranteed 2 years. Knock-down kits at greater savings. Complete "Hawley" "B" Battery charger $2.75. Sample cell 35c. Order direct—send no money—simply pay the expressman cost on delivery. Or write for my free literature, testimonials and guarantee. Same day shipments.

B. HAWLEY SMITH, 315 Washington Ave., Danbury, Conn.

SM PARTS

THE SC RECEIVER

In this new, single-control, all-wave, 4-tube receiver, designed by eight eminent, engineering staffs, SM PARTS were used wherever possible. Their unquestionable excellence and dependability made SM Parts the logical selection for this advanced receiver. That is why in almost every successful receiver design of past and present seasons you will invariably find SM Products—depended upon, and dependable.

Type 316 Condenser, .00035 Mfd. for single or gang control. Brass plates, die cast frame. Price, $5.75.

SM THORDARSON RAYTHEON B-ELIMINATOR

The SM Type 650 Kit includes Thordarson Transformer, choke, Tube Condensers, genuine Raytheon Tube, Bradleyohms and all necessary parts....................$34

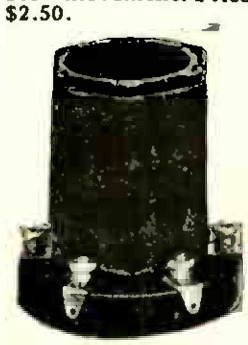
This Eliminator will deliver from 20 to 200 volts at three different adjustable voltages with maximum current of 50 milliamperes—more than enough for the largest receiver. Send for Assembly Instructions by Mc Murdo Silver....................10c

Type 801 Universal Vernier Dial, Ratio 14.5:1. Fits any standard condenser right or left, 180 or 360° movement. Price, $2.50.

See SM Products at Your Dealers or Write for Circulars

Silver-Marshall, Inc.

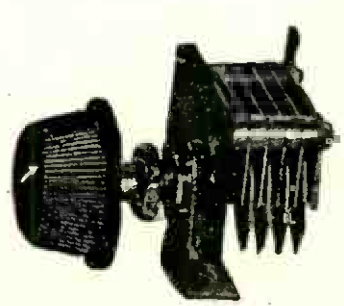
112 S. Wabash Ave., Chicago.

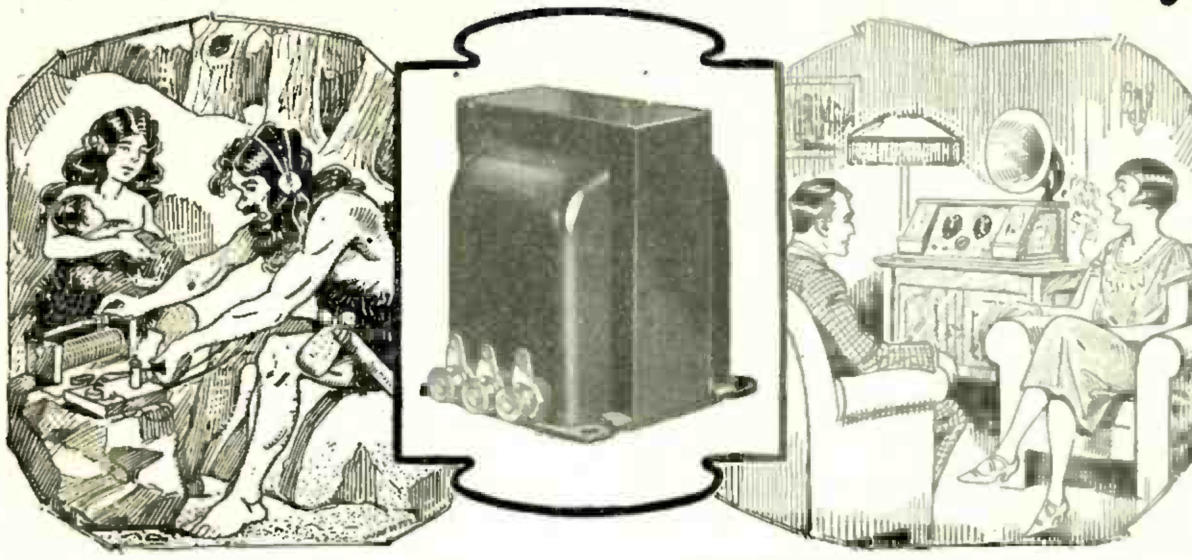


Interchangeable Coils for any wavelength. Standard Sizes, $2.50. Type 515 Coil Socket, $1.00.

Type 510 All-Bakelite Socket for UX Tubes, 50c.

Type 340 Compensating Condenser, .000025 Mfd. with knob, $1.50.





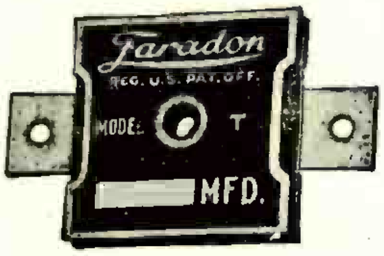
Faradon

ELECTROSTATIC CONDENSERS

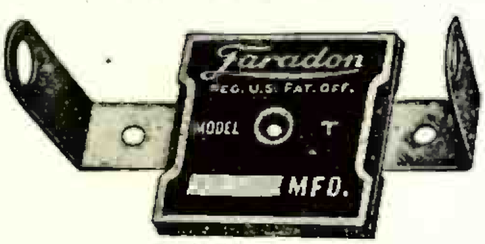
19 YEARS OF SPECIALIZATION IN THE RADIO FIELD

are behind each Condenser Trade Marked

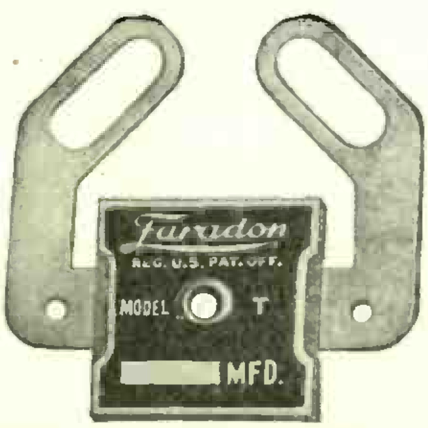
Faradon



Type I Terminals
For Soldered Connections in Any Portion of Circuit



Type II Terminals
Holds Standard Cartridge Grid Leak—Also Takes Soldered Connections



Type III Terminals
For Transformer or Other Binding Post Mounting—Also Takes Soldered Connections

In Radio Receiving Sets the Biggest Little Things are the FIXED CONDENSERS.

The MODEL T FARADON is furnished in all usual sizes to meet the requirements of Quality Performance.

Quotations covering quantity requirements furnished to
SET MANUFACTURERS
promptly upon request.

Some Important FARADON Users:

U. S. Army—U. S. Navy—U. S. Signal Corps—U. S. Bureau of Standards—General Electric Co.—Radio Corporation of America—Western Electric Company—Tropical Radio Tel. Co.—Westinghouse Electric & Mfg. Co.

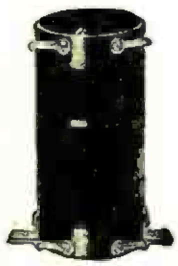
WIRELESS SPECIALTY APPARATUS COMPANY

JAMAICA PLAIN—BOSTON, MASS.

PRECISION OCTAFORM COIL

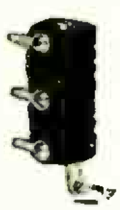
A new type of inductance used in the Cockaday LC-26 Receiver. The only coil that can be used in this set. Price $5.50.

PRECISION AUTODYNE COUPLER



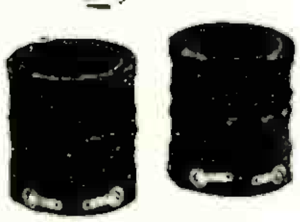
Used in the Superheterodyne Reflex Receiver described in January 1925 issue of Popular Radio Price $3.50.

PRECISION COIL SET



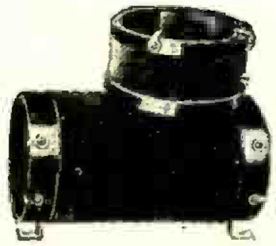
No. 300

For the new Orthophase Receiver described in February Popular Radio. Price, per set of three, $7.50.



COCKADAY COIL $5.50
(New Octaform Base)

The fact that this coil was used in the 4-Circuit Tuner as designed by Mr. Cockaday, is significant recognition of the accuracy and efficiency of Precision Coils.



COMPLETE KITS

EXACTLY THE SAME AS MR. COCKADAY'S LABORATORY MODELS

Insure your getting the same results Mr. Cockaday gets from his Laboratory Models by purchasing kits from us. Our buying department has exceptional facilities for getting the exact parts Mr. Cockaday uses. Write us.

POWER PACK AMPLIFIER

1 Amertran power transformer, type PF-52	$18.00
1 Amertran DeLuxe A. F. Transformer, second stage	10.00
3 Amerchokes, type 854	18.00
2 Dubilier filter condensers, type 769, 2 mfd	7.00
2 Dubilier filter condensers, type 770, 4 mfd	14.00
4 Dubilier filter condensers, type 766, 2 mfd	8.00
1 Aerovox-Craig resistor, type 980	4.00
1 Bradleyohm No. 25—25,000 to 250,000 ohms	2.00
2 Pacent single circuit jacks, No. 61	1.00
2 Benjamin Push-type sockets, No. 9040	$1.50
Bakelite sub-base, 7 x 21 x ¼ inch	4.45
Bakelite binding post strip, 7 x 1 x ¼ inch	.45
Angle brass reinforcement strips for sub-base pr	.90
Angle brass for holding binding post script, pr	.10
Brass brackets for mounting resistor unit M	.35
Brass strip for mounting filter condensers	.35
Complete	$90.10

COCKADAY LC-26 KIT

1 General Radio variometer, type 269, equipped with rheostat knob	$5.30
1 General Radio rheostat, type 214-a, 7 ohms, equipped with rheostat knob	2.25
1 Precision Octaform coil set	5.50
1 Amsco special double unit condenser No. 1814 each section .0003 mfd	6.25
1 Micamold fixed condenser, .00015 mfd	.35
1 Micamold fixed condenser, .00025 mfd	.35
2 Daven resisto-couplers (new type which incorporates .1 mfd. condenser concealed in base)	3.00
1 Amertran DeLuxe transformer, first stage	10.00
Bradleyleak, ¼ to 10 meg	1.85
3 Bradleyunits, ¼ megohm	2.25
1 Bradleyunit, ½ megohm	.75
3 Amperites No. 1a	$3.30
1 Amperite No. 112	1.10
5 Benjamin standard "Cle-ra-tone" sockets	5.00
1 Carter single-circuit jack, No. 101	.70
2 Carter Jack switches, No. 2	2.00
8 Eby binding posts	1.20
1 Fynur vernier control knob and dial	3.50
1 Universal decorated panel, 8x22 inches	7.50
Blueprints	1.00
4 Small brass brackets; 1 Antenna connection block, 1x2 inches; 1 Battery connection block, 1x9 inches; 2 Large brass brackets; Screws and buss wire	1.75
Solid Walnut Cabinet	17.00
Total	$81.90

COCKADAY 3-TUBE 4-CIRCUIT TUNER

1 Precision Octaform 4-circuit Coil Set	$5.50
1 Lombardi Dual S.L.F. variable condenser (2 sections)	9.50
1 Aerovox mica fixed condenser .00025 mfd	.30
2 Perry audio-frequency transformers	12.00
1 Bradleyleak	1.85
1 Jones seven-point inductance switch	1.50
1 E-Z-stat, 6 ohms	.75
1 Amperite No. 112	$1.10
2 Na-ald De Luxe sockets	1.50
1 Benjamin Claratone socket	1.00
1 Yaxley open-circuit filament jack	.70
1 Gee Haw vernier dial	3.00
1 panel, 7 x 18 inches	2.40
1 baseboard, 6¾ x 16¾ inches	.35
Seven Eby binding posts	1.05
Price Complete (Including panel and baseboard)	$42.50

OTHER KITS IN STOCK

Complete parts for the S-C Receiver described in March Popular Radio $58.85

Complete parts for the Raytheon "B" Eliminator $42.05

PRECISION COILS AND KITS ARE ABSOLUTELY GUARANTEED

Send money order today or we will ship C.O.D. upon receipt of your order anywhere in the U. S. A. Dealers—Write for information about the complete Precision Line.

PRECISION COIL CO., INC.

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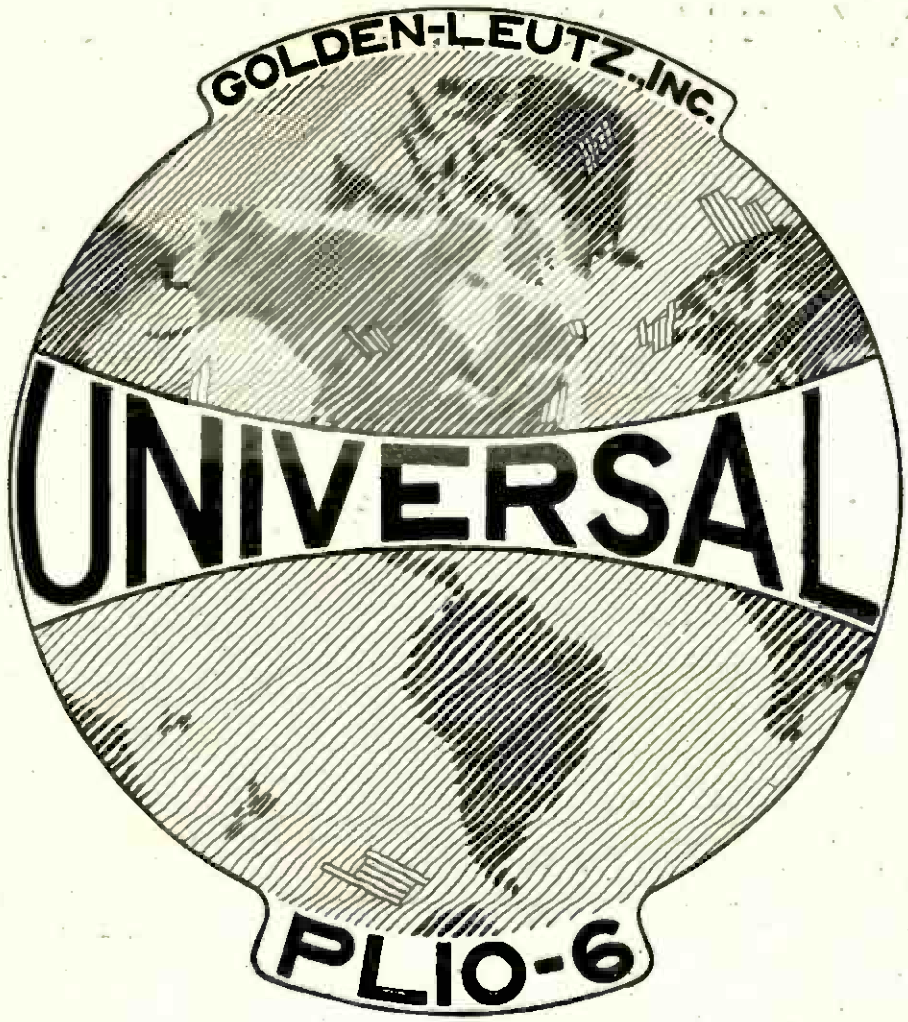

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LONG ISLAND CITY, N. Y.

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PLEASE MAIL IMMEDIATELY WHEN READY AND WITHOUT OBLIGATION ON MY PART FULL DESCRIPTIVE LITERATURE ON YOUR NEW LINE INCLUDING

1. STANDARD PLIO 6 A POWERFUL HIGH GRADE MEDIUM PRICED BROADCAST RECEIVER.
2. UNIVERSAL PLIO 6 HAVING THE EXCLUSIVE FEATURE OF TUNING ALL WAVELENGTHS FROM 35 TO 3600 METERS FOR PERFECT BROADCAST RECEPTION.
3. UNIVERSAL SUPER 8 A VERY HIGH GRADE SCIENTIFIC BROADCAST RECEIVER ALSO FOR ALL WAVELENGTHS FROM 35 TO 3600 METERS.
4. UNIVERSAL TRANSOCEANIC THE MOST POWERFUL AND MOST ADVANCED RADIO BROADCAST RECEIVER IN THE WORLD.

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YOURS VERY TRULY

NAME..

ADDRESS..

MYERS

The World On Your Dial

MYERS RADIO TUBES

Seven Years of Superiority

KNOWN as the original HI-MU tubes before the days of BCL;

Preferred by amateurs and experts before the first popular receiving set was sold;

Progressively improved in construction and performance;

Made in the newest and best equipped plant in America.

Get the World on Your Dial With Myers Tubes

Low impedance, high amplification constant, high mutual conductance. Best results in any circuit —impedance, resistance or transformer coupled.

At Your Dealer's

Myers Radio Tube Corporation
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Attractive, compact, correct inside and out, no clumsy materials. Made by pioneer designers and builders of Radio Tubes.

Marvelous Clarity and Distance

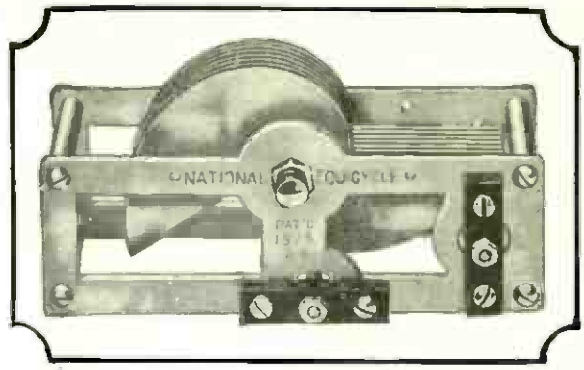
Use Myers Tubes in *any* set and get better results in volume, tone, range and ease of control.

Made with standard four prong base, or double-end, in types Myers 01 A, Myers 01 X, Myers 99, Myers 99 X.

List Price
Type 01
$2.00
Type 99
$2.25

At Your Dealer's

—a distinct innovation in the capacity unit field



THE *New* NATIONAL EQUICYCLE Condenser

Patented Feb. 10, 1925

The latest development in straight line frequency control as applied to NATIONAL CONDENSER design.

Increases range of rotation from 180° to 270°, permitting more precise adjustment and sharper separation of stations. And accomplishes this without gears, cams or levers.

It has the same electrical efficiency and mechanical ruggedness that have always characterized NATIONAL DX Condensers. Prices:

Made in Two Sizes	With Dials	Without Dials
.0005	$7.00	$5.00
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Get the genuine. Insist upon NATIONALS. Your dealer appreciates your patronage and will gladly get them for you. Write for Bulletin 111 PR.

NATIONAL COMPANY, INC.
W. A. READY, President
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ALL-AMERICAN

TRADE MARK

Complete with Raytheon tube, $45

Constant-B

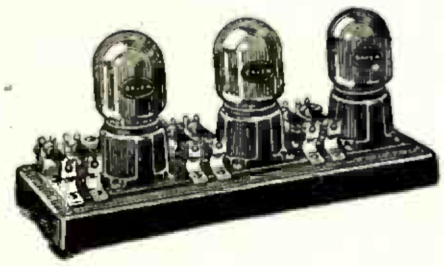
a thoroughly dependable B power—designed to be trouble-proof and permanent.

See it and try it—and remember it is

Radio Built for the Years to Come

"Tune in" the *Lost notes* with DAVEN

AMPLIFICATION



YOU will never know the meaning of *full note* reception until you have improved your radio set with Daven Amplification.

It brings to you such perfect *natural-toned* reception you feel as though you could reach out and touch the artist.

[Simple to install—accurate in tone reproduction — inexpensive — and above all, it insures you against the fear of your radio set becoming obsolete!]

Go to your Authorized Daven Service Dealer. He is competent to make the installation.

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Amplifier Tubes	*Resisto-Couplers*
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DRF Coils	*Resistors*
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Please send me the following on Resistance Coupled Amplification.

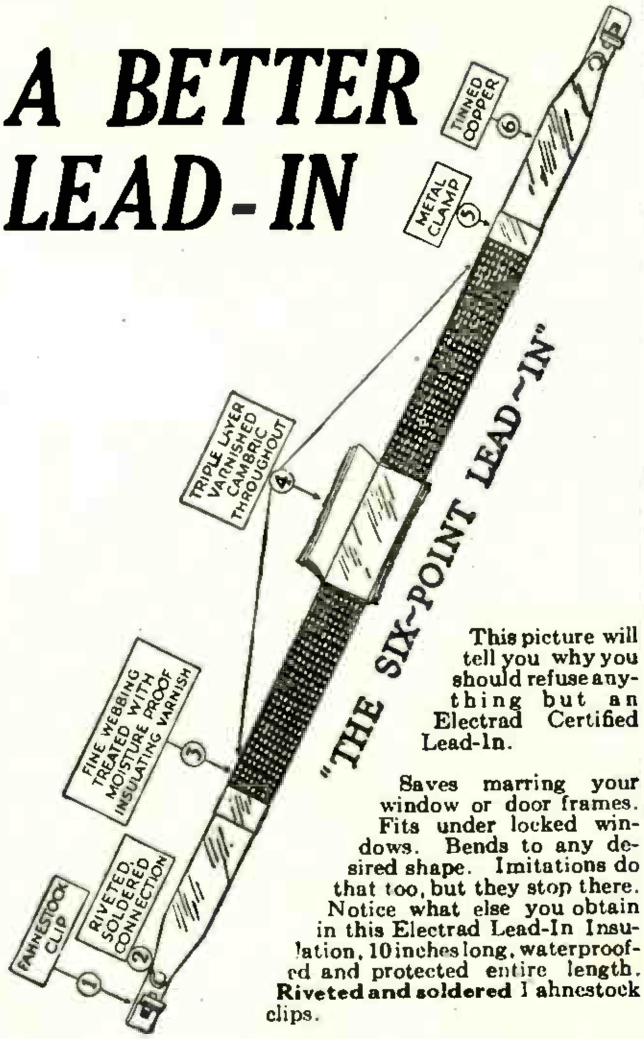
Check the one you prefer. ☐ Resistor Manual 25c. is enclosed ☐ Complete Catalogue *(free)*

Name ....

Address ....

FOR DEALERS: Send your letterhead or card, or this coupon and we will have our nearest distributor communicate with you.

A BETTER LEAD-IN

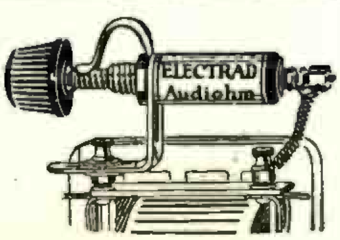


This picture will tell you why you should refuse anything but an Electrad Certified Lead-In.

Saves marring your window or door frames. Fits under locked windows. Bends to any desired shape. Imitations do that too, but they stop there. Notice what else you obtain in this Electrad Lead-In Insulation, 10 inches long, waterproofed and protected entire length. **Riveted and soldered** Fahnestock clips.

Sold at all good radio stores and counters. Price 40c. Canada 60c. Ask for it by name. For safety's sake refuse imitations.

For Clearer, Purer Reception Do This



Place an Electrad Audiohm across the secondary of your audio-transformer. Then you will enjoy your radio. Kills distortion, eliminates squeals and howls. Fits all audio transformers. Easy to attach. For sale at good radio stores and counters, $1.50. Canada $2.10

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Makers of Certified Radio Essentials and Accessories: Grid Leaks, Fixed Condensers, By-Pass Condensers, Variohms, Resistances, Rheostats and Potentiometers. Write for catalog. Jacks, Switches, etc.

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READY FOR IMMEDIATE DELIVERY
POWER UNIT

Parts used in building the Laboratory Model of the "Power Unit"

1	Amertran power transformer, type PF-52	$18.00
1	Amertran De Luxe A. F. transformer for second stage	10.00
3	Amerchokes, type 854	18.00
2	Dubilier filter condensers, type 769, 2 mfd. (working voltage 400 volts D.C.)	7.00
	Dubilier filter condensers, type 770, 4 mfd. (working voltage 400 volts D.C.)	4.00
4	Dubilier filter condensers, type 766, 2 mfd. (working voltage 160 volts D.C.)	8.00
or	1 Ward-Leonard vitrohm resistor unit, size C or Aerovox Craig resistor, type 98	8.50 or 4.00
1	Bradleyohm No. 25 25,000 to 250,000 ohms	2.00
2	Pacent single-circuit jacks, No. 61	1.00
2	Benjamin push-type sockets, No. 9040	1.50
	Bakelite sub-base, 7 x 21 x 1-4 inch	6.45
	Bakelite binding post strip, 7x1x1-4 inch	.45
	Angle brass reinforcement strips for sub-base	
	Angle brass for holding binding post strip, Pair	.10
	Brass brackets for mounting resistor unit M. Pair	.35
	Brass strip for mounting filter condensers	.35

Our new Catalog contains full information and discount sheet. Be sure to get your free copy.

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Just off the Press—Our new, completely illustrated radio Value Book and Guide! Compiled by experts, contains startling values in sets, cabinets, parts and accessories. Write for it today. A postal brings it!

Hammerlund-Roberts LC-26 Kit

McLaughlin's 1 control Superheterodyne

Raytheon Plate Supply

Cockaday's Tone Clarifier

Ultradyne and many others

New S-C 4 Tube Receiver

		List Prices
1	S-C Belden Wiring Harness	$ 4.00
1	Centralab Resistance, No. 25 M. S. R.	2.00
1	Polymet, or Micamold or Dubilier .00015 condenser with grid leak clips	.45
1	Polymet, or Micamold or Dubilier .002 condenser	.40
1	Polymet, or Micamold or Dubilier .005 condenser	.60
1	2 megohm leak	.25
1	Drilled and Engraved Front Panel	4.50
1	Drilled and Engraved Sub-panel	2.50
2	Silver Marshall No. 316, .00035 Condensers	11.50
2	Silver Marshall No. 515 Coil sockets	2.00
1	" " No. 801 Vernier Dial	2.00
1	Silver Marshall No. 110A Coil	2.50
1	" " No. 114A Coil	2.50
4	" " No. 510 Tube Sockets	2.00
1	" " No. 340 Condenser .000025	1.60
1	Silver Marshall No. 540 Mounting Brackets	.70
2	Thordarson Equiformers	16.00
1	Yaxley No. 16K 6 ohm Rheostat	1.35
1	" No. 1 Jack	.60
1	" No. 2 Jack	.60
1	" No. 10 Switch	.50
1	Box of screws, consisting of 12-¾" 6/32 R. H. Brass screws (Round-head) 8-½" 6/32 R. H. Brass screws (Round-head) 4-1" 6/32 F. H. Brass screws (Flat Head) 24 6/32 brass nuts	.50
	Factory Sealed Kit	$59.25

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Wholesale Distributors of RADIO APPARATUS

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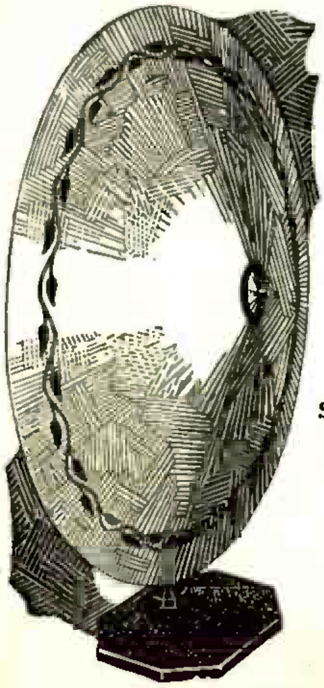

Easy to Assemble This Cone Speaker —and Save $25

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No need to spend $35 for a cone speaker. Now you can get all the parts including special complete cone unit and assemble them in an hour or two and *actually save* $25. Blue print and directions make everything clear. You risk nothing, for you can get your money back within ten days if not completely satisfied.

Natural Tone—18 Inches High

Stands 18 inches high, complete in every detail. The difference between this cone and horn speaker is the same as the difference between hearing a person talk naturally and hearing the same person shout through a megaphone. You can shut your eyes and believe it's real.

Says F. N. Boudreau of Cohoes, N. Y., "It works fine. I am going to build and sell these loud speakers. Send me your best prices on 10 Cone Loud Speakers at once."

Why This Amazing Offer?

There are four reasons why this offer is possible. *First*: Quantity production. *Second*: By buying direct you get factory prices. No middlemen's profits. *Third*: Shipping the speaker dis-assembled saves expensive packing. *Fourth*: You assemble and save our labor costs.

These are the reasons *why* we can offer you a $35 loud speaker for only $10.

Send No Money

Simply send name and address and the complete outfit will be sent you by return mail. You pay the postman only $10 in full payment. If you aren't absolutely delighted—simply return the parts within 10 days and your money will be instantly refunded. You take no risk. Write NOW!

Scientific Radio Laboratories
254 West 34th Street, Dept. 34
New York City

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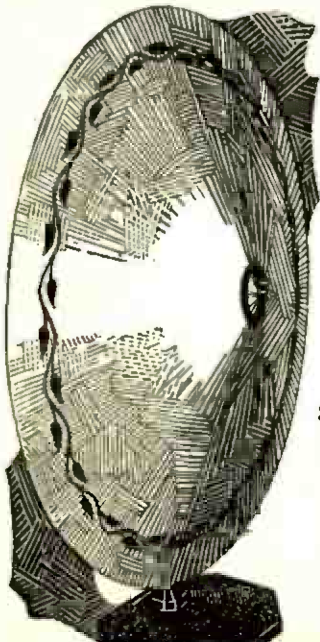

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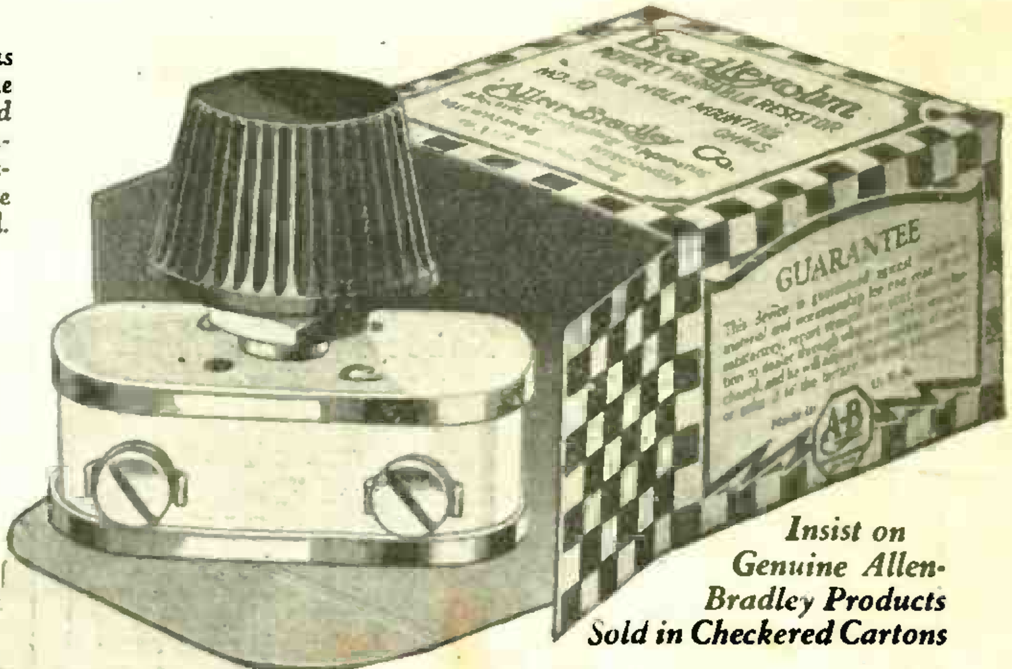
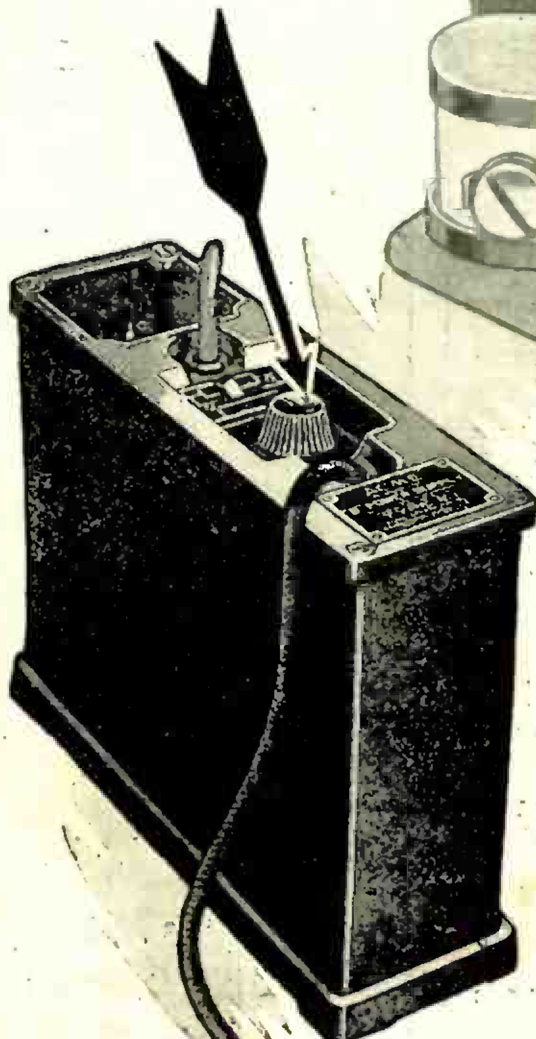
Scientific Radio Laboratories
254 West 34th Street, Dept. 34
New York City

The Bradleyohm is used as standard equipment in the Acme B-Power Supply and most other B-Battery eliminators provided with voltage control. Silent voltage control is thereby assured.



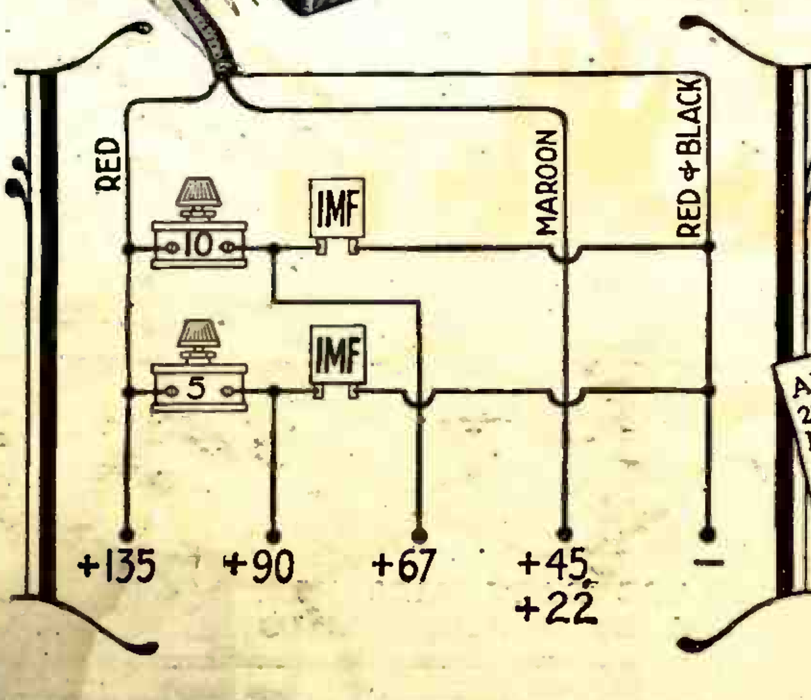
Insist on Genuine Allen-Bradley Products Sold in Checkered Cartons



How to Get Extra Voltage Taps from Your B-Eliminator

MANY radio receivers are provided with several B-Battery terminals for detector, amplifier and radio frequency tubes. To provide the extra voltage taps from B-battery eliminators, such as the Acme B-Power Supply unit, is a simple matter. The diagram below shows the method of connecting the necessary Bradleyohms and condensers.

A Bradleyohm No. 10 for the 67-volt connection and a Bradleyohm No. 5 for the 90-volt connection provide marvelously smooth control over a wide range for these terminals. The condensers may be larger if desired, especially when used with audio-frequency taps. The standard Bradleyohm in the eliminator gives sufficient range for the detector plate voltage. Your dealer can supply you with Bradleyohms and condensers. Try these connections tonight and improve your receiving set.



Mail the Coupon for Literature

ALLEN BRADLEY COMPANY
276 Greenfield Avenue
Milwaukee, Wisconsin

Please send me literature on Allen-Bradley radio products including the Bradleyohm.

Name ....

Address ....

....

PRESS OF WILLIAM GREEN, NEW YORK

FRESHMAN *Announces* Another SENSATION!

Model 6-F-1

New and Improved FRESHMAN MASTERPIECE

The World's Greatest Radio Receiving Set

Freshman's latest sensation has a real appeal to the women of the home. It is built of five-ply genuine mahogany; a handsome piece of furniture that fits in any corner of the room. It is compact and comparatively small, giving it preference over clumsy consoles. Contains an especially large tone chamber,

With Built-in Loud Speaker of Great Volume and Superb Tone

When not used as a radio, it can be entirely closed. The top is stationary and provides an attractive resting place for vases and other ornaments. Spacious compartments afford ample room for all batteries, etc.—not a single wire being visible.

The Radio Receiver Women Have Been Waiting For

$99.50

Prices slightly higher Denver and West and Canada.

Sold on Convenient Terms by Authorized Freshman Dealers, who also Install and Service Them.

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