Popular Radio

★ June · 1926

25¢

For the BROADCAST LISTENER—
How to Put Up an Aerial

For the EXPERIMENTAL SET-BUILDER—
How to Build the New "Home" Receiver

RCA power Radiotrons bigger volume without distortion

DRIVE a car uphill beyond its power—and the motor knocks. Drive a radio set beyond its power—and the last tube chokes, the loudspeaker blasts. The RCA power Radiotron has just one function—to stand the strain the last tube gets. More *power* can flow through it without choking or blasting and it means a decidedly clearer, finer tone—at a greater volume.

Radiotron UX-112, storage battery power tube $6.50

Radiotron UX-120, dry battery power tube $2.50

One of these tubes, in the last stage, uses extra batteries and gives greater volume of tone.

Use quality you *know*

You would not use any but a MAZDA lamp. Why use any but an RCA Radiotron? They are made by the same skilled workers, backed by the same research laboratories. But the Radiotron is far more delicate to make. Be sure all the tubes in your set are Radiotrons. And keep a spare handy.

RADIO CORPORATION OF AMERICA
New York Chicago San Francisco

RCA

RCA Radiotron

MADE BY THE MAKERS OF RADIOLAS

Brandes

A Great Name in Radio Development

IN about three million homes—today, tonight—happy family circles gladly pay homage to Brandes.

This fame and respect is a rightful heritage to such a worthy staff of radio scientists—men who have given the name, Brandes, such high repute.

From the earliest days of radio, the Brandes Laboratories have done much to advance this science which brings so much enjoyment to the people of all the world.

Never content, Brandes experts strive to better what may even be ranked as perfect.

This Brandes spirit has a deep meaning to radio owners —it stands always for advancement. It means a wonderful staff of scientists are ever striving to add to your pleasure.

Acoustics by
Brandes
means the ultimate in reproduction

Popular Radio

EDITED *by* KENDALL BANNING

FOUNDED 1911

VOLUME X June, 1926 NUMBER 2

¶ These Outstanding Features *of this Number include articles of special interest and practical helpfulness to every type of radio fan—from the inexperienced Beginner to the experienced Experimenter and to the Scientist—*

DEPARTMENTS

VOLUME X JUNE, 1926 NUMBER 2

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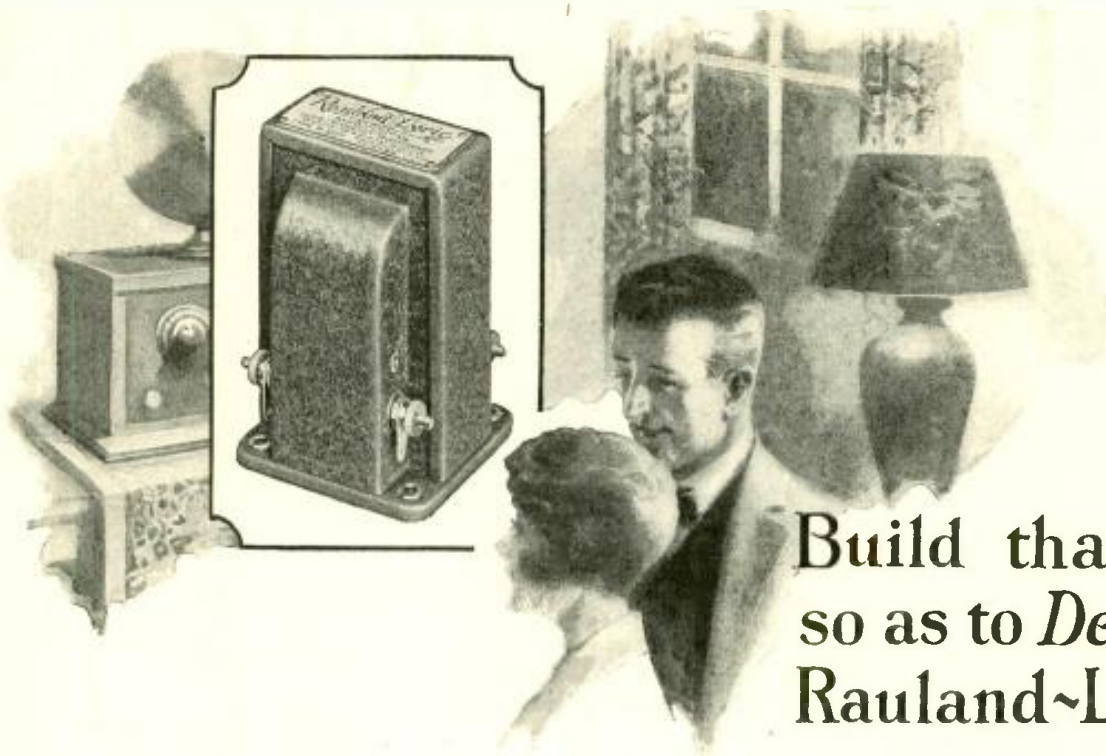
E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, *Technical Editor* JOHN V. L. HOGAN, *Contributing Editor*



Build that Set so as to *Deserve* Rauland-Lyrics

Gone is the day of the jerry-built radio. Whether you build for use or for profit—one set or a hundred thousand—skimping on quality *does not pay.*

For the radio frequency stages, choose any good circuit and any type of coils you like—opinions differ. But, having chosen your circuit, *be fair to it*—let it show what it really can do—give it the benefit of *Rauland-Lyrics.*

As a man is known by the company he keeps, so is a set known by the audio amplifier which its maker deems it worthy of. Yet some builders, who would not tolerate the uncertainty of an open spring contact even in a battery circuit, will allow a dozen of them in a three-stage audio amplifier! *Two* stages, *Rauland-Lyric-equipped*, presenting no such potential trouble spots, assure ample volume for any speaker, with tone quality faithful beyond cavil.

Rauland-Lyric
AN
ALL-AMERICAN
TRADE MARK
TRANSFORMER

FOR THE MUSIC LOVER

The Choice of Noted Music Critics

Rauland-Lyric is a laboratory-grade audio transformer designed especially for music lovers. The price is nine dollars. Descriptive circular with amplification curve will be mailed on request. All-American Radio Corp., 4211 Belmont Ave., Chicago, U. S. A.

MEMBER R.M.A.

OWNING AND OPERATING STATION WENR—266 METERS

ALL-AMERICAN

Radio Built for the Years to Come

A Page With The Editor

At this time of year even the hardest boiled radio fan succumbs to the lure of the outdoors. And unless he can take his radio receiver outdoors with him, the tuning dials are likely to be in for a period of comparative rest.

* *

But outdoors—on a summer evening—is quite the most enjoyable place of all to listen in!

* *

To enable the fan to enjoy broadcasting in just this way the Popular Radio Laboratory has been working for several months on a highly efficient portable set that the experimenter may assemble for himself.

* *

And those who have heard it in operation report that it is quite the best portable set that has yet been developed—with plenty of volume, good tone quality—and good capacity for distance for those who believe that the best programs are farthest away.

* *

In other words, it is just such a receiver as the average fan wants to take along in his motor car, or set up in camp or at the sea shore or on the farm, with the least possible trouble.

* *

In the next number of Popular Radio this new "Town and Country" portable receiver will be described in such detail that any experimenter of average capacity may build it himself.

* *

The set is a dry-cell operated, seven-tube superheterodyne receiver in a self-contained portable cabinet; another unit in a small suitcase carries enough batteries for four weeks operation as well as the loudspeaker and the loop. A power tube is used in conjunction with a cone speaker on the last stage of amplification.

* *

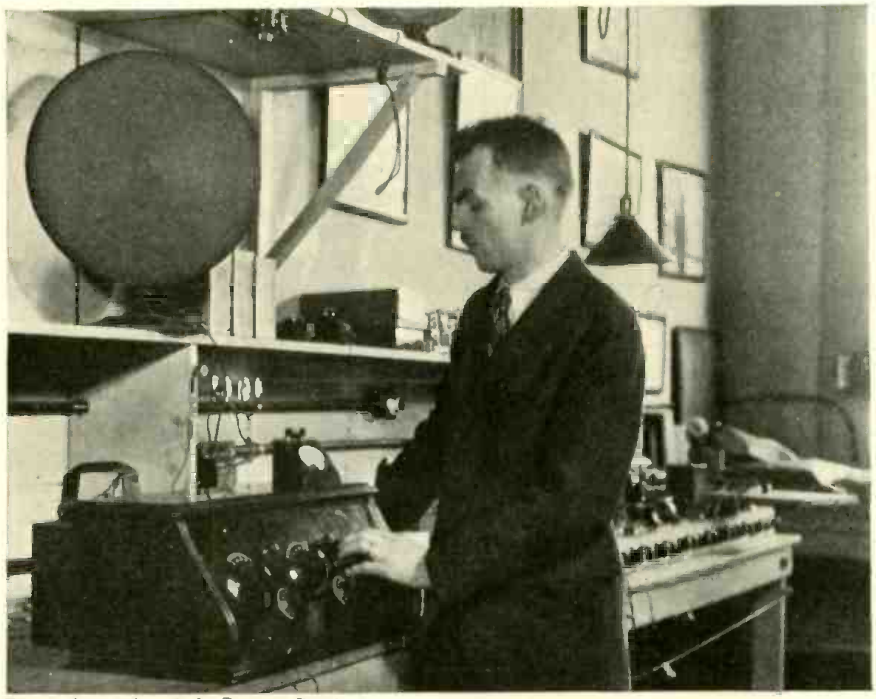
"You would. no doubt, be interested in knowing what the traveling salesmen think of your paper," writes Mr. E. R. Halpin, on the stationery of Hotel Kingsbury in Waterbury, Conn.—from which the editor assumes that his correspondent is a traveling salesman who is on tour.

* *

"While it is contrary to the common belief," he continues, "travelers are interested in things other than the fair sex. If you were to listen in to their conversations in club cars, smokers and hotel lounges, you would know that they are well up in many subjects, including radio.

* *

"Popular Radio is quoted more often and read more closely by this group of men than any other radio publication. In the course of a month we have much time to read, and in this time we buy almost every radio publication sold on the newsstands. The more we read of other publications, the better we appreciate Popular Radio. And this is the consensus of the opinions of the many travelers with whom I have spoken."



From a photograph made for Popular Radio

Will Bradley, Jr., the designer of the new three-tube Home Receiver announced on page 116 of this issue, is to a peculiar degree, a Popular Radio *product. Not only was his interest in radio first aroused by this magazine, but he has built practically every receiver described in our "How-to-build" series.*

Following the announcement of the institution of the *Popular Radio Medal for Conspicuous Service* the Secretary of the Committee of Awards has received numerous recommendations—including several recommendations of radio amateurs who obviously come within the category of those "who have directly or indirectly, through the medium of radio, been instrumental in alleviating human suffering or saving human life."

* *

Upon receipt of these recommendations the Secretary has begun investigations. In several cases he has already obtained sufficient corroborative evidence to submit for action to the Committee of Awards.

* *

Within the next few weeks the first of these awards may be announced—possibly in the July issue.

* *

"I am writing to you to let you know," writes Godfrey Dickens of Lake Worth, Florida, "how pleased I am with the LC-26 receiver. The first night I had it working I received about twenty stations in all parts of the country. During the Trans-Atlantic tests I received several stations of which I could not get the call letters."

* *

"Last year I built the old style Cockaday and had wonderful results with it. Down in this part of the country the stations are few and far apart but with the LC-26 I can get them all over. Yesterday afternoon about three o'clock I was able to get WJZ with plenty of volume. I have never heard of anyone doing this before. Here are a few of the stations I have received: WMBF, WGBU, WGHB, WJAX, WSB, WRC, WCAP, WEAF, WJZ, WGY, WLS, WLIB, KYW, KFI, WSMB, KDKA, KPRC, WFAA, WIOD, KOA, WPG, WTAM, WKAQ, WSM, KFDM, KSD, WSAI, WTIC, WWJ and many others. The LC-26 is the best receiver one can build."

* *

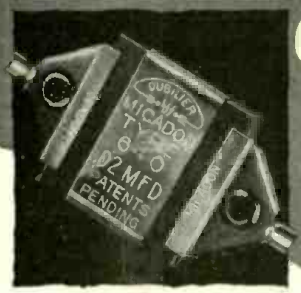
From a town in Virginia comes back to our Subscription Manager a renewal card that brings an echo of the fate that overtook one of Popular Radio's most enthusiastic readers. The card is signed with strict impersonality "The First National Bank," and carries the stern but not entirely unfeeling report:

"Our radio fan spent too much time with radio, so he now has all of his time to spend on it. Our present force is looking after the bank's work."

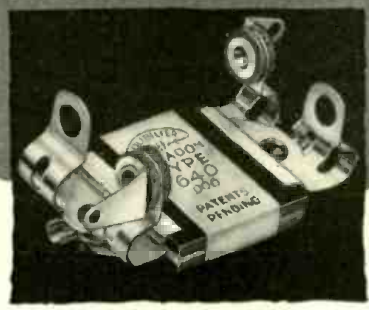
Kendall Banning

Editor, Popular Radio

in radio little micadons make a big difference!



MICADON 640
An improved design making possible a wider range of capacities.



MICADON 640A
Compactly made for use in resistance coupled amplifiers.

MICADON 601
The standard fixed condenser of radio.

THERE doesn't seem to be much to a Micadon when you look at it. The infinite care that is given to every detail in the manufacture of Dubilier Micadons is your assurance that they will always do their job.

Micadons are a small item in the cost of any radio set. But the difference between clear and poor reception, and the change from noise to natural tones may often depend upon their use.

Send 10c for our booklet which shows fourteen ways in which you can improve your set by simple applications of fixed condensers.

4377 Bronx Blvd., New York

Dubilier

CONDENSER AND RADIO CORPORATION

"I've just had a lesson in radio economy, and, believe me, it's illuminating"

"I WENT into my radio dealer's this noon for a couple of Eveready 'B' Batteries and said, 'Tom, give me a pair of Eveready 45-volt "B" Batteries No. 772's.'

" 'How many tubes in your set, Jim?' he asked.

" 'Five,' I answered.

" 'Then what you want is a pair of Eveready Layerbilt No. 486's.'

" 'Why?' I asked.

" 'Because the Eveready 772's are meant for sets having one to three tubes. With average use of the set, and used with a "C" battery*, they should last a year or longer. But on a five-tube set, with average use and with a "C" battery, they will only last about four months. Anyone with a four or five tube set should buy a pair of Eveready Layerbilts No. 486. Used with a "C" battery they should last eight months or longer.'

" 'Yes, but the 772's cost only $3.75 each,' I said, 'and the Layerbilt $5.50. There's some difference.'

" 'Well, figure it out for yourself,' said Tom. 'Two sets of 772's should last you about eight months, and will cost you $15. One set of Eveready Layerbilts should last about eight months, and will cost you only $11.' "

The simple rules for this satisfaction and economy are:

On 1 to 3 tubes—Use Eveready No. 772.
On 4 or more tubes—Use the Heavy Duty "B" Batteries, either No. 770, or the even longer-lived Eveready Layerbilt No. 486.
On all but single tube sets—Use a "C" battery.

When following these rules, the No. 772, on 1 to 3 tube sets, will last for a year or more; and the Heavy Duties, on sets of 4 or more tubes, for eight months or longer.

We have prepared a new booklet, "Choosing and Using the Right Radio Batteries," which we will be glad to send you upon request. This booklet also tells about the proper battery equipment for use with the new power tubes.

*NOTE: A "C" battery greatly increases the life of your "B" batteries and gives a quality of reception unobtainable without it. Radio sets may easily be changed by any competent radio service man to permit the use of a "C" Battery.

Manufactured and guaranteed by

NATIONAL CARBON COMPANY, Inc.
New York San Francisco
Canadian National Carbon Co., Limited
Toronto, Ontario

LEFT—*No. 486, for 4, 5 or more tubes. $5.50.*

RIGHT—*Eveready Dry Cell Radio "A" Battery, 1½ volts.*

EVEREADY
Radio Batteries
—they last longer

Tuesday night means Eveready Hour —8 P. M., Eastern Standard Time, through the following stations:

WEAF-*New York*
WJAR-*Providence*
WEEI-*Boston*
WTAG-*Worcester*
WFI-*Philadelphia*
WGR-*Buffalo*
WCAE-*Pittsburgh*
WSAI-*Cincinnati*
WTAM-*Cleveland*
WWJ-*Detroit*
WGN-*Chicago*
WOC-*Davenport*
WCCO { *Minneapolis* / *St. Paul*
KSD-*St. Louis*

"Of Value to Any Man Interested in Radio"

"Popular Radio is an excellent magazine. I find it not only desirable but quite necessary to read it through each month because of the wide variety of subjects covered which are of value to any man interested in radio. From a semi-technical standpoint these subjects could not be better handled than they are by Popular Radio."

—R. A. Heising

S. R. Winters

The Greatest Cause of Static Is Earth Electricity

Many investigations have shown that most of the static originates in discharges of the electricity of the earth and the atmosphere. Double movable loops, as shown here, are used by the United States Bureau of Standards and other radio laboratories to determine the direction and intensity of static impulses. There is undoubtedly a close connection between the facts gradually being learned in this way and the facts of earth and atmospheric electricity described by Dr. Free in the following article.

Popular Radio

VOLUME X June, 1926 NUMBER II

EARTH ELECTRICITY

Does It Affect Radio Reception?

¶ *All radio propagation takes place between two great electric charges—the positive charge of the upper air and the negative charge of the earth's surface.*

¶ *These charges probably have important effects, still poorly understood, on many radio phenomena. Radio fans will be hearing much about earth electricity and about earth currents.*

¶ *This article summarizes what is now known about the amount, changes and source of the earth's electricity.*

By E. E. FREE

IF you were told to stick your head into the works of a condenser charged to five hundred or six hundred volts you would probably hesitate before obeying.

If you decided to try it you would expect to receive a shock, and you probably would not be disappointed.

Yet you and I and all of us here on earth actually live in a set of circumstances not so very different from those which exist between the plates of a charged condenser. The ground surface of the earth carries a negative charge. The air at the level of your head has a different potential, usually some one or two hundred volts more positive than the potential of the ground. At the height of an ordinary radio antenna, the air potential may reach a voltage as much as two thousand volts higher than the potential of the ground.

Why Our Bodies Do Not Accumulate Electricity

The only reason why we do not go about all the time with electric sparks streaming from our ears and our noses is that the quantities of electricity concerned are small. The negative charge of the ground, which charge we share when we stand on the soil, is continually leaking away slowly into the air. It leaks away from our bodies just as it does from the soil itself. The charge does not pile up, as it does, for example, on the glass plates of a static machine, until the sparking voltage is reached.

Nevertheless, we do live between the plates of a highly charged condenser.

The upper plate is formed by the positive charge of the upper levels of the air, possibly in the Heaviside Layer, but more probably in some atmospheric level a little closer to the earth than that.

The other plate is the surface of the ground. The voltage across this great condenser may be as much as a million volts. The negative charge of the earth is continually leaking across the earth condenser, through the air. It is as continually renewed, no one knows how. At different hours of the day and during different months of the year, these conditions of earth electricity vary.

Radio Waves Must Pass Through Vast Electric Disturbances

All of our radio transmission and reception take place, necessarily, in the midst of these vast and world-wide electric disturbances. That the magnetic properties of the earth and of the atmosphere are influential in the propagation of radio waves has now been realized. The modern theory of radio waves—the Eccles-Larmor theory—takes this defin-

itely into account.* The polarization of radio waves, studied recently by Alexanderson† and Pickard,‡ involves still more importantly the reactions between the radio wave, the magnetism of the earth and the charged electric particles of the air. Less attention has been paid to the possible effects of earth electricity on radio, perhaps because the facts about it are less generally known and less thoroughly studied than the facts about terrestrial magnetism.

Until recently, there was no great incentive to urge the study of earth electricity. Practical applications seemed unlikely. The chance of making any really great discovery in this field seemed remote.

Radio is likely to alter this.

Not only will the availability of radio apparatus and of radio waves give the physicists new tools for the study of the electric conditions of sky and earth, but the need of more precise information for the purposes of radio theory is sure to stimulate research in this relatively neglected field. Within a few months we are likely to be hearing as much about the earth's electric charge and about earth currents as we do now about the Heaviside Layer and about ions in the upper air.

*See "How the Air Affects Radio," POPULAR RADIO for September, 1925, pages 199-206; and "How Earth Magnetism Affects Radio Waves," by H. W. Nichols and J. C. Schelleng, POPULAR RADIO for October, 1925, pages 309-316.

†"A New Theory of Wave Transmission," by E. F. W. Alexanderson, POPULAR RADIO for March, 1926, pages 207-212.

‡"The Polarization of Radio Waves," by Greenlead W. Pickard. Presented before the Institute of Radio Engineers (New York), January 18, 1926. To be published in the *Proceedings* of that Institute.

How a French Scientist Proved Franklin's Theory of Atmospherics

Knowledge of earth electricity goes back to Benjamin Franklin. In 1750 Franklin set forth, in his celebrated letters to his friend Collinson of the Royal Society of London, his theories of lightning and of atmospheric electricity. Among other items, he described his lightning rod. Late in 1751 these letters were translated into French and read before the Academy of Sciences in Paris. They came to the attention of a French scientist, Dalibard, who decided to attempt an experimental verification of Franklin's ideas. He erected a vertical metallic rod in a suburb of Paris and waited for a storm. A laborer was left to watch the rod.

On the 10th of May, 1752, came a small thunderstorm—a thunderstorm destined to go down in the history of science as one of the most important of scientific events.

The laborer ran to look at Dalibard's rod. Sparks were pouring from the lower end of it into the earth. Through the downpour of rain the laborer ran to fetch the curé of the local church. He, too, braved the storm to see the great phenomenon. Dalibard, who had arranged it all, was away in Paris and missed the occasion. Nevertheless, the proof had been obtained. Three days later, on May thirteenth, 1752, he assured the Academy of Sciences that the existence of a difference of electric potential between the earth and a thundercloud, was a proven fact.

As time went on many scientific men, both in Europe and in the growing colonies of the New World, repeated and extended these pioneer observations. It was discovered that similar potential differences, although smaller ones, existed between the earth and the sky even when the air was cloudless and when no storm was going on. It was not until after the middle of the last century, however, that the investigations of the famous English physicist, William Thomson, afterward Lord Kelvin, finally established beyond doubt the existence and nature of the electric charge on the earth and the fact of the leakage of this charge upward through the atmosphere.

What We Know About the Electricity of Earth and Sky

At the present time, what we know about these matters can be summarized briefly. Ordinarily, the surface of the earth carries a charge of negative electricity, relative to the air above it. This charge is usually of such magnitude that what is called the "potential gradiant" in the air just above the soil is in the neighborhood of 150 volts a meter. This means that at a height of one meter (three feet and three inches) above the ground, the air is 150 volts more positive than is the soil itself. At two meters above the soil the difference of potential is about 300 volts, at three meters it is about 450 volts, and so on. As one rises higher above the ground, the potential difference for each meter of height becomes less. The evidence which exists indicates that at heights greater than about five miles the potential ceases to grow more positive. It is possible that at still higher levels the change of potential reverses, so that the highest levels of all are negative.

If this is true our earth is surrounded by a sheath of positive electricity at a level of five or ten miles above the ground. The highest levels of all (the Heaviside Layer) and the ground itself are negative. It is impossible to be certain, however, what potential exists in the region of the Heaviside Layer. The only thing that we are sure of is that the ground is usually negative with reference to the accessible parts of the atmosphere, and that the positive potential of the atmosphere continues to grow as the height above the ground becomes greater. The rate of increase, however, gradually becomes less, with each succeeding increase in height.

Department of Terrestrial Magnetism, Carnegie Institution of Washington

Laying the Earth-Current Conductor

At the observing station at Watheroo, Australia, the scientists of the Carnegie Institution of Washington measure the currents of electricity in the earth by a system of long, insulated wires laid in pipe conduits under the earth's surface. A true Australian touch is supplied by the small kangaroo who seems to be such an interested spectator of the pipe-laying operation.

The Earth's Negative Charge

The negative charge of the ground is not, however, a constant thing. During storms, especially thunderstorms, it may change greatly and rather suddenly. Sometimes it grows still more negative; more often it decreases. In some storms, and on rare occasions when there is no storm, the ground potential may change altogether in sign, becoming positive while the air is negative.

There exists, furthermore, a more or less regular sequence of daily and annual changes through which the ground potential passes. These are quite large, frequently exceeding half of the average potential gradient of about 150 volts a meter. At most of the stations at which records of earth-charge have been kept continuously enough to be of any value, the negative charge of the earth is greatest in the early part of the night, usually some time between eight and ten o'clock P. M. From this high point, the charge gradually falls off, reaching a minimum in the early hours of the morning, some time between three and six o'clock A. M. After sunrise the charge again increases, reaching at about eight or nine o'clock A. M. another maximum, usually not so high as the maximum in the evening. In the afternoon, the potential falls again. There is a moderately low minimum at about three or four o'clock P. M., after which the rise to the principal evening maximum begins. This describes a normal day. Many days are much disturbed and do not show these regularities.

How the Earth Potential Changes With the Seasons

The annual variation of the charge on the earth moves with the seasons. In moderate latitudes, like those of the United States or Europe, the earth's negative potential is highest in the winter months, falling off to two-thirds or even one-half of its value during the summer months. In the arctic regions the highest values come a little later in the year, the maximum being in the spring instead of in the winter. In the tropics seasonal variations are much less marked. Judging by the comparatively meagre data now available, the potential difference between the ground and the air is always less in those regions than it is farther to the north or to the south.

How "Earth Currents" are Formed

It is apparent from this description that the potential of the ground is not likely to be exactly the same all over the earth at the same instant. This being true, one would expect streams of electrons to flow from places of higher negative potential to places of more positive potential. They actually do so. They form the so-called "earth currents," which show up so frequently on telegraph lines and other long electric conductors connected at both ends to the ground. Although the existence of these earth currents has been well known since the earliest days of the electric telegraph, as has also the fact of the extreme and variable strength of the earth currents during the "magnetic storms" usually credited to the influence of sun spots,* the details of earth-current phenomena have been little studied. The Carnegie Institution of Washington began, in 1923, the continuous recording of the earth currents in two directions, north-south and east-west, at Watheroo, Australia. One year's results have been published.†

Underwood & Underwood

An American Expert on Earth Electricity

Professor W. F. G. Swann, Director of the Physical Laboratory at Yale University, is one of the foremost scientists now studying the puzzling problems of earth electricity and earth magnetism. Professor Swann has concluded that the most probable theory for the origin of the continually renewed negative charge on the earth is the idea that positive electricity is being continually annihilated within the earth.

How the Earth Is Continually Losing Its Electricity

Amid all these facts one basic circumstance must be kept in mind. This is that the air transmits electricity. The insulator between the two plates of our great earth-condenser is not a perfect insulator. If a charged body is placed on

(*Continued on page 180*)

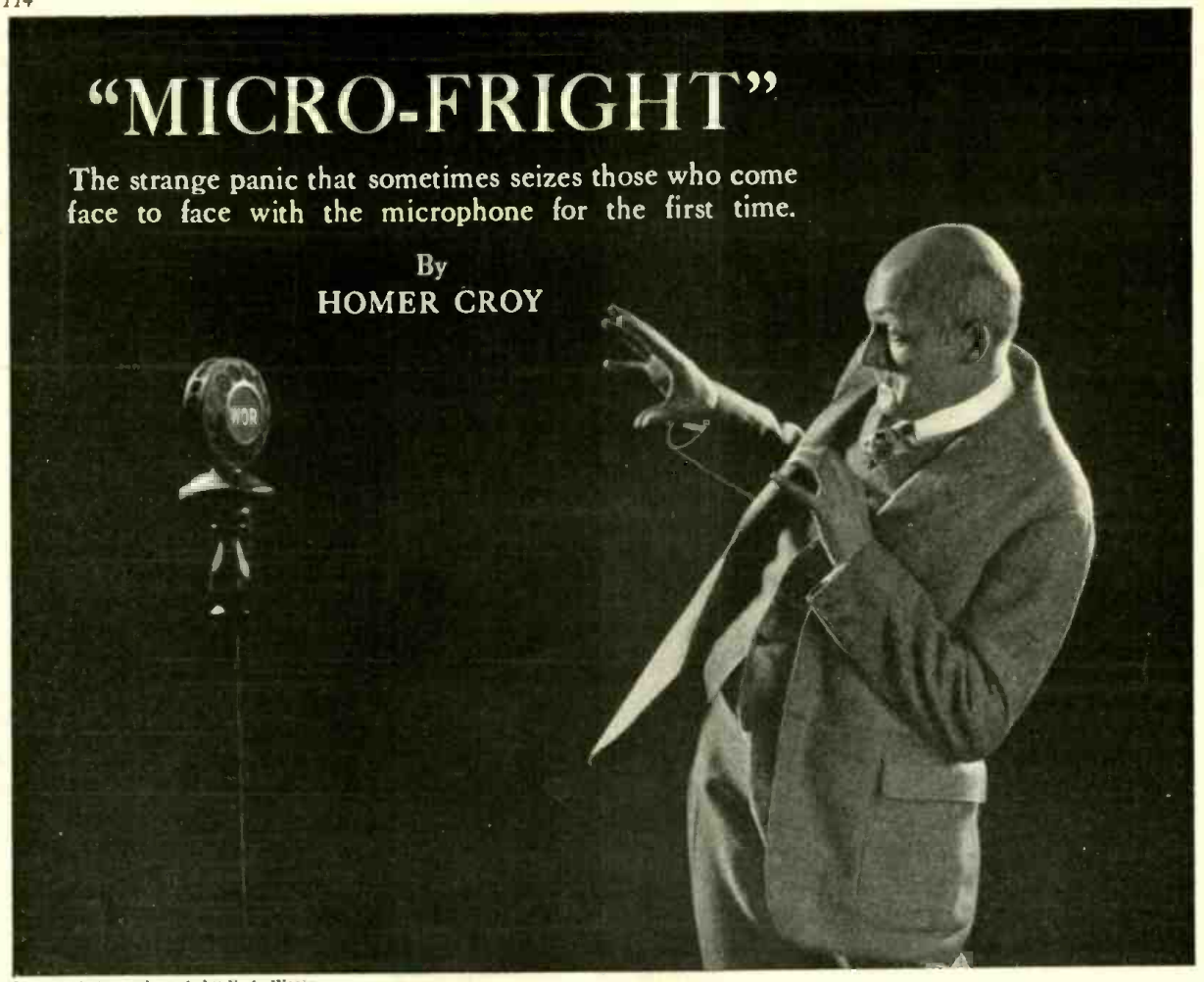
*See "Radio Ills from Sunspots," POPULAR RADIO for April, 1926, pages 367-369.

†"Characteristics of Earth-Current Potentials at Watheroo as Shown by One Year of Continuous Records," by O. H. Gish and W. J. Rooney. *Yearbook of the Carnegie Institution of Washington*, volume 24, pages 214-215 (Washington, D. C., 1925).

"MICRO-FRIGHT"

The strange panic that sometimes seizes those who come face to face with the microphone for the first time.

By
HOMER CROY



From a photograph made by F. A. Weeks

Because Homer Croy is the author of best sellers ("West of the Water Tower" made him famous overnight), he was invited to appear on a broadcast program. His report of his first experience with "mike" was so illuminating that we asked him to write it out. This is it!

I HAVE just had an experience which shows what happens when human being meets microphone, face to face.

Station WOR had planned a Book Week, during which two authors were to speak each day. Half an hour was set aside for this; and special advertising and arrangements were made. The two authors were to come to the studio together so that the studio manager would be sure that they were present when the big moment came.

I arrived on time; and in a few moments the woman author, who was to follow me on the program, also arrived; and the studio manager rubbed his hands with the satisfaction of one who has done his work well and fears not the future.

At the proper time, the announcer stepped before the soup plate, with a smile on his face and a ring in his voice. He introduced me and I came before that sensitive tympanum.

I was to speak for fifteen minutes. I had prepared and rehearsed enough material to cover that period of time. After a few moments of nervousness, I went along with my talk as best I could.

Sitting where I could see her was the woman author who was to follow me. As she saw me going through the silly operation of talking and gesticulating before a piece of metal, she began to look uneasy.

I am not an inspired speaker; and, now and then as I talked, I glanced at the clock on the wall, wishing that the agony was over.

I told everything I knew. Then I went back and told it in a different form, and still the clock had paralysis.

At last, thirteen minutes went limping by; and, just as I was undertaking the fourteenth, I was astonished to see the announcer creeping toward me with a slip of paper in his hand and fear in his face.

Closer and closer he came, as silently as a mouse on a wool blanket, the piece of paper held before him. Thrusting it into my hands he went creeping away again; and then, trying to keep the words coming, at the same time I did my best to read the scribbled note. It said, *"Imperative you should continue fifteen minutes more."*

That was all the warning I had and I had run out of everything I had to say; yet with a minute's notice I had to continue fifteen minutes more!

I did. I carried on, somehow; but what I said has since been a hazy and haunting memory. I have never met anybody who listened in on that hectic afternoon in March and I hope I will be spared that suffering. I hope I will never be called on to do it again and I expect, if the audience votes, that that will make it unanimous.

The minute I was clicked off I rushed up to the announcer and asked how come; and then it was that I found the explanation.

The woman who was to follow me had suddenly developed microphone fright; she would not go on. Possibly, seeing me talking into an empty soup plate was too much for her; anyway, she was not able to go on and I had to carry the message to Garcia for her.

Since then I have found out that mine was not an uncommon experience. Other people have gone to broadcasting studios and suddenly found an uneasiness at the stomach that Mothersill's or any other remedy wouldn't touch.

Broadcasting managers are not eager to hang out the sign that there is such a real and painful thing as microphone fright, for the simple reason that it might tend to keep talent away. But in my rambles around the studios I have found that it is a very common and devastating experience.

And the bigger the artists, the harder it hits 'em.

A person may have been used for years to appear before audiences; he may be able to make 'em laugh and make 'em weep as he wishes; but a curious catalepsy comes over him when he steps into a padded room and has before him only a silent, inscrutable plate not much bigger than the bottom of a tin can.

There is no, what the actors call, "audience re-action"—there is nobody there to help him out. He must fall back upon himself—and sometimes he falls with a bang.

One time Charlie Chaplin came up to the studio to go on the air. According to the boys in the studio, he was one of the most frightened performers who ever met Mike face to face. Before Charlie took the Sunset Limited for Hollywood, he was a vaudeville actor and a good one; I myself saw him in "A Night in a Music Hall"; and I recall what a vivid performance he made of it. And before that, in England, he was on the legitimate stage. All his life, in fact, he has faced audiences.

But when Charlie stood alone with the microphone he was a school boy on Friday afternoon speaking his first piece at school. And coupled to this was the fact that Charlie had it all written out, too!

Twice, according to eye-witnesses, who wouldn't tell a lie even in an income tax report, Charlie reached for his handkerchief and cleansed his brow from a moisture that all the cameras in Hollywood couldn't bring out.

A similar experience befell James Kirkwood, famous as a motion picture actor and director, and before that as a star on the speaking stage. He came to WJZ to tell the world something or other—and the world came pretty near not hearing it. For Kirkwood suddenly developed locomotor ataxia in his knees, which up to that time had shown no tendency to get in each other's way.

"Opening night on Broadway is nothing in comparison," said Kirkwood, as he came out of the steam room.

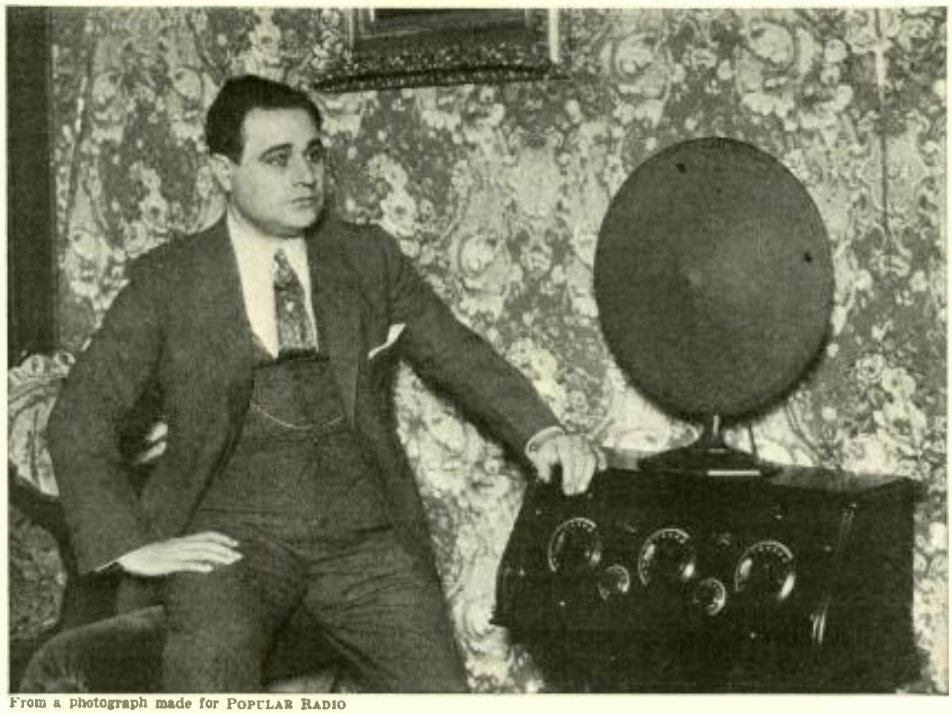
Strangely enough it is the actors and people who are accustomed to appearing before the public who suffer most when they are alone with Mike—and especially is this true of vaudeville performers.

Vaudeville performers work with, as the expression goes, "lights up"; that is, they prefer the house-lights on so that they can watch the faces of the audience. Actors in legitimate plays work with the "lights off"; that is, they themselves are in a glare of light on the stage, but the audience is unseen by them. On

(*Continued on page 160*)

FOUR RULES FOR THE BROADCASTER—

1: Rehearse your talk or your song before you face the microphone:
2: Bring your sheet music or manuscript with you:
3: Use a porous paper that does not crinkle when you turn the pages:
4: Clear your throat before you begin to talk or sing.



From a photograph made for POPULAR RADIO

THE INVENTOR'S MODEL IN THE HOME OF A GRAND OPERA STAR

When Beniamino Gigli, the famous tenor of the Metropolitan, had concluded his search for the "best radio receiver to be found," he asked Mr. Will Bradley, Jr., who developed this new circuit, to build this receiver for him. This remarkable new set is described here for the first time.

HOW TO BUILD

The New Home Receiver

By WILL BRADLEY, JR.

COST OF PARTS (without cabinet): *Not more than $74.00*
RECEPTION RANGE: *3,000 miles*

HERE IS A LIST OF PARTS USED IN THE LABORATORY MODEL—

A, B and C—Bruno coil set (Bradley wound);
D—Carborundum stabilizing detector unit;
E, F and G—Benjamin (new type) S.L.F. condensers, .00035 mfd., equipped with 4 inch Kurz-Kasch Aristocrat dials;
H—X-L variodenser, Model N;
I—Dubilier mica, fixed condenser, .002 mfd.;
J—Tobe bypass condenser, .5 mfd.;
K—AmerTran DeLuxe first-stage audio transformer;
L—AmerTran DeLuxe second-stage audio transformer;
M—Amsco 20 ohm rheostat;
N—Amperite, No. 1A;
O—Amperite, No. 112;
P1, P2 and P3—Amsco Universal A. X. 102 tube sockets;
Q—Amsco open-circuit jack;
R—Marco battery switch;
S—Marco five-point switch;
T—Insuline decorated panel, 8 by 22 inches;
U—hardwood baseboard (furnished with cabinet);
V—Corbett sloping panel cabinet;
W—small, brass brackets (see Figure 9);
X1—antenna connection block, 1 inch by 2 inches (see Figure 9);
X2—battery connection block, 1 inch by 9 inches (see Figure 9);
Y1 and Y2—Tait brackets;
9—Eby binding posts.

¶ *To any reader who has difficulty in obtaining any of the parts which are necessary in making up these model receivers and power units,* POPULAR RADIO SERVICE BUREAU, *627 West 43rd Street, New York City, will gladly assist in seeing that his requirements are promptly supplied.*

FIDELITY of reproduction has been the main objective in the development of the Home Receiver; and the laboratory set that is described here is the final result of several years of experiment. During that period many models have been made and placed in the homes of real music lovers.

Most experimenters have definite ideals as to just what qualities should constitute the perfect receiver for home use; and the consensus of opinion in any family would place good reproduction first.

The author believes that anyone who constructs this set of the parts that are specified will be amply repaid by the results that he will obtain from it.

The accessories which are necessary to perfect reception represent so much in proportion to the actual cost of the set that the builder is advised to buy only the best parts obtainable. It will pay in the end; and the difference in price is not enough to warrant the substitution of inferior or unsuitable apparatus for the parts that are specified.

The set will produce as great a volume as the last tube is capable of handling.

An analysis of the circuit itself, as shown in Figure 2, should explain how really remarkable results have been obtained with the economy that is afforded by the use of only three tubes. Selectivity and sensitivity are assured by the use of two stages of radio-frequency amplification which precede the crystal detector. Because of the variable coupling in the antenna circuit it is possible to adjust the selectivity of the receiver for any antenna, either indoors or outdoors.

By neutralizing the first tube, in the manner shown, the effective inductance that is necessary to cover the entire broadcast waveband may be employed. By means of the tapped system, that is used in the plate inductance of the second tube, there is obtained not only a positive means of controlling oscillations over the entire scale but also a satisfactory volume control.* The signal intensity which must be amplified by all three tubes is easily controlled by the variable resistance in the filament of the first tube. This rheostat also affords considerable economy in "B" battery consumption.

The fact that too much regeneration in a detector tube will cause distortion is too well known to require any further elaboration. The use of the crystal detector entirely eliminates trouble from this source; and the author can do little more than heartily endorse the claims of the manufacturers for the very remarkable stabilizing unit that is specified. The use of a storage battery to obtain the proper bias in this connection, obviates the replacement of the dry-cell "C" battery.

After rectification, the signal is amplified by two stages of good transformer-coupled audio-frequency amplification. Loudspeaker reception of thirty-nine stations in fifteen minutes or the logging of six European broadcasters during the International tests which were conducted a year ago, is a record of the Home Receiver. It is not, however, because of these results, that the author introduces this circuit to POPULAR RADIO readers.

*The closed crystal circuit which includes the secondary of coil C and the primary of transformer K seems to act somewhat as an absorption system which makes use of the entire energy which is obtained from the plate circuit of the second tube.

How to Construct the Set

After all the instruments and materials for building the set have been procured, the panel (shown in Figures 1, and 5) should be prepared.

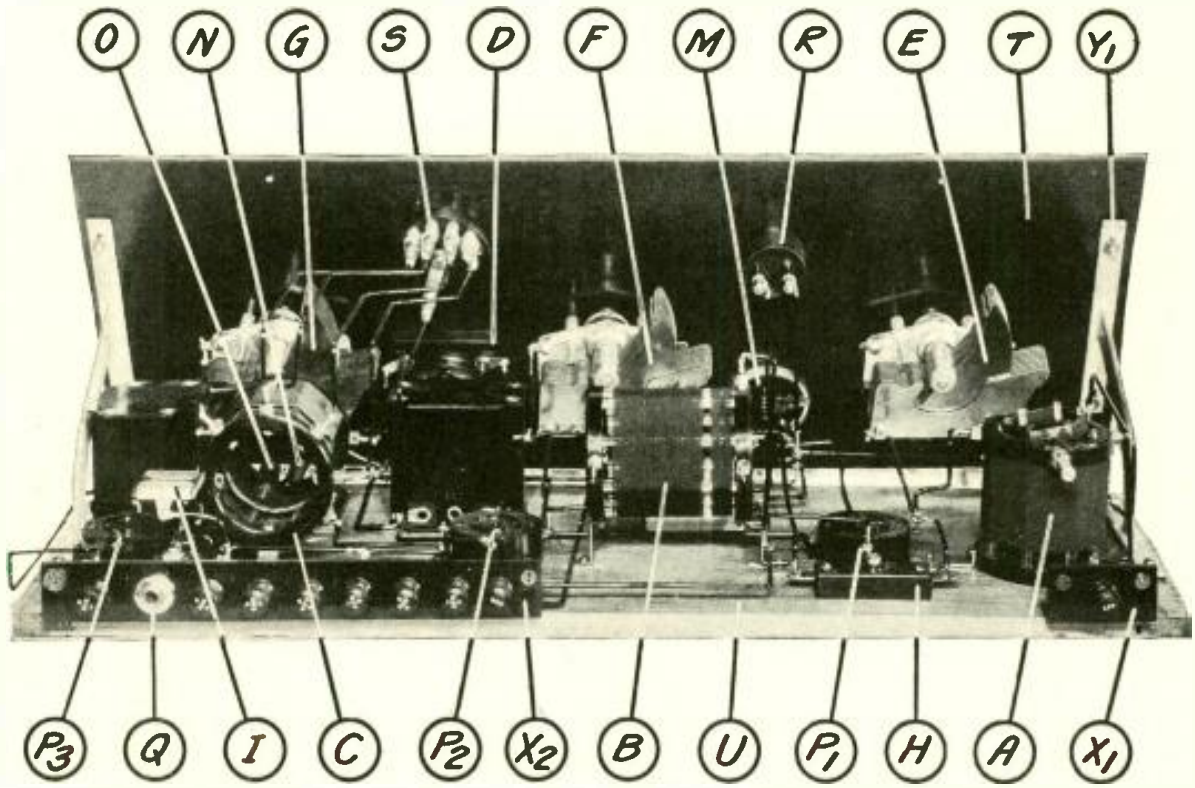
First of all, cut the panel to the correct size, 8 by 22 inches. Then, square up the edges smoothly with a file.

The centers for boring the holes, which are used in mounting the instruments, should then be laid out on the panel, as shown in Figure 5. A convenient method of doing this is to lay out all center holes on a piece of paper the same size as the panel and then to fasten the piece of paper on the panel and to mark the centers directly on it by punching through the paper with a sharp pointed instrument.

If all of the holes are started first with a small drill, one-sixteenth of an inch in diameter or less, they may be more nearly centered.

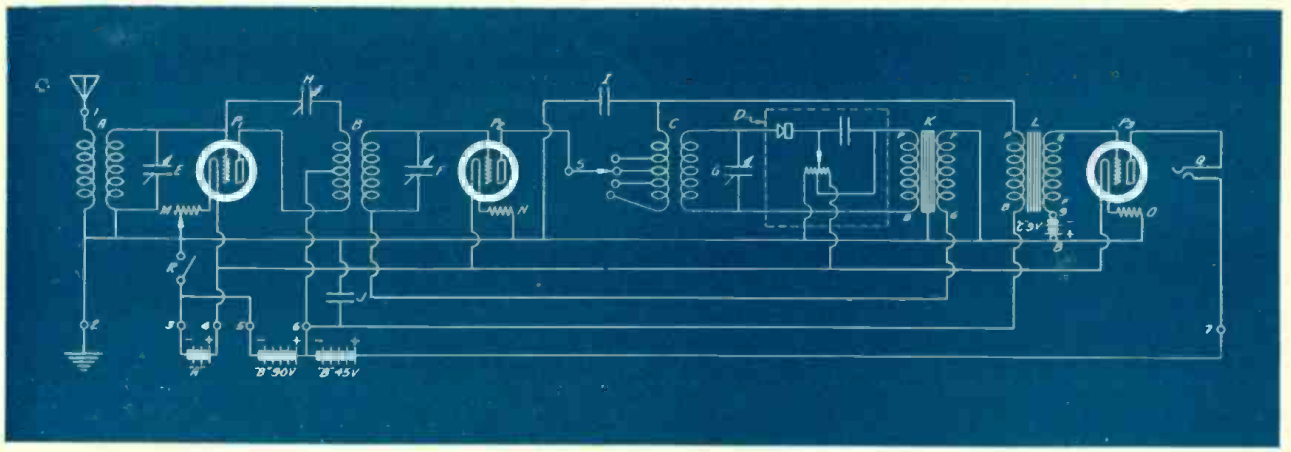
The holes that are outlined with a double circle, in the diagram, should be countersunk so that the flat-head machine screws that are used for fastening the instruments may be flush with the panel. All the rest of the holes are straight, drill holes. Sizes for the diameters of these holes have not been given; but the builder may easily find what size holes are necessary by measuring the diameter of the screws and shafts of the instruments that must go through them.

When the panel is drilled, the builder may give it a dull finish by rubbing the face of the panel lengthwise with fine sandpaper until it is smooth. This process then should be repeated, except that light machine oil should be applied during the second rubbing. Finally rub the panel dry with a piece of cheesecloth. A permanent dull finish will be



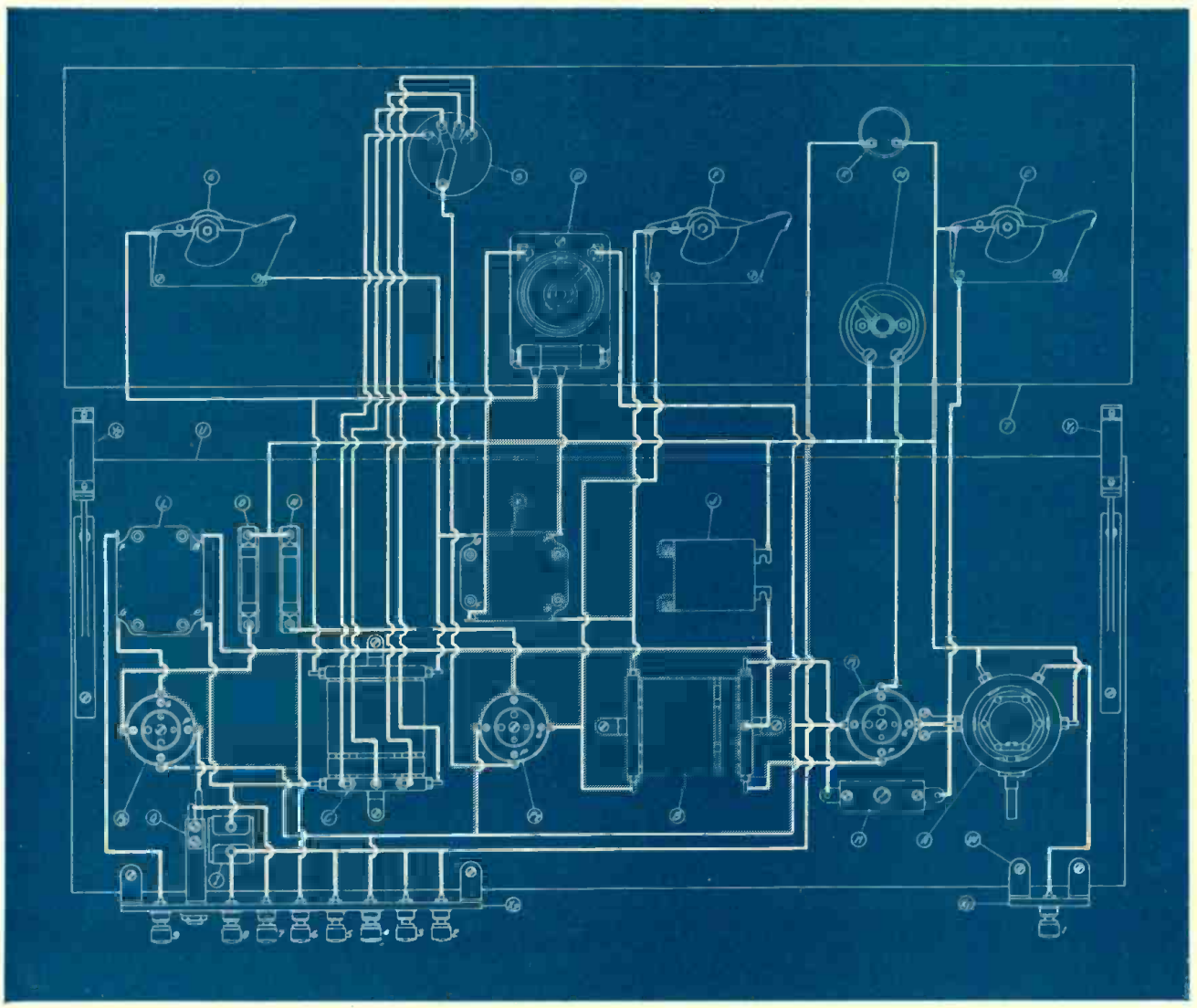
A VIEW OF THE SET FROM THE REAR

FIGURE 1: *This picture shows the general arrangement of practically all of the instruments that are fastened to the panel or base. The exact locations for the instruments are shown in the working drawings on the following pages.*



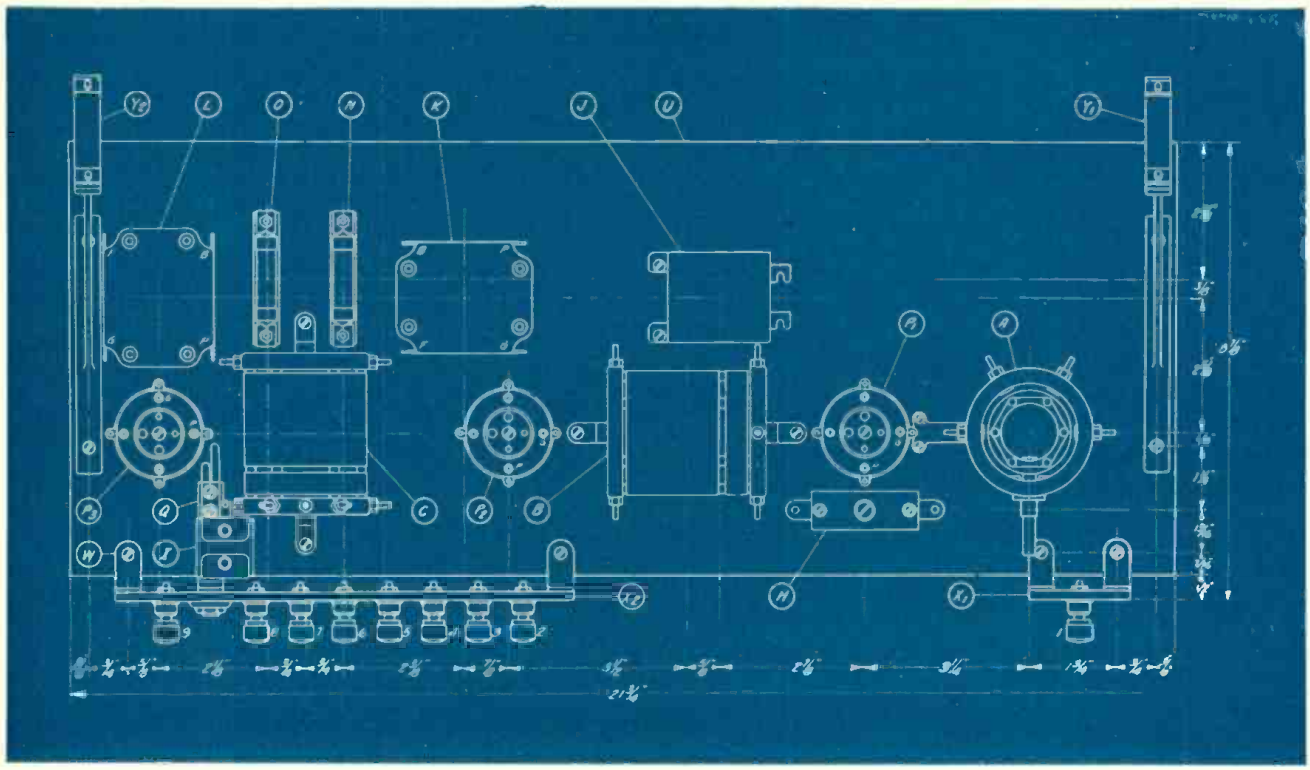
THE CIRCUIT DIAGRAM FOR THE HOME RECEIVER

FIGURE 2: *The complete hook-up of this new three-tube set. All of the symbols for the instruments bear designating letters which are used in the list of parts, the text and the illustrations and diagrams.*



THE PICTURE WIRING DIAGRAM

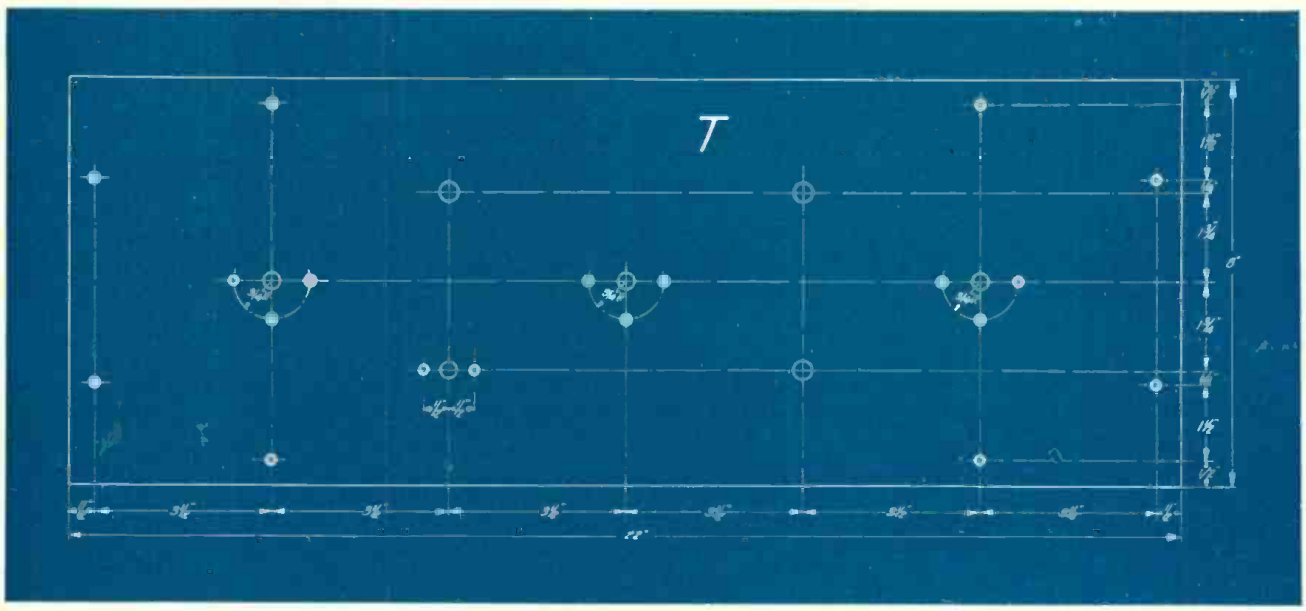
FIGURE 3: *The upper rectangle represents the panel and the lower, the base—both show the instruments in approximately their correct positions. The heavy white lines show the way to connect up the mounted instruments.*



THE WORKING DRAWING FOR CONSTRUCTION

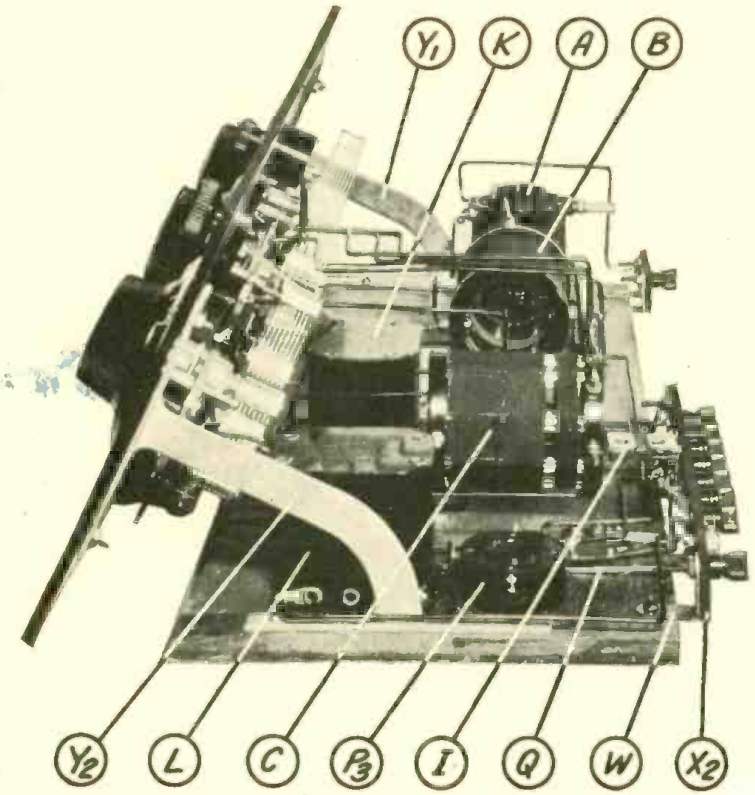
FIGURE 4: *The exact positions of all the instruments mounted on the base are shown in this layout, using center to center dimensions. This drawing should be referred to constantly in building the set.*

¶ The diagrams on these two pages contain nearly all of the fundamental constructional data and they should be referred to constantly in building the receiver. The best plan is to lay the open magazine beside you on the table and to check your own set with the diagrams as each instrument or wire is put in place.



THE DRILLING PLAN FOR THE PANEL

FIGURE 5: *This drawing shows where to drill the holes for mounting the panel and also for mounting the instruments on the panel. The holes with the double circles should be countersunk.*



THE RECEIVER AS SEEN FROM THE RIGHT

FIGURE 6: *This end view of the Home Receiver shows the manner in which the panel is held in position by the heavy supporting brackets and also the general location of the binding-post strip.*

the result. Or, the panel may be left with its original shiny-black finish, if care has been exercised not to scratch it during the drilling.

After the panel has been prepared the experimenter is ready to mount the instruments upon it.

If the specified drilled and engraved panel is bought this work will be unnecessary, as the drilling and finishing have already been done by the manufacturer of the panel.

First of all, mount the three condensers, E, F and G so that the rotor plates will swing upward when the plates are unmeshed. Attach three 4-inch dials in such a way that 100 on the dials will be at the indicator points when the condenser plates are fully meshed.

Now, mount the rheostat, M, in position, as indicated in Figure 1, and attach the dial.

The next task is to prepare the crystal stabilizing unit, D, for mounting. Using the screw-driver and small pliers, remove the two brackets which are furnished with the unit to hold the "C" battery. Care must be taken during this operation not to break the fine resistance wire that is held in place by the nuts. Remove the two screws; and replace them with 6-32, ½-inch round-head, brass machine screws. These should be inserted from the panel side of the unit so that the heads of the screws will make contact with the resistance wire.

Fasten the screws with two 6-32 brass hexagon nuts. Now attach a soldering lug on each screw by using two more hexagon nuts. The unit should now be mounted on the panel with the crystal at the bottom.

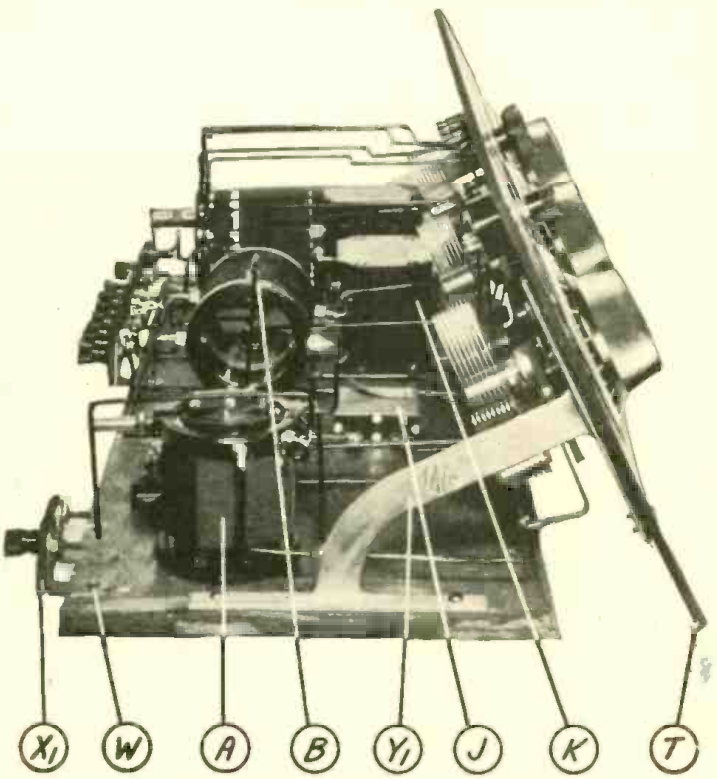
Next mount the switch, R, in position on the panel, as indicated in Figure 1. It will now be necessary to remove one of the switch points of the five-point switches. Remove the first and second posts from the right (looking at switch from the rear) and replace the second post, with the first, which has the attached stop, to prevent the switch arm from leaving the points. Then mount the switch on the panel with the four posts on top.

This completes the work on the panel; and you are now ready to mount the instruments on the baseboard that is supplied with the cabinet. Reference to Figure 4 will make it easy to mount the instruments in their proper positions.

Begin by mounting the three sockets, P1, P2 and P3, care being taken to place them with the terminals and larger holes in the same position as indicated in Figure 4.

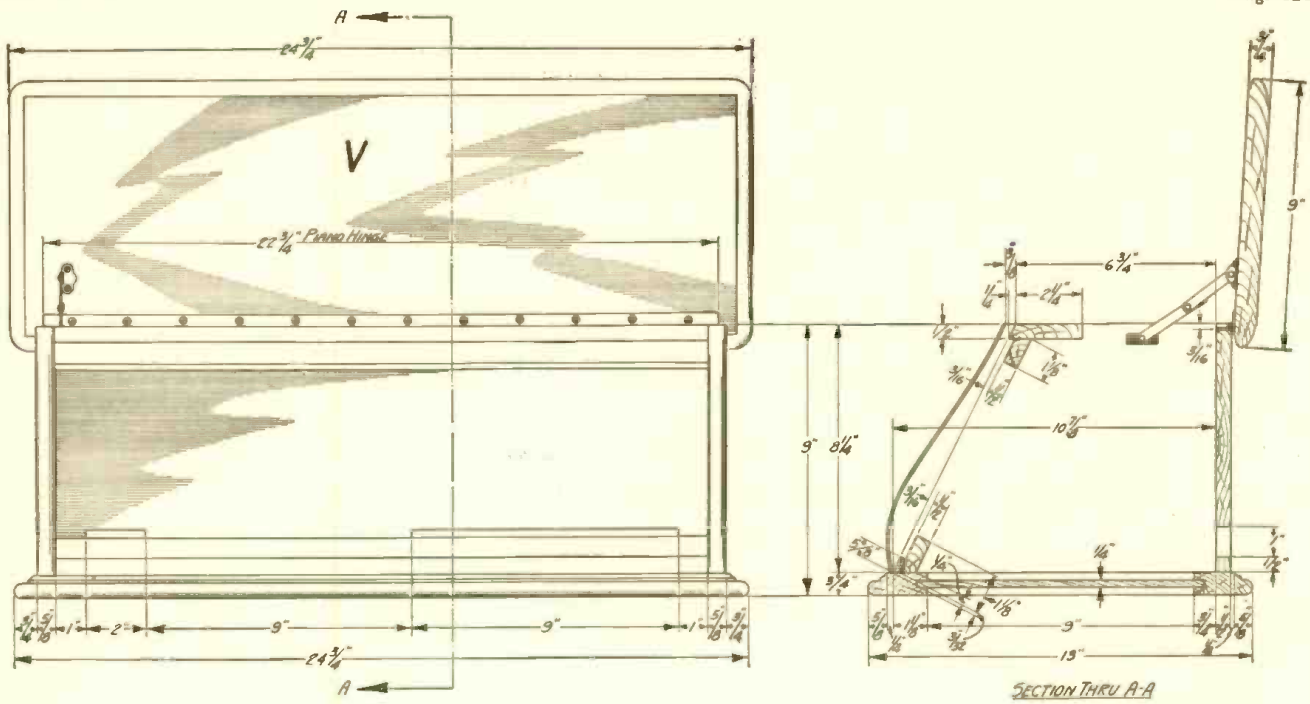
Next attach the two amperites, O and N, in position, as shown in Figure 4.

Now mount the transformer K in position with its lugs at the base of the transformer and the grid and filament lugs toward the back of the set. Transformer L should next be put in place with its lugs at the base and the plate



A LEFT-HAND VIEW OF THE SET

FIGURE 7: *This illustration gives a general idea of how the inductances and the tuning condensers are mounted.*



THE DIMENSIONS FOR THE CABINET

FIGURE 8: *This diagram (which contains the top, front and side measurements for the walnut cabinet) may be turned over to a competent cabinet maker who will be able to build from these directions a cabinet which will be exactly the right size for the set.*

and "B" battery lugs facing the amperite, O.

Next, attach the bypass condenser, J, in position, as indicated in Figure 4; and fasten the neutralizing condenser, H, in place, so that the lettering on top of it may be read when looking at it from back of the set.

You are now ready to mount the three coils, A, B and C. Mount coil A, so that the rotor shaft points to the rear of the baseboard. Coil B should be placed so that the end with the three taps faces the socket, P1. Use the brackets furnished with the coil for this purpose. Now, attach coil C in position with the tap end to the rear, again using the brackets furnished with the coil.

The two binding-post connection blocks should next be prepared as described in Figure 9. When the binding posts and jack have been fastened in their correct places, attach the small brass brackets (W) to the holes at the extreme end of each block.

Next, notch the bottom cleat of the cabinet, against which the panel rests, so that the crystal unit will permit the panel to be pressed back into its proper position. This notch should be 3½ inches long running from a point 5¾ inches from the inside of the right end of the cabinet to the left. By placing the panel against the cabinet, you can readily see where the notch should be made.

You will now be ready to adjust the panel and the baseboard to fit the cabinet. First, place the baseboard in the cabinet so that it fits against the back of the cabinet and is centered between the two ends.

With the baseboard in position, adjust the connection blocks (X1) and (X2) in their respective holes in back of the panel; and, with the punch, mark the points in the baseboard where the four screws which hold the brackets should be placed.

Now, fasten the large brackets, Y1 and Y2, in position on the panel, as shown by Figures 6 and 7; but do not tighten the screws which hold these brackets to the panel. By placing the panel in position on the cabinet, you may readily adjust the brackets to their proper positions and mark the places for the screws in the baseboard.

When this position has been determined, tighten the machine screws into the panel. Now, remove the panel and the baseboard and fasten the panel to the baseboard in the position already determined. Do likewise with the connection blocks.

You are now ready to start in wiring, as all of the construction work is completed. In wiring, all references to the front of the receiver refer to that part of the set which is nearest to the panel. Right or left refer to the constructor's right or left as he sits facing the back of the receiver.

How to Wire the Set

The design of the receiver is such that the wiring of the grid circuit of each of the three tubes is as short as possible and is isolated from the other parts of the circuit. In fact, this idea has been employed throughout; and the leads have been so arranged that the shortest possible connections may be used. Because of this, the set should be wired with bus bar.

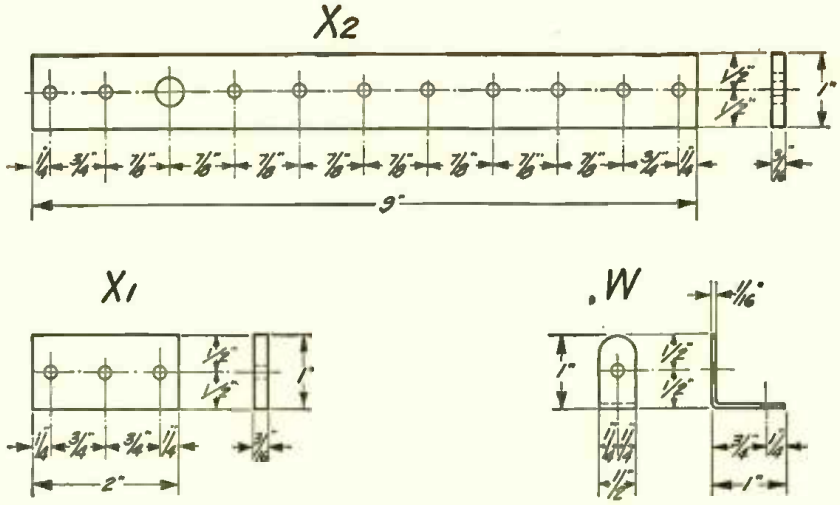
Either a tinned-copper, round bus-bar or an insulated, round bus-bar such as "Celatsite" may be used for all connections. All wires should first be shaped to fit; and all connections should be made permanent by soldering.

It is best to refer constantly to the wiring diagram in Figure 2 and more specifically to the picture diagram in Figure 3 for the exact way in which to run the wires.

Start by running a wire from the left binding post of switch R down toward the baseboard, then to the left and back between socket P2 and coil B and connect it to post No. 2. Continue the same wire to posts No. 3, No. 5 and on to post No. 8.

From the right-hand binding post of switch R again drop toward the base with a wire and connect it to another wire that connects the front terminals of the two amperites, O and N. From this wire also run connecting wires to the left top soldering lug on the stabilizing unit, D and also to terminal F on the transformer, K. From this same wire, a connection should be made to the left-hand post of rheostat M and also to the front terminal of condenser J.

Now, from the same wire, run a wire



THE DETAILS OF THE BRASS BRACKETS AND THE CONNECTION BLOCKS

FIGURE 9: *The necessary data for making the insulated block on which the binding posts are to be mounted as well as the dimensions for the small, brass brackets that are used to fasten these connection blocks to the base.*

under condenser E to a point opposite the right-hand lug of coil A, and thence back to this lug. All of the coil lugs are made for a permanent soldered joint which is made by inserting the bus-bar n the hole of the terminal and soldering with a hot iron held against the wire and the lug. Extreme care should be used, not to hold the iron any longer than is necessary to flux the solder, so that the solder holding the coil wire to the screw will not be melted. From this wire, which has just been fastened, make connections to the front left terminal of the same coil and also to the rotor lug of the condenser E.

Next, connect the remaining terminal of the rheostat, M, to the front lug of socket P1. Run a wire from the rear terminal of the amperite, O, along the baseboard to the left terminal of socket P3. Make a similar connection from the amperite, N, to the front terminal of socket P2.

This completes the A minus (−), B minus (−) and ground connections.

You are now ready to proceed with the A plus (+) lead. From post No. 4, run a wire to the left-hand terminal of socket P2, and thence to the left-hand terminal of socket P1. From this wire run a connection to the right-hand top lug of the stabilizing unit, D.

Now, from the same post No. 4 run another wire to the rear terminal of socket P3. This will complete the filament leads; and they may be tested by connecting a storage battery to terminals 3 and 4 and inserting the three tubes in the sockets. If the filaments light you are now ready to proceed with the balance of the wiring.

Connect a wire from post No. 1 to the front right lug of coil A. Now run a wire from the left terminal of the same coil to the right-hand lug of socket P1. From this lead make connections to the stator plates of condenser E and the right-hand terminal of the neutralizing condenser, H. From the remaining terminal of this condenser run a wire to the front, right terminal of coil D. Next from the rear, right terminal of coil B make a connection to the rear lug of socket, P1.

Now, run a wire from binding-post No. 6 to the top right-hand terminal of coil B; and make a connection between this lead and the remaining lug on condenser J. From the same post No. 6 run another wire to the front right-hand lug of transformer, L.

Next, connect the left, rear terminal of coil B to the right lug of socket P2; and continue this lead to the stator lug on condenser F. Connect the front, left terminal of the same coil to the rear, right lug of transformer, K; and from this lead make a connection to the lug on the rotor plates of condenser, F.

Now, remove the crystal from its clips and make a connection between the lower, right-hand binding post of the stabilizing unit D, and the front, right lug of transformer K. Connect the remaining terminal of the crystal unit to the rotor plate of the condenser, G, and from there continue to the front, left terminal of coil C.

Then connect the front, right terminal of the same coil to the left, front terminal of transformer K; and from this lead run a connection to the stator plates of condenser G. Replace the crystal in the clips, with the end of crystal marked A on the left-hand side.

Connect the grid lug of transformer L to the front lug of socket, P3.

Then run a wire from the front left lug of the same transformer to binding post No. 9.

Run a wire from the right lug of socket P3 to the lug attached to the bottom terminal of the jack, Q. The remaining lug on the jack should be connected to binding post No. 7.

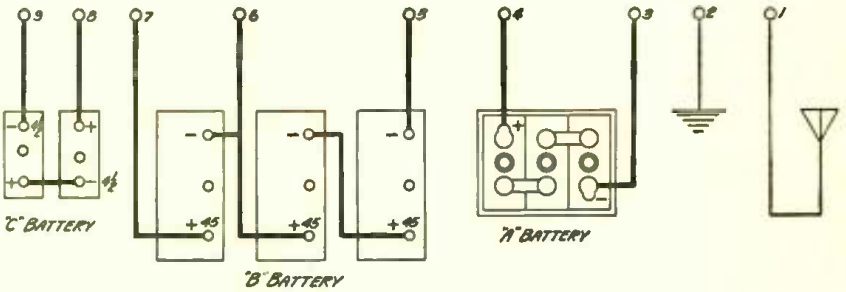
Next connect the left, lower-rear lug of coil C to the right, rear lug of transformer L. Between this lead and the binding post No. 8, solder in place the condenser, I. From the rear lug of socket, P2, run a lead to the bottom (or single) binding post on switch S. This wire should be run well above the transformer, K.

Now, from the lower, right-rear terminal of coil C run a wire to the upper right-hand binding post on switch S. Connect the next adjoining terminal of coil C to the next post (from right) on the switch. Following in consecutive order, connect the two remaining terminals on coil C to the remaining terminals of the switch. The position of these wires is clearly shown in Figure 3.

This completes the wiring and the set is ready for installation.

How to Install the Set

After checking over all connections, fasten the set in its cabinet with four wood screws, at the points indicated in Figure 5. First, connect the "A" minus (−) lead to binding-post No. 3 and the



HOW TO HOOK UP THE BATTERIES

FIGURE 10: *The builder cannot make a mistake in connecting the batteries to the terminals of receiver if he follows these instructions carefully. The terminals that are shown in the wiring diagrams are marked with numbers that correspond exactly to the numbers given here.*

"A" plus (+) lead to binding-post 4. Insert the 201-a tubes in the first two sockets and the 112 tube in the last socket. Turn on the rheostat, M, a little more than half way. Turning on the switch should now light all the tubes.

Now, disconnect the "A" plus (+) lead at the set and attach it in succession to binding posts No. 6 and 7. If the tubes light with either of these connections, it shows that the wiring is short-circuited, and a careful recheck should be made.

Replace the "A" plus (+) lead on binding post No. 4 and connect the "B" minus (−) to binding post No. 5; "B"-90 to binding post No. 6; and "B"-135 to binding post No. 7. Connect the "C" battery leads to posts No. 8 and 9, as shown in Figure 10.

Next make the antenna and ground connections to posts No. 1 and No. 2 respectively. Finally, insert the loud-speaker plug in its jack and the set is ready for use.

How to Operate the Set

Adjust the crystal knob until the contact arm is just beyond (clockwise direction) the center point of the resistance winding where the soldered joint is.

Turn the rheostat, R, until the first tube lights to the proper brilliancy. Then, turn switch S to tap No. 2. The small coil within the coil, A, should be set so that the windings of both coils are approximately parallel.

Refer to the tuning chart on this page, and turn the three large dials to the proper setting for the wavelength of some local station. If the station is on the air, you should immediately hear it. Now, readjust the large dials (E, F and G) for maximum response. When this has been done, turn the knob of the stabilizing unit, slightly, to the point of maximum signal intensity. You may now regulate volume by the rheostat.

When you have proceeded thus far you are ready to neutralize the first tube. Set switch S on tap No. 1. Adjust coil A until coupling is about midway between minimum and maximum.

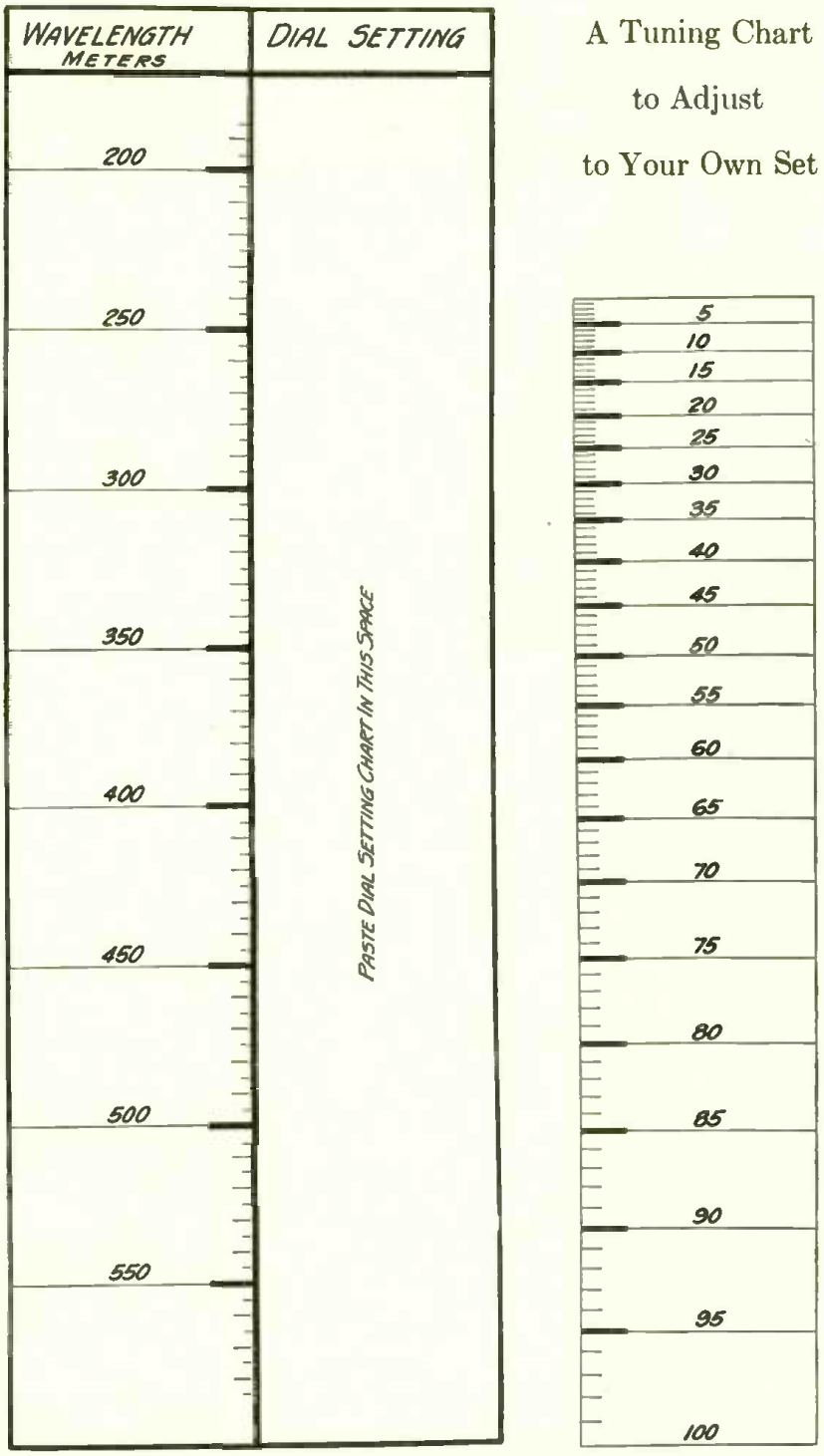
Now, tune in your strongest local station to maximum signal strength. Turn the rheostat, M, completely off. The station may still be heard but with a great decrease in volume.

Next, with a screw-driver, or better still with a sharpened wooden rod, turn down the adjustment screw of condenser N until the signal entirely disappears. If the screw-driver is used in this operation it will be necessary to remove it after each trial so that the hand capacity will not affect its adjustment.

If a very short or indoor antenna is in use, it may be necessary to slightly increase the coupling of coil A for complete neutralization. You may easily determine the proper coupling for this coil to meet your own condition and when once found the setting may be left in that position and forgotten.

Switch S may be left on tap No. 1 for all local stations; but, in distance reception the higher taps should be used —the taps varying according to the wavelength of the station received.

A Tuning Chart to Adjust to Your Own Set



INSTRUCTIONS FOR USE: *Cut out the chart at the left and paste it on a piece of thin, stiff, white, bristol paper. Then cut out the small chart at the right. It should be pasted in position on the blank space on the right-hand side of the main chart underneath the heading "Dial Setting." To get it in exactly the right position tune in a station of around 350 to 450 meters and find out what setting it comes in on on your dial. For instance, a station on 405 meters would come in somewhere near 74, 75 or 76 on your dial according to the variation of the condenser in the set. If it comes in at 75 (say), paste the dial setting part of the chart in place so that 405 meters on the wavelength scale is exactly opposite 75, on the dial setting scale. Then all the other stations will tune in exactly as indicated by the completed chart.*

Radio Uses
NO ETHER WAVES

By WALTER W. MASSIE

The author, whose portrait appears at the left, is one of America's earliest and best known radio pioneers. He has never accepted the conventional ether-wave theory of radio. In this article he explains an alternative theory—a theory which assumes that radio is propagated along the magnetic field of the earth.

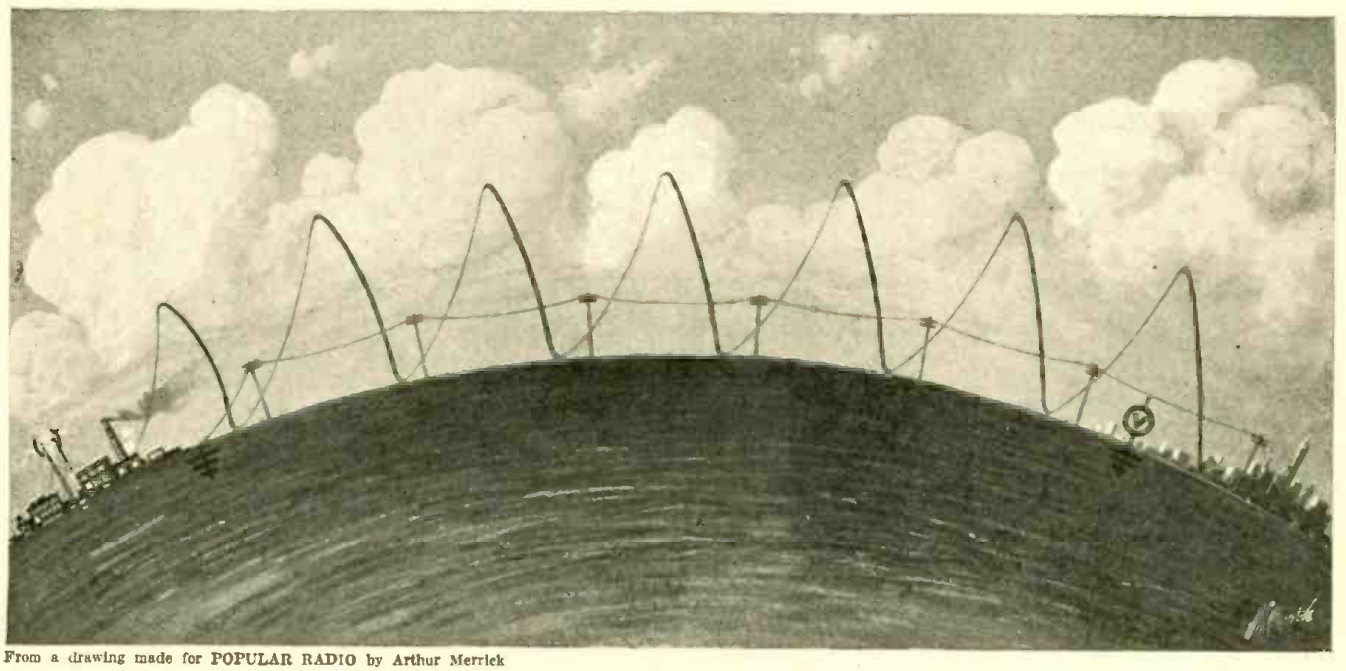
SCIENTIFIC theories and traditions are a good deal like religious creeds. It is heresy for the ordinary scientist to depart from them.

This fact was strongly impressed upon me twenty-five years ago when I could not accept the prevalent theory that wireless was propagated by free Hertzian waves. During my work of more than a quarter of a century on the subject of wireless I have found it best to stay down upon the earth and have been able to explain all radio phenomena with the magnetic wave theory.

When the theory was advanced that wireless was propagated by free Hertzian waves, traveling in straight lines like light I could not accept that theory. The early results obtained did not seem to support it and as far as I was concerned it took a lot of explaining to show how signals could travel around the globe.

In my home I set up a small transmitter automatically operated by a clock to give signals at short intervals. Carrying a microphonic receiver around the house to test the signal strength at different distances from the transmitter, I found that the signal strength was strongest near a lighting fixture, regardless of the distance from the transmitter. There was no doubt the wireless waves were following the conductors provided by the lighting installation.

With a "filings" coherer and a bell for a receiver and a buzzer for a transmitter I began experimenting and found that the buzzer would ring the bell a foot away from the coherer. But if a wire of any length was stretched out with one end near the coherer, the buzzer would ring the bell when operated at any point



From a drawing made for POPULAR RADIO by Arthur Merrick

HOW THE MASSIE THEORY COULD BE TESTED

The telegraph line, grounded at both ends, is set up between the transmitting station and the receiving one. A voltmeter inserted in this line registers the potential of the earth currents. This potential will correspond, Mr. Massie believes, with the perfection of radio transmission between the two stations.

From a drawing made for POPULAR RADIO by Arthur Merrick

RADIO IS CARRIED BY THE EARTH'S MAGNETIC FIELD

According to the Massie theory the lines of force of the magnetic field run parallel to the earth's surface. They are disturbed by a radio transmitter, as is indicated in this drawing, by the crinkles in the magnetic lines. These disturbances are propagated along the lines of magnetic force, thus producing the radio phenomena.

along this artificial ground. There was no doubt that the wireless waves followed the conductor. I then formed my grounded magnetic wave theory and in the book* of which I was co-author, I set forth my theory as follows:

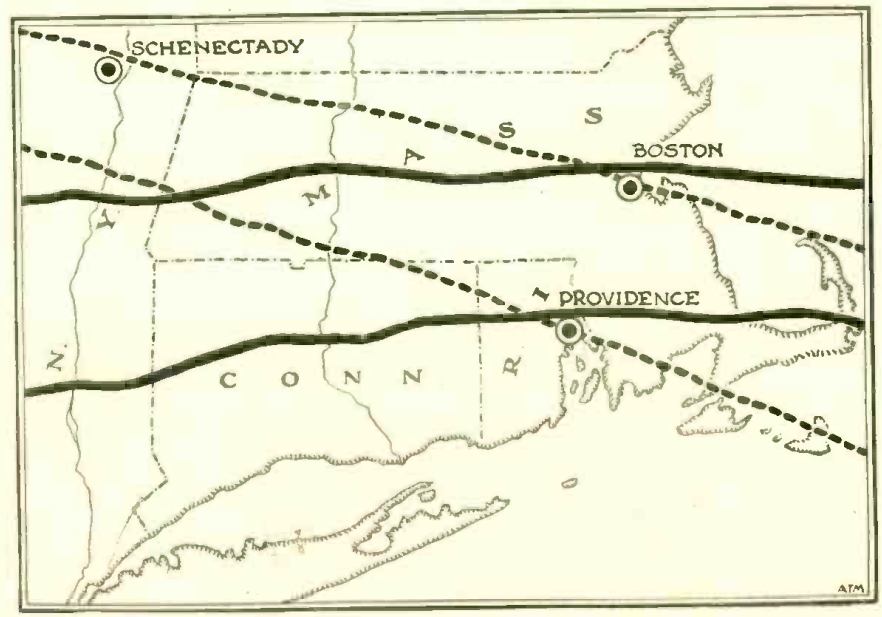
> "Wireless signals are a wave motion in, or disturbance of, the magnetic forces of the earth, and are propagated through this magnetic field, following the curvature of the earth, just as a tidal wave would follow the surface of the ocean. Practice indicates that the nodal points of the waves are at, or near, the earth's surface."

This theory which I began testing as far back as 1902 and which the work of other investors indicated was the correct theory, I thought had been universally accepted. But the theories now being advanced to explain fading indicate radio scientists are getting back into the air again. Fading can be explained by my theory of grounded magnetic waves and can be definitely settled by certain corporations or by the Federal government which has experimental use of telephone or telegraph lines.

We know there are earth currents, that they vary in strength and that they travel in paths of least resistance. Charts have been made to show the earth current paths.

Every telegraph operator has to contend with these earth currents. If one end of a long telegraph or telephone line is grounded and the other end tested for voltage it is found at times the potential impressed by the earth currents alone may run into hundreds of volts. As a matter of fact in the operation of long distance telegraph lines it is necessary to watch the earth currents with a great deal of care and adjust accordingly the current fed into the line from the batteries.

One day in the fall of 1903 when I was installing a wireless station at Point Judith, R. I., the telegraph companies reported the earth currents exceptionally strong. At the same time it was noticed that the wireless reception was



HOW EARTH CURRENTS AFFECT RADIO

When the paths of the earth currents follow the heavy lines western stations will be received well at Boston and Providence. If the direction of the earth currents shifts to that of the dotted lines, Schenectady will be exceptionally strong at Boston. Radio moves best along the lines then being followed by the earth currents.

* "Wireless Telegraphy and Telephony," published 1908.

extraordinarily good, indicating there is a direct connection between earth currents and radio reception.

The stronger the earth currents, the stronger the resultant magnetic field and the greater the distance the radio waves will travel and the greater the strength of signals at the receiver. Earth currents are constantly varying in strength and follow paths according to the conductivity of the earth's strata. When we have compiled enough data on these earth currents, I believe we will have an explanation of practically every radio problem not yet satisfactorily solved.

Of one thing I am certain; it has been demonstrated to my satisfaction, time and again during the past twenty-six years, that there is a very definite relation between the signal strength and transmission distance and the strength of the earth currents. I feel certain that radio waves travel greater distances when following along the earth-current paths. This by itself explains some of the peculiarities of radio reception.

On land, due to the almost constant change that is taking place in the conductivity of the earth-current paths, more current may be traveling at a given time in one path and at another time in another path. These currents vary not only from day to day but also from path to path. There is nothing about them that seems fixed.

Now let us suppose that on one night the earth currents in the most direct path between the broadcasting station and the receiving station are exceptionally strong, that this path has less resistance than any other path between the two stations. We would then expect to have great signal strength and exceptionally good reception. There is reason to believe this is actually the case.

Suppose, however, that on the following night something has happened to make the strength of the current in this path almost equal to that flowing between the stations by more circuitous paths. The waves that come together after traveling over different paths might not be exactly in place. As a matter of fact those in one path might be lagging behind or leading the others by just the right amount as to counteract each other and there would be no signal at all at the receiver. If the waves from the two paths were slightly out of phase, they would periodically re-enforce and then counteract each other and the signal strength would build up and then fade away.

Under these conditions, fading would ordinarily be most pronounced on the most distant stations and less pronounced on those stations nearest the receiver. However, on account of the peculiarities of earth currents and their paths and the great number of things that may affect these currents and their paths this could not be adopted as a universal rule.

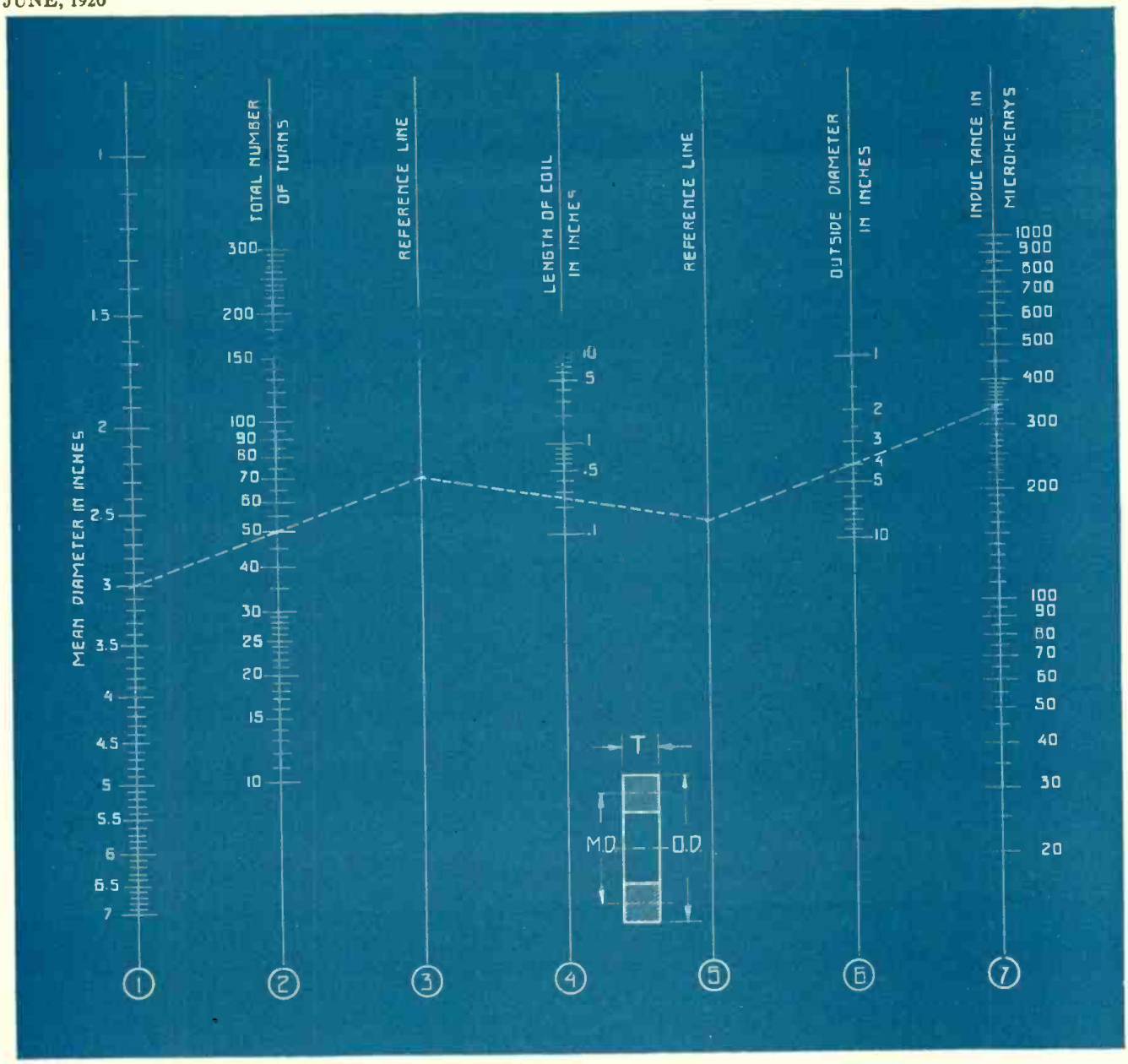
I am not trying to advance a proved theory; I am merely submitting an idea that I believe is worth careful thought and extensive investigation. It is obvious that the simple experiments I conducted to satisfy myself that radio waves are really grounded magnetic waves would not suffice to demonstrate that fading is caused by earth currents. Much more study must be given to earth currents than has ever been given before. A vast amount of data we do not now possess must be compiled.

It will require extensive research over a wide area to establish this idea as a theory. I believe, however, that work along this line is along the right line, and that it is possible to establish positive proof of my claims.

Therefore, I pass along the idea with the hope that it will be taken seriously by enough investigators to enable us, during the next few years, to gain the knowledge of earth currents and their relation to radio that is necessary to establish it as a proved theory—a theory that will show in a sound and satisfactory manner the cause of fading.

ENGLAND'S BEST-KNOWN "HAM"

Thousands of American amateurs are familiar with the signals of Mr. Gerald Marcuse (2 NM). Here is the radio shack from which they come at Caterham, Surrey, England. Mr. Marcuse's receiving apparatus is shown at the left of the picture, while just to the right of his head may be seen the huge quartz tube used in many recent transmissions.



A MEASUREMENT CHART

FOR USE IN CALCULATING THE INDUCTANCE OF A MULTI-LAYER COIL

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

THIS chart may be used as an easy means of calculating the inductance of a multi-layer coil.

Maximum inductance in a coil may best be obtained through the use of multi-layer winding. A formula has been evolved, by the use of Nagaoka's formula, together with Coursey's correction factors for multi-layer coils, which will give the inductance of such coils with sufficient accuracy for ordinary engineering purposes.

This formula is:

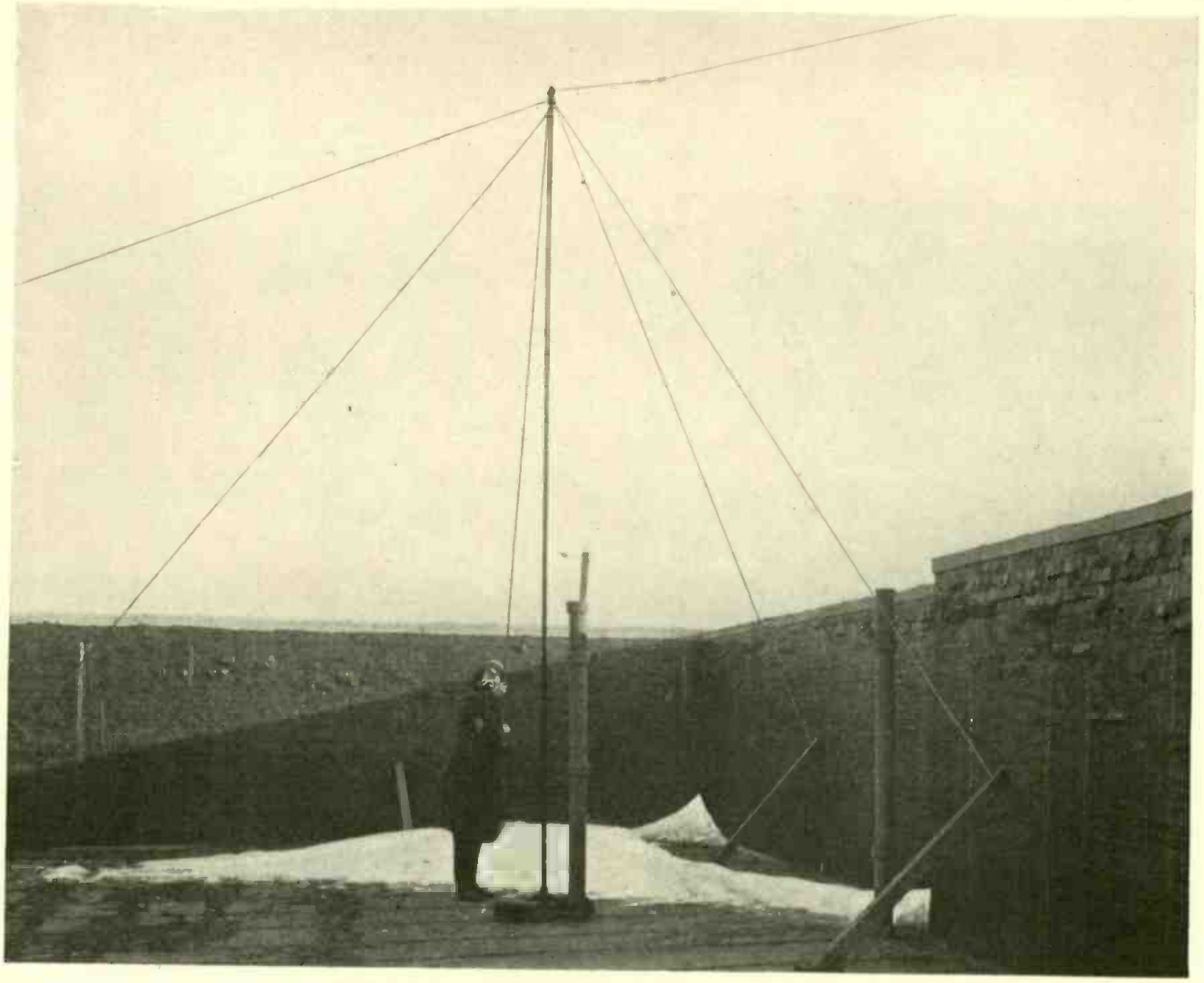
$$L = .0174 \frac{M.D.^{5/2}\, n^2}{T^{1/2}\quad O.D.}$$

Where L is the inductance in microhenrys, MD, the mean diameter (see sketch), n, the total number of turns, T, the thickness or length, and OD, the outside diameter of the coil; all dimensions being given in inches.

The accompanying chart will prove to be an aid in rapid coil designing. It acts as a substitute for the equation, which is given above, when the mean diameter, on scale No. 1, is connected with the number of turns, on scale No. 2, then, the intersecting point on reference line No. 3 with the thickness, on scale No. 4, and the intersecting point on reference line No. 5 with the outside diameter on scale No. 6. The point where this final connecting line intersects scale No. 7 will give the inductance of the coil.

Example: To find the inductance of a multi-layer coil consisting of 50 turns, which has a mean diameter of 3 inches, an outside diameter of 4 inches and a thickness of ¼-inch.

Connect 3, on scale No. 1, with 50, on scale No. 2; then connect the intersecting point on reference line No. 3 with .25 on scale No. 4, and connect the intersecting point, on reference line No. 5 with 4 on scale No. 6. This last line will intersect scale No. 7 at 340, the inductance of the coil in microhenrys.



HOW THE ANTENNA LOOKS WHEN COMPLETED

FIGURE 1: *Nothing short of a hurricane could blow down this strongly-constructed antenna installation on the roof of a modern apartment house. It is an ideal type of installation for the city fan; rigid, well-supported and not at all unsightly.*

HOW TO PUT UP

A Good Outdoor Antenna

Without a good aerial even the best of receivers will not work satisfactorily. Here is an antenna that is particularly recommended to the radio fan who lives in town.

By LAURENCE M. COCKADAY

THE first problem that a prospective buyer of a receiving set should answer—even before he decides what set to buy or to build—is whether or not he has facilities for an outdoor antenna.

For without the right kind of an antenna the best receiver in the world cannot function properly.

Usually the troubles that beset the inexperienced owner of a receiver may be traced to an improper installation of his antenna. In most cases, of course, the beginner knows nothing about antennas or the method of installing them; and only too often the printed instructions that come with the set are too meager to be of much practical value.

Yet the antenna installation is one of the most important parts of the whole radio receiving apparatus.

The first step that the beginner should take is to determine what kind of an aerial is needed; whether a short wire 50 feet in length will serve the particular set he owns, or a 75 foot wire or a 100 foot wire will give the best results.

After this point is decided, the next step is to obtain a set of antenna fittings, somewhat similar to the set shown installed in Figure 1, for example.

There are several manufacturers who make these units. A size that is suitable for a 1-inch pipe should be obtained.

A close up picture of such a set is shown in Figure 2.

Next, the beginner should obtain two lengths of 1-inch pipe (one inch is approximately the diameter of the *inside*

of the pipe). This pipe may be 10, 15 or 20 feet long.

He will also need about 350 feet of stranded-copper antenna wire and four insulators. It is best to use the same kind of wire for the guy wires as is used for the antenna itself.

In addition, he will need a porcelain tube about 12 inches to 14 inches long and a lightning arrester to complete the installation.

The only tools he will need are a wrench, a hammer, a set of pliers and a knife.

A block of heavy wood, about 15 inches by 20 inches in size, will serve as the base for the mast. Two of these, similar to that shown in Figure 3, are needed.

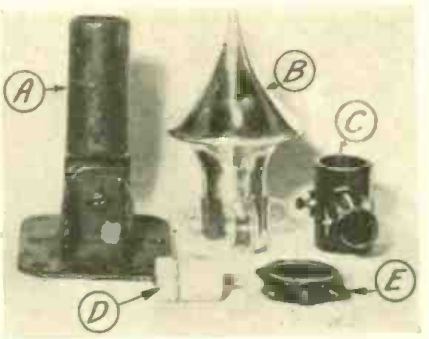
When laying out the antenna, select the room in which the radio set is to be placed with a view of bringing down the lead-in wire at a suitable position on the building.

Then place the radio set near a window.

Next, go up on the roof to a spot that is directly above this window. This should be the "near" end of the antenna; the lead-in wire should go down the side of the building or airshaft close to this spot. The lead-in wire will then be as short as possible.

Then measure off, in a direction that is best available, the space that is needed for the antenna, 50, 75 or 100 feet.

The antenna should extend in the direction from which you want to receive. In other words, if you want best reception from the East or West, the antenna should run East or West from that point; if you want best reception from the North and South, the antenna should run North or South from this point.



THE METAL FITTINGS FOR THE MAST

FIGURE 2: *Parts similar to the ones shown above may be obtained from any radio dealer; they should then be fitted to the mast as told in the text. A is the mast seat; B, the top piece (with pulley); C, the elbow joint; D, the porcelain insulator; and E is a small guy wire ring.*

After you have located the best position for the two ends of the antenna, start erecting the "far" mast for the end of the antenna.

Begin by screwing down the mast seat to one of the wooden bases I, as shown in Figure 3.

Then screw into the socket in the mast seat one end of the one-inch pipe, F, that constitutes the mast itself. (This is also shown in Figure 3).

Next, fasten the top piece, B (that contains the pulley) onto the top end of the mast. This piece is equipped with a pulley and three or four eyelets for the guy wires, G, which should be cut to a little longer than the right length at this time.

Now look around and see where these guy wires will have to run. Be sure that you make them long enough. There are usually pipes or stanchions on the roof that make suitable guying posts.

After the ends of these guy wires, G, have been attached (as shown in Figure 4), the end of the antenna should be run through the pulley with two insulators, H, attached, as shown in Figure 5 and diagrammatically in Figure 7.

This wire that runs through the pulley is not the antenna itself but the hoisting wire that is used to pull the antenna tight, so that it will be stretched evenly. This wire should be long enough to reach about 4 or 5 feet out from the pulley to the insulators and then down through the pulley to the base of the mast where it may be temporarily fastened.

The next step is to set the mast up straight, so that it will stand upon the wooden base, I, squarely (as shown in Figure 1).

It is best to have two persons hold the guy wires while the third person raises the mast in position, as shown in Figure 8.

The guy wires may then be fastened securely (as shown again in Figure 1) to suitable pipes or stanchions. Usually, if the mast is not over 20 feet high, it

HOW THE BASE IS ATTACHED TO THE MAST

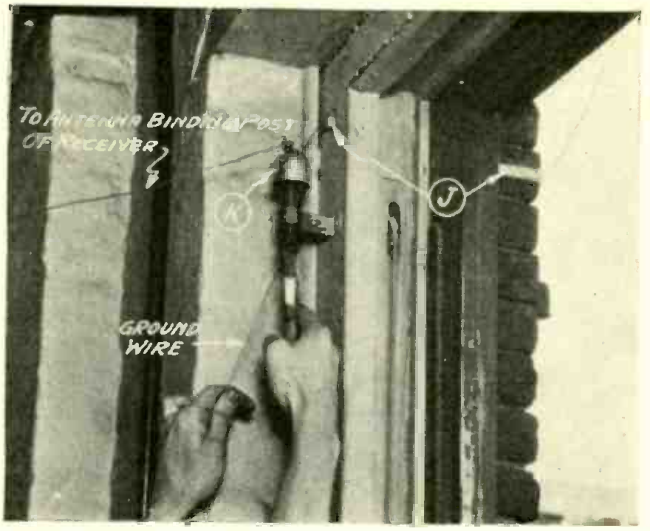
FIGURE 3: *The mast seat, A, is first attached to the wooden block, I, by means of screws; the pipe, F, is then tightened in the socket.*

ATTACHING THE GUY WIRES TO THE TOP PIECE OF THE MAST

FIGURE 4: *The guy wires, which are designated here as G, are next attached to the top piece, B, with a pair of pliers.*

HOW THE INSULATORS ARE ATTACHED

FIGURE 5: *The two insulators, shown at H, should be connected in series between the antenna wire proper and the hoisting wire.*



WIRING THE LIGHTNING ARRESTER

FIGURE 6: *The lead-in wire is led through the porcelain bushing, J, and attached to the arrester. The ground wire is attached to the opposite terminal.*

needs one set of guy wires at the top of the mast; and the extra small ring, E, that comes with the set, for guy wires is not needed.

When the far antenna mast has been set-up, the near one should be erected in a similar manner except that the elbow joint, C, shown at the right in Figure 2, should be attached part way up the mast and a suitable wooden rod (a broomstick handle will sometimes suffice) inserted at the elbow so that it sticks over the edge of the roof.

The porcelain insulator, D, shown in Figure 2, may then be attached to the end of this rod for carrying the lead-in over the edge of the roof without touching the side of the building.

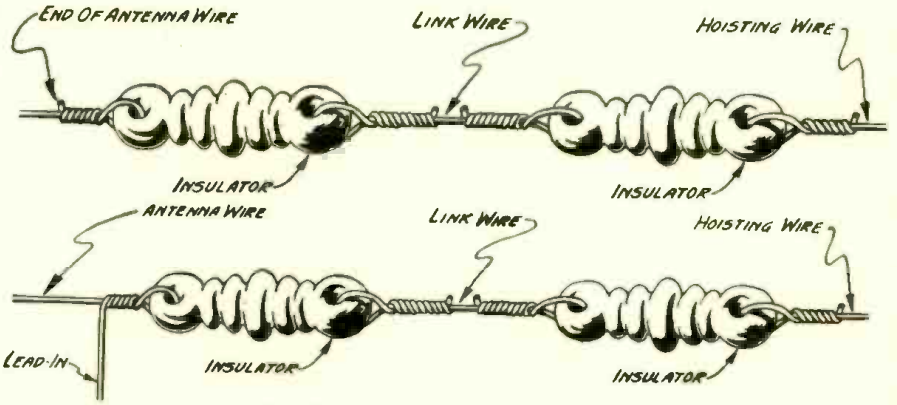
The antenna itself is fastened in one piece at the near mast to the insulators, so that the same wire runs down to the house and forms the lead-in (see Figure 7). In this way no soldering is necessary; and the hoisting wire, which is also made of antenna wire, will run through the pulley and should be fastened at the base of this mast.

Next, the antenna itself should be pulled tight by the two hoisting wires, one at each end, so that the insulators will be spaced equally between the two masts.

Then, the lead-in wire should be run through the insulator which is on the wooden rod at the near mast and let down past the window where it is to be brought in.

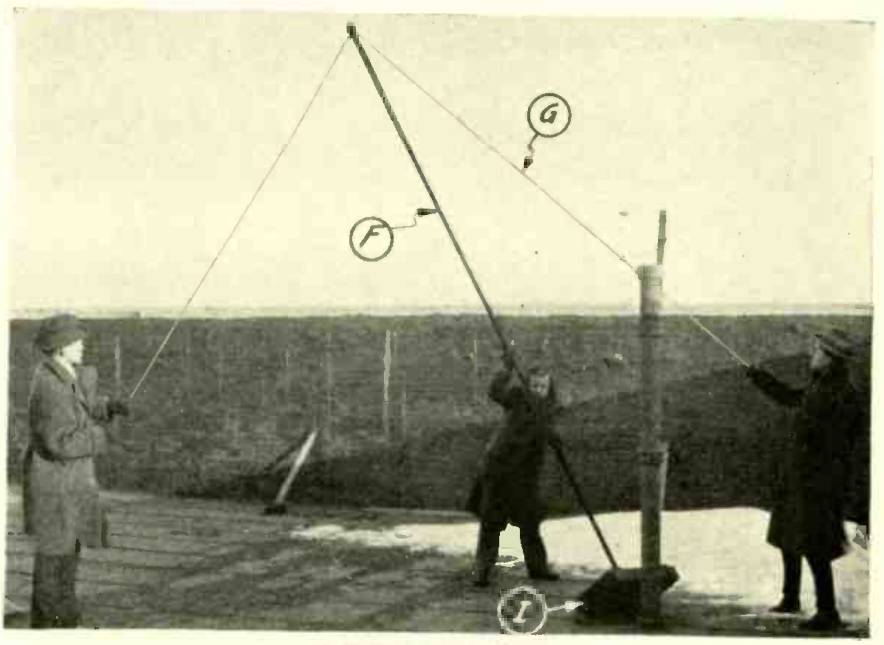
A large, wood drill should then be used to drill a hole through the window casing for the porcelain bushing, J, as shown in Figure 6. The porcelain bushing, J, should slope downwards to the outside so that it will not collect water and drip into the house.

The lightning arrester, K, may then be installed as shown in Figure 6.



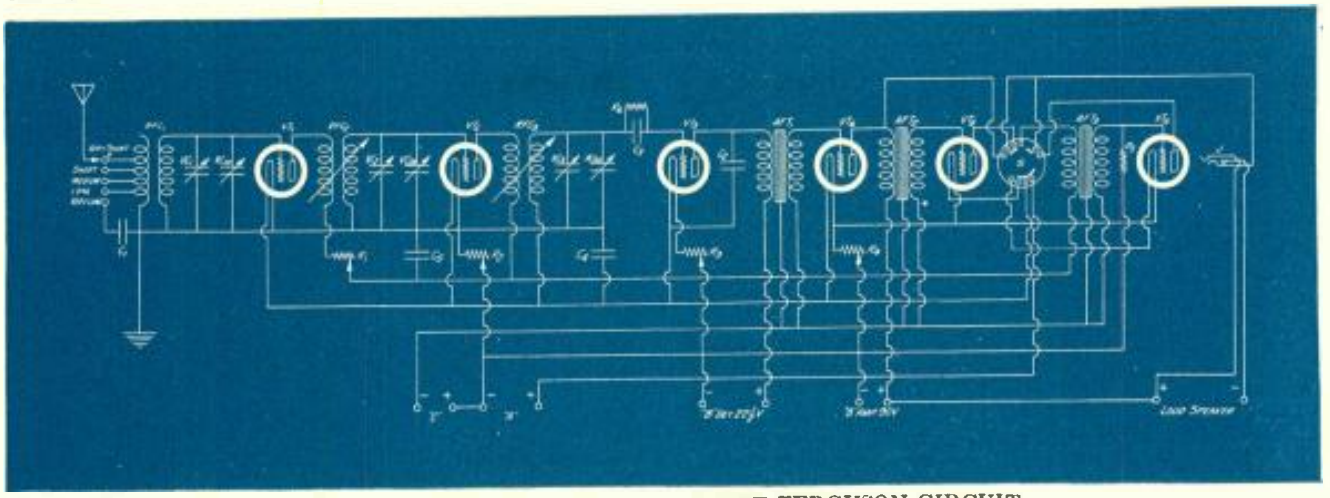
HOW THE INSULATORS ARE WIRED

FIGURE 7: *The upper drawing shows how to install the two insulators between the "far" end of the antenna and its hoisting wire; the lower, the "near" end. The lead-in is one piece with the antenna wire.*



RAISING THE MAST

FIGURE 8: *The mast, F, is raised in position on the base, I, supported by the guy wires, G, which will later be fastened to stanchions.*



THE THEORETICAL DIAGRAM OF THE FERGUSON CIRCUIT

FIGURE 1: *The designating symbols which are used in this drawing are explained in the list of parts and in the text of the article.*

HOW TO GET THE MOST OUT OF

Your Ready-made Receiver

No. 11: The Ferguson Model "Eight" Receiver

This series of articles explains the theory, operation, equipment and care of standard receiving sets

This series does not indorse the product of any manufacturer or make comparisons between receivers. The sets already described include: No. 1, the Eagle Neutrodyne; No. 2, the Radiola Superheterodyne; No. 3, the Melco Supreme Receiver; No. 4, the Crosley Trirdyn; No. 5, the De Forest Reflex; No. 6, the Atwater Kent; No. 7, the Grebe Synchrophase Receiver; No. 8, the Freed-Eisemann Receiver; No. 9, the Garod Neutrodyne Type V Receiver; No. 10, the Thompson Minuet Receiver.

By S. GORDON TAYLOR

EXPLANATION OF SYMBOLS IN FIGURE 1—

RFC1—Antenna coupling coils;
RFC2 and RFC3—Radio-frequency coupling coils;
VC1, VC2 and VC3—Variable condensers;
VC1a, VC2a and VC3a—Balancing condensers;
VT1, VT2, VT3 and VT4—UV-201-a type of vacuum tubes;
VT5 and VT6—(See section under heading "*What Tubes to Use.*")
C1—Fixed antenna series condenser;
C2, C4 and C5—Fixed by-pass condensers;
C3—Fixed grid condenser;
R1—Variable resistance which is operated by the volume control knob on the front of the receiver;
R2, R3 and R4—Filament control rheostats;
R5—Stabilizing resistance;
R6—Grid-leak;
J—Loudspeaker jack;
S—Automatic switching device, operated by notched volume control on front of receiver.

SIX vacuum tubes are used in this receiver which is of the tuned-radio-frequency type. The electrical circuit which is employed has long been recognized as highly efficient. Heretofore not less than six to ten tuning controls were needed with this type of circuit and considerable ability was required on the part of the operator to tune the receiver properly. Painstaking work upon the design of the receiver has made it possible to reduce the number of tuning controls to one. It is as easy to tune as a single-tube receiver.

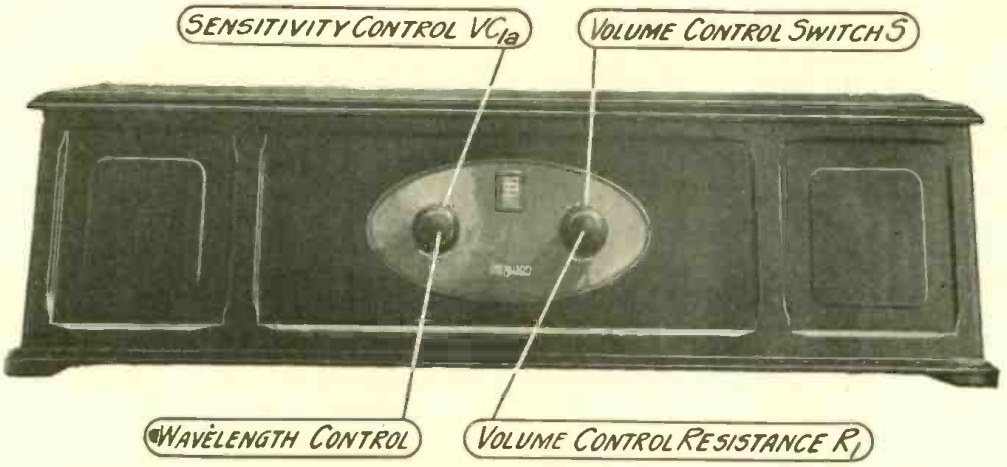
The Construction of the Receiver

The entire "works" of this receiver are mounted on an aluminum "chassis" to which has been attached a composition panel. In gearing a number of tuning units together to operate from a single control, it is of course essential that they be mounted in a rigid manner to avoid the possibility of any of them shifting out of alignment. It is for this reason that all the rotatable units are mounted on the massive aluminum casting. The other instruments, which do not require a rigid mounting, or which require an insulated mounting, are attached to the composition panel which is supported by the aluminum framework.

The cabinet is of polished wood and it serves merely as a housing for the receiver and the batteries. The tuning and tube controls are located on an oval-shaped metal plate which is set in the front of the cabinet, as shown in Figure 2. A small window is provided in this plate, behind which is mounted a revolving drum. Its circumference is calibrated directly in wavelengths. Thus if it is desired to tune in a broadcasting station operating on 300 meters, for instance, it is only necessary to turn the tuning control knob until the figure 300 on the drum is opposite the indicator in the window. This is an ideal arrangement for the average owner of a radio receiver because it eliminates the necessity for keeping a record of the dial settings for various stations. The wavelengths of the various stations may be obtained from the daily radio programs which are printed in the newspapers. Compartments are provided at either end of the cabinet for the "B" and "C" batteries. Only the storage "A" battery is left outside of the cabinet.

How the Receiver Works

The signals transmitted by a broadcasting station are intercepted by the antenna



A VIEW OF THE RECEIVER WHICH SHOWS THE SIMPLIFIED CONTROL ON THE OVAL METAL PANEL

FIGURE 2: *All the tuning in this receiver is done by the control on the left. The wavelength that you are receiving on appears in the small rectangular window at the center of the panel.*

and pass through the antenna circuit which consists of the antenna, ground and the turns of the primary coil of RFC1 which connect the antenna and ground. The number of turns between the antenna and ground determine the amount of intercepted energy that will be passed on into the receiver. If too much energy is transferred to the receiver there will be a lack of selectivity in tuning.

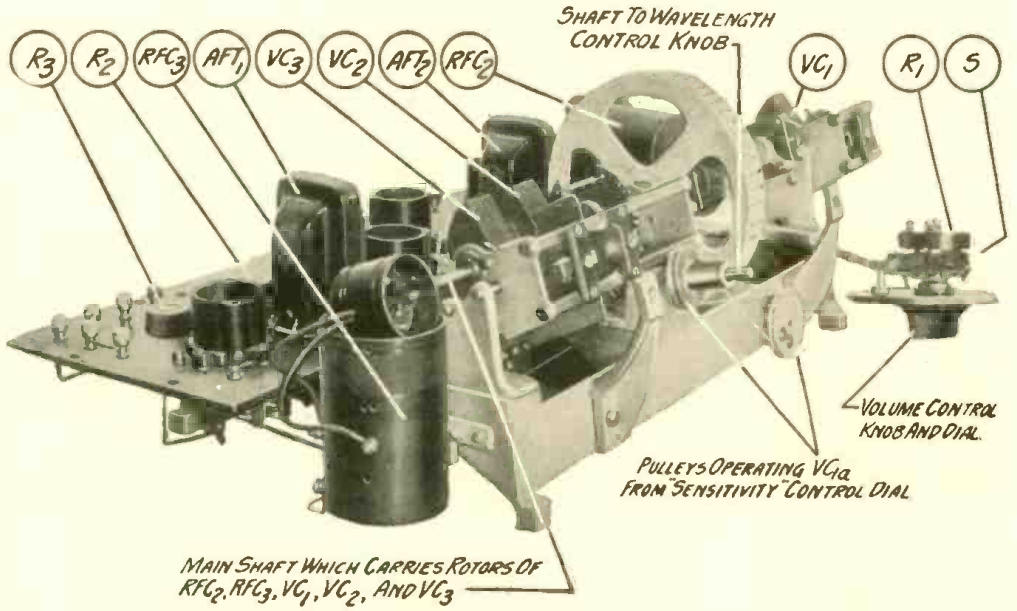
If the antenna is very small it naturally picks up less energy; therefore a comparatively large number of turns should be used in the primary coil. On the other hand a large antenna may require cutting the number of turns down to one or two, or even the use of a condenser connected in series, which has much the same effect as reducing the size of the antenna. Such a condenser is shown at C1. For this reason five "antenna" binding posts are incorporated in the receiver and the diagram. Figure 1 shows how these five posts are connected to accommodate antennas of any length.

The energy in the primary of RFC1 is transferred to the secondary coil by means of electro-magnetic induction. This transfer of energy would be possible even if there were no actual connection between the two coils. The amount of energy transferred in this way will be greatest when the secondary coil is tuned, by means of VC1, to the same frequency (wavelength) as the incoming signal.

The secondary coil is connected across the grid and filament which are the "input" terminals of the first radio-frequency amplifier tube, VT1; and the energy in the secondary coil is therefore impressed on the tube. Due to the amplifying action of this vacuum tube the energy put into the tube may be taken out at the output terminals (plate and filment) in much larger quantities.

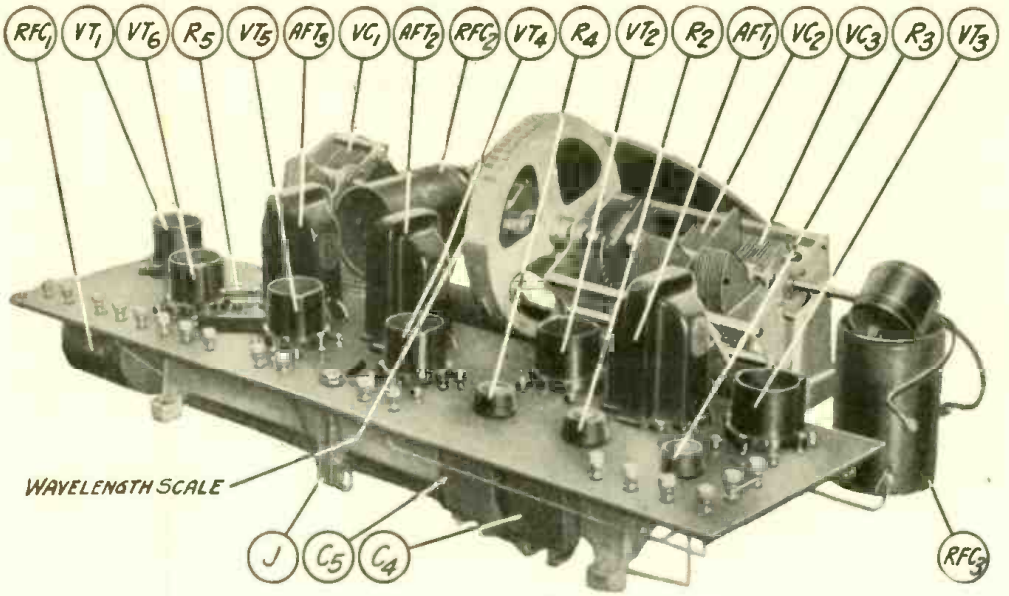
Strange to say, however, none of the electrical energy which was put into the tube from RFC1 is taken out. Instead, all of the energy in the plate circuit of the tube comes from the high voltage "B" battery; but this new energy is in exactly the same form as the original energy which was intercepted by the antenna and passed through RFC1. The incoming signal energy simply causes the grid circuit of the tube to act as an automatic throttle which governs the amount of energy drawn from the "B" battery. Therefore, there is in the primary of RFC2 an exact duplicate of the energy in the antenna circuit; but it is of increased amplitude, due to the fact that this coil is connected between the plate and filament of the tube (through the "B" battery).

This energy in the primary of RFC2 is passed on to the secondary by induction, as in the case of RFC1. The amount of energy transferred in this case is regulated not only by the number of turns on the primary coil, but also by its relation to the secondary coil. When the windings of the two coils are parallel the energy transfer is greatest. On signals of high wavelength the coupling between the two coils must be close for maximum results.



THE RECEIVER REMOVED FROM THE CABINET

FIGURE 3: *This view shows the general arrangement of the various tuning units as well as the rotating disc which carries the wavelength calibration. The designating letters in this illustration correspond to those in Figure 1.*



A REAR VIEW OF THE WORKING PARTS

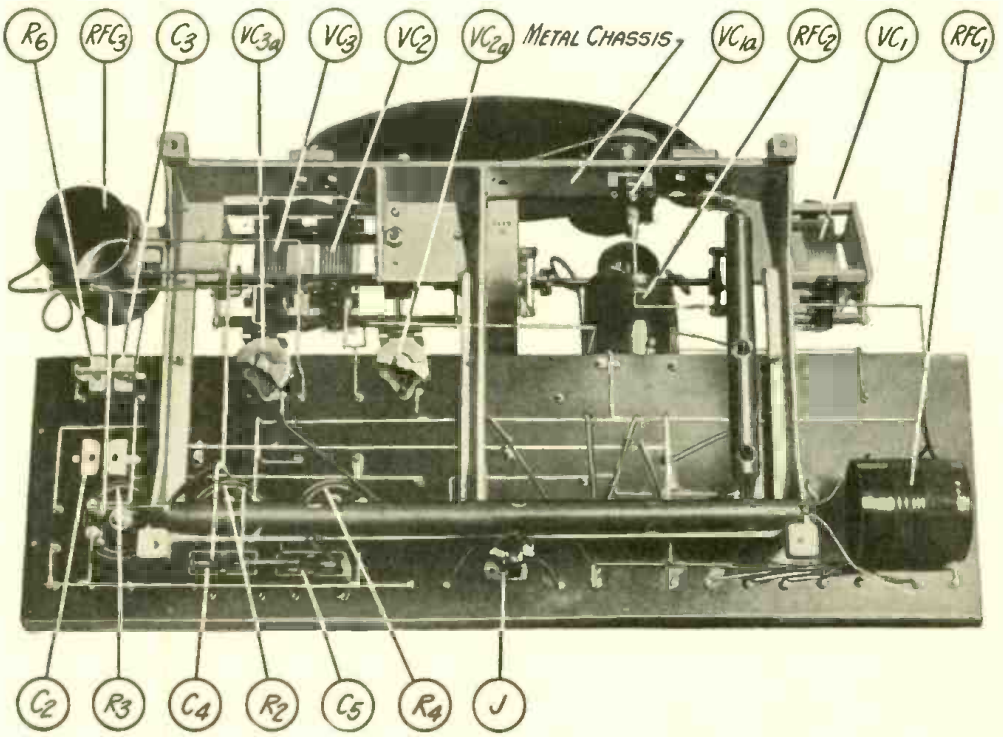
FIGURE 4: *A rigid aluminum frame carries all of the instruments. Some are mounted directly upon it while others are fastened first to an insulating panel.*

Close coupling (parallel windings) on signals of low wavelengths, however, provides too much transfer of energy. To obtain maximum transfer of energy on all wavelengths without oscillation, it is obvious that some means must be provided to vary the coupling between these two coils so that the coupling will be greater for high-wave signals and less for the low-wave signals. This is accomplished in this receiver by having the primary coil rotate within the secondary so that the relation of the windings can be varied with variations in wavelengths of received signals.

From the secondary of RFC2, which is tuned by VC2, the energy is impressed on the grid circuit of VT2 and is amplified in this tube through the same process as in VT1. The output of VT2 is then transferred by VT3 by means of RFC3 as before.

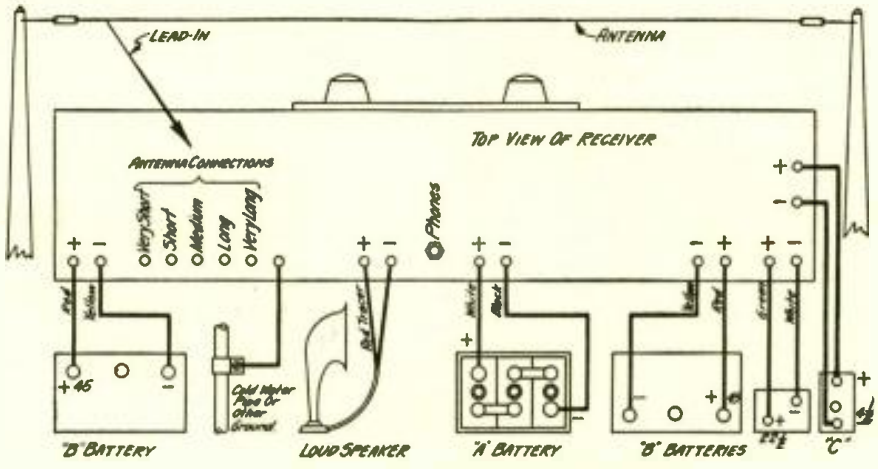
It is obvious that the three coupling circuits must be tuned to resonance with the wavelength of the incoming signal or the circuit which is not so tuned will block the passage of the signal. With this thought in mind the conclusion was reached that if the three variable condensers were geared together so that they could be operated by a single control the actual tuning would be much simplified. An obstacle was encountered, however, in the fact that it is physically impossible to manufacture coils and variable condensers so that all will have exactly the same values of inductance and capacity. This obstacle was overcome in the Ferguson receiver by shunting a small variable condenser across each of the three larger ones. By the adjustment of these small condensers, the values of the three circuits can be satisfactorily balanced.

The values of the input circuit to VT1 will vary somewhat due to the influence of



THE BOTTOM VIEW OF THE RECEIVER

FIGURE 5: *This picture shows more clearly the rugged aluminum frame to which is attached the sub-panel. Notice how the low tension leads are assembled in a center group by means of insulated tubing.*



HOW TO CONNECT UP THE RECEIVER

FIGURE 6: *All the external connections are shown here including the antenna, ground and loudspeaker. If you wire the set in this manner, you should have no trouble in getting it to operate.*

the antenna circuit. It was therefore found necessary to provide means for balancing this input circuit when it was used with any particular antenna. For this reason the "sensitivity" dial is provided on the front of the receiver. This dial operates the small balancing condenser VC1a. The other two small condensers VC2a and VC3a can be adjusted to exactly balance the other two circuits before the receiver leaves the factory because nothing takes place later to unbalance these two circuits.

Thus the three tuning controls have been reduced to one. More than this, however, the primaries of RFC2 and RFC3 have also been geared to the single tuning control so that there are actually five variable adjustments accomplished by the operation of the single "wave-length" knob on the front of the receiver. Before the development of the single-control idea manufacturers did not provide variable coupling in RFC2 and RFC3 because it was not considered practical to provide the lay user with a receiver which required the operation of so many tuning controls. It was necessary to find a happy medium between the utmost in efficiency and the practical limit of tuning controls. With the cleverly planned arrangement of the Ferguson receiver no compromise was necessary. The utmost in efficiency is retained and the tuning controls have been reduced to one.

Up to VT3, in the circuit in Figure 1, the energy has been in the form of an alternating current of high frequency, commonly known as radio-frequency current. It is in this form that the signals reach the antenna; and this form is retained throughout the radio-frequency amplifier. The frequency of this energy is far too high to actuate the comparatively sluggish mechanism of a loudspeaker, or headphones. Even if this were not the case, the frequency would be too high to be within the audible range.

It is necessary to provide a means for reducing the signal so that the frequencies of the voice or music which is being broadcast will be available; and for this purpose the detector tube, VT3, is used. It accomplishes a rectifying action which in effect smothers out the radio-frequency current, leaving only the current fluctuations of audio frequencies. The condenser and resistance, C3 and R6, are in the circuit of this tube to assist in this action. If headphones were connected in the output circuit of this tube the broadcast signals would be heard, but would not be strong enough to operate a loudspeaker.

Another form of amplifier is therefore added to the circuit to bring the volume up to a point where the loudspeaker may be used. This is known as the audio-frequency amplifier and includes VT4, VT5 and VT6. The theory of the operation of this amplifier is the same as that of the radio-frequency amplifier. The coupling devices, AFT1, AFT2 and AFT3 are different, however, because of the different nature of the current.

The volume of sound obtained from the loudspeaker will depend on whether it is connected after VT4, VT5 or VT6. The change from one to the other is automatically made in this receiver by means of the switch S, which is operated by the "knurled" volume control on the front of the receiver. If low volume is desired, the volume control may be set on 4. This operation not only connects the loudspeaker into the output circuit of the fourth tube (VT4) but also cuts off the filament current to VT5 and VT6, thus conserving the "A" battery supply. Setting the switch on 5 provides greater volume and the last tube is brought into use by setting the volume control on 6.

The smaller volume knob on the front of the receiver controls the variable resistance, R1. This resistance limits the amount of energy that can be drawn from the "B" batteries by VT1 and thereby adjusts the amount of radio-frequency amplification to any degree desired. By reducing the resistance in this circuit up to the proper point (by turning this control knob in a clockwise direction) the radio-frequency amplifier can be made extremely efficient and sensitive.

The Antenna and Ground

This receiver offers extreme flexibility in its antenna requirements. In the case of the average receiver the selectivity, which means the power to separate the reception of broadcasting from two stations which work on neighboring wavelengths, varies more or less inversely with the length of the antenna. In other words, almost all receivers are selective if a very small antenna is used but become less selective if a large antenna is used.

The five antenna binding posts in this receiver are for "very short antenna," up to 25 feet in length; "short antenna," up to 50 feet in length; "medium antenna," up to 100 feet in length; "long antenna," up tp 150 feet in length; and "very long antenna," over 150 feet in length.

When an indoor antenna is to be used it is advisable to run the antenna through two or more rooms in a fairly straight line rather than in the form of a loop around four sides of one room. Such an antenna should be of insulated wire. The so-called "single lamp cord" with either cotton or silk insulation will serve nicely. It may be run along the top of the picture moulding, or may be tacked to the wall and need not be insulated from these objects except by the insulation of the wire itself. Care should be exercised, however, to see that the tacks which hold it up do not pierce the insulation and touch the bare wire. It is best to use double-pointed tacks or staples.

A drawing on page 252 of the March, 1926, issue of POPULAR RADIO suggests the precautions necessary in installing a good outdoor antenna. Excellent insulation is needed outdoors to prevent "grounding" of the antenna in wet weather. The drawing is self explanatory; and the ideas incorporated in it should be followed as closely as possible in making any outdoor installation. An excellent length for an outdoor antenna for use with this receiver has been found to be 125 feet, measured from the receiver to the most distant end of the antenna and including both the antenna proper and the lead-in wire. If great distance reception is not wanted, a shorter antenna will give as good results as the longer type; and in that case an antenna of about 60 to 75 feet in overall length will meet all the requirements for good reception.

Average daily use	2 hours	3 hours	4 hours
No "C" battery	105 days	63 days	38 days
1½ volt "C"	125 days	75 days	48 days
3 volt "C"	141 days	86 days	57 days
4½ volt "C"	154 days	96 days	64 days

ESTIMATED LIFE OF "B" BATTERIES WITH THE FERGUSON RECEIVER

This tabulation clearly shows the increased life of the two 45-volt "B" batteries where a "C" battery is used. This table is based on the use of "large" size batteries, with five vacuum tubes in operation (volume control dial set at 5) and with rheostats adjusted for maximum volume. Further increase in "B" battery life may be obtained by using only four tubes when these will supply sufficient volume, and by turning rheostats back to reduce the volume to just the desired degree.

The "ground" connection is made to a cold-water pipe preferably. In the absence of a nearby cold-water pipe a steam radiator will serve.

The pipe to which the ground wire is connected should be filed or scraped until it is shiny where the connection is to be made. A regular ground clamp should then be attached to the pipe and the ground wire attached to the ground clamp by means of the bolt and nut which accompany the clamp.

A lightning arrester is usually required with an outdoor antenna. The requirements are different in different sections of the country so it is not practical to give detailed instructions here on this point. Complete information may be obtained from any fire insurance agent.

The Correct Tubes to Use

The use of the UV-201-a type of tube throughout is advised. Since the advent of the new UX-112 power-amplifier tube, however, the author has found that both tone quality and volume are improved by the use of this tube for the second audio amplifier tube, shown at VT5 in Figure 1. Ordinarily there is no necessity for using the sixth tube in this receiver because more than ample volume on all but very distant stations can be obtained with the use of only five tubes, that is, when the notched "volume" control knob is set at 5. If six tubes are used, the UX-112 tube should be placed in socket VT6 instead of VT5.

What Batteries to Use

This receiver requires two kinds of batteries: the "A" battery, a 6-volt storage battery for lighting the filaments, and the "B" battery, which is made up of two 45-volt blocks and a 22½-volt block of standard dry-cell "B" batteries. The use of a "C" battery is optional.

The "A" battery should have a capacity of not less than 60 ampere hours. A 100-ampere hour battery is better as it requires recharging less frequently. When six UV-201-a tubes are used the filament-current consumption from the "A" battery is slightly less than 1¼ amperes; and a fully charged 60-ampere-hour battery should operate the set for approximately 40 hours before the "A" battery becomes discharged. Actually, however, it is not advisable to allow the "A" battery to discharge entirely before recharging so the practical life of a single charge is more nearly 25 or 30 hours with this number of tubes. On the other hand a 100-ampere-hour "A" battery would operate these tubes for over 50 hours before recharging is necessary.

The state of charge of the "A" battery cannot be judged by the number of hours the receiver is used on a single charge. For this purpose an instrument called a hydrometer is used. This is a small glass and rubber device which shows the specific gravity of the battery solution. By means of a rubber bulb some of the solution from the battery is drawn up into the glass chamber of the hydrometer in which there is a small calibrated glass float. The specific gravity is read on the scale of the float at the level of the top of the liquid in the chamber. The specific gravity, if the battery is fully charged, should read about 1280, while in the case of a discharged battery the reading will be about 1150. When the reading drops to 1185 the battery should be recharged.

The "A" batteries may be taken out to battery service stations to be recharged; but the more practical plan is to charge the battery at home with one of the standard chargers which are now on the market.

From a photograph made for POPULAR RADIO

CHECKING UP ON THE WAVELENGTH CALIBRATION

FIGURE 7: *Checking up on the dial setting to see that the wavelengths indicated are correct. The small box surmounted by a coil contains a portable oscillator wavemeter that is used in the calibration.*

Before purchasing a battery charger it is necessary to know whether the house-lighting supply is alternating current or direct current.

Convenient connections for the battery charger with the necessary switch were shown on page 433 of the November, 1925, issue of POPULAR RADIO, where the house lighting supply is alternating current. The charger shown on page 435 of the same issue is all that is necessary where the house supply is direct current, the lamps serving as resistances to reduce the charging current to the required amount of two or three amperes per hour.

The charger should have a charging rate of two or three amperes-per-hour for ordinary home use. A higher rate than this is liable to cause "gassing" of the battery, which results occasionally in splattering the battery solution through the vent holes in the battery caps onto the top of the battery and perhaps onto the surrounding floor. If this occurs the acid solution which is used for the electrolyte will eat the finish off of the floor. It will also eat holes through rugs or clothing. Due care should be taken to avoid having it come in contact with anything which it might harm. A good plan is to place a rubber mat under the battery and keep a glass receptacle handy for the hydrometer so that when it is removed from the battery it will not drip on the floor.

The two 45-volt "B" batteries may be either the "large" or the "heavy duty" size, and of the vertical type. The 22½-volt battery may be of the smallest size (about 3½x2½x2 inches). The small 22½-volt battery supplies the plate current for the detector tube only. This current drain is so small that this size 22½-volt battery will have a life some where in the neighborhood of six months to a year.

A table is given herewith which shows the approximate life of a set of two "large" size, 45-volt batteries when used with the Ferguson receiver. This table will give the owner a good idea of how long he may expect his "B" batteries to last. In order to keep a definite check on the batteries, however, a small voltmeter should be purchased which has a scale reading from 0 to 50 volts. The voltage of the batteries may then be tested from time to time. When the voltage has dropped from the original 45 to about 34 volts for each battery it is time to replace them. The small 22½-volt battery should be replaced when its voltage drops to 17.

The "heavy duty" batteries mentioned above will have approximately twice the life shown in the table below, and are therefore more practical because their overall operating cost is considerably less than that of the "large" type.

The use of a "C" battery is advised because of its effect in reducing the "B" battery current consumption. As the table indicates, the use of 3 or 4½ volts of "C" battery results in a surprising increase in the life of the large "B" batteries. It will also be noticed that the use of a "C" battery improves the tone quality of the receiver. To find the most desirable "C" battery voltage to use in any specific case, different voltages from 1½ to 4½ should be tried to find which voltage provides the quality of reproduction without reducing the volume. Bear in mind that the "B" battery life increases with an increase in the "C" battery voltage that is used.

There are devices on the market which are intended to take the place of "B" batteries and by means of which the high voltage ordinarily supplied by the "B"

batteries is obtained from the house lighting line. All of these devices will not work in all receivers. To such an extent is this true that it is always advisable, in purchasing a device of this kind, to require a demonstration of the device in the home with the receiver with which it is to be used, or at least to demand a money back guarantee. Where a "B" battery eliminator is used it will usually be found advisable to keep it at least two or three feet from the receiver. Otherwise, unless the device is thoroughly shielded, an alternating-current hum will be heard in the receiver.

How to Operate the Receiver

Figure 6 shows the way to connect the batteries, antenna, ground and loudspeaker to the receiver. When these connections have been completed, and the six vacuum tubes have been inserted in the sockets the receiver is ready for operation.

The three rheostat knobs at the rear left-hand side of the large composition panel inside of the cabinet should be turned as far as possible in an anti-clockwise direction. This is the "off" position and with the knobs in this position the tube filaments are not lighted. The left-hand rheostat knob should be turned half way on so that its pointer is over the center of the indicating arrow on the panel. This should light the detector tube, VT3. The "radio" rheostat knob is next turned about two-thirds on, in a clockwise direction, which will bring its pointer about a quarter inch beyond the arrow head. The tubes VT1 and VT2 in the radio-frequency amplifier will then light.

The setting of the third rheostat knob will depend upon the number of tubes in use. For instance, when the notched knob of the volume control on the front of the receiver is set with the white mark pointing to the figure 4, only one of the three audio frequency amplifier tubes will be connected. Therefore, the "audio" rheostat knob inside of the receiver should be turned on only about half way, otherwise it will allow too much current to flow through the filament of this tube with the result that the active life of the tube will be shortened. If the volume control is set at 5, two of the audio tubes will be connected into the circuit. Inasmuch as both of these tubes obtain their filament current through the "audio" rheostat, it is necessary to turn this rheostat on about two-thirds to provide sufficient current to the tubes. If the volume control on the front is set at 6 the three audio tubes will be in the circuit and will require a still higher filament current, and the "audio" knob is turned still further.

The exact setting of the "audio" knob can be determined in each individual case by adjusting the knob, while a broadcasting station is tuned in, to the lowest point where maximum volume is obtained and beyond which no further increase in volume is procured. After the receiver has been in operation for a while it will usually be left at one setting of the notched volume control knob and in that case readjustment of the "audio" rheostat knob will not be necessary after it is once set. The smaller volume control knob which is mounted in front of the notched knob, on the front of the receiver, has no bearing on the setting of the rheostat knob; therefore it may be used freely without the necessity for readjusting the rheostat.

To tune in the first station, after the rheostat knobs have been set and the front and rear volume controls have been set half-way "on" and at "5" respectively, the wavelength knob is adjusted until the wavelength of the desired station appears opposite the indicator in the window.

Suppose, for instance, that it is desired to tune in station WEAF. The radio program in the newspaper is consulted to determine whether this station is "on the air" at the time, and also to find its wavelength. The wavelength is 492 meters so, if the station is operating, the wavelength knob is turned until the indicator in the window is at 492.

The station should then be heard. If the station is not heard, rotate the "sensitivity" knob until it is brought in with best results.

Several stations should be tuned in, in this manner, until the operator becomes familiar with the handling of the tuning controls. Then it is time to study the refinements of tuning.

With a broadcasting station tuned in, preferably an out-of-town station 100 miles or more distant, turn the smaller control all the way to the left (anti-clockwise) and then turn it slowly to the right. At a certain point the broadcasting station will be blurred out and a shrill whistle will start. Just below the point on the volume-control knob where the whistle started will be the point where the receiver is most sensitive to weak signals. If no whistles are heard, it is probable that the tube in socket VT1 does not have suitable characteristics for that position. In this case it is well to interchange the tubes until the one which operates best in VT1 has been found.

It is found that whistles are heard as the wavelength tuning control, or the sensitivity controls are moved, it is an indication that the small volume control is turned too far to the right; and it should be turned back at once. When the receiver is tuned to the higher wavelengths the volume knob can be turned further to the right than when the receiver is adjusted for the lower wavelengths.

How to Chart the Receiver

In the case of most receivers which are tuned by means of the usual dials or knobs, calibrated in degrees, it is necessary to make a record of the dial settings for the various stations. In the case of the Ferguson receiver, where the tuning control is calibrated in wavelengths, such a record is not necessary. For convenience, the scale behind the small window on the front of the Ferguson receiver is provided with ample space to permit writing the call letters of stations directly on the scale. If this is done, a station which has once been tuned in and marked on the scale may be tuned in again whenever it is wished to listen in on a program without even bothering to determine its wavelength.

Pacific & Atlantic

THE NEW SUBMARINE RECEIVER

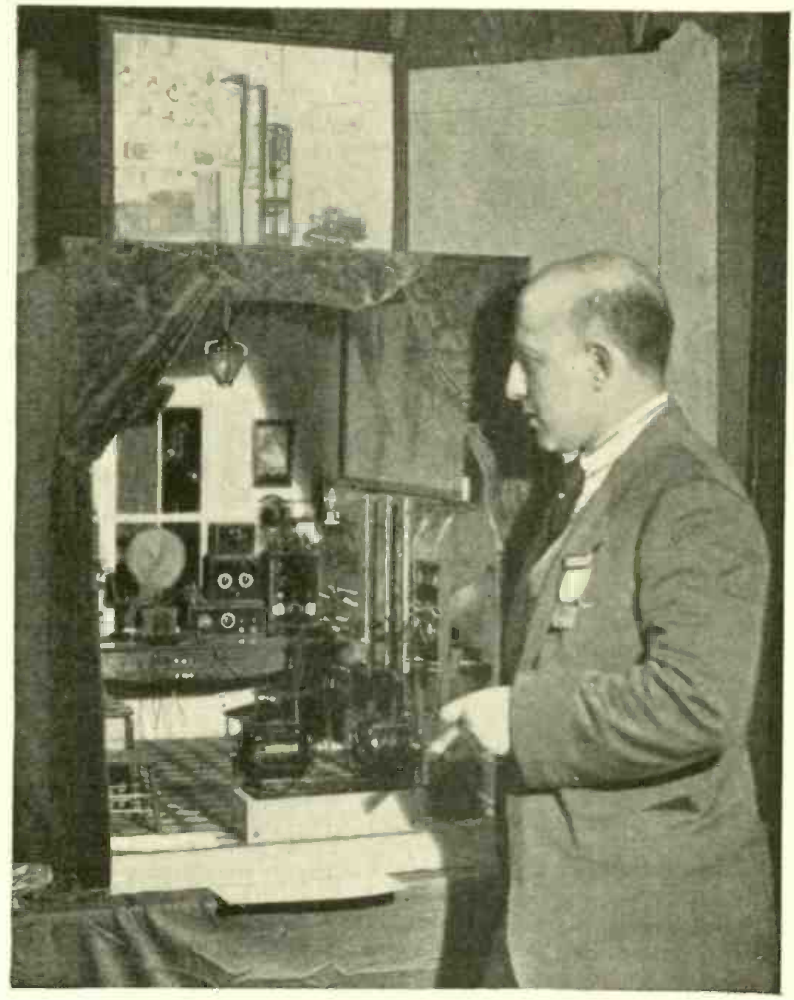
This new set, which uses an underwater antenna for radiophone communication between submerged submarines, has recently been developed by scientists in the Naval Research Laboratories at Bellevue, D. C.

New Wrinkles in Radio

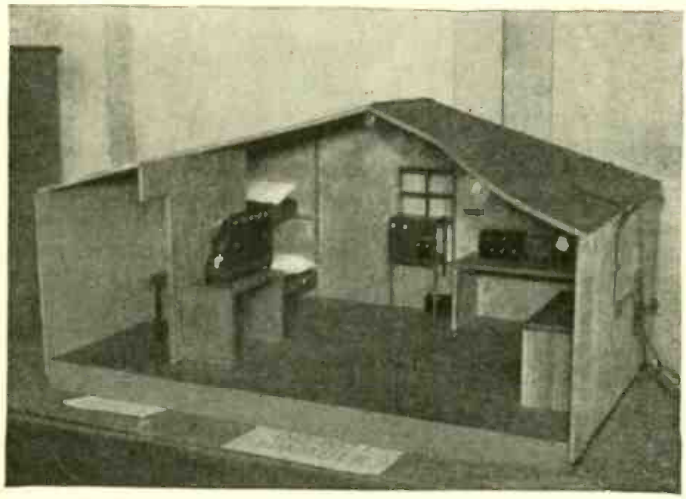
Miniature Models and Ingenious Inventions Made Recently by Radio Fans

Photographs by Kadel & Herbert

Let flippant announcers and off-key singers beware, for their broadcasting sins may be recorded for future generations of radio fans by means of this radio recording apparatus, invented by Francis R. Hoyt. It operates much as the machines which make records for your phonograph.



Any "ham" would find himself perfectly at home in this miniature model of station 2FZ which was built by its owner, Frank Frimerman. Power plant, transmitter and receiver have all been reproduced in minicture down to the finest detail.

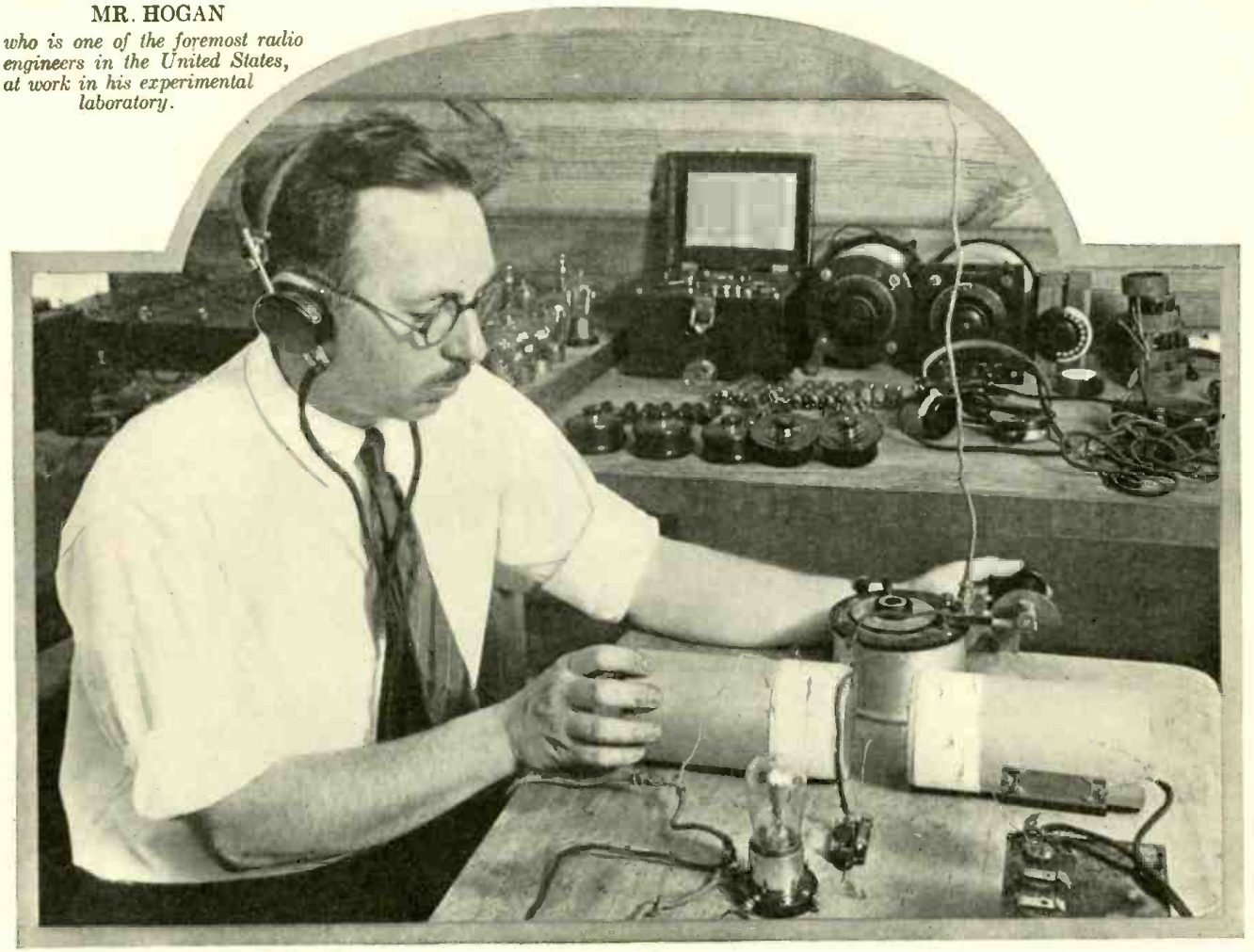


The "ham's" paradise, a miniature radio shack equipped with transmitting and receiving apparatus, a workbench and even bunks where he may roll in in the early morning after a night of "working" fellow hams half-way round the globe. Fred Parsons built this model of his own station, 2-ABM.

Even the absent-minded professor could not forget to tune in on a radio program with this invention of Ushichiro Tokumi, attached to his set. It will turn a radio set on or off at any time you wish, by closing an electric circuit when the clock reaches the hour at which the indicator is set.

MR. HOGAN

who is one of the foremost radio engineers in the United States, at work in his experimental laboratory.



From a photograph made for POPULAR RADIO

Audio-frequency Amplification

How to Get It Without Distortion

Practical pointers for the radio fan who ought to get uniformly good results from his loudspeaker and his audio-amplifier system—and doesn't.

By JOHN V. L. HOGAN

THERE is a widespread opinion, among radio users, that the quality of tonal reproduction is dependent entirely upon the loudspeaker used. This is based upon one of the half-truths that are so common in radio circles and that lead to so much regrettable confusion.

The fact is, that unless you use a good loudspeaker you cannot get natural or pure reproduction of radio speech or music in volume sufficient to fill even a small room; but the corollary fact, so often overlooked, is that even the best loudspeaker will not give good reproduction unless it is used with a good audio-amplifier system.

This brings us down to the problem of defining what are and what are not "good" amplifiers and loudspeakers; and that is really something of a problem, largely for the reason that it is complicated by the volume of sound required in any case, and because of the interdependence of the speaker and the amplifying system.

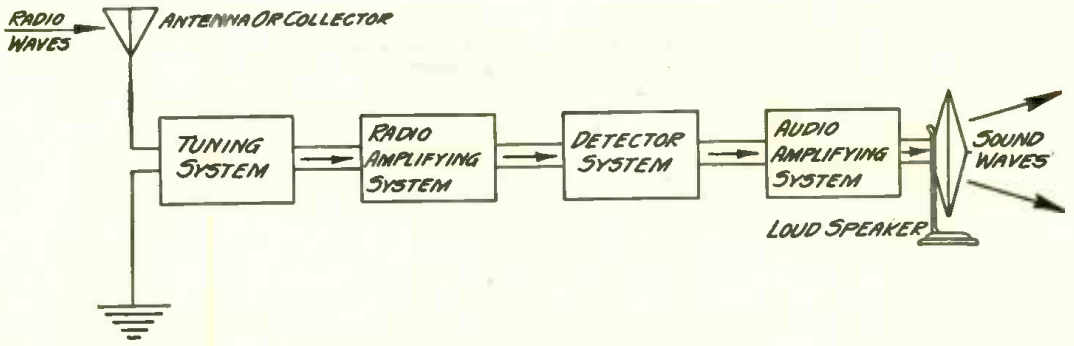
What we actually desire is a combination of amplifier and speaker that work well together.

From some viewpoints, we do not care whether our particular speaker will work well when connected to another type of amplifier, or whether our particular amplifier will give good results when used with a different type of speaker. We want the combination that we are using, our own amplifier and our own speaker, to produce natural and clear, undistorted speech and music. Also, we want that reproduction to retain its clear characteristics as the volume is increased to a reasonable point.

What Is a Good Amplifier?

Before we attempt to define more closely a "good" reproduction system, including both the amplifier and the speaker, let us consider the problem in a rather general way.

We may omit detailed consideration of the radio transmitter and of the wave



THE VARIOUS UNITS IN A RECEIVER

FIGURE 1: *The radio waves that carry the energy that you hear as sound first pass through the antenna circuit and the tuning system and then are strengthened by means of the radio and audio-frequency amplifiers and rectified by the detector. The current waves are then led to the loudspeaker and transformed into sound waves. Distortion may be introduced through faulty operation in any one of these units.*

propagation through space between the sending station and our receiving set, although they do have a definite effect upon the quality of reproduction. Unless the sounds picked up at the broadcasting station are correctly impressed upon the radio waves it sends out, we can hardly hope to get good reproduction of those sounds from our receiver.

Similarly, if the radio waves are badly mangled as they flash through space, for instance by some of those little-known causes that produce rapid "fading" or distortion, we will not hear natural tones at our receiver, no matter how carefully it is built. This simply means that for high quality we must listen to broadcasting stations that have carefully designed and carefully operated transmitting apparatus, and that are not too far away. Often it happens that signals of beautiful quality come through from very distant stations, but more often the fading or other effects spoil the naturalness of signals from all but the relatively nearby transmitters.

Coming to the receiver, then, we may leave out detailed discussion of the antenna and of the circuits preceding the detector. It is true that the tuning characteristics of these circuits sometimes affect the fidelity of tonal reproduction, for instance, because of an attempt to use excessive amounts of regeneration; but as a rule there is not much loss of quality to be attributed to this part of the system. So, also, the detector tube occasionally causes defective reproduction by reason of overloading or an attempt to produce loud responses with insufficient audio-frequency amplification. This condition is not usual, however; and so we may properly consider, with some care, the two elements that are responsible for the greatest amount of tone distortion, namely, the audio-frequency amplifier and the loudspeaker. Nevertheless, one should not lose sight of the fact, that even with a perfect amplifier-speaker combination, some attention should be given to the transmitter, wave-propagation, tuning and detector conditions in order to get the best results.

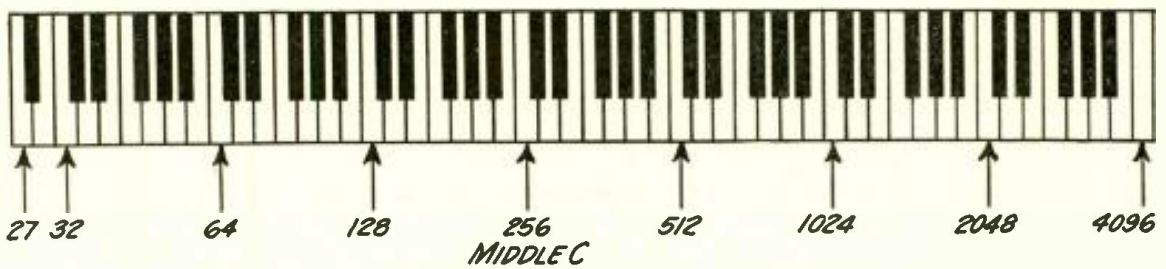
The Purpose of the Detector

The detector of any radio receiver of the type we are considering, delivers to the audio-frequency amplifier an irregular alternating current that corresponds, in amplitude (or intensity) and in the frequencies represented, to the intensity and frequency of each of the component sounds which affect the radio transmitter. The form of this alternating current changes from instant to instant, as the music or speech that is being reproduced, changes in sound. The original sound waves are exceedingly complex, in most cases; and, consequently, the detector output current (which is an electrical picture of the sound waves) is also extremely complicated in form.

The purpose of the audio-frequency amplifier is to magnify this rapidly-varying sound-current so that it is capable of doing more work.

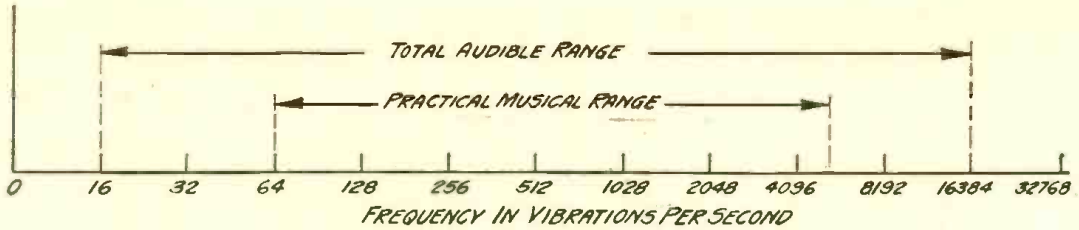
If you are satisfied with head-telephone reception, you do not ordinarily need any audio amplifier. The alternating current, just as it is delivered from the detector, is, as a rule, strong enough to operate the telephone receivers. As the detector current is usually a quite accurate representation of the sound, the response heard in a telephone is generally quite good in quality of reproduction. That is probably the main reason why so many people say they would always prefer to listen to radio in a head-set, if it were not for the discomfort of wearing phones for an hour or more at a time.

The vast majority of powerful radio receivers, which have been made up to now, have contained audio-frequency amplifiers that do not deliver to the loudspeaker an enlarged current that is an exact copy of the detector output current. Most of them, in the process of magnification, introduce some substantial (and often a very great) amount of distortion. As soon as one



HOW TONE FREQUENCY COMPARES WITH THE NOTES ON A PIANO

FIGURE 2: *If all of our music were played on that part of the piano that is above middle "C" we would have a thin kind of music. This is the kind of reproduction that is obtained from a poor transformer which slights the notes that correspond to the lower frequencies: that is, between 27 and 128 cycles.*



THE FREQUENCY RANGE THAT MUST BE COVERED TO OBTAIN GOOD REPRODUCTION

FIGURE 3: *The outer range (16 to 16, 384) covers the extreme limits of sound that the human ear can pick up; but the inner range is absolutely necessary for the good reproduction of ordinary music.*

thinks about the matter, it becomes clear that even a perfect loudspeaker, when connected to such a distorting amplifier, cannot reproduce the original sounds accurately. A poor speaker with a poor amplifier usually makes things just so much worse. That is why so many people say they wouldn't tolerate loudspeaking radio sets in their homes.

Radio Receivers Are Improving

Fortunately the trend of progress, in radio design and manufacture, is turning strongly toward improvement in tone reproduction. A number of last year's sets and speakers showed striking improvements in this direction; and the coming season will doubtless see greater numbers of outfits which are capable of giving true tones and natural speech.

Evidently a distorting audio-frequency amplifier is a bad thing.

What must an amplifier do, then, or what must it avoid doing, in order to give us the effects we desire?

Speaking generally, it should give the required magnification of current to produce the intensity of response desired, for currents of any frequency within the range that the human ear can hear. As the average person will recognize, as tones, any sound-wave whose frequency lies between the lower audible limit of 16 vibrations per second and the upper limit of about 16,000 per second, this is a very stiff requirement. Moreover, the magnification of each and every one of these frequencies of vibration should be uniform, for otherwise certain of them will be either accentuated or depressed and natural reproduction will be impossible.

An Adequate Frequency Range

As a matter of practice, we do not need to insist that our amplifier reproduces all frequencies from 16 to 16,000. Human speech does not cover nearly so wide a range; and the extreme frequencies have little use even in the finest music. The lowest note on the piano keyboard has 27 vibrations per second, and the highest, 4096 (on the scientific scale). You know how little either of these is used. The lowest "C" of the piano has 32 vibrations per second, and the "C" above that has 64. We should certainly try to reproduce frequencies of this order, if we expect to hear low tones naturally. The frequencies just quoted are the so-called fundamental frequencies of each of the notes; that is to say, the lowest frequencies they contain.

Most musical instruments produce tones that contain upper harmonic frequencies in addition to the fundamental. Thus a piano struck at its lowest "C" will give off a sound that is a mixture of 32, 64, 128 and some higher multiple or harmonic frequencies.

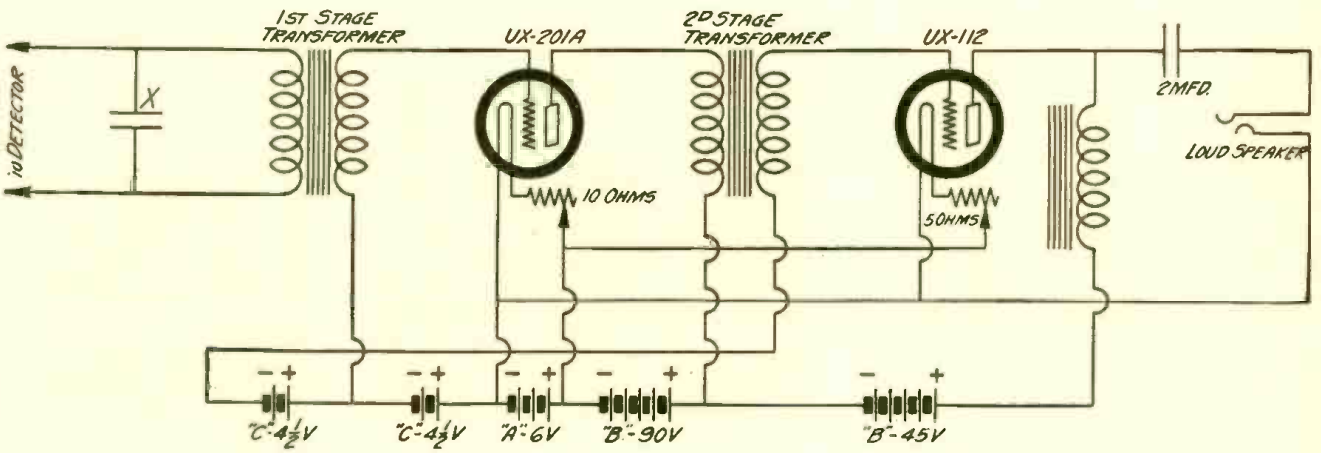
As a result of this fact our amplifier will give a response (though not a perfectly natural one) to the lowest notes even though it does not efficiently magnify vibration rates quite as low as those of the deepest fundamental tones.

At the other end of the piano scale we have an opposite condition.

Although the highest notes are not often used, those having frequencies up to 1500 or 2000 vibrations a second (the latter representing approximately the third "C" above "middle C") are quite common in musical compositions. Moreover, as we want natural reproduction that will give us not merely the pitch of the note but also its "tone color" that characterizes the particular instrument that is being played, we must get responses to the harmonic or multiple frequencies that run up to 3000 and 6000 vibrations per second.

It is the blending of these harmonic frequencies in various proportions that

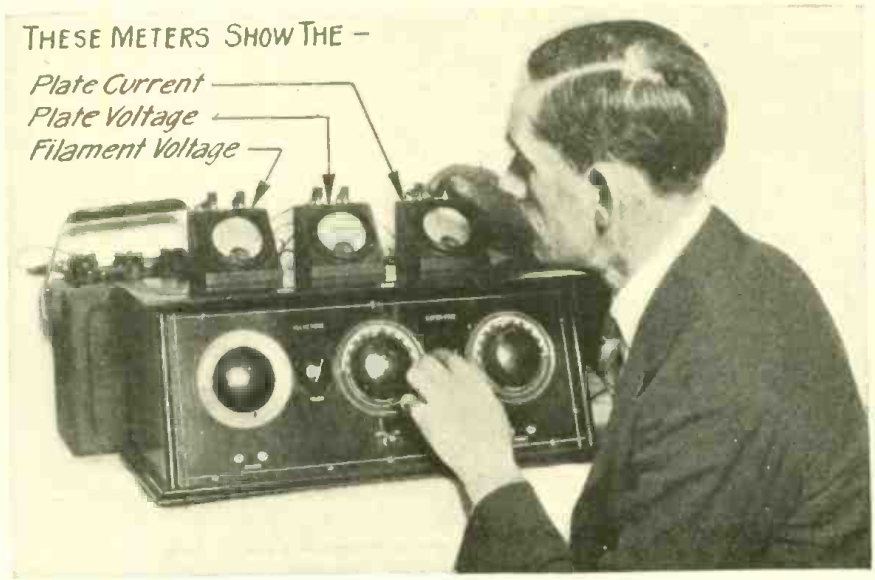
(*Continued on page 188*)



A GOOD AMPLIFIER CIRCUIT

FIGURE 4: *If excellent transformers are used for the first and second stages in this diagram, good reception should be obtained. Notice that two values of the "C" batteries are used and that an output filter is used to keep the direct current from the last tube. If the plate voltage of the last tube is raised higher than the values given, the "C" battery voltage should be increased accordingly.*

¶ *You wouldn't run your motor car without meters. Why run your radio set without them?*



Use Meters to Avoid Break-downs

Every radio fan whose set has suddenly ceased to work because of a run-down battery, a burned-out tube or other preventable disturbance that should have been anticipated, can profit from the practical advice in this article.

By DWIGHT BRADFORD HILL

"OF what use are meters on radio receiving sets?"

It is true that most of us have operated our sets fairly well without them. Is it necessary then that we should add such an expense to a piece of apparatus that is already more or less costly?

Yet who would think of operating an automobile without proper indicators for the oil, gasoline and mileage? Of course, this may be done but it would be an inconvenient and frequently an extravagant economy which might at best leave us stranded without fuel miles from a filling station, or, at the worst, result in a motor or transmission being burned out through lack of lubrication.

So your radio receiving set through lack of proper meters may sometimes be stranded hours from a charged battery, or may have a burned out set of tubes when you want to receive a program that is especially worth while.

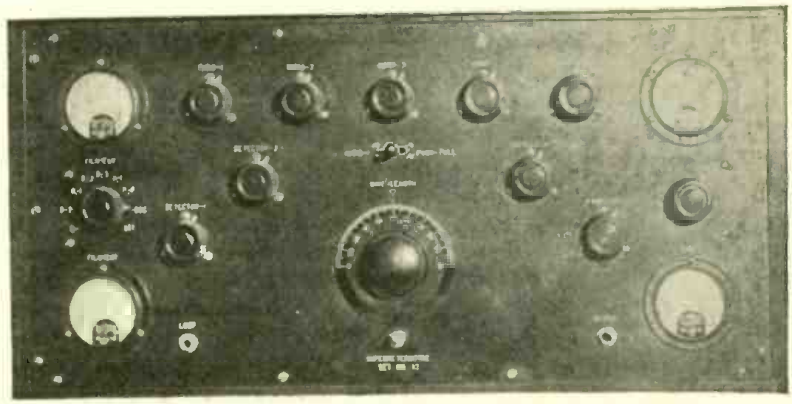
A complete set of meters installed on a radio receiving set gives a visual indication that the set is being operated so as to approach these conditions; and, if the warning is heeded, more satisfactory radio reception may be maintained over a far longer period of service than is otherwise possible. This extra and more satisfactory service is the secret of the economy of meters on any radio receiver.

The Most Important Meter— The Filament Voltmeter

The first and most important meter for the receiving set is the filament voltmeter.

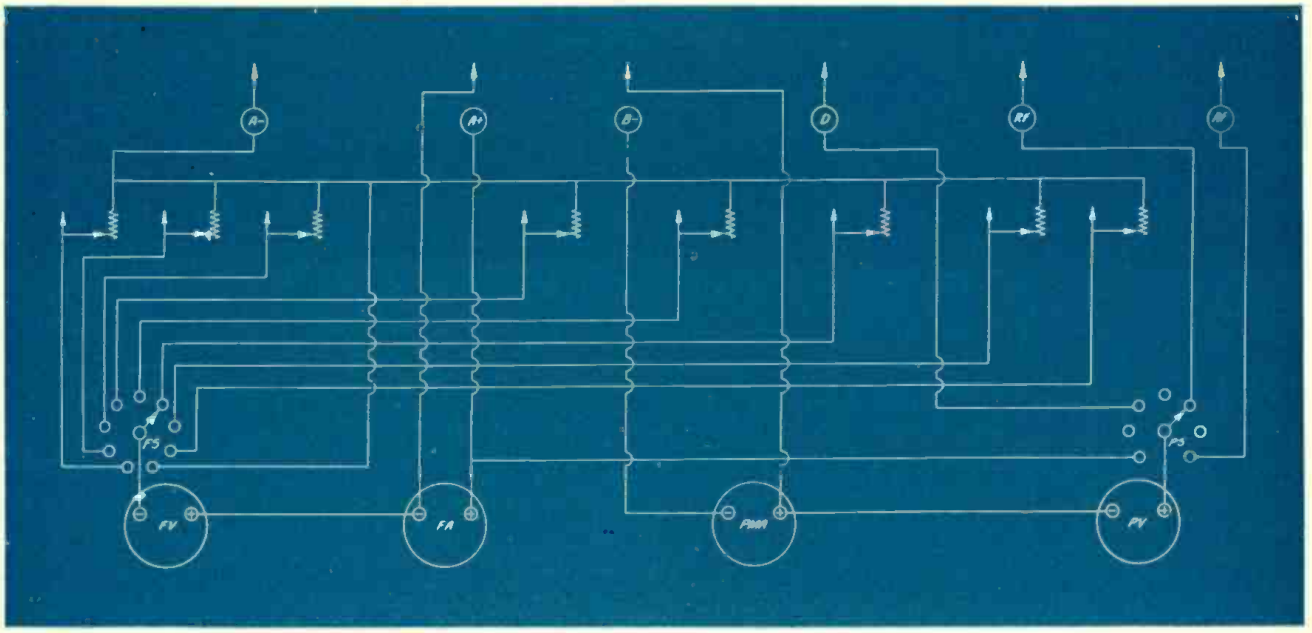
Whether you have a three-tube regenerative set that uses dry-cell tubes or a ten-tube superheterodyne that uses storage-battery tubes, a voltmeter will show the proper rheostat setting for the best and most economical operation.

It has been common practice to have an arrangement of holes in the panel through which the color of the lighted tubes might be observed. However, the



A SINGLE-CONTROL SUPERHETERODYNE WITH FOUR METERS INSTALLED

FIGURE 1: *As orderly in arrangement as the control board of a modern airplane is this layout of four meters on this special receiver. On the left is the filament meter assembly—the voltmeter and the ammeter; on the right is the plate meter assembly—the voltmeter and the milliammeter.*



HOW TO INCORPORATE THE METERS IN A SET

FIGURE 2: *The meter at the left, designated as FV, gives the voltage on the filaments of all the tubes. It is controlled by the switch, FS. The second meter, FA, is a filament ammeter and registers the current flowing through the filament circuits. The third meter, PMA, which is a milliammeter, registers the current flowing through the plate circuits of the tubes; and the last meter on the right, PV, registers the plate voltage of any tube by means of the switch, PS.*

most experienced eye is not accurate enough to judge filament voltage by the color of the filament.

There are two important reasons why this method is not satisfactory. In the first place, the apparent temperature of the filament seems to change with varying light conditions in the room. In a dark room a given filament brilliancy seems bright while, without change of setting, strong daylight makes it seem faint. The second objection to the holes in the panel is that dust and moisture may more readily enter the receiver and affect its operation.

With a reliable voltmeter mounted on the panel and a selector switch, having as many points as there are rheostats in the set, each tube or set of tubes may be accurately adjusted for filament voltage, so as to maintain efficient operation at all times. The necessity for observing the tube in operation no longer exists; and the cabinet may and should remain tightly closed.

The wiring diagram for the installation of the filament voltmeter and selector switch is given in Figure 2. The voltmeter is shown as FV and the switch as FS.

Why the Plate Voltmeter Is Important

The plate voltmeter should be considered as next in importance if you have "B" batteries, either dry or storage, which are not always reliable, or if you have a plate supply unit (so-called "B" Eliminator), working directly from the alternating-current lighting system, in which the possible output is in excess of 125 volts.

The reason for this is that excessive plate voltage has a detrimental effect upon filament life and other parts of the circuit as well.

When two dry-cell units of 45 volts each are used the question of a dangerous excess need not be thought of. The bad practice of adding a third unit to a doubtful two, however, may produce this condition.

Another point that makes this meter most important is that good quality and volume with any combination of circuits and tubes may be obtained only with the correct voltages on the plates of the tube. These values may be determined by trial; but as batteries lose voltage with use the voltmeter is needed to maintain, by frequent check, the correct plate potential. In the case of the storage "B" battery, it also gives an indication of the condition of charge.

This is a compromise, for radio-frequency circuits may not always function at their best when the voltage is suitable for the audio tubes. The reverse may also be true. This condition becomes more apparent when resistance-coupled audio-frequency amplification is used.

It is always better to use three "B" battery connections. They should be marked "Detector," "Radio," and "Audio." The plate voltmeter may then be used to determine the correct value for each. Frequent checks thereafter will then make it possible to maintain efficient operation of *both* circuits.

In connection with the plate voltmeter a selector switch with twice as many points as there are plate circuits, less one, should be used.

In the case of the properly constructed neutrodyne, for instance, there will be three plate circuits, marked "Detector," "Radio," and "Audio." There should then be twice three, or six, less one, that is to say, five points in the selector switch.

This leaves an idle point between two adjacent live points. This is necessary so as to prevent short-circuiting sections of the "B" battery when moving the switch. This condition is not possible with the "A" or filament selector switch since all tubes are run from the same battery tap and are at nearly the same operating voltage.

The wiring diagram for the installation of the plate voltmeter and selector switch is also given in Figure 2. The meter is shown as PV and the switch as PS.

The Use of the Plate Milliammeter

The next meter for the radio receiving set and one that rivals the plate voltmeter in importance is the plate milliammeter. This meter requires no special wiring for it is merely inserted in the negative "B" lead. The only precautions necessary are that the polarity as marked on the terminals of the meter be observed and that the meter be located so as to indicate plate-current flow for all of the tubes in the receiver.

This meter remains permanently in circuit as shown at PMA in Figure 2. This is not the case with the plate voltmeter which is cut into circuit from time to time as an indicator that the plate battery and circuit is functioning properly; and then, by placing the selector switch on an idle point, is cut out. The plate voltmeter is a drain on the "B" battery, which is equal to that of about four or five operating tubes, so that *its constant use is not advisable*. The plate milliammeter, however, does not consume any appreciable amount of battery energy, but merely indicates at all times the amount of current flowing in the plate circuits.

Many uses may be made of this information by observing any departure from the normal milliampere flow of plate current. A small leakage in the receiving set, which would otherwise escape notice, may be detected and useless battery discharge saved by prompt action.

Other Functions of this Meter

Another function of this meter is to check the aggregate tube action of the set. When the active material of the tube filaments begins to be exhausted the first indication is in a decreasing flow of current through the plate milliammeter. This, of course, assumes that the plate voltmeter shows a normal voltage application on all tubes.

The most important use for this meter, however, is to determine the proper grid-bias for the tubes. During reception the hand of the milliammeter connected in the plate circuit of the last tube should reach a position determined by various conditions of the set and remain there without fluctuation. If the hand dips, decreasing or increasing its reading on a strong signal, it means that amplification is being carried too far down the tube amplification curve with resultant distortion. In the second instance, we are working too far up the tube amplification curve and distortion is again present.

The proper section of the curve to use is its flat middle portion. When this has been found by making the proper "C" battery adjustments the hand of the milliammeter remains fixed during loud signals and produces strong undistorted amplification.

The Filament Ammeter as a "Fuel Indicator"

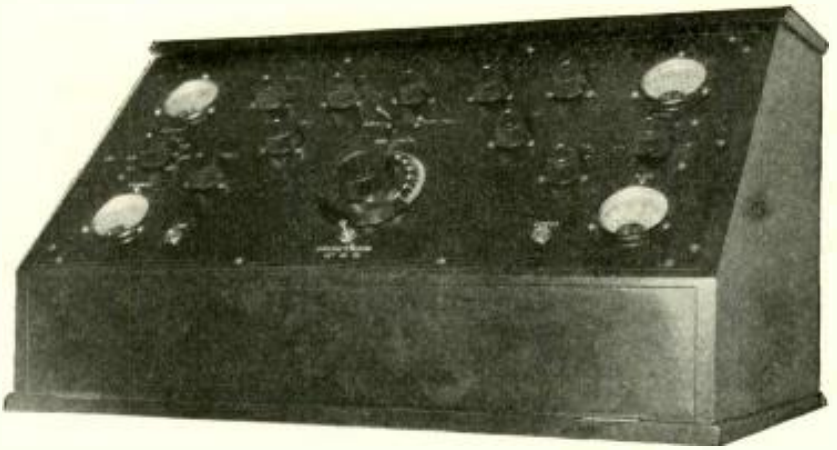
The fourth and last meter required for a completely-equipped, radio receiving set is the filament ammeter. This meter, while not so important as the other three, still has its uses. It gives a check on the filament battery consumption for all tubes and with a little practice becomes a "fuel indicator."

The ammeter like the milliammeter requires no special wiring but is merely inserted in one of the "A" battery leads. The polarity, as marked on the meter, must be observed.

The wiring diagram for the installation of the filament ammeter is also given in Figure 2. The meter is shown as FA.

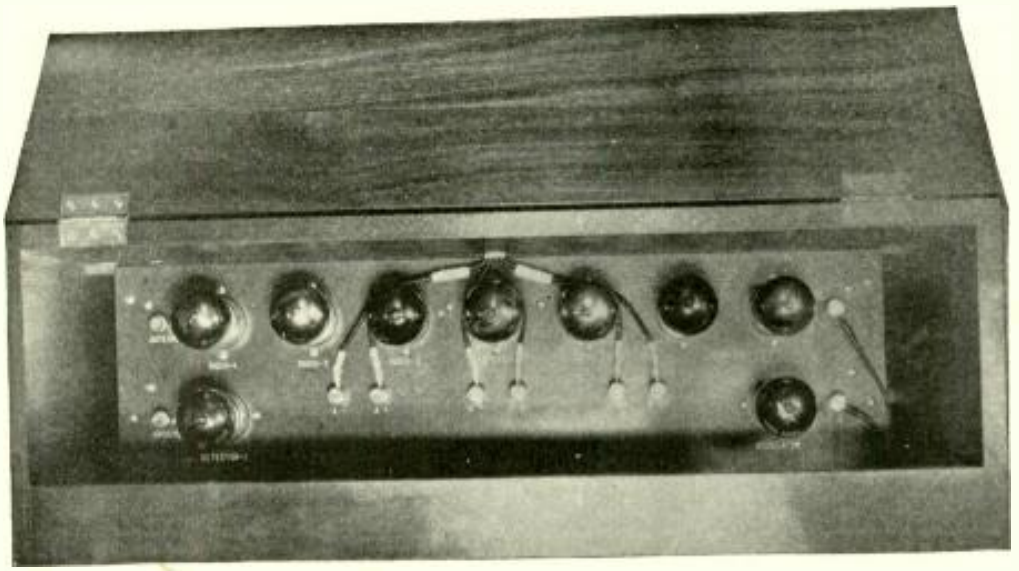
In explanation of the peculiarities of this hook-up, as shown in Figure 2, a description of the set from which it is taken will be of assistance. The set has been in constant operation for nearly a year, so that it cannot be called merely an experimental one. It is a nine-tube superheterodyne, using standard, storage-battery tubes throughout. It has a first detector, three stages of intermediate frequency amplification, a second detector, a stage of resistance-coupled, audio amplification, a stage of push-pull amplification, and an oscillator. All tubes have individual rheostats except the two push-pull tubes, which operate on the same rheostat control.

(*Continued on page 164*)



THE COMPLETE RECEIVER IN ITS CABINET

FIGURE 3: *This is the superheterodyne receiver, the panel of which is shown in Figure 1.*



THE NEAT TUBE LAYOUT OF THE RECEIVER

FIGURE 4: *A view of the nine tubes in the receiver as seen from the top. Notice that the binding posts are all attached in accessible positions without any complication in the wiring.*

F. M. Delano

ETHER WAVES THAT DISPEL NIGHTMARES

The mind of the patient who is upset by the shock of illness or accident tends to sleeplessness, which in turn leads to nervous disorders that create actual toxic poisons. In the treatment of such cases radio may play an important part.

Rebuilding Bodies by Radio

The significant effect of broadcast reception upon the subconscious mind, particularly of a patient who is afflicted with nervous disorders, as viewed by the distinguished head of the great 3rd London General Hospital of London.

SIR BRUCE BRUCE-PORTER, K.B.E., C.M.G., M.D.

WE are all of us possessed of two kinds of minds—the thinking, or conscious, and the automatic subconscious.

These two parts of a mind are to be found in every normal human being or higher type animal.

The conscious mind is that with which we direct to the best of our ability our actions, our ideas, and in fact our lives. With this conscious mind we do our mathematical calculations, arrive at decisions, develop our theories, and control our actions so as to bring about certain desired results.

The subconscious mind, on the other hand, seems to be more for the primary registration of sensory impressions and for the control of those many reflex (involuntary) actions which cause us to take our hands away from a hot stove which we have touched, even before we know whether we are burned or not, automatically to dodge when we hear a bullet fly overhead, though the missile is past by the time we have made this involuntary motion. The subconscious mind will register sounds for us, when we are so absorbed in a book that we are taking no notice of our surroundings; and, if the sound persist, it is often capable of breaking into our consciousness and disturbing our reading.

Why the Subconscious Mind Causes Nightmares

It is this subconscious mind that seems to be the cause of our nightmares, too. It is one reason why patients in hospitals are apt to dream a great deal, at a time when they should be enjoying a complete and unbroken sleep. As most of the patients who come into a hospital are suffering from shock, through the effect that accident, operation, or illness has had on their minds, these subconscious thoughts turn into fear-inspiring nightmares. The patient is wide awake, startled, and mentally upset—perhaps unable to get back to sleep, if he is in a very nervous condition. This counts against his rapid recovery, because it increases his irritability, creates nervous disorders, and thus causes actual toxic poisons formed by these sharp emotions to be passed into the system.

The wounded soldiers coming back from the war showed this to a great degree. They had left fields of battle, inconceivable uproar of guns and bombs, mind-shattering nervous strain and tension. Their minds were filled with all the conditions of the battlefields, and they came straight to a hospital ward, where they were surrounded by other war-wounded patients who had had no chance to acquire any of the calmer ideas that a clear view of the normal surroundings would have produced. Whenever, for example, they were awakened by the sound of a motorcycle roaring through the streets, they immediately thought they were up at the front

undergoing another dose of machine-gun fire. Their subconscious minds leaped out and tricked them into spending wakeful, unhappy hours, because there was no "background" save of horror.

The Effect of Music on Disordered Minds

The essential thing, then, was to replace these terrifying "sound memories" by more soothing ones. Music was found, of course, to be the most soothing of all, and the gramophone was of great assistance in supplanting the roar of battle with the peaceful strains of waltzes or the exhilarating and stimulating notes of other music.

Now comes radio broadcasting, and a new chapter has been opened for the treatment of the sick and convalescent. For gramophones must be heard by all; and there may be some who do not like them—but cannot get away if confined to beds and so prove a source of what we are trying to avoid, i.e., irritation. With radio, headphones can be provided for those who wish to listen; but those who do not, are not obliged to hear anything which might grate on their nerves.

Radio can also supplant the increasing uproar of the city streets, to the average hospital patient. Where a steady stream of traffic, with consequent blowing of horns, screaming of brakes, and thunder of motors will gradually begin to wear on a sick person's nerves, he can put headphones on, and at one time muffle the outside troublesome sounds and replace them by soothing and interesting ones. He is bound to react to this by a relaxation of his whole nervous system and resultant rest which he would not be able otherwise to obtain.

F. M. Delano

DR. RADIO FILLS THE SUBCONSCIOUS MINDS OF CHILD PATIENTS

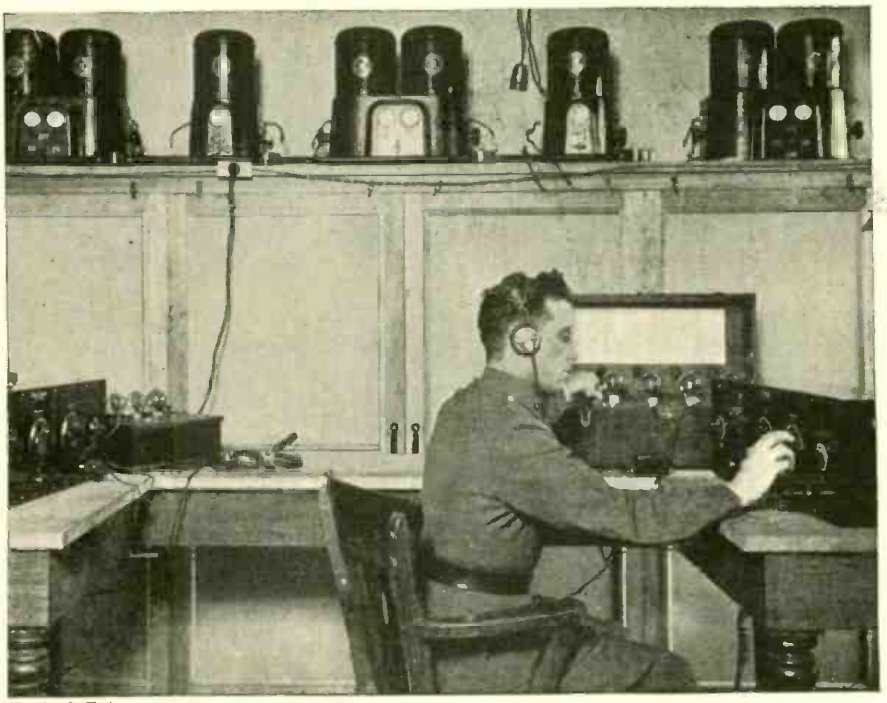
All patients are egotists, particularly children. Radio programs take them out of their self-centered condition and give them an outside interest. This picture was made in St. Mary Abbott's Hospital in London.

All patients are egoists. As Sir Richard Quain so aptly remarked, "You must learn that the wart upon milady's nose is far more important than the cancer in her neighbor." Sick people are always thinking of themselves. They have little chance to do otherwise, what with a group of would-be sympathetic (and actually a little idiotic) friends, who come to them with long faces and recount horrible tales of what *they* went through with this sort of operation, or what they heard about the frightful complications of someone else.

The Part Played by Radio on the Patient's Brain

A sick person in a hospital, who has a large amount of time with nothing to do, and without the energy to produce healthy thought, naturally dwells on the morbid. He is sorry for himself, and feels so completely out of the world that he builds this abused and sorry feeling up even higher, until ofttimes he gets into a state of depression which may retard him for an appreciable time in his recovery. If he be given healthy recreation, he has a chance to break away from this morbid introspection and take an interest in affairs. And here radio plays an all-important part.

Listening is actually far less tiring



Harris & Ewing

A DISPENSARY THAT DEALS IN PRESCRIPTIONS OF ENTERTAINMENTS

The Walter Reed Hospital for disabled veterans, located in Washington, D. C., is equipped throughout with headphones and loudspeakers. The sergeant in the radio room tunes in the programs for the patients, who need merely to adjust the headphones with which each bed is equipped.

than any other form of amusement. When a man listens, if the sounds soothe or bore him, he can drowse off to sleep. If they irritate him on a radio set he can turn off the set or take off the head-phones and put them away. If he tried to read he would be physically tired twice as fast; his eyes would hurt and off would go the nervous system again. With visitors he must exert even more effort. Radio, on the other hand, is not insulted if you do not answer back. Visitors are ofttimes tiring because of a lack of sympathy (of character, not of kindness); but a patient cannot tell them to go home. But with radio he can either change from one program to another; or he can shut it off entirely. He is taken out of his morbid condition until he is ready to sleep; and then he has a pleasant background of music or lectures to fill his subconscious mind when he is slightly roused by twinges of pain, so that he is much more apt to avoid nightmares.

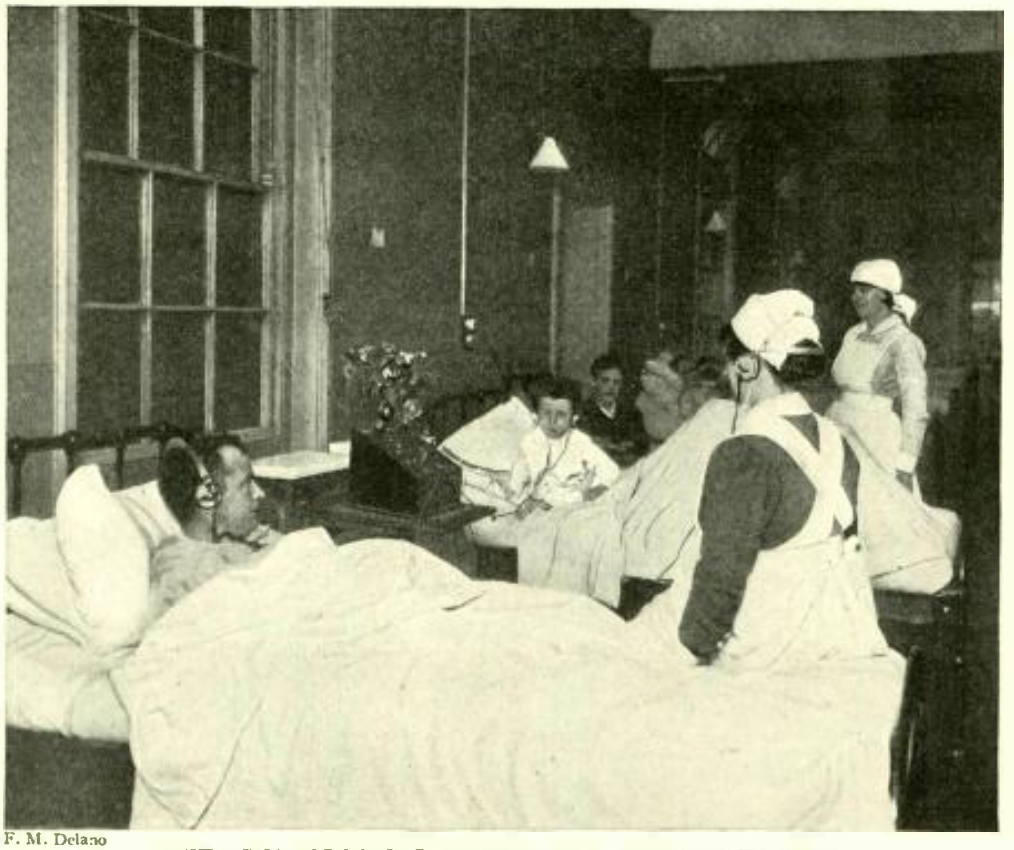
How Broadcast Programs Serve a Curative Purpose

One of my patients, an elderly woman, who has been bedridden for a long time, and will remain so for the rest of her days, was very depressed. I persuaded her to get a radio set with which she could bring in the London station, and some from the Continent. She said, after a short while, that "it brought her back into the world again." A gramophone was useless to her, because it always played the same tunes. The uncertainty of radio she found brought life to her, and as unpleasant things were never broadcast, she could spend her day listening in. It brought back the element of expectancy.

This indicates probably the greatest value that radio can have in the hospital or sick room. The patient is more or less completely segregated from the world and from all the life of the city. He sees a few friends, who tell him stories of things that have happened. He may hear a few familiar gramophone records. The actual human touch is missing. It is frankly mechanical, and it is therefore less inspiring. A human being needs the company of humans—society, in the larger sense—to get the greatest enjoyment out of things. Just as men rarely drink save when with other men, so they cannot get the full joy out of an orchestra piece which has been played long before by some people in a studio, and is now being brought out by a mechanical apparatus.

But let a patient listen in to the Savoy Orchestra, for example, with all the people in the great ballroom actually dancing. He can hear the exhilarating strains of the jazz, which he knows is being played by living people just at that moment. He hears the steady, rhythmic scrape of feet and he can realize that those are his fellow creatures dancing and enjoying themselves. (Even if we cannot dance, we often love to sit outside and look on.) And then he hears the music stop, and a great roar of applause. He hears the hum of voices, the movements of the orchestra—perhaps a couple pass close to the microphone and he catches a few phrases—"Jolly music, isn't it?" "Yes, awfully—I say, do you know that latest tango step—look—." The patient has ceased to be a poor cooped-up being in a hospital; he is for that moment living among gay faces, pretty women, beautiful clothes. He can picture himself there, among them, one of them—the picture, of course, of his own favorite dancing place being conjured into his mind. Radio, like some obedient genus, has for the time being taken him out of the hospital and brought him back into the life of the normal healthy

(*Continued on page 162*)



F. M. Delano

THE PSYCHOLOGICAL EFFECT OF A BROADCAST PROGRAM ON A PATIENT

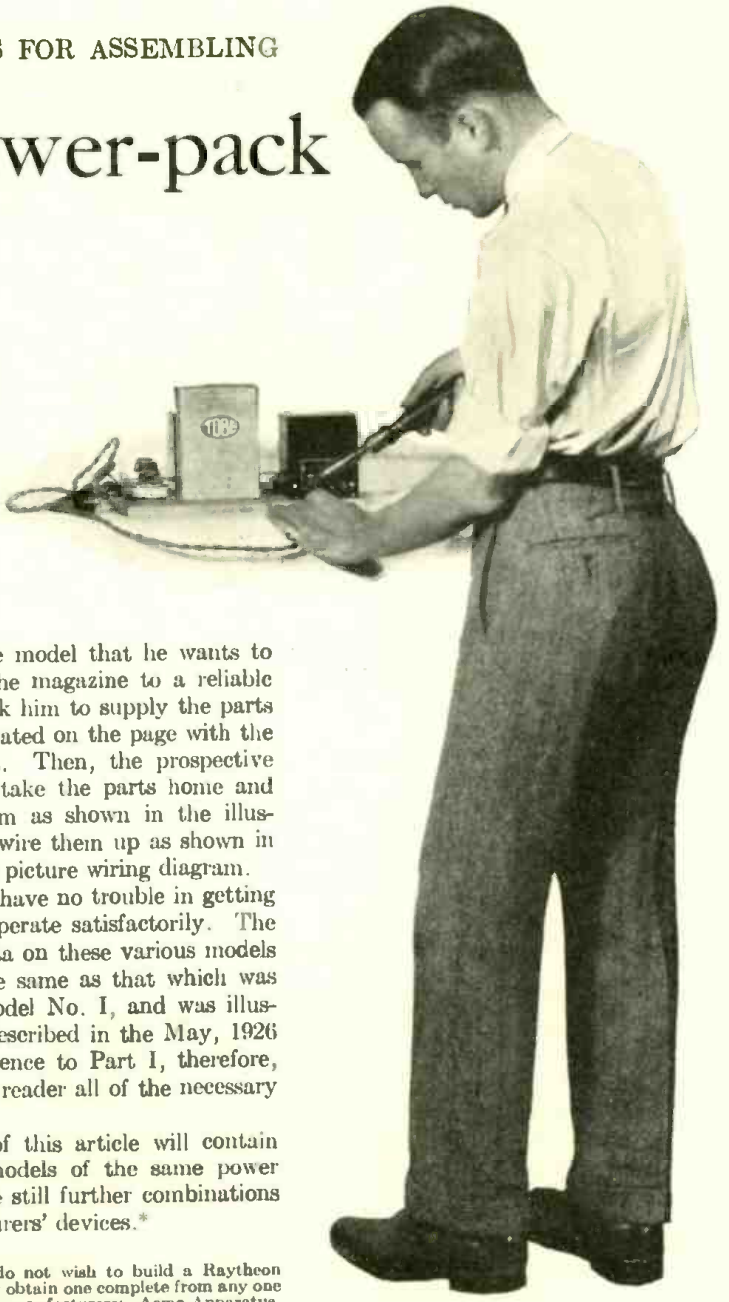
"The patient ceases to be a poor, cooped-up being in a hospital; he is for that moment living among gay faces, pretty women, beautiful clothes. He can picture himself in the midst of jovial surroundings which the radio program suggests."

FOUR NEW COMBINATIONS OF UNITS FOR ASSEMBLING

The Raytheon Power-pack

PART II

Have you your own favorite part that you want to use in it? This series of three articles gives nine combinations.



By LAURENCE M. COCKADAY

SOME readers of POPULAR RADIO who build the improved Power-pack may have a preference as to what manufacturer's products they would like to use.

In Part I of this article, which appeared in the May, 1926, issue of POPULAR RADIO were given the constructional details for Model No. I. In the present article four more models are offered for the discriminating radio experimenter.

In each of these models the same fundamental circuit diagram is used; but the various parts have been grouped in combinations that may make one or another of them more suitable for the reader's individual needs.

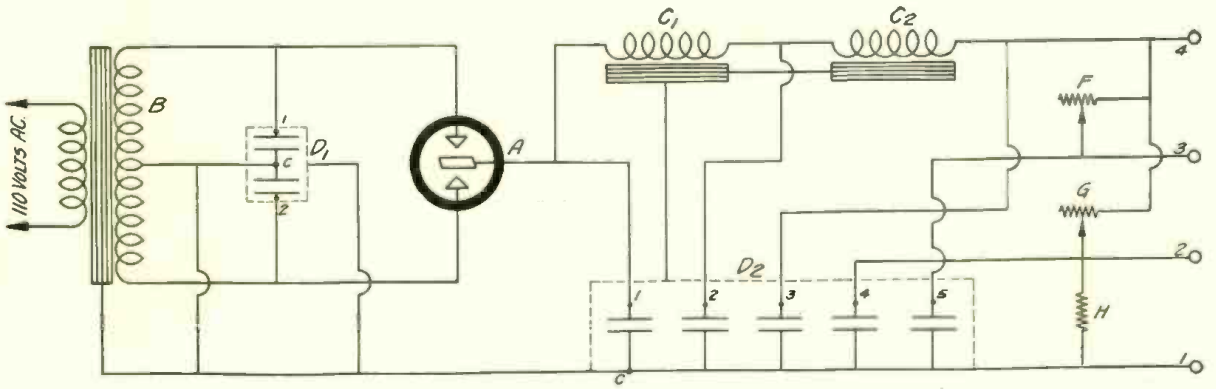
The following pages contain a layout picture of each of the models together with lists of the exact parts that were used in each one of them. The lower part of each page shows a blueprint diagram of the exact way in which to wire the set.

All that the experimenter need do, is decide on the model that he wants to build, take the magazine to a reliable dealer and ask him to supply the parts that are indicated on the page with the model layout. Then, the prospective builder may take the parts home and assemble them as shown in the illustrations and wire them up as shown in the blueprint picture wiring diagram.

He should have no trouble in getting his unit to operate satisfactorily. The operating data on these various models is exactly the same as that which was given for Model No. I, and was illustrated and described in the May, 1926 issue. Reference to Part I, therefore, will give the reader all of the necessary details.

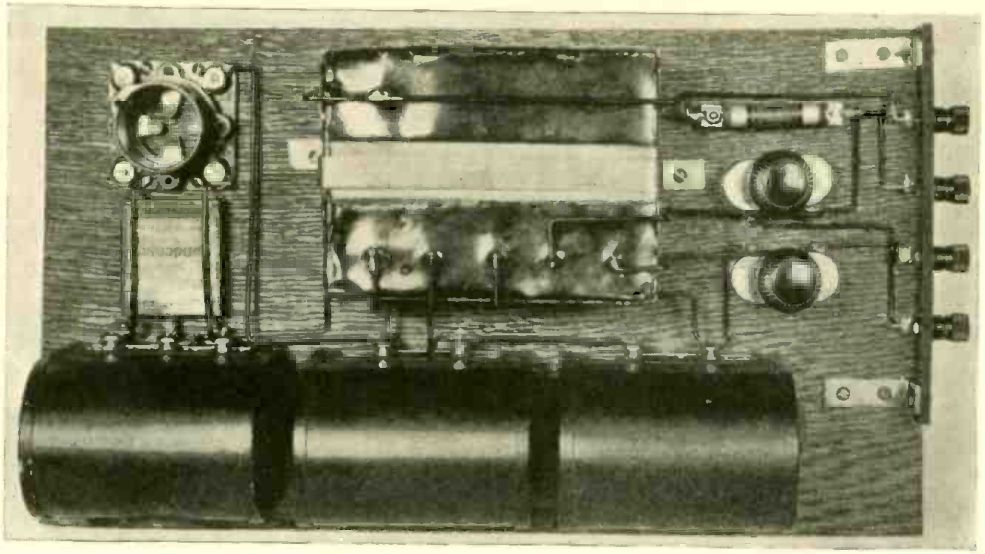
Part III of this article will contain four more models of the same power unit that use still further combinations of manufacturers' devices.*

*Those who do not wish to build a Raytheon Power-pack may obtain one complete from any one of the following manufacturers: Acme Apparatus, Webster Electric Co., All-American Radio Corp. and the Mayolian Co.



THE FUNDAMENTAL CIRCUIT DIAGRAM OF THE RAYTHEON UNIT

All of the various models of the improved Raytheon Power-pack that are described in the pages of POPULAR RADIO *employ the circuit that is shown above. The characteristics of the various models are therefore due to the special characteristics of the parts which are used.*



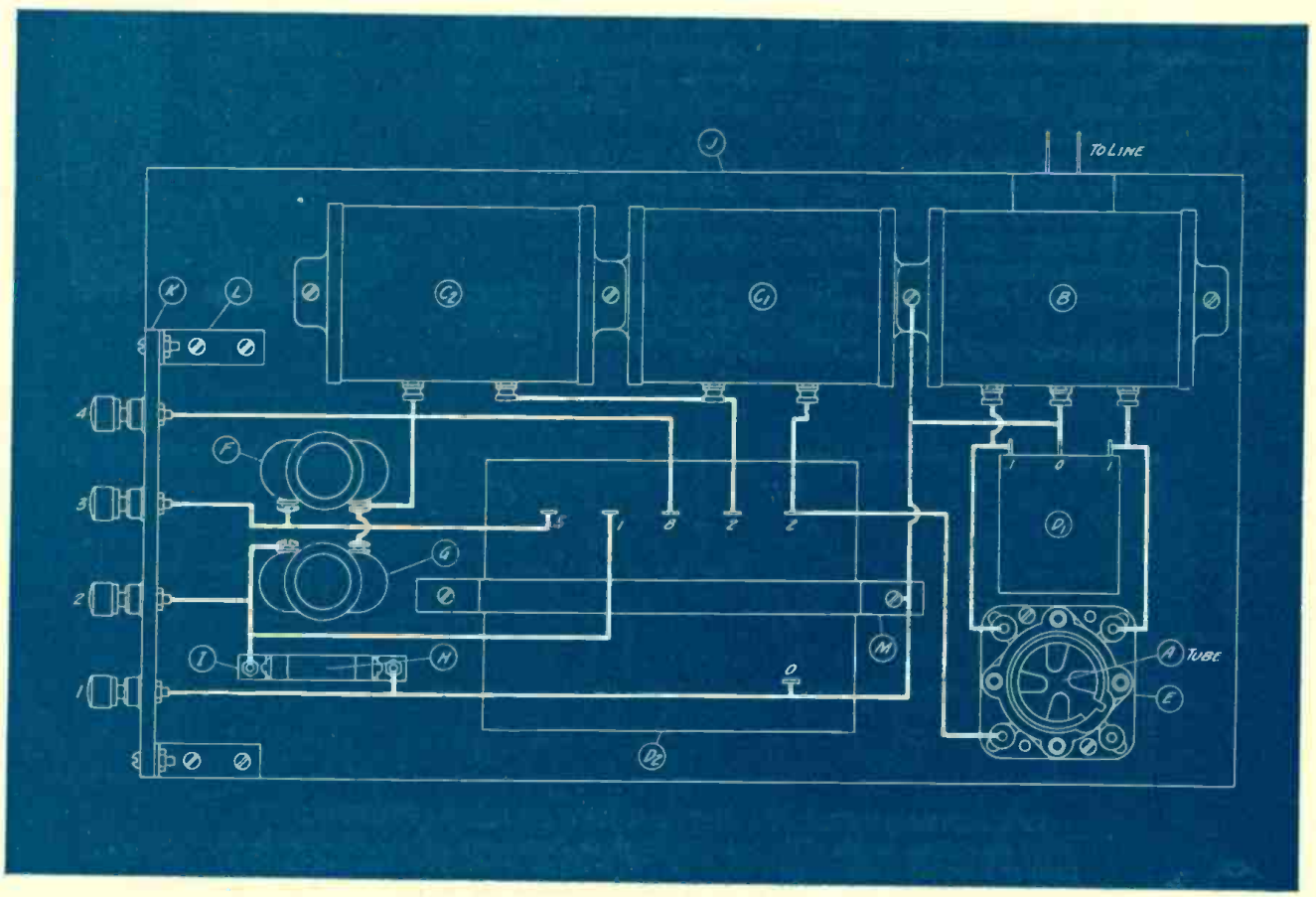
A High-Voltage Model of the Power-pack

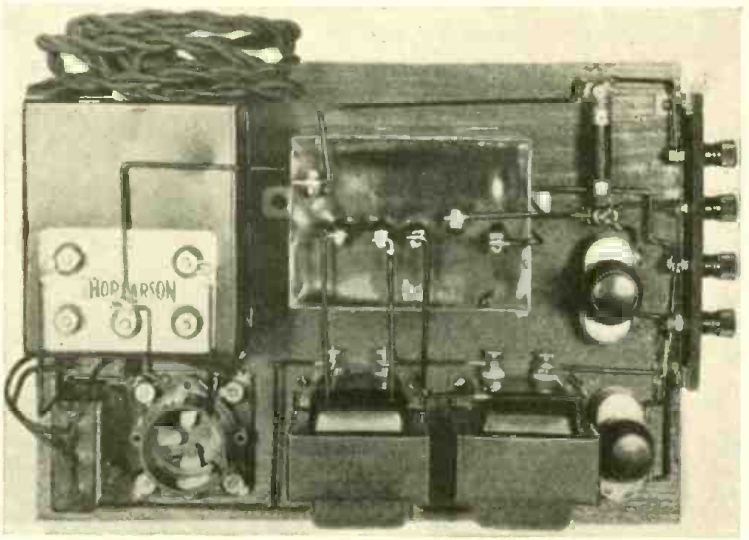
The particularly high-voltage characteristics of this model of the improved Raytheon Power-pack will appeal to many readers who wish to build this unit. It is slightly larger than several of the other models; but it is set upon a long, narrow baseboard that will help it to fit easily into many cabinets.

HERE IS A LIST OF THE PARTS THAT WERE USED IN THE LABORATORY MODEL OF THIS UNIT—

A—Raytheon tube;
B—All American step-up transformer;
C1 and C2—All American chokes;
D1 and D2—Potter condenser units for Raytheon circuit;
E—Benjamin standard tube socket (old style);
F—Bradleyohm, No. 10;
G—Bradleyohm, No. 25;
H—Bradleyunit, 7500 ohms;
I—Electrad grid-leak mounting;
J—wooden baseboard;
K—binding-post strip;
L—brass brackets;
4 Eby binding posts.

Note: This unit was referred to in Part I as Model II.





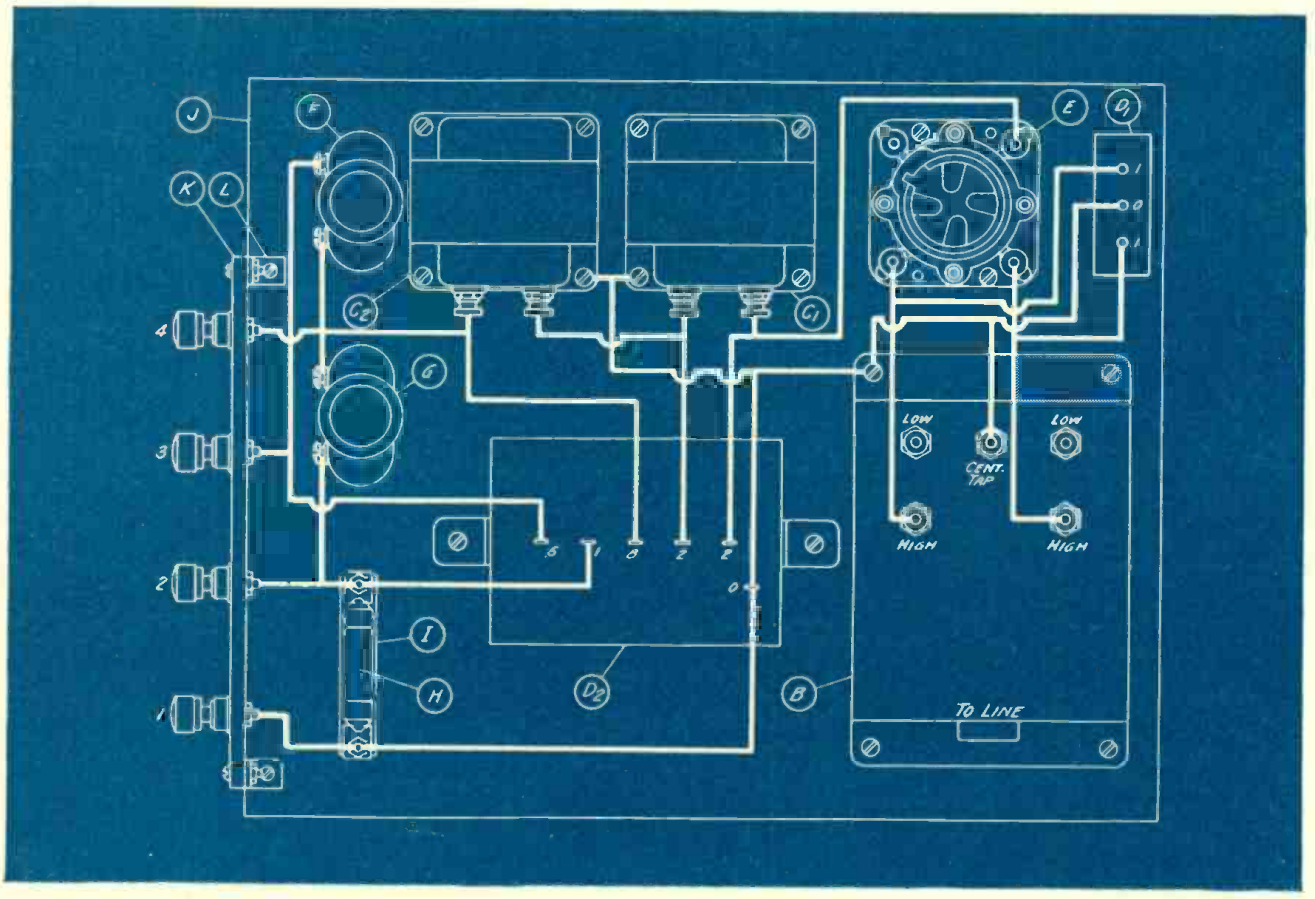
A Compact Power-pack for Small Cabinets

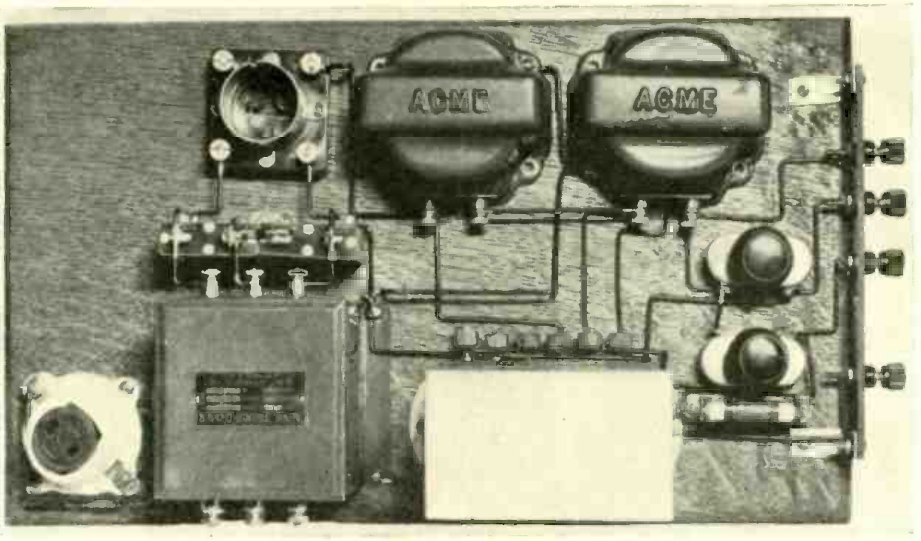
Builders of the improved Raytheon Power-pack who have a limited amount of cabinet space at their disposal will find this model of the unit particularly suited to their needs.

HERE IS A LIST OF THE PARTS THAT WERE USED IN THE LABORATORY MODEL OF THIS UNIT—

A—Raytheon tube;
B—Thordarson step-up transformer;
C1 and C2—Thordarson chokes;
D1 and D2—Dubilier filter condensers for Raytheon circuit;
E—Benjamin standard tube socket (old style);
F—Bradleyohm, No. 10;
G—Bradleyohm, No. 25;
H—Bradleyunit, 7500 ohms;
I—Electrad grid-leak mounting;
J—wooden baseboard;
K—binding-post strip;
L—brass brackets;
4 Eby binding posts.

Note: This unit was referred to in Part I as Model IV.





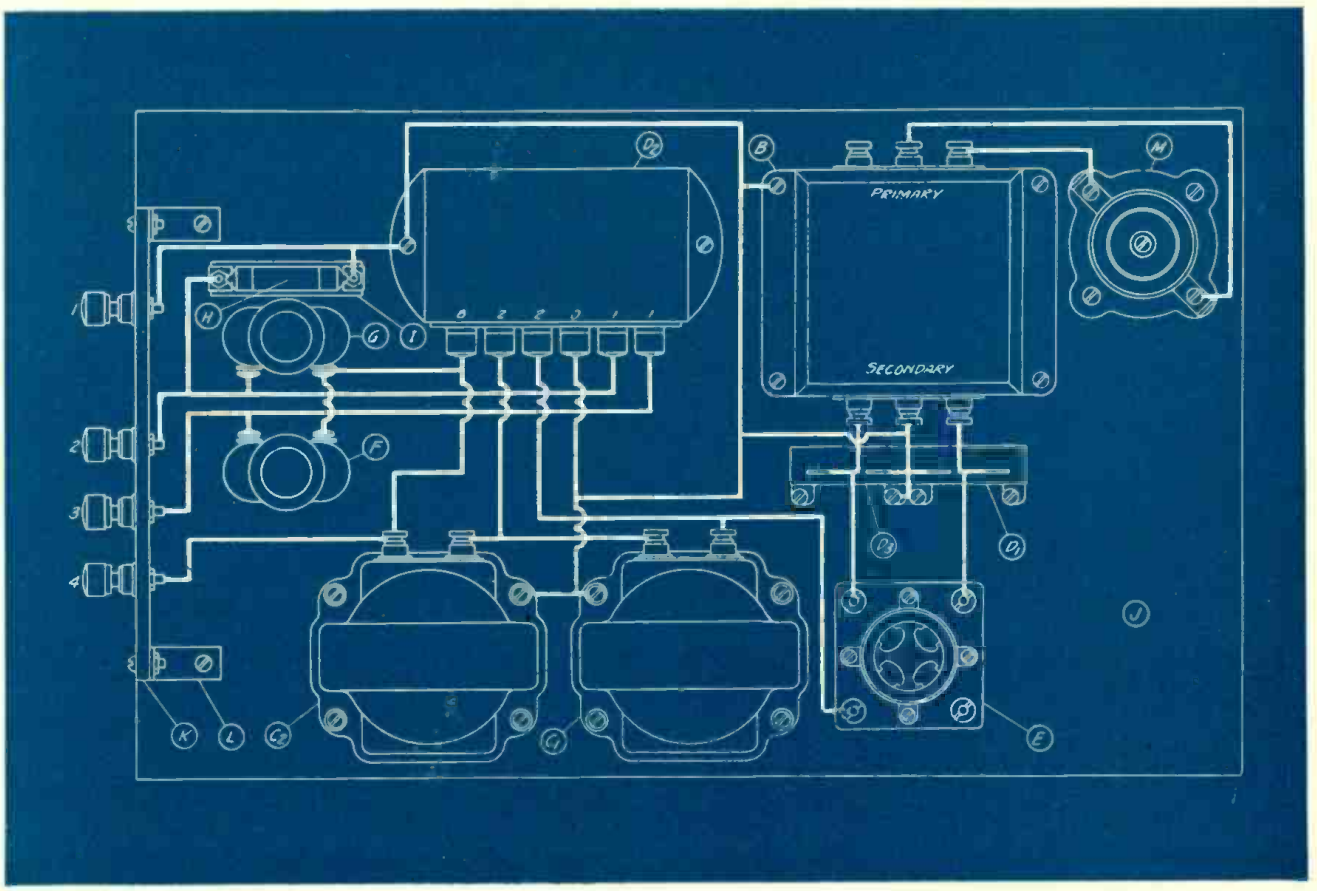
A Model Built from the Original Raytheon Parts

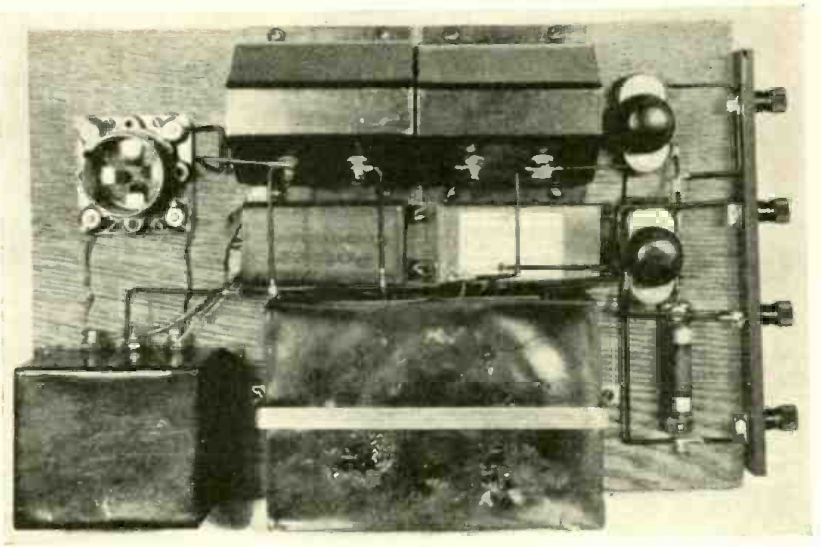
This model of the improved Raytheon Power-pack was designed to enable the builders of the original Raytheon unit (as described in the November, 1925, issue of POPULAR RADIO, *to convert these units into the new type with as little additional expense as possible.*

HERE IS A LIST OF THE PARTS THAT WERE USED IN THE LABORATORY MODEL OF THIS UNIT—

A—Raytheon tube;
B—Acme step-up transformer;
C1 and C2—Acme chokes;
D1, D2 and D3—Tobe filter condenser units for Raytheon circuit;
E—Federal socket;
F—Bradleyohm, No. 10;
G—Bradleyohm, No. 25;
H—Bradleyunit, 7500 ohms;
I—Electrad grid-leak mounting;
J—wooden baseboard;
K—binding-post strip;
L—brass brackets;
M—Benjamin porcelain socket fixture;
4 Eby binding posts.

Note: This unit was referred to in Part I as Model V.





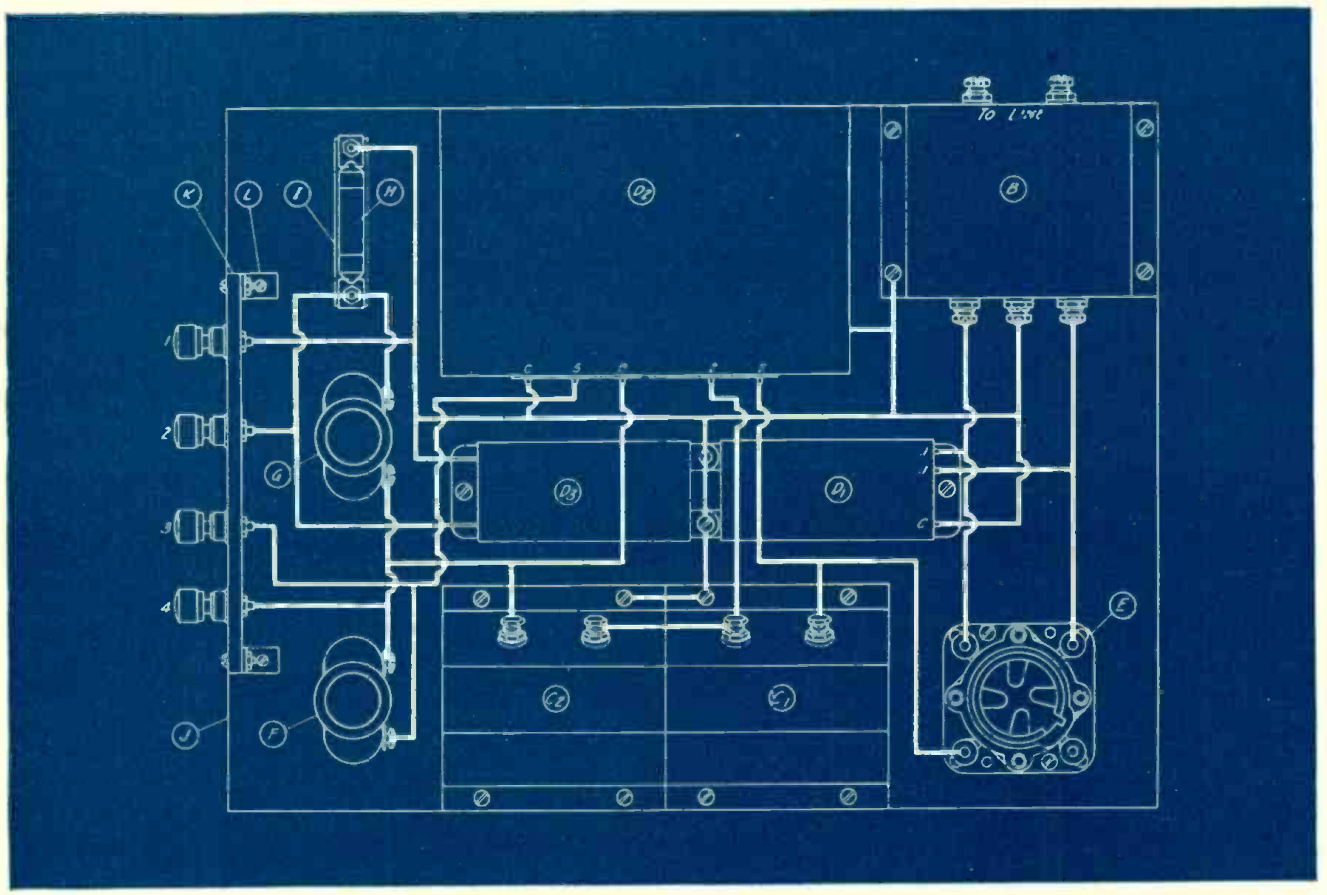
A Compact and Efficient Raytheon Unit

This efficient model of the improved Raytheon Power-pack is compactly set upon a baseboard that is nearly square in its dimensions. It has slightly lower voltage characteristics than the models previously mentioned, but this does not in any way interfere with its efficiency.

HERE IS A LIST OF THE PARTS THAT WERE USED IN THE LABORATORY MODEL OF THIS UNIT—

A—Raytheon tube;
B—Precise step-up transformer;
C1 and C2—Precise chokes;
D1, D2 and D3—Potter filter condenser units for Raytheon circuit;
E—Benjamin standard tube socket (old style);
F—Bradleyohm, No. 10;
G—Bradleyohm, No. 25;
H—Bradleyunit, 7500 ohms;
I—Electrad grid-leak mounting;
J—wooden baseboard;
K—binding-post strip;
L—brass brackets;
4 Eby binding posts.

Note: This unit was referred to in Part I as Model VI.



IN THE WORLD'S LABORATORIES

CONDUCTED BY DR. E. E. FREE

What Sounds Can You Identify?

OUR London contemporary, *Popular Wireless*, staged recently one of the most interesting and novel radio contests which has come to light for a long time. A series of twenty sounds, all more or less familiar, was selected. These were then broadcast, every attention being given to having the sounds absolutely correct; but no spoken clue (or only very indirect clues) were given as to what the sounds really were. Listeners were asked to send in their identifications of the different sounds. It was believed, as actually proved to be the case, that the information obtained might be of help to the British Broadcasting Company in putting on their radio plays.

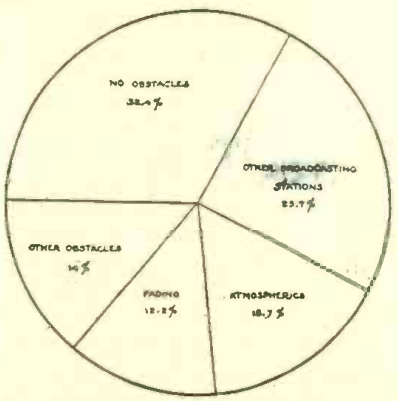
The results of the tests are now briefly described by the Editor of that publication.* Some of them are surprising. For example, one of the sounds that was very poorly identified was the sound of a kiss. Can it be that British radio fans are not listening when kissing is being done? The firing of a gun and the flight of a shell were poorly recognized, also, although there must have been many ex-artillerymen in the radio audience. The sounds incidental to laying a table for seven people were much missed, also, as was the sound of a mouse caught in a trap. On the other hand, the crackling sound of a wood fire, which was not expected to "get over" well, was identified correctly by a large proportion of the listeners. More usual and characteristic sounds, such as that of an elevator, that of a turnstile, that of a telephone pay station, that of tearing calico, that of a cash register, that of stropping a razor, that of hammering a nail in the wall and that of a sewing machine, were very well identified.

On the whole the sound-identifying power of the British radio public seems to have shown up very well. Doubtless before this item can be printed, some enterprising broadcaster will have repeated the novelty in the United States. To him we would offer one suggestion. It is that an effort be made to determine the particular frequencies in each sound which render it possible of identification. In the case of the kiss, for example, it is quite probable that the essential sound is of relatively low frequency (no humor intended) and that it did not get through the receiver circuits of most of the listeners, if, indeed, it survived the modulating apparatus of the transmitter.

*"The Radio Sounds Competition," by The Editor. *Popular Wireless* (London), vol. 8, pages 953-954 (December 19, 1925).

What Obstacles Most Impede Broadcasting Reception?

MOST radio enthusiasts will remember that in 1922 and 1923 the United States Bureau of Standards organized a group of cooperating observers who kept records of the reception of Station KDKA, at Pittsburgh, for a long series of nights, recording the character of the reception and the chief causes of interference. Several preliminary notes of the results have been issued from time to time by the Bureau. The full report has now appeared.*



RADIO INTERFERENCE

This chart shows the percentages of different causes of interference to good radio reception, as indicated by the tests of the United States Bureau of Standards in 1923. It is probable that the results of a test now would indicate a much lower percentage of interference from other broadcasting stations and a higher percentage of good reception.

The most interesting feature of the statistics, now reported, as the analysis of the obstacles encountered in hearing KDKA between August 1, 1922, and July 31, 1923. A total of 7,372 observations is taken into account. Practically one-third of the observations (32-4 per cent) report no obstacle to reception. Of the remainder, the largest single cause of bad reception was interference from other broadcasting stations. The total so included equalled 25.7 per cent of the observations. Atmospherics were responsible for bad reception in 15.7 per cent of the observations, and fading, in 12.2 per cent.

It may be doubted, of course, whether a renewed test at present would show equivalent results. The average receiver is now more selective and broadcasting stations are probably operated more competently. Probably the percentage of "other station" difficulty would now be less.

*"A Statistical Study of Conditions Affecting the Distance Range of Radio Broadcasting Stations," by C. M. Jansky, Jr. Technologic Paper No. 297 of the Bureau of Standards; being Vol. 19, pages 641-650 (dated October 8, 1925.)

The Roof of the Earth

THE discussion, which was so active two years ago, concerning the reality of the Heaviside Layer and its part in long-distance radio transmission is gradually being decided, by preponderance of evidence, in favor both of the existence and the effectiveness of this Layer.*

The evidence in favor of this conclusion comes from two quite different lines of research. One is the study of the transmission and reception of the short waves, especially the examination of the "skip-distance" effect.† The other is the increasing number of measurements that indicate that radio waves arriving at a distant station actually do come downward from the upper air toward the receiver, instead of horizontally along the surface of the ground.§

Simultaneously, the investigation of the upper atmosphere by methods not in-

*For an account of the modern form of the Heaviside Layer theory (frequently called the Eccles-Larmor theory), together with references to the earlier discussions see: "How the Air Affects Radio," POPULAR RADIO for September, 1925, pages 199-206.

†See, for example, the work of Drs. Taylor and Hurlburt, of the Naval Research Laboratory; POPULAR RADIO for January, 1926, pages 61-63.

§The work of Dr. Smith-Rose and Mr. Barfield on this problem was described in POPULAR RADIO for September, 1925, pages 281-283 and for February, 1926, page 169. A further report was made by them to the Royal Society, London, on February 18, 1926, and is reported briefly in *Nature* (London), volume 117, page 325 (February 27, 1926). A still more cogent investigation, resulting in a similar conclusion, was made last year by Professor E. V. Appleton and Mr. M. A. F. Barnett and is reported in "Some Direct Evidence for Downward Atmospheric Reflection of Electric Rays," by Appleton and Barnett. *Proceedings of the Royal Society of London*, series A, volume 109, pages 621-641 (December, 1925).

volving radio at all is telling us much about what the Heaviside region is really like. At a recent special meeting of the Royal Society, in London, these matters were discussed by an exceptional gathering of experts, including such distinguished radio engineers as Sir Henry Jackson, Dr. W. H. Eccles, Professor E. V. Appleton and Dr. R. L. Smith-Rose.§§

Sir Henry Jackson contributed to the discussion an account of recent experiments with transmission on a wavelength of 12 meters from a ship at sea to a receiving station in England. Reception was good within a 100-mile distance, probably by means of the near-by ground wave. Thereafter, transmissions were received when the distance was of 1,100 miles, 3,000 miles and 6,000 miles, but not at intermediate positions. These facts are clearly in accord with the previous observations of the skip-distance effect and with the theory of double reflection between the earth's surface and the Heaviside Layer as elaborated by Taylor and Hurlburt in the article referred to above.

Prof. Appleton and Dr. Smith-Rose described their respective experiments in detecting down-coming waves. The latter gentleman announced some calculations, based on the angle of inclination of the received wave, indicating a height of about 88 kilometers (55 miles) for the lower surface of the reflecting layer. This is in good agreement with the height of 50 miles estimated last fall by Breit and Tuve from the time difference in the arrival of direct and reflected waves sent between two stations 7 miles apart near Washington, D. C.*

Of the non-radio contributions to the London discussion the most interesting to the radio engineer was a summary, by Professor Sydney Chapman, of what is now believed to be the physical constitution of the atmosphere in the Heaviside region. Aside from the use of radio waves, there are three ways to obtain such physical data. First, is the use of sounding balloons, which are thin rubber balloons a foot or two in diameter, filled with hydrogen and carrying instruments which will record atmospheric density, temperature and the like. Such balloons have risen to

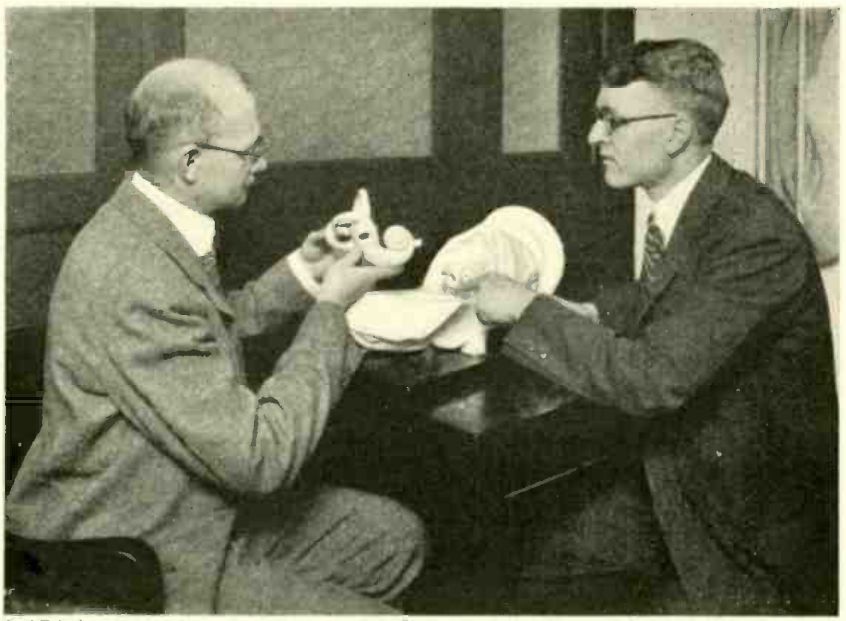
Underwood & Underwood

ONE WAY TO EXPLORE THE UPPER AIR

Instruments arranged to record air pressure, electrification and other characters of the atmosphere important to radio are attached to a small hydrogen-filled balloon which is then released. The cage around the instruments prevents injury to them when the balloon returns to earth. This cage bears a tag asking the finder to notify the proper scientific authority. Balloons like this have risen nearly twenty miles.

§§The meeting is reported in *Nature* (London), volume 117, pages 385-386 (March 13, 1926).

*"A Radio Method of Estimating the Height of the Conducting Layer," by G. Breit and M. A. Tuve. *Nature* (London), volume 116, page 357 (September 5, 1925). The experiments were with 71-meter waves. Other experiments with 600-meter waves and a distance of 100 to 150 miles gave no indication of reflection. It has recently been pointed out, however, by Captain Eckersley, that this negative result is to be expected from the best available theory of the nature of the Heaviside Layer. It constitutes, therefore, a confirmation of the theory and of the estimated height of about 50 miles for the under surface of the Layer. See "The Constitution of the Heaviside Layer," by T. L. Eckersley. *Nature* (London), volume 117, pages 380-381 (March 13, 1926).



Bell Telephone Laboratories

A MECHANISM WHICH RADIO HELPS

Mr. Paul B. Findley, at the left, is holding a model of the inner part of the human ear. The coiled spiral on the right of this model contains the nerves of hearing. The part of the model on the table shows the remainder of the ear. Dr. Harvey Fletcher is pointing to the chain of three small bones which transmit the sounds and which it is claimed that radio practice sometimes helps to loosen and improve.

heights of approximately twenty miles. From the records thus obtained certain inferences can be made as to conditions at still higher levels.

The second source of information about the high atmosphere is the observation of meteors or shooting-stars. By careful study of all the data available, Dr. F. A. Lindemann and Dr. G. B. Dobson concluded, three years ago, that the upper atmosphere is much warmer and much denser than had previously been imagined.* Its temperature came out as perhaps as high as 80 degrees, Fahrenheit, quite comparable with the temperature on the earth's surface. This surprising conclusion was explained by Lindemann and Dobson as due to the presence of a high proportion of ozone in the upper air and to the absorption of heat rays by this gas.

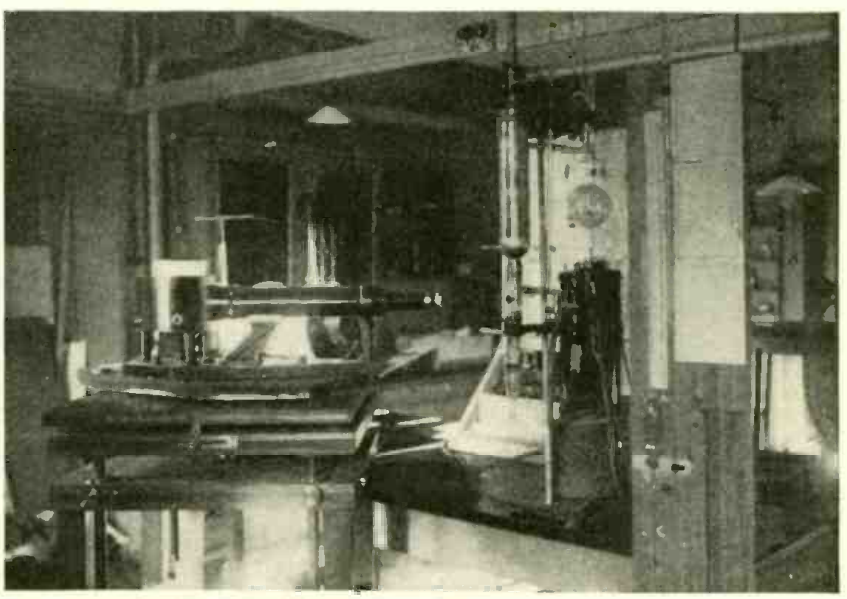
The third source of information about the upper air is the aurora. Observations on it do not agree with the conclusions of high temperature and relatively high density reached by Lindemann and Dobson. On the contrary, Professor Lars Vegard, of Oslo University, Norway, who is the outstanding student of the nature of the aurora, has concluded that the chief constituent of the atmosphere at the height where the aurora occurs is a solid dust of nitrogen, this gas being frozen to tiny crystals by the intense cold which there prevails.† Possibly the reconciliation of the ideas of Dr. Vegard with those of Drs. Lindemann and Dobson may lie in consideration of height. It is possible that at one level the atmosphere is really composed of relative warm ozone, while at a higher level it consists of frozen nitrogen dust. If so, the lower, warm-ozone level is probably the one which includes the Heaviside Layer.

Assuming the idea of a warm layer at the height indicated for the Heaviside region, Professor Chapman calculated a pressure, at 100 kilometers (62 miles), of about one one-hundred-thousandth of that at the earth's surface. The distance traveled by the average gas atom between collisions with other atoms increases from a tiny fraction of a millimeter at the earth's surface to approximately 3 centimeters (over an inch) at the 62-mile height. It is this long path of the atoms, plus the high degree of ionization and electrification, which give to the Heaviside region the conducting properties which are so important in radio.

The investigation of the upper atmosphere is a striking instance of the way in which radio investigations and the studies of other branches of science reinforce each other. As the study of meteors and of the aurora yields more facts about the upper air these facts assist the formulation of a theory of radio transmission. On the other hand, radio data, such as that reported by Drs. Taylor and Hurlburt, by Dr. Breit and Mr. Tuve and by Sir Henry Jackson, promise to provide the atmospheric physicists with much invaluable information.

*"A Theory of Meteors and the Density and Temperature of the Outer Atmosphere to which it Leads," by F. A. Lindemann and G. B. Dobson. *Proceedings of the Royal Society of London*, series A, volume 102, pages 411-421 (1923). The best general account of meteors, including how they can help us learn about the upper air, is "Meteors," by Charles P. Olivier, 276 pages, published 1925, by The Williams and Wilkins Company, Baltimore, Md.

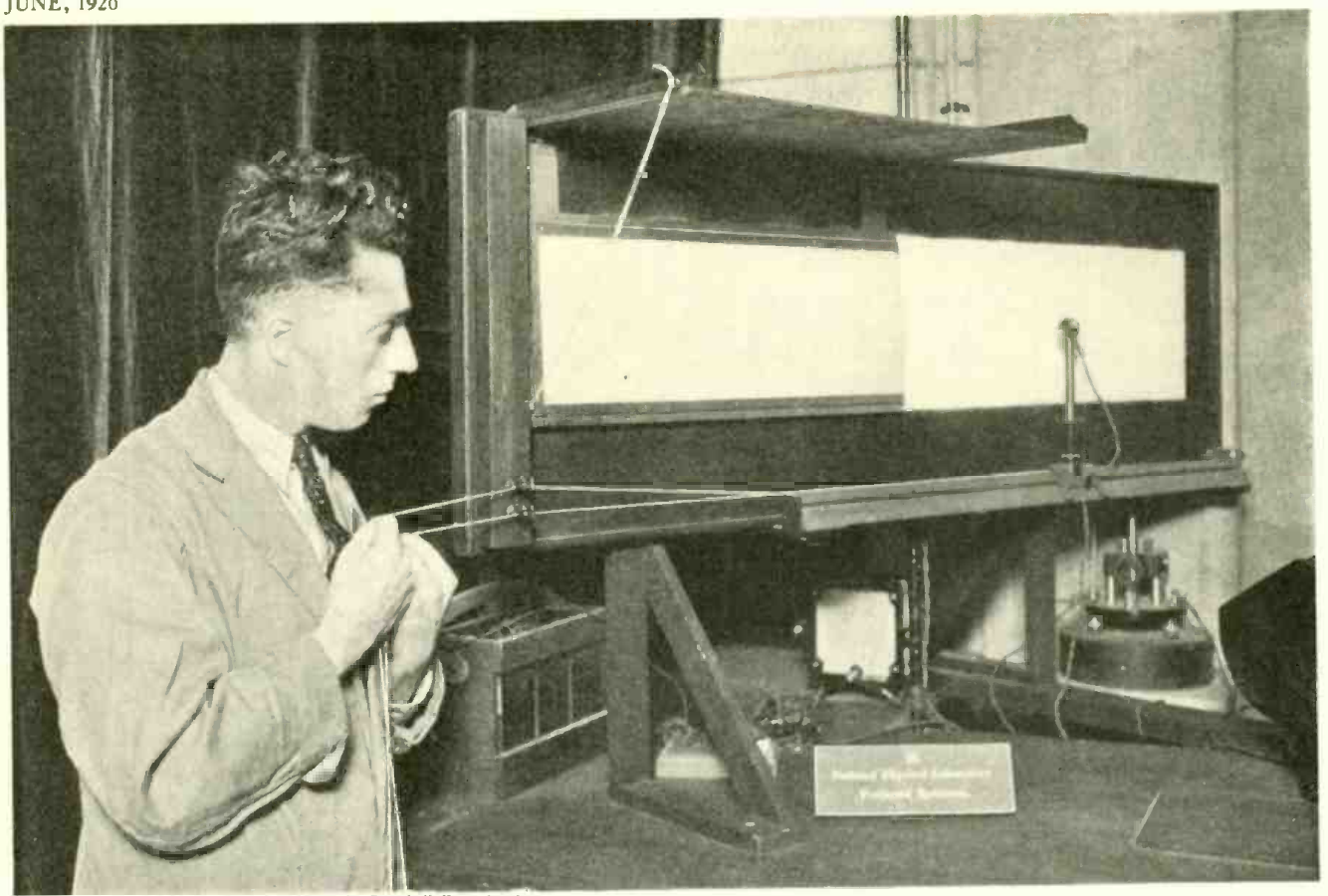
†For accounts of Professor Vegard's work see POPULAR RADIO, March, 1924, page 299, and July, 1924, page 89. A more recent summary appeared as "The Luminescence from Solidified Gases Down to the Temperature of Liquid Hydrogen and its Application to Cosmic Phenomena," by L. Vegard. *Communications from the Physical Laboratory of the University of Leiden (Holland)*, number 175, 105 pages, manuscript delivered June 18, 1925. POPULAR RADIO will print soon a more complete account of Professor Vegard's work, for which we are indebted to his personal courtesy.



From a photograph made for POPULAR RADIO by Borgens, Oslo.

AN APPARATUS FOR DUPLICATING THE AURORA

By these instruments Professor Lars Vegard has produced, from frozen nitrogen crystals, spectrum lines which he believes to be the same as those observed in the streamers of the Aurora. The frozen nitrogen is in the glass apparatus at the right. At the left is the spectrograph through which observations are made.



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

SHOWING A LONG SERIES OF ETHER WAVES

This apparatus was exhibited at the Wembley Science Exhibit, under the direction of the Royal Society of London, to show the extensions of the ether wave spectrum beyond visible light. The short ultraviolet rays were shown on the fluorescent screen occupying the left half of the apparatus. At the right, the longer rays of infra-red and of heat, all of them invisible, were demonstrated by a thermopile, used as a detector. The operator moved this thermopile back and forth by means of the strings. At the extreme right-hand end of the apparatus were found the millimeter electric waves which are now attracting so much attention among the more advanced radio experimenters.

More Radio Aids for the Deaf

OVER two years ago POPULAR RADIO published an account of the work of Dr. Paul V. Winslow, of New York City, in stimulating the hearing of partially deaf persons by feeding radio programs into their ears. By sufficient amplification and the use of headphones, the sounds supplied to the ears may be made extremely loud, far louder than any sounds which would reach the ear in ordinary ways. Of course, these loud sounds are heard better merely because they are loud. That is why many deaf people hear radio when they can hear nothing else. But that, says Dr. Winslow, is not all of the story. The supply of loud radio sounds to the ear actually improves, he believes, what remains of the sense of hearing. This opinion is now shared, it appears, by Dr. Max A. Goldstein, of the Central Institute for the Deaf, in St. Louis.*

The theory is that forced vibrations are good for the ear. Some parts of the mechanism by which sounds reach the sensitive nerve endings in the inner ear are purely mechanical. The ear possesses, for example, a chain of three small bones and a drum-like diaphragm, through all of which the sounds must pass. In some varieties of deafness these bones or other parts seem to become stiff. Sounds do not pass through them well. Forced exercise, as, for example, by listening to loud radio, loosens them up. The subject hears better, Dr. Winslow and Dr. Goldstein claim, not only at the time but later. According to Mr. Paddock, as quoted above, the Institute at St. Louis contains a special radio apparatus adapted to feed stimulating sounds into the ear in this way.

Another conclusion from this viewpoint is that there is probably a measure of truth in the old idea that deaf people hear better in noisy places. This has been much debated, some experts maintaining that the apparent improvement is due merely to the fact that persons speaking to the sufferer from deafness are apt, unconsciously, to speak louder amid noisy surroundings. Dr. Winslow recently made a test of this matter, the hearing of deaf persons being tested while on a moving street car. According to a report of the tests in the New York Times for March 13, 1926, a distinct improvement of hearing was noticed. Dr. Winslow intends to repeat these tests, using more exact controls.

*Dr. Goldstein's work is described in an article "Teaching Deaf Children to Talk," by Paul Paddock. *Popular Mechanics* (Chicago), volume 45, pages 435-440 (March, 1926). The work of Dr. Winslow and Dr. Goldstein is described also in an article by F. M. Delano, Jr., in the Boston Post for March 7, 1926, page B-8. POPULAR RADIO's original mention of Dr. Winslow's ideas was in the issue for March, 1924, page 202.

Can We Make Use of Millimeter Waves?

AT the annual dinner of the Institute of Radio Engineers, in New York held in January, Dr. Irving Langmuir, of the General Electric Company, made the prediction that before long we would be using waves so short that their wavelengths would be measured in thousandths of a meter—in millimeters—rather than in the meters which we use now. It is not probable, Dr. Langmuir predicted, that these extremely short waves will be produced or broadcast by apparatus of the types now in use. Totally new lines of experimentation

(*Continued on page 170*)

WITH THE EXPERIMENTERS

CONDUCTED BY LAURENCE M. COCKADAY

Trouble Shooting in the Cockaday Eight-tube Superheterodyne

THREE years ago the superheterodyne was considered a receiver for the amateur or experimenter. At that time the word "amateur" signified one who dabbled with transmitters—generally known as a "ham." It was not even commonly used by them until a short time after Paul Godley, in England, copied several American "hams" with a "superhet." Those who were in the game at the time will remember that this receiver then had a panel about three feet long that was dimly visible behind an imposing array of knobs and dials. Rumor had it that three men and a boy were required to tune the set.

Had the superheterodyne remained in this state, it is certain that few of them would be in existence today. But a look at any modern super gives at least one reason for its increased popularity. The panel is visible; in fact it may have fewer controls than a neutrodyne or a similar type of receiver.

One reason, then, is simplicity of operation.

Another factor has been simplification of construction. Receivers of this type have been built by experts with the use of standard parts and specifications that permit the duplication of the original receiver by others less skilled. One of the outstanding contributions to this field was the Cockaday eight-tube superheterodyne receiver, that was described in the January, 1925, issue of POPULAR RADIO.

The average constructor of receivers is not in a position to determine the value of a circuit by a mere inspection. He must either build it (in which case he values it in accordance with the results he gets from his own receiver), consult others, who purport to know, or value it by taking into consideration the time of its appearance. Obsolescence, in the latter case, is governed purely by the length of time the set has been "out."

An example of this is the old three-circuit receiver that used two variometers, one to tune the grid and the other the plate circuit. It is an "old" circuit and is valued accordingly by most of the public, although an operator familiar with one can get almost as good results from one using three tubes as the average individual gets out of his five tube—dyne or—plex circuit.

The Cockaday superheterodyne is an exception to this rule as those who handle any sort of a question department are in a position to corroborate. Both the numerous inquiries in regard to it and the comments by those who furnish kits or parts for it testify to this fact. It is for this reason that a discussion of this receiver still seems timely although the receiver was described almost a year and a half ago.

One thing should be borne in mind by the reader before he goes into the subject of "trouble shooting" on such a receiver. This is the fact that simplification of control and standardization of construction *do not simplify the electrical principles upon which such a receiver operates.*

Often the reverse is true. Simplicity of operation is frequently obtained at the cost of simplicity of design. This is true, for example, in a single-control superheterodyne where both tuning circuits (the loop and oscillator) have to be designed so that a constant frequency difference exists between them over the whole tuning range. This rests, among other things, on the construction of true straight-line-frequency condensers which is a problem in itself.

A Knowledge of Electrical Principles Is Essential

In trouble shooting in such a receiver some knowledge of the electrical principles is involved; and it is not, therefore, child's play. Additional tubes and circuits multiply the possibilities of trouble; and such trouble can only be found by systematic, careful testing and elimination. Unless the experimenter has had sufficient experience with receivers to be able to immediately identify the source of trouble, he can only do so by eliminating first one and then another possibility. Such elimination should preferably rest on the order of probability. The most probable source of trouble should naturally be investigated first.

An investigation of this sort, unfortunately, requires at least a slight knowledge of the principle on which the receiver operates.

The most satisfactory way of explaining its operation is to follow a signal from the input of the receiver to the output. This we shall attempt to do considering at the same time the possibility of trouble occurring in the various stages through which the signal passes.

This would normally give a disproportionate emphasis to certain possibilities; that is, considering the probability of its occurrence, and we will attempt to give a more accurate emphasis in the conclusion. The possibilities will be numbered successively and then a list of these numbers, in the order of their probability, will be given at the end of the discussion.

How the Signal Changes on Its Way Through the Receiver

Figure 2 illustrates roughly what occurs in the receiver. (All references to parts in the original receiver will include the original designating letters. The layout of the tubes in Figure 1 corresponds to the layout of the tubes on the baseboard and not to the schematic diagram of the receiver (shown in Figure 1). We have found that many owners of this receiver do not know the functions which each tube performs.)

The change in length of the dots and dashes that are used to illustrate the path of the signal signifies a change in frequency. The shorter the dots, the greater the frequency. An increase in thickness or width (using a fixed length) indicates an increase in the amplitude or volume of the signal.

The signal from the loop enters the tube I1 and is amplified at this frequency, as is shown by the increase in the width of the line and the fact that the length of the dot remains constant. This tube first acts as a radio-frequency amplifier.

The signal then enters the tube I2 where it combines with the auxiliary current, shown as the oscillator current, and reduces the frequency (as shown by the increase in length of the line). The current is rectified before it goes to the tube I3 so that *this tube is a detector*. A theoretical discussion of the necessity for rectification is out of the scope of this article but it may be discussed at some future time. The tube also per-

forms the function of oscillator as shown by the auxiliary oscillator current.

The tubes I3, I4 and I5 successively amplify the signal at the intermediate frequency.

The tube H decreases the frequency (by rectification) and is the second detector.

The decrease in the thickness of the line at this point does not indicate a decrease in amplitude due to this tube. The thickness is merely relative and applies only to a particular length of dash (or frequency). This audio-frequency signal then goes through the tube I1 as shown, is amplified at this frequency, and goes through the last two stages of amplification—tubes I6 and I7.

Let us follow the signal from the input to the output of the receiver. The original diagram is reproduced in Figure 1 to facilitate reference to the various parts. Those who cannot follow such a circuit may refer to the lay-out diagram which appeared on page 39 of the January, 1925, issue of POPULAR RADIO. Both figures use the same designating letters for the various parts.

The Loop Circuit

The curve that shows the setting of the loop tuning condenser A (K1 in the original article) indicates a wavelength range of approximately 266 to 550 meters. This curve was made for the middle switch point or inductance setting of the Korach loop.

This was done to simplify the chart. Each tap has a different calibration curve that is due to the change in inductance.

This does not mean that the wavelength range of the receiver is restricted to these limits. By the use of different taps the wavelength range of the *loop circuit* may be extended from well below 200 to over 800 meters.

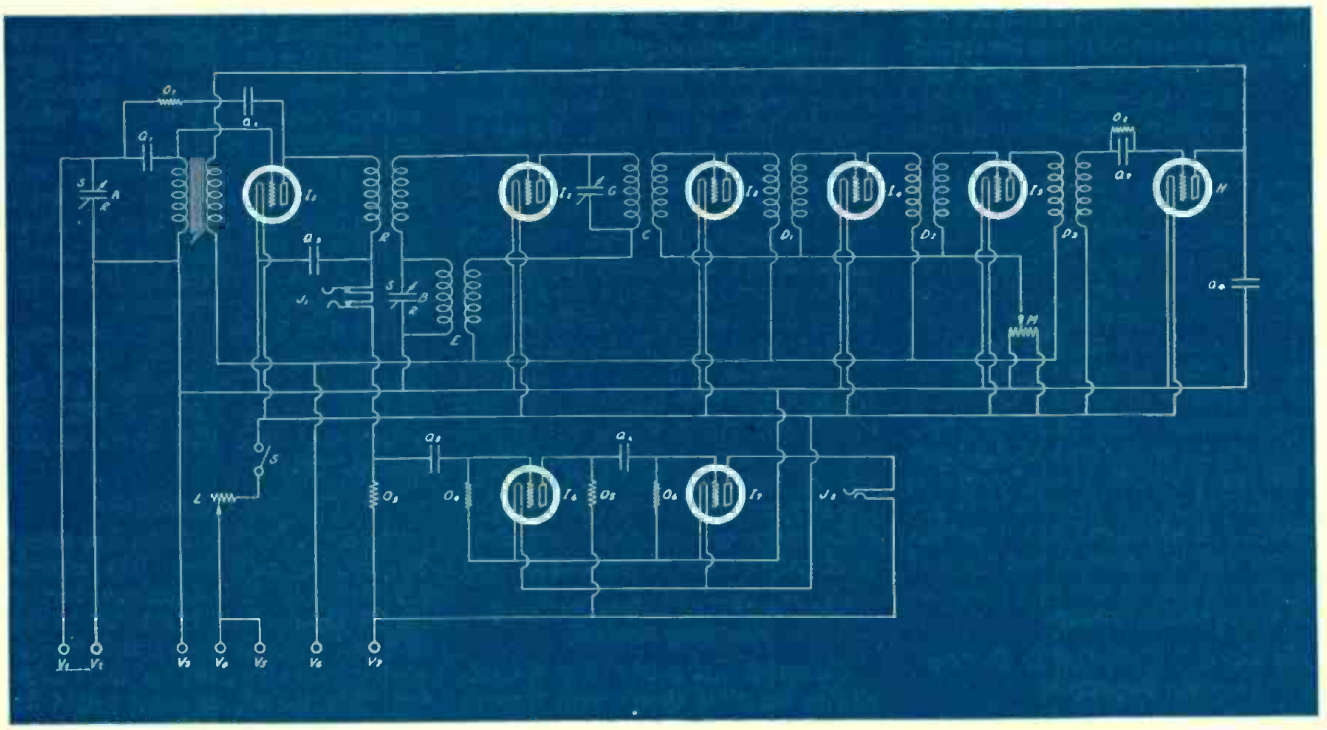
The loop and the condenser A (.0005 mfd. variable) comprise the loop tuning circuit. If your wavelength range is restricted the trouble does not lie in this circuit unless some other type of loop is used that has improper inductance. The same effect could be produced by shortcircuiting several turns of the Korach loop through the switch points; but this is very improbable. (I)

Other factors remaining constant, the signal voltage that is impressed on the input of the first tube is proportional to the number of turns used in the loop. It is advisable, therefore, to use as many turns in the loop as possible and a low setting of the tuning condenser. A fair compromise between increased losses in the condenser at low capacities and increase in signal from the loop with increased inductance may be secured by operating the condenser around 20 degrees or so (about 100 mmfds.). Very little difference will be noted normally when operating in this manner; but it is an aggregate of such small considerations which makes the difference between a set that will receive DX and one that will not.

Rectification in the First Tube

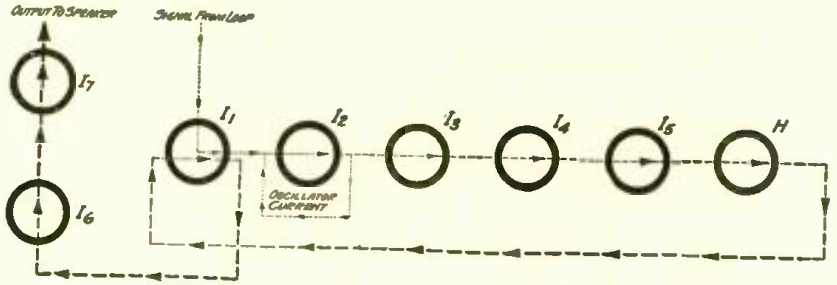
One side of this circuit is connected to the filament lead, in the usual manner, and the other to the grid of the tube I1 through the condenser Q1 which corresponds to the usual grid condenser. The secondary of the transformer is connected in the circuit in the manner in which the grid-leak is normally connected.

Rectification in a tube that employs a grid condenser and leak takes place in the grid circuit (by virtue of the change of slope in the grid current—grid voltage curve). Negligible rectification takes place here, however, due to the fact that the resistance (to direct currents or reactance to low-frequency currents) is very low and also to the fact that the filament end of the secondary is connected to the negative "A" battery lead. The subject of detection is an intricate one and one that we cannot take space to discuss here. The reader has doubtlessly noticed, however, that in "hard" or highly evacuated amplifier tubes of the 201-a type the grid-leak or grid return is connected to the positive "A" battery lead when detection is wanted.



THE SCHEMATIC DIAGRAM OF THE RECEIVER

FIGURE 1: *The hook-up of the Cockaday 8-tube superheterodyne which was described in the January, 1926, issue of* POPULAR RADIO. *All designating letters that appear in the text apply to this diagram and to the layout diagram of the receiver which will appear next month in the second installment of this article.*



HOW THE SIGNAL CHANGES ON ITS WAY THROUGH THE RECEIVER

FIGURE 2: *The path of the signal from the loop to the speaker. An increase in the length of the dashes indicates a decrease in the frequency of the signal while an increase in thickness represents an increase in the amplitude of the signal at that particular frequency.*

The condenser, Q3, offers a certain amount of what is called reactance to the high-frequency current. This is comparable to the resistance that is offered to the flow of direct current (this is not strictly accurate as no energy is dissipated—we again have to sacrifice some accuracy to simplify the discussion). The voltage across the secondary of the transformer and hence across the grid and filament of the first tube (which we want to keep as high as possible) is therefore less than that across the loop circuit by an amount equal to the drop in the condenser Q1. The greater the capacity the less the drop through it.

This capacity may be increased to .00025 or .0005 mfds. with some improvement in signal strength. It cannot be increased too much because as far as low- (audio) frequency currents are concerned it is connected across the secondary. Too high a capacity would seriously impair the amplification of the higher, audible frequencies in the amplifier. (II)

The method of reflexing that is employed here is called "shunt reflexing" due to the fact that the transformer winding is connected directly across, or in shunt to, the input circuit of the tube—not in series with it as is usual. We will return to a consideration of its operation later when the path of the audio-frequency is traced. One thing should be noted. This secondary is connected across or in shunt to the input of the first RF tube. If the impedance to radio-frequencies through this circuit is low, it will considerably lower the voltage that is applied to the input of the tube because it acts as a short circuit to the high frequency.

The Use of a Choke Coil to Increase the Impedance

There is no simple method of determining the impedance of this path to radio-frequencies; but, where trouble is suspected and particularly where other types of audio-frequency transformers that have different secondary impedance characteristics are used, a small choke coil should be inserted between the post, G, of the Karas transformer and the lead now connected to it. This will greatly increase the impedance to the high frequencies and yet offer very little to the audio frequencies.

This choke coil may be made by winding about 120-150 turns of number 36 wire (preferably DCC or DSC) on a one-inch tube. It may be mounted vertically on the base board to the left of the transformer. (III)

In referring to right and left front and rear of the receiver, in the case of instruments, it is assumed that the reader is looking at the set from the front. Where reference is made to the diagram (Figure 1) top and bottom, right and left apply to the position of the leads or instruments upon it.

The signal is then applied to the grid and filament (input circuit) of the RF tube and amplified at its original frequency by virtue of the amplifying characteristic of the tube. Nearly all of the output or plate circuit current at this frequency then goes through the primary of the Duratran transformer. The condenser, Q3, offers very little reactance to this frequency and so most of the current returns to the filament (completing the output circuit) through it. A slight amount of this goes through the resistance O3 to the filament (through the "B" battery). For this reason and others which will appear later a 1 mfd. condenser should be shunted across the "B" battery. The capacity is made large to minimize audio-frequency current variations which might occur in this circuit. (IV)

The Use of the Pliodyne Method of Preventing Feedback

We stated that nearly all of the current in the plate circuit went through the primary of the Duratran. The portion of it which does not go through this winding returns to the grid circuit through the condenser, Q2, and the resistance, O1. This current is opposed to (approximately 180 degrees out of phase with) the current in the grid circuit. It produces what may be termed negative regeneration.

At the frequencies which we are considering, a certain amount of positive regeneration takes place through the inter-electrode capacity of the tube (due to the inductive reactance of the primary winding of R). This positive regeneration may be sufficient to make the RG tube oscillate. To prevent this and also to prevent any of the oscillator current (which we will consider later) from getting back into the loop circuit the negative regeneration is introduced.

The method that is employed is one which is commonly called the "Pliodyne." The amount of negative regeneration is governed by the capacity of Q2 and the resistance of O1. The greater the capacity of Q2 the greater will be the negative "feed back" (less positive regeneration). The higher the resistance of O1, the less will be the negative regeneration.

In some cases, experimenters have found that removing the resistance O1 slightly increases the signal strength. This is due to the fact that a certain amount of positive regeneration is present. The loop is then capable of radiating some energy. (V)

Transformer Amplification

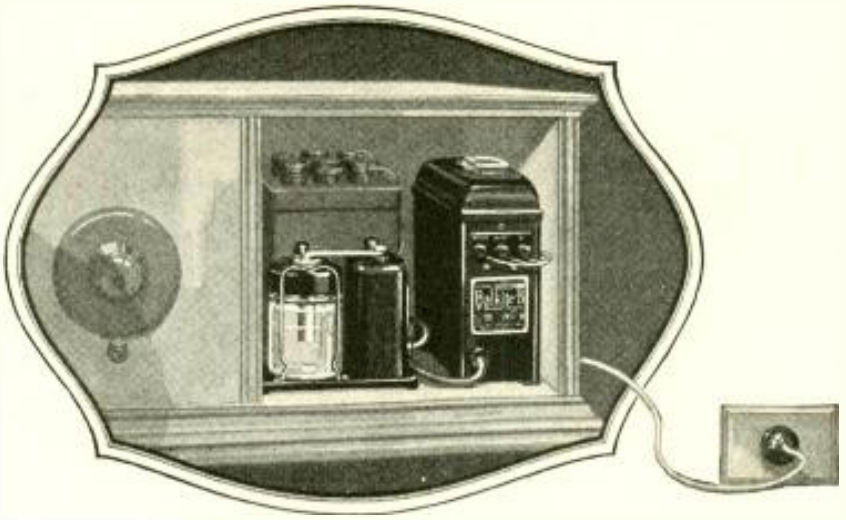
The signal is slightly amplified through the transformer, R, at radio-frequency. This transformer is of the untuned or semi-aperiodic type. It is very difficult to construct a transformer of this type that will give appreciable amplification, and especially, uniform amplification over the whole broadcasting band from 550 to 1500 K.C. The particular transformer used is one of the best available of this type; but its frequency range is restricted to from 550 to 1330 K.C. At the time it was used the use of the higher frequencies had not become common.

This then is the principal frequency (or wave-length) limiting factor in reception. The amplification at frequencies between 1000 and 1330 KC is not very high (300 down to 225 meters). (VI)

The First Detector Tube

The tube, I2, is both the first detector and the oscillator. The secondary circuit of the Autodyne coupler (E, Figure 1), which is shunted by the .001 mfd. variable condenser, is the frequency governing circuit of the oscillator. The tickler, or what might be called the primary winding, of the coupler is connected in the plate circuit in series with the condenser, G, and the primary of C (these two being in parallel). This provides the regeneration

(*Continued on page 170*)



Operate your present radio set from the light socket

with Balkite "B" and a Balkite Trickle Charger

The radio set you now own will operate from the light socket. No changes are necessary. You need only add Balkite "B" at $35 and a Balkite Trickle Charger at $10.

Balkite "B"—the noiseless "B" power supply—replaces your "B" batteries entirely and supplies plate current from the light socket. The Balkite Trickle Charger keeps your "A" battery always at full charge, also from the light socket. If you like you may also purchase from your dealer an automatic switch that cuts out the charger and turns on Balkite "B" when you turn on the set.

This type of installation is the last word in radio convenience and ease of operation. You never have to operate your set on a weak power supply or worry about replacing or recharging batteries. One turn of the switch and you have full, even power, exactly as required by the set. *And because you always have full power you secure a quality of reception possible in no other way.*

Both Balkite "B" and the Balkite Trickle Charger are entirely noiseless. Their first cost is the last. Both are permanent pieces of equipment with no bulbs, nothing to replace, break or get out of order. There is no further expense other than a negligible amount of household current.

Thousands of radio owners have already made this simple addition to their sets. You can make it too, and convert your set into a light socket receiver. *Ask your dealer.*

Prices slightly higher West of Rockies and in Canada

FANSTEEL

Balkite *Radio Power Units*

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"Micro-fright"

(*Continued from page 115*)

the other hand, the variety artist watches every move and expression on the part of the audience. He singles out people in the audience, plays to them, gets an individual *approchement*, as the people who sling French like to say, and thus the vaudeville performer makes his acting a personal matter.

But they can't do this with Mike, for Mike is as impersonal as a hunk of ice. And there is no way of thawing him out. It won't do to bellow out, as some vaudeville people on occasion have been known to do, "Hey, out there! Are your hands chained?"

Mike's hands are always chained. You have to get on the good side of him in some other way.

Often the less figure the person is in the world, the better he performs in front of Mike. After dinner speakers, small fry politicians, unknown football coaches and so on, often do better in the sending room than actors and singers of renown. The former go galloping on, taking the hurdles as they come, and it makes no difference to them what happens. They are not accustomed to bringing audiences to their feet, so when they step in front of the sensitive plate they don't need audience inspiration, and they acquit themselves better than people the public is much more interested in hearing.

Many things must be learned by people who are to meet Mike for the first time. Once a sad experience happened to me. Possibly others, who are to make their debut, may profit by the situation I found myself in.

I was to speak over WJZ and I was to occupy ten minutes in time. WJZ is very particular about what a person is going to transmit and requires that the speaker write down in advance just what he is going to turn loose on the good people. I had written my speech out and sent it in to the studio manager. He had telephoned me that it had passed the requirements, and I was pleased that everything had gone as happily as a wedding bell. I was to go on at a quarter after eight and so took an early train just to make sure that there wouldn't be any slip-up.

I arrived. The colored attendant there whisked my hat and stick from me in the way he has (don't forget him as you go out, boys) and I sat around for some minutes listening to how the others did it. My time came and the announcer, with the geniality of a dentist going to relieve you of a molar, escorted me to the sending chamber. Some woman was just finishing a song and the announcer took his place at the control switch and then whispered to me:

"You have your manuscript all right, haven't you?"

"No," I said, "you have it."

He would not have looked any more scared if he had met a pay roll robber in a lone and deserted street.

"Where is it, then?" he said, leaping to his feet and dashing out the door in a way that would have made Red Grange say, "Aw, what's the use?" He called to the other men in the studio, asking where the manuscript was, but none knew.

"Maybe it's in the filing cabinet," someone suggested, and the announcer started digging through that steel cabinet like a ferret going after a mouse. But he didn't find it; there had been a bungle and the manuscript was in another office and the manager gone home (I trust) to his wife and children. So the poor announcer dashed back to the microphone just as the song was finishing—and then and there he had to step in and oblige with a solo.

As a word of warning to those appearing on the air for the first time, take along your carbon copy; or, if you sing or play, don't depend on the studio library. Play safe and take it along. You won't feel half as foolish coming in with a duplicate set as you will standing in front of Mike without anything except your good intentions. Good intentions don't carry very far over the radio.

Those who are expecting to sing or play over the radio must not expect to go on without a try-out, or as the new and fashionable word about the studios now is, without an "audition."

First, the person sings or plays, or otherwise shows what he can do, while the studio booker looks him over and goes into the next room to hear how he sounds over the speaker. But the person has not gone up into the air; he has merely been switched into the other room for this same audition, for even the most skilled studio manager cannot tell whether a person has a microphone voice. Then the person is told how to remedy his voice, or how to make it carry better, how close he should stand, and so on. In this way the singer, or musician, has had some experience before he goes on for the first time. But a speaker, or story teller, or lecturer hasn't that. He must come without having met Mike before—and then the two are left alone together.

But don't get the idea that the slower and more distinctly one speaks the better.

Recently Cornelius Vanderbilt, Jr., was called upon to speak over the radio. He sent in his speech, all written out, and it passed without the blue pencil falling on a line. But when Mr. Vanderbilt started to speak he spoke so slowly and distinctly that it was painful to listen to him; he sounded like a high school boy making his first speech in a debating class on "Government—What is It?"

For Experimenters who prefer Impedance Coupled Amplification

Type 369
Coupling
Impedance

Price
$5.00 each

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.

In a search for a perfect amplifier experimenters are now giving much attention to coupling impedances.

While transformer coupled amplification produces more amplification per stage than any other method under some conditions slightly better quality may be obtained by the use of impedances and resistances.

By using chokes of sufficiently high inductance, a quality of reproduction may be obtained equivalent to that produced by resistances.

The use of chokes has the added advantage of requiring considerably less plate voltage thus reducing operating costs of the set, and also giving greater amplification per stage.

A three stage amplifier using three General Radio Type 369 coupling impedances will give a combination of generous volume with exceptional purity of tone.

Write for our circular showing wiring diagram for a 3 Stage Impedance Ccupled Amplifier and our latest parts catalog 924.

GENERAL RADIO CO., Cambridge 39, Mass.

GENERAL RADIO
INSTRUMENTS

"Behind the Panels of Better Built Sets"

The studio manager, who had been listening in the reception room, came rushing with a note;

"Speak faster and more naturally."

Young Vanderbilt changed his method of delivery, became himself, talked as if he was speaking to a human being instead of to a piece of vibrating tin, and closed his speech with congratulations on the part of the whole studio staff.

Small points are important when you are alone, with the air before you. One is, if you speak from notes, or if you read your speech, don't use thin, crinkly paper, for in turning it the audience hears every crinkle. Use rough, porous paper.

And be careful about clearing your throat. Recently Station WSB had to give up a speaker for this very reason. He was interesting and was able to put humor in his talks, but he had a way, every few sentences, of clearing his throat. The first time or two it was not noticeable, but repeated constantly through a fifteen minute talk it became annoying.

How can you overcome micro-fright? The dictionary fails to give this word, but for that matter many a good and useful word has been kept out of the dictionary by moral turpitude, or something, when it deserved a place in that proud lexicon. Gelett Burgess (who invented the word "bromide" and made it so popular that it finally found its way to the chaste pages of the dictionary) should come along and give the little orphan a helping hand.

There is no way to overcome micro-fright. And just how frightened one is depends on temperament. *But there is one thing that will help—and that is preparation.*

Don't ever meet Mike face to face expecting to depend on the inspiration of the moment, as so many speakers come to an audience expecting that inspiration will come and cuddle with them, for when you step before Mike there is no more inspiration than if you were talking into a tomato can. That is the reason humor is so hard to make go over the radio.

Comedians depend on their audiences to laugh and to inspire them to fresh witticisms, but Mike, the poor nut, hasn't laughed yet.

Come prepared; say over your speech to your family until you are able to give it everything you have and then come in and look him confidently in the eye.

You'll find he isn't such a bad fellow, after all.

Rebuilding Bodies by Radio

(*Continued from page 146*)

world. His morale has improved tremendously.

An Interest in Radio Is an Interest in Life Itself

It may be opera that he likes—perhaps he can get one of the latest revues being broadcast straight from the theater. He may suddenly gain a keen interest in distant stations, and have the thrill of lying in his own bed and listening to a quartet in Paris, a solo in Berlin, the military band in Madrid, or an instrumental selection from Brussels. He may follow a course of lectures, a class of some sort. But the important effect of radio (and its vast superiority to any other form of entertainment for hospitals) is that the patient is no longer a segregated mortal, cut off from all intercourse with his fellow men and feeling that the world and life are whirling on without him. Instead, he is able to actually take part in the life of the world, and to become a member of human society. The events that happen around him are not recited to him by dolorous callers, but are shared by him. When the callers come, he has something to offer too—he can listen to them discussing things, or he can discuss events with them, which have actually happened that day. He has begun to take an interest in the life outside, and his morbid interest in himself wanes, to be replaced by a healthy interest in—radio and what it brings.

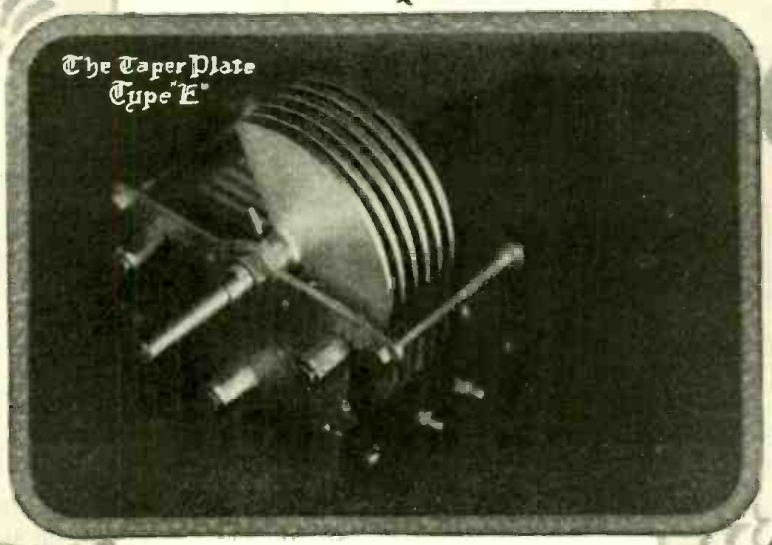
Radio Benefits the Nurses as well as Their Patients

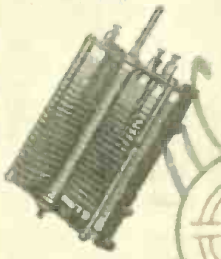
Radio also helps to keep the nurses in a better frame of mind, as they can get in touch with the outside world during their leisure hours, *via* the loudspeaker. This is a humane effect, rather; though indirectly it has its beneficial influence on the patient. Many of the hospitals in London today are installing radio sets—in fact, there is a regular wave of this work going on throughout England which will become even more general as the beneficial effects of radio become better known.

The actual results of the application of the broadcast programs have apparently justified once and for all the claim of the radio receiving set to take its place among hospital appliances and installations. Several radio firms are making special portable sets to sell or hire to patients for hospital use. I personally look forward to the time when every patient will be supplied with his radio set, or at least his set of headphones, just as he is today supplied with bed, garments, or meals. And I expect then to see the percentage of early convalescences and cures definitely and permanently increased by the intelligent employment of radio both in the hospital and in the home to give rest and recreation to the patient's mind.

Cardwell

Accepted





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The Taper Plate Type E Cardwell, accepted as the first logical solution of the straight frequency problem, has proved its right to a permanent position in the Cardwell line

Sold out far in advance of production ever since it was first announced, its enthusiastic reception by the public has rarely been equalled.

Engineers and Editors hail it as an epoch making advance, and that most critical of all users, the amateur, has been loud in his praise.

Prices are as low as consistent with good workmanship. The .0005 mfd. is $5.00, with other sizes proportionately lower. Order yours now!

Send 5c in stamps for 36-page handbook and catalogue. If the nickel isn't handy send anyway.

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If your dealer can't supply you, order direct from us. Prompt attention to all orders.

Condensers

THE STANDARD OF COMPARISON

Use Meters to Avoid Break-downs

(Continued from page 143)

In starting the set the "A" and "B" batteries are turned on and the filament selector switch, "FS," at the left of Figure 2, is set at the first point on the extreme left.

The rheostat for this tube is then adjusted until the proper voltage is shown on the filament voltmeter, "FV," in the lower left-hand part of Figure 2. The filament selector is set on the second point and the second rheostat set by the voltmeter reading, and so on for all tubes. The last point on the filament selector switch is so connected as to read "A" battery voltage.

When all tubes have the proper filament voltage the total ampere-flow for the set will be shown on the filament ammeter, "FA," in Figure 2. The lowest reading consistent with good volume and quality should always be maintained. This is the secret of conserving tube life.

How the Selector Switch Is Used

In connection with the use of the filament voltmeter it will be noted that all rheostats are on the negative side of the line. This is necessary if a simple selector switch is to be used. In this way the positive side of the voltmeter is permanently connected with the positive side of the "A" battery, and the negative side of the meter can then be connected at will to each tube through the selector switch.

This location of the rheostats is in accordance with recommended practice of the standard tube makers. If, however, as is common in sets with one or two stages of neutralized radio-frequency amplification, all amplifier tubes have the rheostats on the positive side of the "A" battery and the detector rheostat on the negative side, it is advisable not to make detector connection to the selector switch. It is then possible to make the permanent meter connection to the negative side of the "A" battery, and to read the filament voltage for each amplifier tube by means of the selector switch.

It is not advisable to attempt to use a selector switch which has two movable arms, so as to take readings of filament voltage when tubes have their rheostats on more than one side of the "A" battery. This is a complication which is likely to give trouble.

Another peculiarity to be noted in Figure 2 is that of the plate-voltage selector switch, which has the first connection to the positive side of the "A" battery. This is, in reality, the plate voltage for the first detector tube as no "B" battery is used here. The negative side of the "B" battery after going through the plate milliammeter connects with the negative of the "A" battery. The first detector plate return then goes to the

positive "A" battery. This gives a first detector plate voltage of only six volts and is, by the way, a practice that the writer highly recommends.

It should then be noted that the second point of the plate voltage selector switch, "PS," in Figure 2 has no connection. This follows for every second point and must be observed, for otherwise contact of the switch arm with two live points simultaneously would short-circuit sections of the "B" battery. By rotation of the switch arm the plate voltmeter, "PV," in Figure 2, is connected successively with each detector plate, the radio-frequency plates and the audio-frequency plates.

The relative connections of the plate voltmeter and the plate milliammeter should also be noted. In Figure 2 it is so arranged that the current consumed by the voltmeter registers on the plate milliammeter. This is recommended so that the total consumption of "B" battery current will always be known and also because there is dual indication that the plate voltmeter is in circuit, a condition that should be necessary only for short periods of time at infrequent intervals.

It will be noted that the selector switch points, as shown in Figure 2, have no designating marking.

In Figure 2 all arrows pointing up indicate leads to the set. This applies to both binding posts and rheostats.

Figure 3 shows a picture of the radio receiving set described, with single-dial tuning control.

The Panel Arrangement

Figure 1 shows the details of the panel. On the extreme left is the filament meter assembly. The upper meter is the voltmeter, the lower the ammeter, and between the two is the filament selector switch.

On the extreme right of Figure 1 is the plate meter assembly. The upper meter is the voltmeter, the lower the milliammeter, while between the two is the plate selector switch.

Figure 4 shows the top of the set with the cover open. The position of the binding posts all placed where connections may be easily made should be noted. At the extreme left of the shelf are the antenna and ground connections, while the "C" battery connections are located on the extreme right.

In the centre of the shelf, and in front of the tubes, are the "A" and "B" battery connections. All plate connections are from the binding posts to the rear of the set; and the radio-frequency circuits are at the extreme rear.

The plate voltmeter wiring is from the binding posts to the panel. Thus no complication of wiring is introduced near the radio-frequency part of the set.

And finally remember that meters on a radio receiver are an insurance against trouble and breakdowns if the information they give you is heeded.

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

A Scheme for Keeping A Springy Antenna Taut

LIKE many other listeners, I have tied my single-wire antenna to a tree about 80 feet away from my house. The installation, which is shown in Figure 1, is unusual in that it employs a method of taking up the slack and the spring which the tree gives to the wire in a wind.

The 80-foot length of wire runs directly to one of the upper limbs of the tree, where it is fastened with a heavy rope which has been tarred. It is well insulated. At the house end, it does not come directly to the side of the wall, but is connected to a spring, such as is used to close screen doors.

The antenna wire passes through its length and thence to the insulator. The lead-in is taken off at this point. About 20 inches of slack are provided for by the spring connection.

As the wire is fastened to the spring, this device relieves the wire itself from any excessive tension. As the tree sways, the tightness or slackness is automatically compensated for by the spring.

Not only is this arrangement inexpensive to install, but it saves many an antenna from snapping when the tree sways in a high wind.

—CHARLES MACPHERSON, *Santa Cruz, Cal.*

How I Preserve My Wooden Battery Case

BROKEN or leaky battery jars on a storage battery will permit the acid to attack the bottom part of the battery box; and destruction usually starts around the top edges.

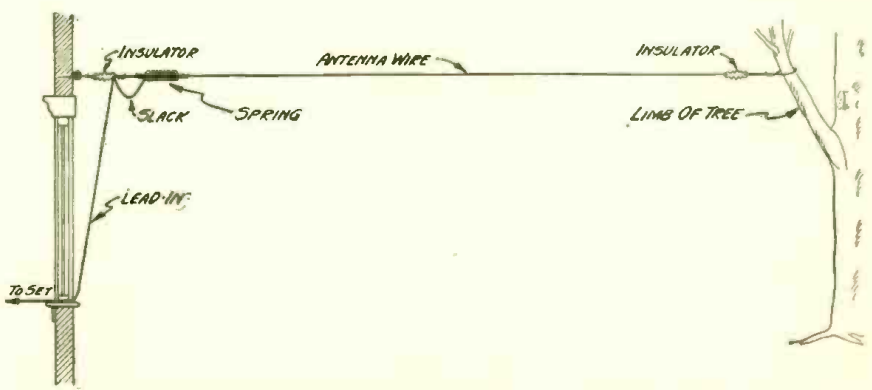
I have found that this may be due to the fact that the case is not fully painted on the inside, where the protection is most needed. To prevent this, I have been in the habit of following the treatment which is given below, every time I get a new battery:

I buy about five cents' worth of sealing compound from a service station. I then heat it and pour it around the inner edges of the wooden case. I take care, of course, not to drop any of the molten material inside of the batteries proper.

By means of an old knife, which has also been heated, I spread the sealing compound on top of the battery, evenly, like butter. I do this job thoroughly and cover every part of the wood.

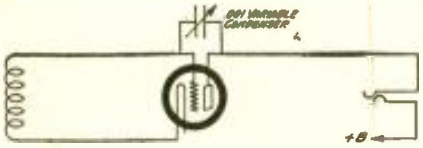
If I see any small cracks, I fill them up at once. These cracks sometimes occur between jars, and sometimes between the jars and the case; it is through these cracks that the acid seeps into the battery case and attacks the inside.

—ARCHIE KLINGBEIL, *Ashtabula, Ohio*



HOW THE ANTENNA INSTALLATION IS MADE

FIGURE 1: *A spring is used to take up the slack wire in the antenna when it is fastened to a swinging support, such as the branch of a tree.*



"TUNING THE OUTPUT"

FIGURE 2: *A variable condenser connected between the grid and plate of the last audio tube allows tuning to get various tone qualities from the set.*

I Get Better Speaker Results by "Tuning" the Output

DUE to the fact that my receiver, which was a five-tube tuned, neutralized-radio-frequency type, gave me impure loudspeaker results, I decided to try the shunting of a fixed 0.0001 mfd. mica condenser across the grid and plate of the last audio-frequency tube.

Although this worked, and did away with all of the distortion, there was a noticeable difference in the quality of the cone speaker. Using different capacities gave me different results.

After some experimenting, I decided to use a large variable condenser in this position. This is the arrangement I now have in my circuit (Figure 2).

I have found that the capacity of this condenser may be adjusted in receiving some stations, with great resultant improvement in the loudspeaker reproduction. Musical selections of a certain type will require a different adjustment than a voice speaking or singing An approximate setting can be found that will take care of the average type of broadcast.

—EDMUND F. LAMB, *Montreal, Canada*

* *

Are Your Conditions of Reception Undergoing a Change?

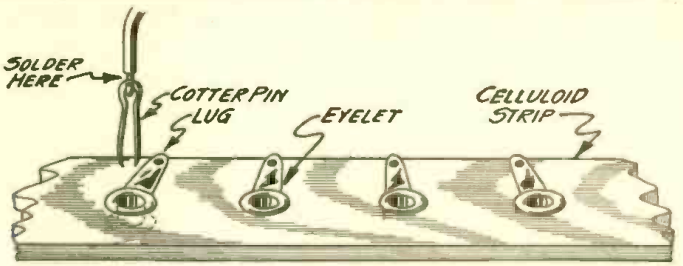
HAVE you noted a peculiarity, or rather a directional change, in receiving conditions this past winter?

From November, 1924, up to May, 1925, I frequently received northeastern stations as far away as Montreal (CKAC) and New York (WEAF), on my loudspeaker. It was difficult if not impossible for me to hear any Southwestern stations beyond Salt Lake City and Los Angeles.

This winter, on the other hand, to get Chicago is a rarity. But I have received New Orleans, Chattanooga, Tenn., Kennonwood, La., Phoenix, Ariz., Mexico City, Mex., and many others on the loudspeaker. Only once have I tuned in Winnipeg, and no stations further East, except occasionally Chicago.

In these observations I have used a De Forest 5-tube, type D-17 receiver, with loudspeaker enclosed. I live on the sea-side, and have an antenna 100 feet in length attached to the set.

THOMAS A. WOOD, *Vancouver Island, B. C., Canada.*



A SIMPLE TERMINAL STRIP

FIGURE 3: *The drawing shows how ordinary eyelets and soldering lugs may be used for handy connections.*

A Short Cut for Plugging In

BY the use of an eyelet machine, such as is employed in the average office to fasten papers together, I have made attractive and serviceable terminal strips for my coils, as shown in Figure 3.

Although I use celluloid for the material on which the terminal holes are made, thin bakelite or hard rubber is just as good. The advantage of the celluloid lies in the fact that it may be fastened onto the celluloid backing of some of the windings that are now popular, by means of a little collodion.

To make the terminal, bore a hole, the diameter of which should be big enough to admit the half of the eyelet. Place the second half in the machine; and fasten them together by manual pressure with pliers.

For the connection, I have used a small cotter pin, made of spring-brass. The wire is passed through the loop and soldered in place. The sides of the cotter pin are separated apart as much as may be necessary to provide good frictional contact when inserted in the eyelet terminal.

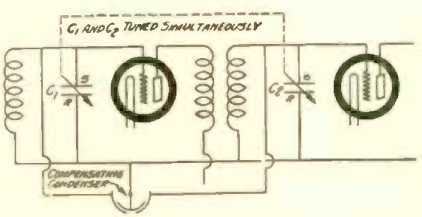
—MARSHALL BAIRD, *New York*

* *

How I Made My Double Condensers Work With Any Set

I HAVE just built one of the S-C receiving sets which was described in the March, 1926, issue of POPULAR RADIO.

I have experienced one difficulty that is common to all of these sets; the twin condensers, due probably to some slight change in the wiring layout, sometimes do not tune exactly alike. When I tried to equalize each circuit with a midget condenser, for example, I set the main dials, and then readjusted the smaller condenser. But I always found it necessary to retune the main dial afterwards.



BALANCING TWIN CONDENSERS

FIGURE 4: *Two stages of tuned-radio-frequency amplification may be easily balanced by the use of a compensating condenser of a small size.*

I finally solved the difficulty by using a Cardwell split stator condenser, such as was used in the Pressly "super." By connecting each stator to one of the stators of the double condenser, and the rotor, to the frame of the double condenser, as shown in Figure 4, it became an easy matter to equalize the two circuits. My set works finely now.

When you increase the capacity of one side of the balancing condenser, you decrease the other, automatically compensating either circuit. I imagine that these compensating condensers would work in any set which used a double condenser to simultaneously tune both circuits.

—FRANK E. EPZEL, *Montclair, N. J.*

* *

A Successful Experiment With My Four-circuit Tuner

I AM using my fourth—and my best—Four-circuit Tuner. I have had such good results, that I should like to tell other Listeners about them.

I employed the three-tube hook-up, shown on page 57 of the July, 1925, issue of POPULAR RADIO, with some variations. I also used the baseboard of a five-tube resistance-coupled amplifier, using the same coil required, and placing the detector where the first amplifier is usually located on the baseboard. This gave me three inches added distance between the coil and the detector tube.

The first stage of the audio-frequency circuit is transformer-coupled; the second stage is resistance-coupled.

All through the summer I have been able to get the higher powered stations; I have heard Chicago, Davenport, Dallas, Pittsburgh and Cincinnati while a storm was raging here. While a fellow-listener, equipped with a standard type of five-tube, tuned-radio-frequency receiver, tuned in seven stations between 7:30 and 11 P.M. one evening, I logged 31 in the same period of time.

I use 22.5 volts on the detector and the same voltage on the two amplifier tubes, for headphone reception. As the detector battery is five months old and has been used on an average of five hours a week this summer and about 20 hours during cold weather, I think that these results are worthy of notice.

—R. R. MILLS, *Indianapolis, Ind.*

How I Handled Greater Output from My Powerful Set

ONE of the ways which enable me to handle comfortably the output of any of the sets made from directions in POPULAR RADIO, is through the use of parallel tubes in the last stage of the audio-frequency transformer.

The arrangement is very simple. Instead of one tube, a complete duplicate tube layout is needed. Obtain another socket and a similar tube and make space for both on the base. Then connect the two up as if there were but a single tube. The grid connections of the two tubes are run together to the correct post on the output of the last transformer. The two plate terminals go to the positive of the high voltage battery, as shown in Figure 5.

The filament circuit is placed in parallel to the other filaments; and a single rheostat is all that is needed for the two tubes.

Ordinary receiving tubes may now be used for the handling of this last stage. As the "load" is distributed between the two tubes, they will better be able to take care of it. It must be borne in mind, however, that as the circuits are in parallel, it is essential that the two tubes be exactly the same; you may have to try many tubes to match them, or measure them on a tube meter for similar characteristic readings.

If still greater power is to be handled, the use of the newer "power tubes" will be necessary.

—JOHN J. O'NEILL, *Freeport, L. I.*

* *

How an Auxiliary Antenna Improves Local Reception

SOMETIMES a receiver is too selective for the best results; on certain stations the peak is reached too abruptly; and no amount of fine tuning will yield reception of the proper quality and desired modulation. This is especially true of distant stations, with an output of 1,000 watts, when received with the aid of tuned-radio-frequency. To cope with this condition a Philadelphia amateur tells how he got better reception:

I employ a secondary antenna. This may be fifteen or twenty feet of silk-covered wire running along a floor or molding, a light socket adapter or an independent ground lead. This additional collector is connected directly to the primary winding of the middle neutroformer or other type of coil.

The writer uses coils with binding posts, so that it is an easy matter to make connections (a small battery clip may be used for this purpose). The result is a greater number of stations truly received and a greater facility in tuning. The receiver also becomes more stable in action.

When you want to spend an evening with local broadcasting stations, there is no necessity of using the radio-frequency portion of a five-tube neutrodyne type of set. The auxiliary antenna may then be transferred to the input primary of the third or detector coil. The first tubes may then be cut out. This is a far more convenient method than disturbing the regular ground and antenna connections.

The auxiliary antenna also presents a good method of testing the efficiency of a tuned-radio-frequency receiver.

—LIONEL MURRAY, *New York*

* *

Does Radio Cause Drought?

THE real cause for good or bad weather is still shrouded in mystery —but radio has come in for a share of the blame or credit for both.

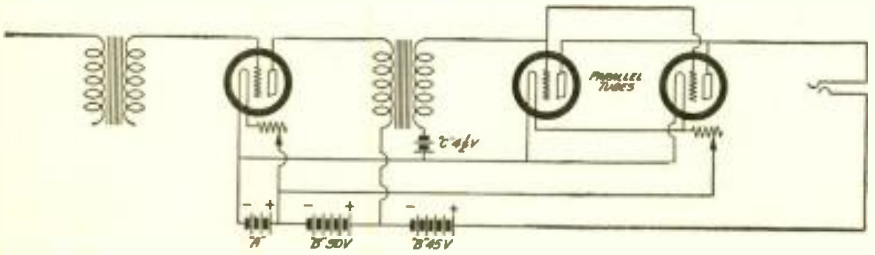
Last summer, for example, people blamed radio for the drought. This year they are saying that radio is the real reason for so much rain.

Yet scientists all agree that radio has nothing at all to do with the state of the weather!

Scientists tell us that the amount of electrical energy sent into the air by all the radio stations put together is but a drop in the ocean compared to the tremendous electrical manifestations that Mother Nature stages for herself in the form of lightning, northern lights, and many forms of static discharges.

The temperature of the water in the north Atlantic Ocean has averaged about eight degrees above normal this year, and the heavy rains have been attributed to the extra amount of water that evaporates into the air under these conditions.

—JOHN RAMSAY, *Baltimore, Md.*



HOW TO HANDLE OUTPUT FROM A POWERFUL RECEIVER

FIGURE 5: *The tone quality of almost any receiver may be considerably improved by the use of two tubes in parallel for the last stage of audio-frequency amplification.*

With the Experimenters

(*Continued from page 158*)

that is necessary to keep the tube I2 oscillating at the frequency to which the secondary of E is tuned.

If this circuit were tuned to a frequency which varied only slightly from the received frequency (as is the case in fundamental frequency oscillators) it would offer considerable impedance to the frequency in the secondary of R which we wish to amplify. This means that only a portion of the available signal would be impressed on the input of 12.

A separate tube may be used, of course, oscillating at a frequency comparable to the incoming one and with the two coupled together loosely to provide the necessary heterodyning. At the time this receiver was designed economy in tubes was a fairly important consideration and the second harmonic principle was utilized.

How the Autodyne Coupler Is Used to Prevent Interaction

In this system the secondary of the autodyne coupler, E, is tuned to half the frequency wanted for heterodyning (twice the wave length). The second harmonic of this current, which has twice the frequency of the fundamental, is then used to do the heterodyning. The secondary circuit of E is then tuned to a frequency which differs so much from the incoming one that it offers negligible impedance to the incoming frequency and permits practically all of the voltage available at the secondary terminals of R to be impressed on the input circuit of 12. Interaction between the two circuits is thus minimized. This arrangement is one which was first suggested by Mr. Harry Houck who worked with Mr. Armstrong in developing the superheterodyne.

What Happens When a Signal Is Heterodyned

A brief discussion of what takes place when a signal is heterodyned may help at this point. Let us assume that we have a continuous wave which is impressed on the input circuit of a tube (the same consideration holds in any circuit). If another continuous alternating current is impressed on the same circuit, there will be a resultant current which includes a frequency equal to the difference of the two.

If, for example, one current has a frequency of 1,000,000 cycles (300 meters) and another that has a frequency of 900,000 is superimposed upon it, the resultant current will contain, among others, a frequency of 100,000 cycles—100 K.C. (3000 meters). As the second frequency (900,000) approaches the first (1,000,000) the difference will become less and less until the difference enters the audible range (this is what you do when you get a carrier wave beat which is audible in an ordinary regenerative receiver).

When they are the same the difference will be zero. As it is increased still farther a difference will again appear; and, when the second equals 1,100,000, we will again have a resultant current which contains a frequency of 100,000 cycles.

This is what occurs in a superheterodyne. The first frequency, which we were considering and which is fixed, is that of the broadcasting station. The second, is that produced locally by the oscillator. It is evident therefore, that there will be at least two points on the oscillator dial at which a signal may be received. These points will occur when the oscillator is tuned to a frequency which is less or greater than the received one by a certain amount. This "certain amount" is another fixed frequency which we wish to amplify. It is ordinarily called the intermediate frequency and it usually lies between 30 and 150 K.C.

A question very naturally arises regarding the necessity for this frequency. It is this conversion which distinguishes the "super" from other circuits.

We mentioned, in discussing the R.F. amplifier, that a certain amount of regeneration takes place through the inter-electrode capacity of the tube. This, it happens, is proportional to the square of the frequency and therefore it decreases rapidly with decrease in frequency or increase in wavelength. The interelectrode capacity also reduces the amplification which may be secured at higher frequencies. Expressed differently, the amplifying efficiency increases with a decrease in frequency. To amplify the signal efficiently its frequency is therefore reduced.

Returning to the problem of the oscillator we confront one of the most common complaints against the super. This complaint hinges on the fact that stations are received on two or more points on the oscillator dial. We have examined the reason for the two which normally occur. Why are there more of them?

The Reason for Extra Repeat Points

In an oscillator of the usual type there exists, in addition to the fundamental frequency (considered the first harmonic), a series of harmonic frequencies which are multiples of the fundamental. That is, frequencies which are two, three, four, five or more times the first.

The amplitude of these frequencies depends on a number of factors. In the first place, all of the factors which produce distortion in the usual type of amplifier enter, and must be considered.

The harmonics are due to a departure of the wave form from the sinesoidal (sine wave). If the amplitude of the oscillations is permitted to become great enough both the variations in grid and plate voltage include portions of their respective curves which are not linear.

Unless the oscillator is very carefully operated it will be possible to use the first three harmonics in heterodyning, providing, of course, that they fall within the required frequency band. It is this fact which permits many stations to be received at six points on the oscillator dial. Can we eliminate the "extra" ones—that is, all above the two which would normally occur?

How to Eliminate the Unnecessary Repeat Points

This *can* be done but it is not a simple problem that is involved. If a fundamental frequency oscillator were used, we could resort to the methods that are ordinarily used to produce sinewave oscillations. Some distortion is necessary in this case, however, to give us the second harmonic that is necessary for heterodyning.

One line along which we can direct our efforts is based on the fact that the amplitude of the output current of the first detector is proportional to the product of the amplitude of the incoming signal and the locally generated current. Incidentally, it is this fact which makes the first detector more sensitive than the ordinary one (which follows the square law) and permits distortionless amplification.

In passing it may be well to point out that if the tube is operated anywhere within its ordinary operating limits *there is no such thing as a "threshhold value"* or input voltage below which *no* signal can possibly be received.

It frequently happens that the local stations come in at four or six points on the oscillator dial whereas DX stations come in at only two points. This is due to the fact that the product of the received local and locally generated (or heterodyning) current is sufficient to give a fairly loud signal. If the amplitude of the heterodyning current is low (it may, for example, be the third harmonic) the product of it and the amplitude of the DX station, which is likewise low, may be insufficient to actuate the speaker (or rather to produce an audible signal).

—HUGH S. KNOWLES

(Another article on this receiver, which will contain trouble-shooting data on the remainder of the circuit, will appear in the following issue of POPULAR RADIO—*for July.)*

* *

A Department of Commerce radio inspector states that he has received sufficient requests for assistance, to keep him occupied fourteen hours a day for the remainder of the fiscal year.

Pacific & Atlantic

THE HOLDER OF THE HOOVER CUP IN ACTION

Ted Ostman (at left), the only holder of the coveted Hoover cup in the East, takes a low-wave message from R. C. Dotson of Tampa, Florida, for transmission to St. Petersburg, Alaska.

BROADCAST LISTENER

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

By RAYMOND FRANCIS YATES

Will Broadcasting Become A "Public Utility?"

BROADCASTING, in the mind of this sanguine reviewer, is still a vast experiment that has almost entirely eluded the business acumen of its Pittsburgh progenitors. It is a good idea running amuck.

The problem of making radio something more than a free lunch has been carried to the college professors of finance and economy for diagnosis but they have shaken their academic craniums in grave doubt. Broadcasting is to them a curious new specimen about as entertaining as a four-legged louse might be to the entomologist. It electrifies the imagination but it gripes judgment and reason. It is fascinating and dynamic with possibilities but it is at the same time loaded with a new kind of business poison that has within the last few years laid low an astonishingly large number of victims.

Bombastic, Kiwanistic, enthusiastic America, the business laboratory and booby hatch of contemporary civilization, was the only hot house in which a nebulous idea like broadcasting could take root and sprout. "Telling the cockeyed world" is profoundly and characteristically American. Broadcasting, as an instrumentality for use in informing the strabismatic world was immense; a wampus kitty of the best sort.

What greater ally of pep could man invent? It was magnificently Rotarian.

America went into the broadcasting business wholesale. It was the spectacle of a duck discovering water upon emerging from a desert.

Here was a new business tonic, a new medium for propaganda, publicity, advertising and good will. Breathless representatives of furniture stores, hotels, chiropractic schools, colleges, universities, street railways, city governments, department stores, churches, laundries, and manufacturers of a long and sundry list of things ranging from tooth paste to playing cards, besieged the Department of Commerce with applications for wavelengths.

Hastily instituted conferences found the confreres unanimous in their belief that a kilowatt of advertising would help them sell more toothpaste and linoleum than eleven pages in the *Saturday Evening Post* and that in radio they had at last discovered a medium which would permit them to tell their "message" to the public smoothly, adroitly and effectively. The expense was reasonable, the results obvious. You had but to squirt your stuff into the unprotesting ether and before you could say "Jack Rabbit" it would leak into a million homes, percolate through millions of receptive intelligences and send them right out into the streets hell-bent for a drug store dispensing

your dyspepsia tablets or a soda fountain unloading your ice cream.

Five years have passed since this hysteria was at flood tide and these years have disillusioned many a rampageous adherent to broadcasting. Tidy fortunes have been thrown to the bowwows in the search for the new elixir of advertising and many red-hot and violent passions formerly located in the cortex have slipped down to the stomach to produce nausea and colic. The events of the first three years were somewhat gratifying. The public, fascinated by the novelty of this new colossus of communication, was liberal and ingratiating in its correspondence. It was not long, however, before the public began to write itself out of appreciation. Then it finally became indifferent and calloused.

Now it is fickle and positively critical. It has long since stopped writing to the enthusiastic managers of WBX and WVC, and those enthusiastic managers have shown symptoms of palpitation in presenting their reports to the directors of the Little Wonder Gas Lighter Company and the Imperial Hotel.

The figures and the results are not on friendly terms.

These notes are not the random jottings of an alarmist nor are they the frothy musings of an armchair statistician. Broadcasting is in a precarious position. That is an obvious and demonstrable fact.

Every ruse to get public reaction in something more than a puny measure has been unavailing; and advertisers paying fancy sums for the services of toll stations have, in many instances, been unable to reconcile the expenditure with results. As an object of exploitation, the announcer has become as barren as a desert. His puerile harangues of by-gone days have been supplanted with the tasty morsels of deep-dyed psychologists; but even these have failed to make the public express itself. If the public does not write, one cannot send out one's booklet, one cannot tell one's dealers of the great interest shown in one's product and one cannot, with any degree of certainty, determine what one has done for oneself in the way of creating good will.

While the improvements in broadcasting technique have not been overwhelming, they have been perceptible, and diligent investigation would reveal a still-growing list of listeners.

The trouble is that the public has grown tired of writing and that is the price the broadcasters ask. Why should the public write? The responsibility for this thing rests with its Pittsburgh papas; with those who started it. Certainly not with those who were induced to support it.

The simple truth of the whole matter is that broadcasters are losing their incentive. The game is not worth the

B. R. Babcock, Shenandoah, Iowa

253 MILES OF TELEGRAMS

When station KFNF of Shenandoah, Iowa, recently celebrated its anniversary, it received this pile of congratulatory telegrams—over 200,000 in all. Try and count 'em!

candle. There are no evidences of panic, but an observer with anything like a sense of proportions cannot help but discern a growing uneasiness in the ranks of even the most faithful. The pressure on the Department of Commerce for new wavelength assignments has been considerably reduced and a surprisingly large number of studios were abandoned during 1925.

If the present system of broadcasting, which at its best is a haphazard, unorganized effort, is showing unmistakable signs of decay, what has the broadcast listener to look forward to?

While this Department has never had a record for crystal gazing, it cannot help but feel that broadcasting will survive only as a public utility. This means that eventually radios will be rented like gas stoves and telephones and that the renter will be responsible not only for the entertainment but for the care of the instrument as well. The present situation cannot endure indefinitely.

That is as plain as your gold tooth.

* *

The Lost Squawk

Seated one day at the radio,
I was weary and without smiles,
And my fingers wandered idly
Over the much-used dials,*
I knew not how I was tuning,
Or what I was dreaming there,
But I struck one brand new station
Like the sound of a jazz band blare.

It linked all well-known squeals
Into one horrid din,
And trembled away into silence
As if it were loath to sin,
I have sought, but I seek it vainly,
That one lost squawk divine,
Which came from the heart of radio,
And entered into mine,
It may be that an announcer
Will speak through that squeal again,
It may be that he will tell me,
This is WAAM.

—*Catherine E. Dennis*

*Poetic License No. 6278.

* *

Now You Write One!

Now that the tearful pleading for mail has reached and moved all of the soft-hearted people in the country, our broadcasters who do a little advertising business on the side have gone back to one of the oldest tricks in the business. When you come right down to brass tacks, this trick amounts to nothing more than a lot of plain flimflamming.

The trick is this:

You, Dear Reader and Listener, know best what you like to hear on the radio. How can a poor broadcaster who doesn't even know what you look like or what kind of toothpaste you use be expected to get up a program that will please *you*?. Isn't that expecting too much?

Just think of the hundreds of thousands of *yous* whom we are trying—yes, struggling—to please and you will understand that without *your* suggestions, we are lost. So sit right down now and write to the Harmony Boys and tell them what you want them to play.

Unless you do this broadcasting isn't really worth while.

That is the new psychology of announcing. The listener is made to feel like a Little Captain of Programs and unless he speaks and tells the poor studio managers what he wants in the way of music, all broadcasting is futile.

* *

HORSE: (looking at farmer with set of radio earphones on.) Well, of all the crazy harness, that's the darnedest I ever saw! —*Life*.

A Breezy Program Feature

IT's nice to have so many pleasant things to say this month. Once more the little bunch of violets goes to WJZ.

You might begin to think that we are getting to be an old softy where WJZ is concerned. If you do, don't let the thought keep you awake nights, because we are really the same old toughy and it would take a whole express train full of Sunday School teachers to reform us. As tough and touchy as we are, we cannot overlook merit.

For several months now WJZ have been covering the bald spots between its features with news items of national importance. We must admit that this is a mighty fine way of using up spare time.

Incidentally the news broadcast is so fresh and breezy that several very bad cases of pneumonia have been reported.

* *

One of the Three Best Stations

Now that we have run off all of the disagreeable stuff, we shall get out the old jimmy-pipe and be nice and pleasant. You know we really do like to be amiable and all that but if you are the least bit conscientious about your work as a writer of *critique*, it is practically impossible to keep smiling from one paragraph to another.

Going back over last winter's broadcasting one cannot help but feel that WJZ made conspicuous progress both in the quality of its programs and their presentation. Modulation has been improved, power increased and, although Mr. Brokenshire is still untamed, we feel that WJZ is one of the three best stations in America.

And the year before last we were thinking seriously of putting WJZ down on the "just fair" list!

S. R. Winters

THE "BOOK OF REGRETS"

In this volume, in the Radio Section of the U. S. Department of Commerce, are recorded the unapproved applications for broadcasting licenses—nearly 500 in all.

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 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.

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.

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 stockholder 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 cooperate 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.

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E. F. W. ALEXANDERSON, *Chief Consulting Engineer of the Radio Corporation of America.*
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JOHN R. MOSS, *President, Kiwanis International.*
W. D. TERRELL, *Chief Supervisor of Radio, Department of Commerce, Washington, D. C.*

In the World's Laboratories

(*Continued from page 155*)

must be developed, he believes, for the generation and detection of such very high-frequency waves.

The chief present obstacle to the use of waves only a few millimeters long in actual radio transmission, over short distances at least, is the difficulty of obtaining beams of these waves having any substantial intensity. Waves in this wavelength region have been produced by a number of methods;* but they are always of feeble power. The new and needed apparatus, which Dr. Langmuir foresees, will consist, one may be sure, of some device by which these extremely short waves may be produced in much greater intensity or by which the waves from a number of relatively feeble radiators may be concentrated into an intense beam, as is done when the light from several arc lamps is combined to produce the beam of a very powerful searchlight.

Dr. Langmuir's suggestion deserves a hearty second. This is a field which needs to be called especially to the attention of radio amateurs who have time and energy for new lines of experimentation. It may seem a long step from our present broadcasting range to the ultra-short waves in the millimeter wavelengths. It is really no longer, however, than the one which we have already made from the original radio waves, thousands of meters long, to the ten and fifteen meter waves which are now in successful use. The radio amateurs have been the chief agents in opening up the wavelength range between ten and one hundred meters. Let them be the first to try for the still lower waves which Dr. Langmuir suggests.

The successful generator of these waves will consist, quite probably, of some totally new device working on a new principle. Nevertheless, there are three things, now known, which are worth trying. One is the iron-dust generator of Madam Glagolewa-Arkediewa, in which the resonators are tiny individual filings of iron. Another is the device, tried years ago by the French experimenters, of putting the entire oscillating circuit inside the vacuum tube, so that the length of the leads can be reduced. A third is the device of reflectors; a combination of a number of feeble oscillators of the iron-filing type or of the type of Nichols and Tear, with reflecting mirrors so arranged as to give a directed and powerful beam of the very short radiation.

Still another suggestion, which is so little understood that no one knows

*Nichols and Tear produced radio waves as short as one-fourth of a millimeter (one four-thousandth of a meter), see "The Shortest Radio Waves Ever Produced by Man," by E. F. Nichols, POPULAR RADIO for July, 1923, pages 22-29. Equally short waves have been detected in the radiation of a mercury arc lamp, see POPULAR RADIO for August, 1925, page 175. Madam Glagolewa-Arkediewa succeeded in producing waves as short as one-tenth of a millimeter, see POPULAR RADIO for November, 1925, pages 464–465.

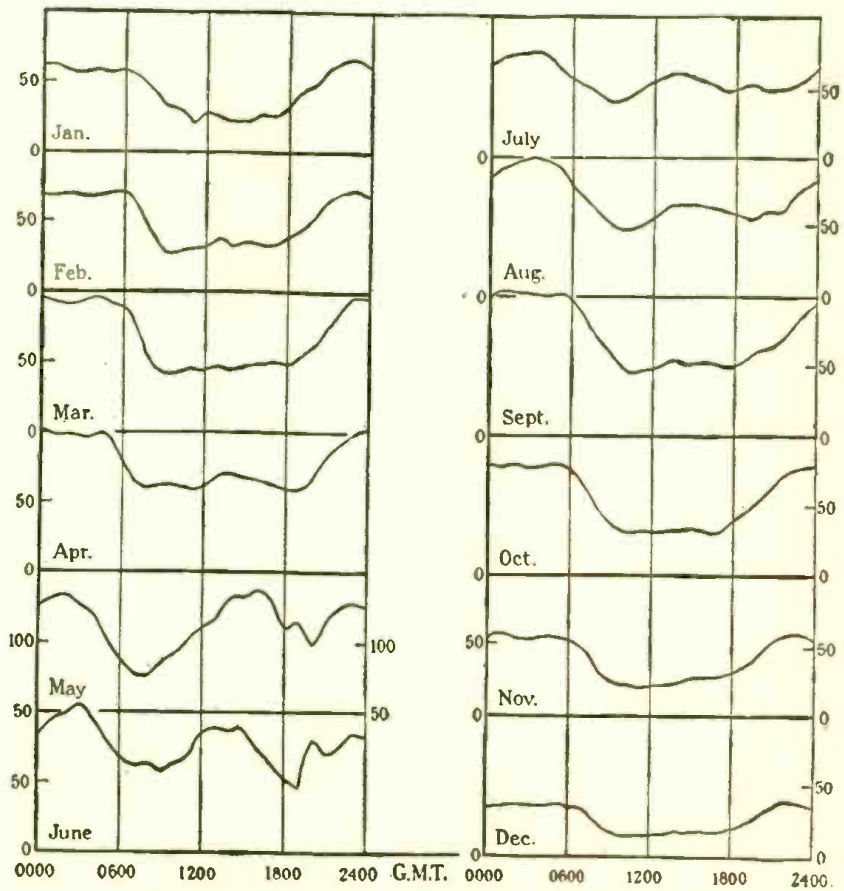
whether it is foolish or not, is the idea that radio waves in this range might be produced directly from heat energy, without involving the oscillation of electric charges (in the usual manner) at all. In the neighborhood of a thousandth of a millimeter wavelength, not much shorter, you observe, than the waves produced by Madam Glagolewa-Arkediewa, the waves of the ether-wave series consist of ordinary heat rays, like those received from the sun. Here lie, also, the "black light" or infra-red rays, rays just a little longer than those which affect our eye as red light. The longer waves of heat overlap the shortest radio waves. Nichols and Tear produced them both and measured both on the same apparatus, thus proving that the heat rays and the radio waves were the same.

No one seems to have experimented importantly with the production of intense beams of the longest heat waves —which would be, of course, the shortest radio waves. Possibly some way can be devised to produce in this way, from some new variety of furnace, the stronger beams of millimeter waves which the use of these waves in broadcasting or in communication would require.

In whatever manner these waves are produced, one chief obstacle to their use will probably be the air. The rays of heat and of infra-red light are largely absorbed by our atmosphere. Much of the heat of the sun fails, for this reason, to reach the surface of the earth. Artificial beams of heat rays, like those produced, for example, from an electric heater, are absorbed in passing only a few feet through air. In the upper regions of our atmosphere, however, the passage of these millimeter waves would probably be almost unimpeded. Even the waves of forty and fifty meter wavelength pass along the upper ionized layer of the atmosphere with very little loss. The practical problem will be, probably, to get the millimeter waves up into this upper layer and down again out of it. But, if strong enough beams can be produced, possibly this problem can be solved. For the first experiments it need not be considered. The work can be done over short distances, as it was at first with the waves in the ten to forty meter range.

Static Writes Its Diary

MR. R. A. WATSON WATT is already well known as one of the leaders in that small group of radio engineers who are endeavoring to learn the exact facts about the great bane of radio, static, or to speak more exactly, of "atmospher-



AN AVERAGE PICTURE OF THE YEAR'S STATIC

The average daily intensity of static, as indicated by Mr. Watson-Watt's automatic recorder over a period of two and one-half years, is shown by these charts, one for each month of the year. Each chart begins at midnight, marked "0000." Noon is indicated by "1200"; six p.m. by "1800" and the following midnight by "2400." "G.M.T." means Greenwich time, which is the official time of England.

ics."* His latest step is the development of an automatic machine which writes a record, hour by hour and day by day, of the intensity and direction of the static impulses that arrive at a receiving station.†

The apparatus works on the principle of a slowly rotating loop antenna, the directional properties of which supply the information concerning the direction of the atmospheric. A magnetic oscillograph operates a pen which makes a mark on the chart, indicating the arrival of an impulse. The position of this mark on the chart also indicates the direction in which the loop was pointing at that instant. Although the instrument is admittedly crude and subject to known errors, it unquestionably does give the most complete record obtained so far of the intensity and direction of static from hour to hour of the day. As Mr. Watson Watt well says, previous records of static have been very inadequate samples; samples covering only those hours when the records happened to be made.

The data obtained for the direction of the static are not yet sufficient to tell us much beyond what we already know. Apparently there is still reason to believe that much of the static, if not all of it, originates in areas where thunderstorms or similar atmospheric disturbances are going on. The distribution of static during the hours of the day is elucidated, however, by a considerable mass of data. The amount of disturbance bears a close relation to the hours of sunrise and sunset. In England, on long wavelengths, the static appears to reach a maximum about six hours after sunset. The minimum is at about four hours after sunrise. There is a second maximum about five hours before sunset and a second minimum at about the hour of sunset.

Mr. Watson Watt suggests an international cooperative investigation of the hours, directions and intensities of static, along lines similar to those followed in this study. It is to be hoped that something of this kind will be done. Static is now the chief obstacle to transoceanic radio telephony. It is a great detriment to broadcasting. Facts which we can learn about it are sure to have practical value, as well as use for radio and geophysical theories. The cost of installing a series of automatic static recorders in several parts of the world would not be great and would be sure to be repaid.

*For an account of the earlier work of Mr. Watson Watt see POPULAR RADIO for February, 1924, pages 205-206.

†"The Directional Recording of Atmospherics," by R. A. Watson Watt. A paper read before the Wireless Section of the Institution of Electrical Engineers, London, March 3, 1926. Information for this note is from an advance copy of the paper distributed by the Institution. At the same meeting Mr. Watson Watt and Mr. J. F. Herd presented another paper on "An Instantaneous Direct-Reading Radiogoniometer," in which similar principles were applied to the automatic registration of the direction of any incoming radio signal. Both papers will be published in the *Proceedings* of the Institution.

Earth Electricity

(Continued from page 113)

insulating supports but exposed freely to the air, the charge on it will leak slowly away. Just so, the negative charge on the earth itself leaks slowly away. Professor W. F. G. Swann, of Yale University, stated recently in a lecture before the Franklin Institute in Philadelphia, that if the negative charge of the earth were not continually renewed ninety percent of it would leak away through the air in ten minutes.*

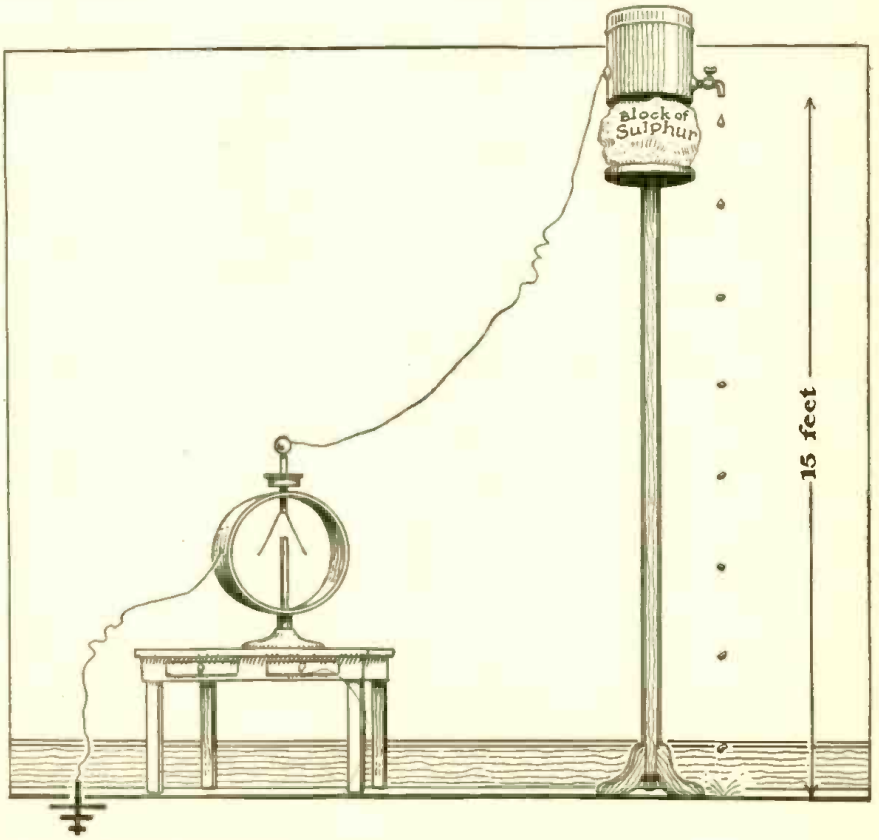
A convenient way to think of this air-leakage of earth electricity is to imagine the atmosphere acting as a great potentiometer. The earth's surface is one terminal, maintained at a negative potential. Some level in the upper air is the other terminal, maintained at a positive potential. Electricity passes between these terminals through the air. The air acts as the wire of the potentiometer. This "wire" varies in conductivity; being more conductive in the higher levels of the atmosphere than it is in the lower. Accordingly, the fall of potential is greatest for one meter of the "wire" in the lower levels, next to the soil. It is less higher up. If you tap off a voltage from any given height in the air, it is the same as though you took off a tap from a certain distance along the wire of a potentiometer. The potential of the tap will lie between the potentials of the two terminals of the potentiometer. Just so an electrode in the air will be positive toward the earth's surface and negative toward the upper air.

Where Does All This Energy Come From?

From this comparison it is apparent at once that the fundamental question of earth electricity is that of the source of energy. Whence comes the negative charge which is maintained so continuously on the earth's surface and which leaks through the atmosphere to create the variations of potential with height?

This question has never been answered satisfactorily. One answer, long considered a plausible one, was the suggestion that very high-speed electrons are arriving all the time on the earth from outer space, possibly from the sun. It is possible to prove that if the speed of these incoming electrons is

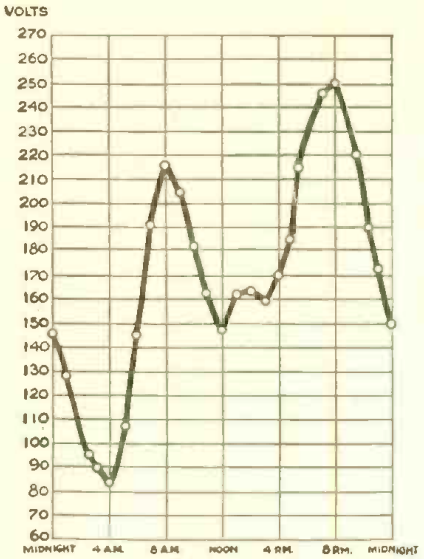
*"The Origin of the Earth's Electric and Magnetic Phenomena," by W. F. G. Swann. *Journal of the Franklin Institute* (Philadelphia, Penna.), volume 201, pages 143-176 (February, 1926). This lecture, together with an earlier one by the same author before the same Institute, constitutes the best short summary of atmospheric electric phenomena with which the present writer is acquainted. The earlier address was "Unsolved Problems of Cosmical Physics," published in the *Journal*, as above, volume 195, pages 433-474 (January, 1923) and reviewed in POPULAR RADIO for February, 1924, page 300.



From a drawing by Arthur Merrick

HOW THE ELECTRICITY IN THE AIR IS MEASURED

The water drops, falling from the metallic can, keep that can at the air potential at its height, here fifteen feet. The difference of potential between this level and the ground is indicated by the electroscope, the gold leaves of which stand apart by virtue of this potential. A block of sulphur forms the best insulator for the raised water can. The air potential fifteen feet up is usually about 400 volts.



ONE DAY'S RECORD OF ELECTRIC POTENTIAL ON THE EARTH

This curve shows the variation of the earth's electric charge hour by hour during an average undisturbed day. The figures of the vertical scale indicate the difference of potential for one meter of height, measured near the earth.

high enough, almost as great as the speed of light, they will penetrate the earth's atmosphere without being stopped by collision with the atoms of the air. These electrons would provide, of course, a negative charge for the earth's surface and this charge would be continually renewed.

It now seems probable, however, that this explanation is not the true one. In the address referred to above, Professor Swann reviews this and other suggestions. This one he rejects because special experiments designed to detect the supposed stream of electrons arriving continually from space have shown no sign of its existence. Other suggestions he rejects for reasons equally cogent. He concludes, finally, that the only plausible explanation, for both the electric charge and the magnetic field of the earth, lies in a modification of our fundamental ideas of electrodynamics.

The usual equations by which engineers calculate the movements and properties of electricity assume that electric charges remain unchanged except as they may be neutralized by equal quantities of opposite charge. It is possible, however, to make slight modifications in the ordinary electric equations, which modifications are not otherwise unplausible, and which permit us to assume a slow and very slight disappearance of positive electricity within the rotating earth. This would leave an excess of negative electricity. It would explain just what we find, namely a continually renewed negative charge on the earth.

In the July issue of POPULAR RADIO *Dr. Free will describe the facts about earth magnetism, why the earth is magnetized, the changes of earth magnetism and how these are believed to influence radio.*

WHAT READERS ASK

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 Diagram and Parts for the Interflex Receiver

QUESTION: Is there such a thing as an Interflex circuit or one having a similar name? I enjoy experimenting with different types of circuits; and I should like to build one. As I just wish to experiment with it I would prefer to make the necessary coils rather than go to the expense of buying them.

—JAMES BRYAN

ANSWER: You probably have reference to the Interflex circuit which has been described both in this country and in the British Isles. A circuit of this receiver is given in Figure 1. This particular set uses two stages of transformer-coupled amplification. Any type of amplifier may be added.

The following parts are necessary:

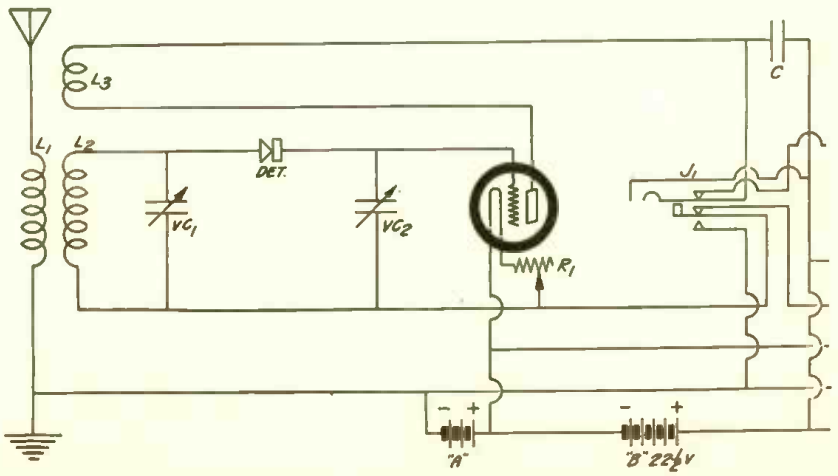
L1, L2 and L3—a special type of coupler used in this circuit;
VC1—variable condenser, .0005 mfd.;
VC2—variable condenser, 2-20 mmfds. (usual "balancing" type);
C—fixed condenser, .00025 mfd.;
R1—rheostat, Bradley or Filkostat;
R2 and R3—filament control cartridges, Brachstats or Amperites No. 1A;
J1—filament control jack, double-circuit type;
J2—filament control jack, single-circuit type;
AFT1 and AFT2—Audio-frequency transformer, first and second stage types;
Det—crystal detector.

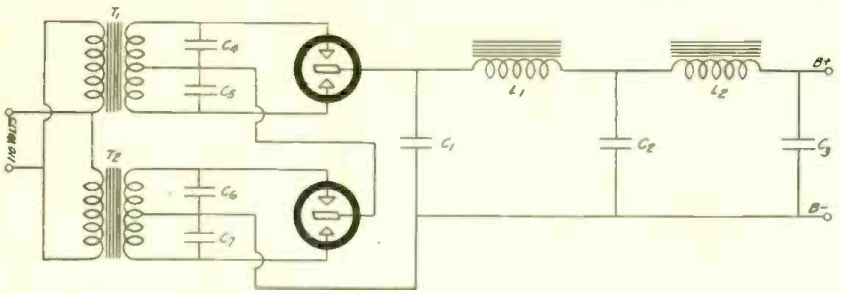
The inductances, L1, L2 and L3, form a coupler similar to the type used in untuned primary three-circuit couplers. The secondary, L2, should consist of 46 turns of No. 22 DCC wire, wound on a three-inch tube about 3¼ inches long. Space ¼-inch from the lower end (to which the filament is to be connected); and wind 8 turns of the same wire for the primary, L1. The tickler, L3, usually consists of a 25-turn honey-comb coil mounted on a threaded rod, which in turn is mounted so that the tickler may be moved from one end of the stator to the other. A knob is fastened to one end of the rod to provide a means of rotating it. The coil is so mounted at the other end that it rotates independently of the rod. Two flexible connections should be made to the tickler.

The crystal detector should preferably be of the carborundum type so that its adjustment will not be critical and will be fairly permanent.

The variable tuning condenser, VC1, may be of any type which has the proper capacity; but, as in any other receiver, the use of one which has something approaching straight-line-frequency characteristics will simplify tuning at the higher frequencies. The use of such a condenser does not increase the selectivity of the set, but merely "separates the stations" in a mechanical sense. That is greater angular rotation of the rotary plates is necessary at low-capacity settings to secure a given change in capacity.

To adjust the receiver, tune in a station that operates on 450 meters or so; and adjust the tickler until the set oscillates. Then tune in a short wavelength station; and adjust VC2 until the regeneration is sufficient to keep the detector just below the oscillating point. You will find from experimentation the best setting for the tickler on DX stations.





THE CIRCUIT DIAGRAM FOR A HIGH-VOLTAGE PLATE SUPPLY UNIT

FIGURE 2: *The connections for the use of two Raytheon tubes for a high-voltage output. A standard two-step filter is used to smooth out current variations. It will be noted that the primaries of the transformers are connected in parallel while the secondaries are connected in series.*

A High-Voltage Raytheon Plate Supply Unit

QUESTION: I want to build a high voltage plate supply unit to supply sufficient voltage and current to operate a UX-210 tube properly. I have some Raytheon full-wave rectifier tubes on hand and would like, if possible, to use them in the unit. The "Power-pack Amplifier," that was described in the April, 1926, issue of POPULAR RADIO is much the sort of thing I want except that I don't require as much current as this unit can supply, and that it uses a rectifier tube of the heated filament type. Is there any way of securing more than 180 volts (which is the maximum I have seen advertised) from the type of unit that I wish to construct?

—J. S. BROWN

ANSWER: A diagram of such a unit is shown in Figure 2. You will need the following parts:

T1 and T2—transformers of the step-up type which give a high voltage, such as the Thordarson;

C4, C5, C6 and C7—condensers, fixed, .1 mfd.;

C1, C2 and C3—condensers, fixed, of the same capacity as normally used in these units except that they should be capable of operating *continuously* at 400 volts (flash test should be about 2000);

L1 and L2—choke coils, any standard type for these units, such as the Thordarson.

This arrangement consists essentially of two units of the conventional type connected in series to keep the voltage across each tube within the operating limits of the tube. This arrangement is recommended by the manufacturer of the rectifier tube.

The filter is a standard one of the same type as were used in the "Power-packs" except that high voltage condensers should be used. Note that the condensers should be tested at a voltage of approximately 2000. The continuous operating voltage should be approximately 20 percent that of the "flash" test voltage to insure proper operation.

The primaries of the transformers are connected in parallel. The secondaries are in series; and it is evident that the secondary of one will have a potential difference to ground almost twice that of the other. For this reason a transformer should be used which has a comfortable safety factor.

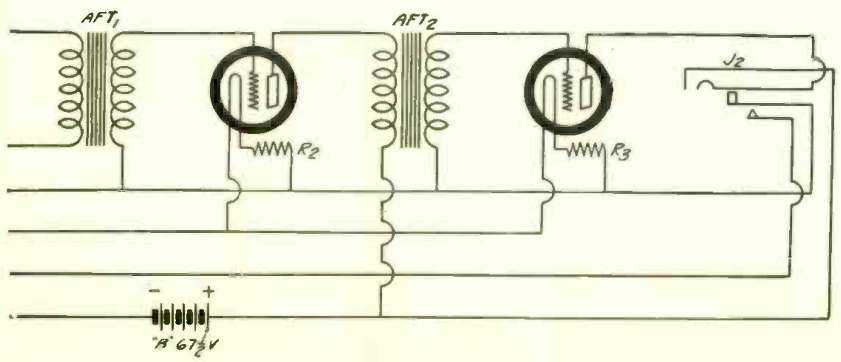
The cores of both transformers and their shells, the cases of the choke coils and the condensers should all be grounded.

Such a unit cannot be loaded as heavily as a single unit; and it will only supply 20 or 25 milliamperes satisfactorily. This is sufficient to operate the UX-210, when properly biased. The supply voltage will vary with the load and with the voltage of the transformers; but it will be of the order of 350 volts.

The high negative bias which is necessary for the UX-210 may be secured by using the drop in a resistance in the plate circuit of the tube. This resistance should have a value of approximately 1,000 ohms. This may be connected, as shown in the "Power-pack Amplifier" that was described in the April, 1926, issue of POPULAR RADIO or in this department in the February, 1926, issue. Shunt this resistance with a 2 mfd. condenser.

THE INTERFLEX HOOK-UP

FIGURE 1: *The connections for the various instruments and parts that go into the makeup of the Interflex circuit. The circuit uses a tube and crystal detector to obtain a combination of radio-frequency amplification and detection as well as two separate stages of audio-frequency amplification.*



BROADCASTS

Is Baseball Most Popular Broadcast Feature?

IN the remarkable development of daylight broadcasting during the past year, baseball is said to be the most popular feature. Probably more than anything else, it was baseball along with football that brought broadcasting stations to realize what a good bet was being overlooked if they closed down during daylight hours.

* *

Facts and Fancies About Fans

To what extent the information that has been brought out by the Congressional inquiry into the radio copyright problem is based on actual figures and to what extent they are based on personal opinions remains to be seen. But here are some percentages that have been submitted for consideration:

Paul Klugh of the Association of Broadcasters, said that 70 percent of the active broadcasting stations were now accepting advertising, using the revenue to pay for talent.

Gene Buck of the Society of Authors, Composers and Publishers, claimed that 90 percent of the composers were poor men, while another witness asserted that nevertheless they controlled 90 percent of the copyright music.

The Society of Composers, it was declared, included 90 percent of the popular music writers.

According to the American Telephone and Telegraph statistics, 50 percent of the 5,000,000 listeners own their own homes, 75 percent of them have phonographs and over 50 percent own pianos.

* *

Why Program Managers Get Grey-headed

WHAT a task faces the program manager of a broadcasting station who must keep track of which copyright pieces of music may be played and which may not, may be judged when it is learned that no less than 21,850 musical compositions have been copyrighted during the past three months alone.

Radio Helps the Copper Business

THE radio industry has more than doubled its consumption of copper during the last two years and is now approximating a total of 10,000,000 pounds a year.

* *

Is Radio Taxation Profitable?

RADIO fans in Sweden are to have the license fees for receiving sets reduced in 1926. This is because the revenue to the Swedish Telegraph Administration, which controls the broadcasting field in that country, has been more than satisfactory for the twelve months just passed.

The net profits to the administration up to November, 1925, were 150,000 crowns. Up to 200,000 licenses were issued at that time. The Swedish Broadcasting Corporation has also been able to make a nice profit from the sale of these licenses alone.

This extra profit is to be turned to the advantage of the listener, because it is proposed to have between 16 and 18 stations in operation in Sweden by the end of the year.

* *

England's Broadcast Experiment Ends

FROM now on the British Government will reign over the field which formerly was entirely in the hands of the British Broadcasting Corporation. At the expiration of the latter's monopoly contract, a permanent broadcasting committee was appointed to study and govern the radio broadcasting situation throughout the British Isles, with the exception of the Irish Free State.

Before the work of this permanent committee is felt, however, British fans will no doubt know how they will be affected. Another Government Committee, of which Rudyard Kipling is a member, will draft plans for the future of England's broadcasting. This committee includes Government officials, as well as radio engineers and scientists.

1,644,325 Licensed Receivers in Great Britain

ALTHOUGH there are a number of "radio pirates," whose failure to secure a license would decrease the official total of British radio fans, there have been, nevertheless, 1,644,325 receiving licenses issued so far. In December, 1925, there were 69,593 licenses issued, which was an increase of several thousand over any other month of the year.

When the grand total reaches the two million mark, Great Britain will probably have more radio fans, *per capita*, than any other country in the world.

As the broadcast stations are conveniently located and efficiently cover the territory within their radius, crystal receivers are numerous.

* *

A Remarkable Transatlantic Radiophone Demonstration

IT is a little over twelve years ago that engineers of the U. S. Naval Laboratory at Arlington, Va., and of the French Signal Corps, at the foot of the Eiffel Tower in Paris, communicated for the first time by radiotelephone across the Atlantic. And it was a great feat. The second experiment of the series was recently accomplished when a four-hour telephone conversation, the 3,000-mile link of which was by radio, was successfully carried on from London and New York.

With a power of 100 kilowatts in each station, and using wavelengths of 5,260 meters for America, and 5,770 for England, as perfect reception and transmission, as with an ordinary telephone instrument, was possible.

The American transmitter is located at Rocky Point, Long Island, and is connected to New York City by means of land wire circuits. The receiving station in England is in Wroughton, from which the signals were sent to London by wire. The transmitting circuit for England originates in London, thence to the high-power station at Rugby, thence, by radio, to Houlton, Maine, where the American receiver is located. Wires convey the messages to New York.

The air line distance was about 3,400 miles, and the total distance travelled by the messages in various circuits was probably another thousand miles.

* *

The Tallest Radio Tower

A RADIO tower which, in its total height is two feet taller than the famous Eiffel Tower, will hold the new antenna of the German Ministry of Posts and Telegraphs' station at Keonigswusterhausen, near Berlin. The tower of aluminum is 828 feet above the ground, and has an antenna mast 58 feet higher. And it takes a half hour for the hardiest climber to ascend the 1,000 steps of the spiral stairway to the top of the tower.

How the Boy Scout Earns the Merit Badge in Radio

1. He must receive and send correctly not less than ten words a minute.

2. (a) He must explain how to get in communication with another station. (b) He must explain how to send a message in proper form.

3. He must tell in his own words the principal laws and regulations regarding radio communication.

4. He must demonstrate at least ten of the radiogram abbreviations (Q signals).

5. (a) He must explain the purpose of a detector and adjust a crystal detector, using a buzzer to test its adjustment. (b) He must name two minerals used in crystal detectors.

6. He must draw from memory, using correct symbols, a hook-up diagram of a complete vacuum-tube transmitting apparatus, including generator or batteries, vacuum tube, condenser, tuning helix key, antenna, ground and the necessary protective devices. He must also describe each part of the apparatus and explain its function. He must explain how to use a wavemeter in connection with this transmitting apparatus to secure the proper wavelength of radiation.

7. He must draw from memory, using correct symbols, a hook-up diagram of a complete receiving apparatus using a vacuum-tube detector, including antenna, two-circuit tuner, detector, fixed and variable condensers, resistances, batteries, phones and ground. He must describe each part of the apparatus and explain its functions.

8. He must describe a vacuum tube and explain its three principal uses—as detector, amplifier and oscillator.

9. He must explain the difference between continuous wave, modulated or interrupted continuous wave and spark signals. He must explain how each kind of signal is produced and how each kind is received.

10. He must construct with his own hands a practical, working, receiving set and demonstrate its operation for receiving signals from a station twenty-five miles or more away.

11. He must explain how to install an antenna, how to connect it to the sending and receiving set, how to ground it properly and how to protect it against lightning. And he must state the Underwriters' laws for safeguarding radio apparatus.

A DISCRIMINATING burglar in New York is reported as stealing nothing but radio sets.

* *

THE only woman who can be sure her husband really works when he says he does, is the wife of the radio announcer. And even she can't tell what he's up to while a selection is being broadcast.

YOUR INDIVIDUAL PROBLEMS SOLVED

POPULAR RADIO maintains for the benefit of its readers a Technical Service Bureau and Laboratory, under the personal supervision of Laurence M. Cockaday which will, without charge, answer by personal letter any question, problem or request for information submitted by a subscriber. This service is, however, also available to readers, other than subscribers, at the very nominal rate of 50 cents the inquiry.

In writing please confine your questions to one general subject, writing on one side of the paper only, and enclose a self-addressed and stamped envelope.

It is possible that your individual problem has been covered in an issue of POPULAR RADIO, and so as an aid to you we endeavor to keep a supply of back numbers in stock. The condensed index below gives a few of the subjects that have appeared recently, look this list over and if the information you want is covered, we will be pleased to supply back numbers at 35c. a copy.

June, 1925
—New Development in Vacuum Tubes.
—How to Build a Five-tube A-C Receiver.
—How to Draw Up Your Own Tuning Chart.
—Watt's Law in a Nutshell.
—"What Set Shall I Buy?" First Installment.

July, 1925
—The Best 101 Hook-ups.
—"What Set Shall I Buy?" Second Installment.
—Broadcast Stations in the United States.
—What's New in Radio Apparatus.

August, 1925
—"Motion Pictures" by Ether Waves.
—A New Type of Hornless Loudspeaker.
—How to Build a 5-Tube Radio-Frequency Set with Simplified Control.
—Trouble Shooting.
—Hints for Amateurs.

September, 1925
—How the Air Affects Radio.
—When You Turn Your Dials.
—Useful Charts for Amateurs.
—Call Letters That Have a Past.
—Broadcasts.

October, 1925
—How Earth Magnetism Affects Radio Waves.
—How to Improve Broadcast Reception.
—What Makes a Low-loss Coil?
—How to Build the New 8-Tube Superheterodyne with a Single Control.

November, 1925
—Radio's Newest Instrument—the Photo-electric Cell.
—How to Build the Raytheon Plate Supply Unit.
—New Methods of Calibrating Your Receiver.
—Practical Pointers About Transformers.
—Multi-layer Coils.

December, 1925
—How to Build The New LC-26 Receiver.
—How to Improve Broadcast Reception.
—What Every Radio Experimenter Should Know About Condensers.
—"Truthful Reproduction," How to Get It from Your Set.
—Radio that Runs on a Beam.

January, 1926
—How to Get the Most Out of Your LC-26 Receiver.
—Some New and Useful Facts About Coils.
—When Your Set Won't Work.
—Straight-Line-Frequency Condensers.
—What's New in Radio Apparatus.

February, 1926
—How to Reduce Distortion in Amplification.
—Some Stunt Sets.
—Important Kinks in Wiring.
—How to Cut Down Your "B" Battery Bill.
—Hints for Amateurs.

March, 1926
—A New Theory of Wave Transmission.
—Why and How the Milliammeter Increases the Efficiency of Your Set.
—What "Inductance" Really Is.
—List of Broadcast Stations in the U. S.
—How to Build the S-C Receiver for Short and Long Waves.

April, 1926
—How to Get an Operator's "Ticket."
—What a Straight-line Frequency Condenser Really Is.
—How to Build a Power-pack Amplifier.
—The New "Crystal Pilot"
—How to Build and Operate a Low-Power Transmitter.
—The Popular Radio Medal for Conspicuous Service.

May, 1926
—How to Draw up Your Own "Tuning Graphs."
—How to Build the Improved Raytheon Power-pack.
—How to Build an Antenna Mast for $15.00.
—Fifteen Ways to Reduce Static.
—Do Your Coils Broadcast?

POPULAR RADIO
Department 68
627 West 43d Street New York

Pacific & Atlantic

THE "RADIO PEN" IN ACTION

By merely plugging into the loudspeaker jack of a receiving set, the apparatus shown above, Mr. C. Francis Jenkins, the inventor, reports that ink drawings may be transmitted and recorded by radio in much the same manner as the more familiar telautograph machines.

Who Causes All the Interferences?

AMONG all of the sources of broadcast interference, broadcasting stations that interfere with each other cause 65 per cent of the trouble. Static causes 16 percent of the marring of programs; fading accounts for 12 percent of the difficulties experienced by radio fans, and 14 percent are attributed to "other causes."

These findings are the result of a year's work by some 100 Government listeners, located in every section of the country. Altogether 7,500 observations were made, and during those tests only 33 percent of them were perfect to the extent of being completely free from interference or difficulties.

The observers used station KDKA as the index station. The distances the signals were heard and reported upon varied between 10 and 4,000 miles. The observations were made at 55 minute intervals throughout the year.

Among the "other causes," which contribute 14 percent of the interference, were listed interference from other receiving sets, amateur transmitters, commercial land and ship stations, and power lines.

* *

Predicting Radio "Weather"

IT may not be unusual for radio fans to receive from accredited stations reports very much the same as the U. S. Government weather reports in the morning mail, telling them how the radio weather is going to be for the evening. Interesting experiments have been carried out along those lines by J. C. Jensen, of the Department of Physics of the Nebraska Wesleyan University, which have been watched by Government Weather Bureau experts from Washington.

Mr. Jensen has been able to prepare some forecasts of radio receiving conditions, as affected by weather relations with some success. A typical release, which is transmitted daily from station WCAJ, is as follows: "For Eastern Nebraska: Fine radio night, free from static. Best ranges may be expected from the south, southeast, and east. Fading will be experienced from the northwest."

* *

Where Radio Customers "Build Their Own"

THERE is one place in the world where the radio fan should be a contented soul, the radio workshop of Selfridge and Company, a big department store in London. There radio fans who have secured admission tickets from the store's radio department may build their own sets under the instruction and supervision of set-building experts. The shop, which is open daily, is scheduled off into two sessions. There is no charge for the service.

The system has been called "Wireless without Tears."

* *

One Receiver to Five Families

ACCORDING to a recent survey of the radio industry, one out of every five families in the United States owns a radio set.

In addition, the statisticians tell us that the radio sales have jumped from $5,000,000 in 1920 to $500,000,000 in 1925.

But the most surprising announcement is that almost $15,000,000 were spent last year on broadcast programs.

Educational Tests by Radio

IN addition to the effort of the Swedish Government Radio Service to teach English to its subscribers, it will give a "general knowledge" test feature of an educational nature.

An impartial board, made up of editors from all sections of the press, is to frame a series of questions on geography, history, literature, current events and music. The music tests will ask the listeners to identify famous selections of musical airs.

The questions will be broadcast, and fifteen seconds will be allowed the listeners to write down their answers to each question. Then the correct answer will be broadcast.

There are over 120,000 listeners in Sweden who will have the opportunity to educate themselves in this novel way.

* *

International "Radio Rights" of Authors

So far-reaching have been the effects of radio that it has now become necessary to consider the international aspects of the authors' rights and royalties, with respect to their broadcasting.

In view of this, the Locarno Congress, under the presidence of Professor Bogler, director of the Zurich Conservatory of Music, has been engaged in considering the best ways to solve the problem.

A motion has been made and approved, whereby the Society of Intellectual Development Branch of the League of Nations shall create a special international commission which shall specially study the questions of the rights of authors before the microphones, from an international angle.

* *

A Triple-Control of Broadcasting in Japan

WITH radio broadcasting in the hands of three separate and competitive organizations, one would think that the situation would be particularly bright for listeners of Japan. The Government, however, is seeking to amalgamate the Tokio, Osaka and Nagoya companies, so that greater centralization of the broadcast work may be carried on.

The Tokio Broadcasting Company, which operates the popular Tokio station, has been the most successful so far, having 146,000 subscriber-listeners. The Osaka station is supported by 40,000 listeners and the Nagoya company numbers 16,000 supporters.

* *

A Record Two-way Communication

An outstanding high-frequency development is contained in the report that the U. S. S. *Black Hawk* has held two-way communication with stations at distances from 7,000 to 12,000 miles.

Audio-frequency Amplification

(*Continued from page 140*)

permits us to recognize differences in tone, and so to distinguish between notes of the same pitch played, for instance, first on a violin and then on a flute. Just in so far as our amplifier magnifies these various harmonic frequencies faithfully will we be able to recognize the original sounds.

Requirements in Amplifier Design

Our conclusion is, then, that an ideal amplifier would magnify uniformly and sufficiently from 16 to 16,000 cycles, but that a practical outfit need not be required to go below 64 cycles nor above 6000 cycles per second. It must, however, within this range, give adequate and constant amplification. Such an amplifier, when used with a good loudspeaker (one that has a corresponding frequency range of uniform reproduction), will reproduce radio speech and music of a natural quality that will astound listeners who have been accustomed to the varied kinds of muffled or shrill sounds which are given off by most radio receivers. If you install an amplifier-speaker of this sort, you may expect most of the people who hear it to say they did not know radio was capable of producing such good music.

The three things that are necessary, as practical matters, to get amplifier operation of this desirable kind are:

(1) The use of tube coupling apparatus that operates efficiently from the lowest to the highest desired frequencies.

(2) The elimination of tuning or resonant effects (often produced by by-pass condensers) or feed-back conditions in the audio system, either of which would tend to exaggerate the response at certain pitches or frequencies.

(3) The provision of vacuum tubes sufficiently large to handle the maximum power without overloading, together with adequate power to operate them efficiently.

The Frequency Characteristic

Taking these up in order, the question of how the audio amplifier tubes are coupled to the detector, to each other and to the speaker is of prime importance.

To get sufficient volume to fill a good sized living room, it is desirable to use either two transformer-coupled tubes or three resistance- or impedance-coupled tubes. The resistance-coupled amplifier, when carefully designed, is probably most nearly uniform in amplifying power over a wide frequency range; but a number of the outfits that have been offered for sale do not have desirable characteristics. Some of the modern audio transformers give even better results than the average resistance-coupled or impedance-coupled arrangement; and in general they have the advantage of simplicity and tube-and-battery economy. However, to get good results you must use good transformers. All good transformers seem to be relatively expensive; but it is not so certain that all expensive transformers are good.

The matter of resonant periods is mainly dependent upon how fixed condensers are associated with the transformer coils. Except as a radio-frequency by-pass around the first primary, none should be used; and even here the size of condenser must be chosen carefully with regard to the type of transformer used. In resistance- and impedance-coupled systems this effect is not so prominent, for the tube-linking condensers should be of large size (2 microfarad) despite the economy of smaller values. Artificial augmentation of resonant effects by audio feed-back is usually indicated by a tendency of the amplifier to ring or sing. It is often caused by "microphonic" detector or radio amplifier tubes, in which case it may be cured by replacing the tubes at fault. Where it persists because of battery coupling, large by-pass condensers are often of assistance.

Why Power Is Needed

Perhaps the least recognized, of the three essentials stated above, is the third.

Most radio designers and users have gone on the principle that a tube large enough to reproduce violin music at moderate intensity is powerful enough for any purpose. The fact is otherwise, for, in order to reproduce the low tones that are so essential in a musical background, the final audio-amplifying tube must be able to stand relatively high instantaneous voltages without being overloaded. If it cannot do this, the music will sound broken or distorted whenever deep or loud tones come through, or else the lower tones will be partly suppressed. This is true even though the average volume is made no greater than that desirable for the average living-room. It becomes particularly evident when the outfit is called upon to deliver still greater volume.

The solution of this problem is the use the newer and more powerful tubes for the final audio stage. The UX-112 will do for moderate volume; but the UX-210, used with 300 or 400 volts in the plate circuit, is much better. The larger tubes supply reasonable reserve power; and operation with them gives one the comfortable sense that nothing is being strained. Yet the ability to produce great volume is there for use when desired—for instance to play dance music. The situation is comparable to

that in driving a high-powered motor. One may seldom want to make 70 miles an hour, but the same reserve power that makes it possible on demand has the effect of providing greater flexibility and comfort at lower speeds.

The selection of the loudspeaker is every bit as important as the design of the amplifier; but it is based upon considerations too extensive to be treatcd in this short article. You will get the best results by using the best cone-type speaker you can buy, in conjunction with a powerful and well-balanced amplifier.

In selecting your speaker, be sure that you hear it driven by a proper amplifier; otherwise you may be misled, for a good speaker will show up the defects of an unsatisfactory amplifier by giving poor reproduction when connected with it.

Yet the same speaker used with a correctly designed amplifier may give practically perfect speech and music.

DX Fans on the Warpath

"LISTENERS' boycotts" are new, but they are understood to have won a "silent evening" in Chicago for the long-distance fans. Now in California fans are threatening not only to boycott station KQW, which refuses to keep silent during the DX period, but also all Santa Clara Valley products. Station KQW, which is located in San Jose and is said to represent the local agricultural interests as well as a church, appears to be in a serious situation. Through this very station considerable money has been spent to popularize the products of the local district. How long the supporters of KQW can withstand a boycott on their products is problematical. It is already in effect, according to a report which states that long-distance radio set manufacturers are also being injured by the ruining of the DX period.

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 *(together with the changes which have been published in succeeding months) make the list correct as of April 20, 1926. Further changes will be published each month in this magazine.*

STATIONS DELETED

KFVR	Denver, Colo.	244
KFXM	Beaumont. Tex.	227

CHANGES IN CALL LETTERS

KQP	Portland, Ore., *change to*	KOIN
WFBI	Camden, N. J., *change to*	WCAM
WGWY	Minneapolis, Minn., *change to*	WDGY
WJBG	Greensboro, N. C., *change to*	WNRC

CHANGES IN WAVELENGTHS

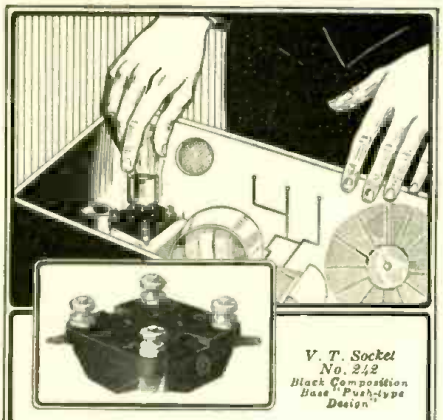
KQP	Portland, Ore., 212.6, *change to*	319
WGBX	Orono, Me., 252, *change to*	234.2

CHANGES IN LOCATIONS

KMOX	*Kirkwood, Mo., *change to*	St. Louis, Mo.
KFVN	†Welcome, Minn., *change to*	Fairmont, Minn.

*Transmitter in Kirkwood, offices and studios in St. Louis.

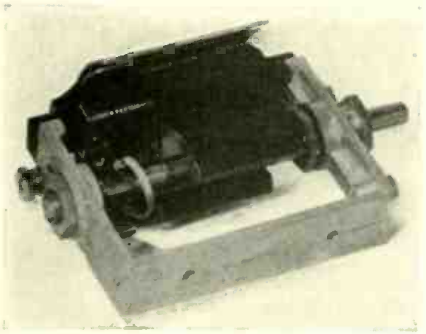
†Transmitter only, changed to Fairmont.



V. T. Socket No. 242 Black Composition Base "Push-type Design"

WHAT'S NEW IN RADIO

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.*



AN ULTRA-COMPACT VARIABLE CONDENSER

Name of instrument: Variable condenser.

Description: In this condenser the plates are probably spaced more closely than in any other condenser on the market. They are mounted in milled slots in a solid rotor. Stationary plates are also mounted on a milled section of metal that is supported by a strip of insulation which also carries a metal shield. The frame of the condenser is of die-cast aluminum fitted with bearings and provided with a stop that allows the rotor to turn only through the prescribed arc that is necessary for operation. The metal parts except the frame are gold-plated. The condenser is of the straight-line-frequency type.

Usage: In any radio-frequency circuit for tuning.

Outstanding features: Extremely compact. Neat in appearance. High efficiency. Electrostatically shielded. Straight-line-frequency tuning.

(*Further details furnished on request.*)

A NEW DETECTOR UNIT

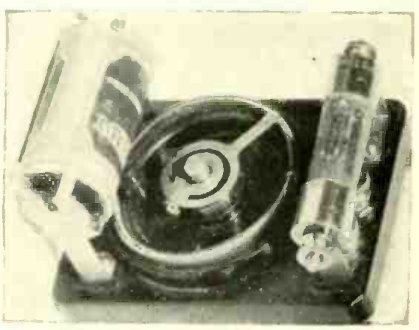
Name of instrument: Carborundum crystal detector.

Description: In this unit is combined in very handy form a fixed carborundum crystal mounted in an interchangeable tube, a small flashlight battery that is mounted in special clips and a potentiometer of suitable resistance for applying the sensitizing voltage to the crystal. The unit will be found extremely effective as a rectifier or a detector following a stage or a number of stages of radio-frequency amplification, or simply as a detector in a crystal set. The potentiometer helps to sharpen tuning and helps to stabilize ordinary radio-frequency receivers.

Usage: In a receiver as a rectifier or detector.

Outstanding features: Compact form. Good sensitivity. Adjustable potentiometer that will control effective resistance.

(*Further details furnished on request.*)



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 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 L through M.

AERIALS

Spring aerial and counterpoise; Mack Co.
Complete aerial kit; Leslie F. Muter Co.

AMPLIFIERS

Complete 3-stage resistance amplifier; Leslie F. Muter Co.

AUDIO-FREQUENCY TRANSFORMERS

Audio-frequency transformer; Liberty Transformer Co., Inc.
Audio-frequency transformer; Marle Engineering Co.
"Marco" audio-frequency transformer; Martin-Copeland Co.
Audio-frequency transformer; Maxum Radio & Electric Co.
Modern-Symphony transformer; Modern Electric Mfg. Co.
Modern reflex transformer; Modern Electric Mfg. Co.
Muter audio-frequency transformer; Leslie F. Muter Co.

BATTERIES

"Red Seal" dry batteries; Manhattan Electrical Supply Co.

BATTERY CHARGERS AND RECTIFIERS
Ful-Wave battery chargers; Liberty Electric Corp. of N. Y.

BATTERY ELIMINATORS
Mayolian B-supply; AC transformer unit, type 601; DC filter unit, type 602; Mayolian Radio Corp.
"B" battery eliminator; Morrison Radio Corp.

CRYSTAL DETECTORS
Wonder fixed detector; Lego Corp.
Mar-Co. crystal detector; Martin-Copeland Co.
Miller-B-Metal crystal; A. H. Miller Radio Co.
Argentite crystal; Mineral Products Co.
"M.P.M." crystal; M.P.M. Sales Co.

DIALS
Mar-Co vernier dial; Martin-Copeland Co.
A. J. vernier dial; Mydar Radio Corp.
"Accuratune" micrometer control; Mydar Radio Corp.

FIXED CONDENSERS
"Micamold" condenser; Micamold Radio Corp.
"Muter" mica fixed condenser; Leslie F. Muter Co.

GRID-LEAKS AND RESISTANCES
Elkay resistor; Langbein & Kaufman
Mar-Co grid-leak; Martin-Copeland Co.
Micamold fixed resistors; Micamold Radio Corp.
"Me-Am-Co" grid-leak; Michigan Elec. & Mfg. Co.

HEADPHONES
Lark headphone; Leich Electric Co.
"Red Seal" headset; Manhattan Electrical Supply Co.
"Repeater" phone; Moss-Schury Mfg. Co.
Mozart-Radioceiver headset; Mozart-Grand Co.
Murdock phones; Wm. J. Murdock Co.

INSULATORS
Insulators; M. & M. Co.
Antenna lead-in insulator; Leslie F. Muter Co.

JACKS
Duo-stage jacks; Leich Electric Co.
Mar-Co Shur-gr-p jack; Martin-Copeland Co.
Non-solder jack; Metro Electric Mfg. Co., Inc.
"Murdock" plug jack; Wm. J. Murdock Co.

KITS
Superheterodyne kit; Liberty Electric Corp.
Lincoln kit; Lincoln Radio Corp.
Resistance-coupled amplifier kit; Micamold Radio Corp.
KU-54 one-dial kit; Mohawk Electric Corp.
8-tube superheterodyne kit; Moskowitz & Herbach.
Complete aerial kit; Leslie F. Muter Co.

LIGHTNING ARRESTERS
Lightning arrester; Leslie F. Muter Co.
Guardian arrester; Leslie F. Muter Co.

LOOPS
Lincoln collapsible loop; Lincoln Radio Corp.
"Red Seal" map-loop; Manhattan Electrical Supply Co.
Folding loop aerial (with couplers); Marion Electrical Mfg. Co.

KNOBS AND DIALS
Knobs and dials; R. Mitchell Co.

LOUDSPEAKERS
The Talking Book; Listen-in Publishing Co.
Magnavox reproducer; Magnavox Co.
Manhattan loudspeaker; Manhattan Electrical Supply Co.
Morrison loudspeaker; Morrison Laboratories, Inc.
Mozart loudspeakes; Mozart-Grand Co.
"Atlas" loudspeaker; Multiple Electric Products Co., Inc.
"Murdock" loudspeaker; Wm. J. Murdock Co.
"Music Master" loudspeaker; Music Master Corp.

MISCELLANEOUS ACCESSORIES
Terminals; Liberty Transformer Co., Inc.
"Bull Dog" mast seat; Mast Seat Mfg. Co.
Choke Coil; Mayolian Radio Mfg. Co.
Step-up transformer; Mayolian Radio Mfg. Co.
Saddle ground clamp; Mertz Specialty Co.
Battery connectors; R. Mitchell Co.
Antenna tensionator; R. Mitchell Co.
Fluxite; Monarch Products Co.
Morrison toner: Morrison Laboratories, Inc.
B-Radicator; Mu-Rad Radio Corp.
Instant adjustable ground clamp; Leslie F. Muter Co.
Resistance mountings; Leslie F. Muter Co.

PANELS
Panel; Marshall-Gerken Co.

PHONE PLUGS
Lark plugs; Leich Electric Co.
Mar-Co switch plug: Martin-Copeland Co.
Mar-Co multi-plug; Martin-Copeland Co.
Automatic shock-proof phone plug; Leslie F. Muter Co.

PHONOGRAPH ATTACHMENTS
"Red Seal" phonograph attachment; Manhattan Electrical Supply Co.
Loudspeaker "Mocking Bird" unit; Morrison Laboratories, Inc.
"Atlas" phonograph attachment; Multiple Electric Products Co., Inc.
"Accuratune" phonograph attachment; Mydar Radio Corp.

POTENTIOMETERS
Mar-Co armorclad potentiometer; Martin-Copeland Co.

POWER AMPLIFIERS
Magnavox power amplifier; Magnavox Co.

RADIO-FREQUENCY TRANSFORMERS
Vario-transformer; Langbein & Kaufman Radio Co.
Special air core radio-frequency transformer; Liberty Transformer Co., Inc.
Radio-frequency transformer; Marle Engineering Co.
Radio-frequency transformer; Maxum Radio & Electric Co.
Superformer; Moskowitz & Herbach
Radio-frequency transformer; M.P.M. Sales Co.

RECEIVING SETS
Elkay Super-Selector receiver; Langbein & Kaufman Radio Co.
Uni-Control receiver; Le Mor Radio, Inc.
Liberty Sealed Five Receiver; Liberty Transformer Co., Inc.
Arborphone receiver; Machine Specialty Co.
Magnavox broadcast receiver; Magnavox Co.
Marwol A-1 receiver; Marwol Radio Corp.
Metro-Magnetic receiver; Mercury Electric Corp.
Mercury receiver; Mercury Radio Products Co.
Metrodyne Super-Five receiving set; Metro Electric Co.
Michigan receivers; Michigan Radio Corp.
Miraco Ultra 5-receiver; Midwest Radio Corp.
Mohawk Single-control receiver; Mohawk Electric Corp.
Moon Satterlee antennaless receiver; Moon Radio Corp.
Moon Ultra-five receiving set; Moon Radio Corp.
Mu-Rad Transcontinental receiver (one dial); Mu-Rad Radio Corp.
Murdock neutrodyne receiver; Wm. J. Murdock Co.
Music Master receiving set; Music Master Corp.

RHEOSTATS
Mirra rheostat; Liberty Screw Products Co.
Marshall-stat; Marshall Electric Co.
Rheostat; Marshall-Gerken Co.
Mar-Co rheostat; Martin-Copeland Co.

SOCKETS AND ADAPTERS
Improved socket; Leich Electric Co.

A MINIATURE VOLTMETER

Name of instrument: Direct current voltmeter.

Description: A small but accurate voltmeter that may be attached directly on the panel of a radio receiving or transmitting equipment. It is furnished with a double range of voltage from zero to 7 volts and from zero to 140 volts.

Usage: On a receiving set for measuring the "A" and "B" battery potentials.

Outstanding features: Reliable. Rugged in construction.

(Further details furnished on request.)

"Thorobred" socket; Marshall-Gerken Co.
Mar-Co V.T. socket; Martin-Copeland Co.
Double-contact socket; Masda Radio Mfg. Co.
Radion Socket; Merrick Laboratories

SWITCHES

"Mac-Kontrol"; Mack Co.
Mar-Co filament battery throw switch; Martin-Copeland Co.
Mar-Co double-pole, double-throw swi ch: Martin-Copeland Co.
Keelock switch; Metro Electric Mfg. Co . Inc.
"Se-Ar-De" automatic selector switch; R Mitchell Co.
Double-pole, double-throw switch; Leslie F. Muter Co.
Single-pole, double-throw switch; Leslie F. Muter Co.

TESTING INSTRUMENTS

Mack Reconditioner; Mack Laboratories

TOOLS AND EQUIPMENT

Alcohol blow torch; Lenk Mfg. Co.

TUBES

Elektron tube; Lectrodio Corp.
Magnavox tube; Magnavox Co.
Dyn-a-blue tube; Magnite Laboratories
Dynatron tube; Magnite Laboratories
AC tube; McCullough Sales Co.
McCullough rectifier tube; F. S. McCullough Co.
Duotron tube; Miles Electric Co.
Myers tube; Myers Radio Tube Corp.
Myers tubes; E. B. Myers Co.

TUNING INDUCTANCE UNITS

Universal variometer; Langbein & Kaufman Radio Co.
Variable clarifying selector; Langbein & Kaufman Radio Co.
Lincoln tuner; Lincoln Radio Corp.
Oscillascope; Lincoln Radio Corp.
Low-loss tuner; A. C. Lopez & Co.
Control-O-Meter; Malone-Lemmon Products.
Variometer; Marshall-Gerken Co.
Mar-Co tuner; Martin-Copeland Co.
Cockaday coils (silk wound); McConnell Cable & Specialty Co.
"Se-Ar-De" coupler; R. Mitchell Co.
Toroidal coil; Morris Register Co.
Precision selector; Moskowitz Herbach.

VARIABLE CONDENSERS

Mirra straight-line-frequency condenser; Liberty Screw Products Co.
Low-loss condenser; Lincoln Radio Corp.
Lombardi SLF condenser; Lombardi Radio Mfg. Co.
Lombardi condenser; Lombardi Radio Mfg. Co.
Red Seal variable condenser; Manhattan Electrical Supply Co.
Mar-Co super-vernier condenser; Martin-Copeland Co.
Variable condenser; Mignon Electric Mfg. Corp.
"Se-Ar-De" condenser; R. Mitchell Co.
3-Gang condenser; Mohawk Electric Corp.

A FIGURE EIGHT WINDING

Name of instrument: Radio-frequency transformer.

Description: The coils that are located inside the bakelite housing, shown in the illustration, are wound in the form of figure eight coils that are self-supporting. Two terminals are brought out on each side of the unit—two for the primary and two for the secondary. Coils of this type have a very small external field.

Usage: In a radio-frequency circuit as in interstage-coupling device.

Outstanding features: Compact. Inductive field. Neat appearance.

(Further details furnished on request.)

A TRANSFORMER WITH A VARIABLE RATIO

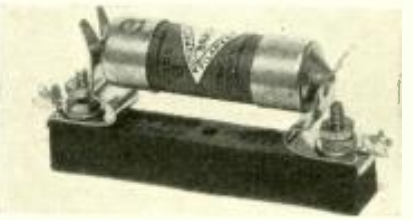
Name of instrument: Audio-frequency transformer.

Description: This transformer is unique in that it contains four taps on the inductance of the primary winding. In this way, the ratio of the transformer may be changed to suit the conditions in the receiver with which it is used. It has been designed especially for the radio set builder and experimenter who wishes to use just the right ratio for the circuit which he is trying.

Usage: In a radio receiver as an audio-frequency interstage-coupling device.

Outstanding features: Neat construction. Accessible terminals. Variable ratio. Good tone. High amplification.

(Further details furnished on request.)



AUTOMATIC FILAMENT CONTROL

Name of instrument: Automatic rheostat.

Description: This unit is furnished with a mounting similar to the ordinary grid-leak mounting circuits in place of the ordinary rheostat for controlling the filament current of vacuum-tube receivers. It may be used in any tube where it is necessary to vary the filament current, as in the case with a regenerative detector.

Usage: In any receiver as an automatic filament control.

Outstanding features: Compactness. Reliability. Requires no adjustment.

(Further details furnished on request.)

A USEFUL INSTRUMENT

Name of instrument: Moulded grid leak.

Description: The resistance element in this part is moulded inside and hermetically sealed in a solid bakelite compound so that moisture and climatic conditions cannot affect its resistance value. It is made with a terminal on each end to fit into the standard grid-leak mounting.

Usage: In any receiver where a fixed resistance of low current carrying capacity can be used.

(Further details furnished on request.)

A TANDEM VARIABLE CONDENSER UNIT

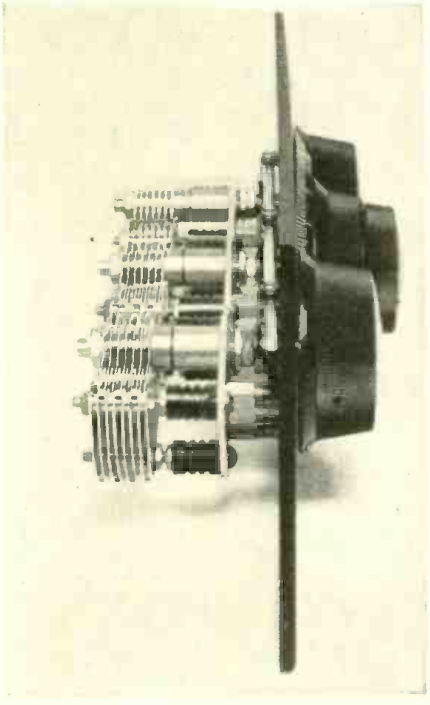
Name of instrument: Single-control variable capacity unit.

Description: This unit consists of a special assembly of two standard-make variable condensers mounted so that the gears comprising parts of the separate instruments mesh with each other and with a special gear furnished with the unit for controlling both condensers from a single dial.

Usage: In a receiver for radio-frequency tuning.

Outstanding features: Single-control. Low minimum capacity. Neat and compact assembly.

(Further details furnished on request.)



A TRIPLE CONTROL

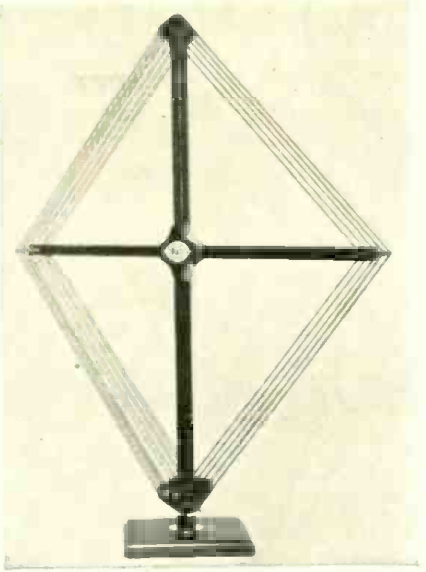
Name of instrument: Triple tuning control.

Description: By means of three special vernier knobs with the center one equipped with a dial, three condensers may be mounted on the panel and controlled with a single dial. The complete assembly operates by means of smooth acting bakelite pinions engaging with a long rack which in turn actuates the three condensers synchronously. The two outer knobs merely act as verniers to line up the capacity of all three instruments to the same value. A vernier on the middle dial operates all of the condensers with slow motion.

Usage: In any radio-frequency circuit for single dial tuning.

Outstanding features: Simplified control. Smooth operation. Neat appearance. Equipped with verniers.

(Further details furnished on request.)



A NOVEL LOOP

Name of instrument: Loop antenna.

Description: A collapsible loop that may be folded up by simply bending the four supporting arms of the center junction. The wooden supports terminate at the outer end in a slotted bakelite strip through which the wires are threaded. This strip is cut in the shape of a V and gives a V section to the loop wires. The two terminals are brought out to binding post at the lower end of the loop close to the center of revolution.

Usage: In connection with a radio-frequency receiver as a pick-up device.

Outstanding features: Neat appearance. Good workmanship. Well insulated.

(Further details furnished on request.)

AN AUDIO-FREQUENCY TRANSFORMER

Name of instrument: Audio-frequency transformer.

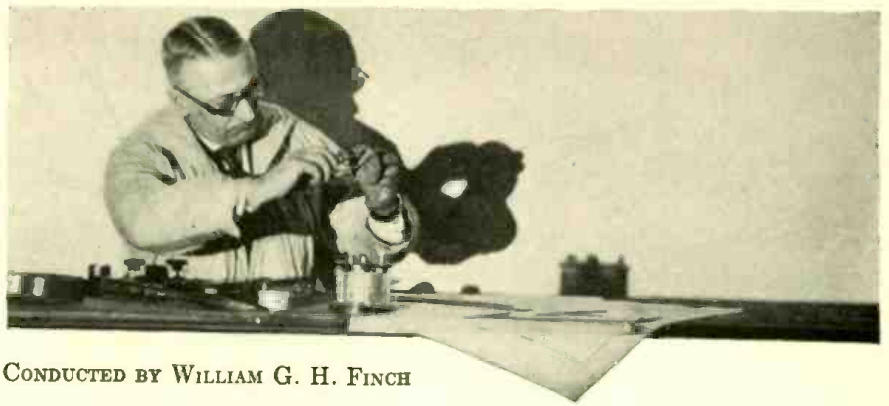
Description: This transformer is mounted in a novel form of case with an insulating slab at the top that carries the solenoid lug terminal. The transformer has a heavy cross-section; and the windings are such that pleasing reproduction is obtained from an amplifier which utilizes these units.

Usage: In a receiver as an interstage audio-frequency coupling.

Outstanding features: Ease of mounting. Good quality. Neat appearance.

(Further details furnished on request.)

WITH THE INVENTORS



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 Device for Using Your Telephone as an Antenna

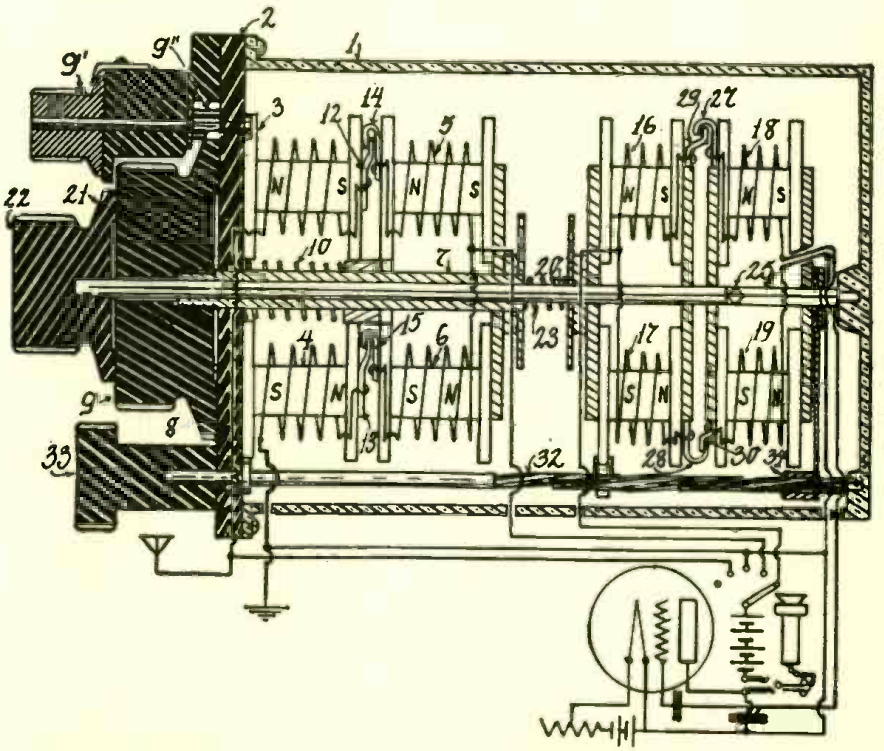
PATENT No. 1,554,626, issued to Harry J. De Nault, of Springfield, Mass., is a simple device for utilizing the usual telephone desk set, with its electric circuit, as an aerial. This does not in any way interfere with the ordinary operation of the telephone or injure it.

The invention consists essentially of a radio-receiving plate that is made up of a bed of insulating material. This bed is provided with a flange or rim that projects some distance above the top. There is also an electrically-conducting member mounted upon this bed, which is provided with means for a wire connection. The plate constructed in this way is large enough to receive the base of the stand of a telephone desk set, together with any other parts that may be necessary to make it serviceable as an antenna.

Some New Developments In Variable Inductances

AUGUST J. KLONECK, of New York City, was recently granted U. S. Patent No. 1,556,612 for improvements in variable inductances and couplers.

The variable inductances described in this invention are of the type which is chiefly used for tuning alternating or high-frequency currents which are em-



NEW DEVELOPMENTS IN VARIABLE INDUCTANCES

FIGURE 1: *How the inductances are mounted as primary or secondary coils in this invention so that sets of coils may be placed in positions where they are mutually magnetic or in opposition to other sets of coils.*

ployed in radio telephony and telegraphy.

The invention aims to produce a variable inductance by moving two or more coils in respect to one another so that they are mutually magnetic or opposing one another. It also aims to combine sets of these inductances so as to form co-operating coils such as the primary and the secondary coils of a transformer.

These objects are attained by the novel arrangement and combination of parts which is illustrated in Figures 1 and 2.

Attached to the inner side of the cover of the apparatus are two semi-circular coils which form a stationary part of one set of inductance coils. These coils are connected together to form opposing poles at one side of the set.

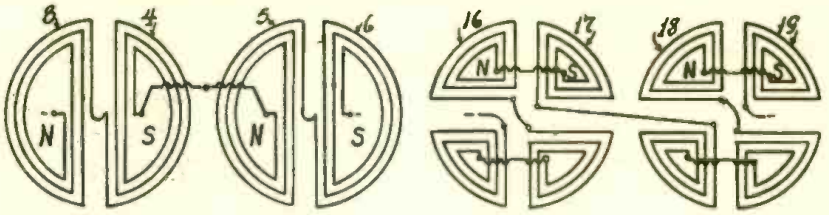
Co-acting with these stationary coils are two rotating coils. These latter are arranged upon a tubular shaft which runs from the coils and a center hole in the cover plate to a brake and dial and an adjusting knob. A spring upon the tubular shaft causes the dial to move upon the cover with friction. For this purpose the dial and cover are centrally undercut so that only a circumferential band is engaged. A separate knob operates the dial by gear for finer adjustments.

As each of the movable coils have different magnetic poles facing the stationary coils, at one position of the coils, the stationary and movable coils will mutually magnetize one another. It follows that when the position of the rotating coils is reversed the magnetic poles of the stationary and movable coils will be opposed to each other and the inductance of the coil set will be zero. Connection between the rotating coils and the stationary part is established by two contact brushes which make contact with ring collectors.

If a separate primary and secondary inductance is needed, another coil may be set in inductive relation to the coil set already described. The latter then forms an independent circuit for a transformer. This second coil set comprises twonon-rotating coils which aremounted on slides so as to obtain a loose coupling effect with the first coil set.

Two rotating coils are mounted on a shaft and co-act with the other coils as a single coil combination. This rotating shaft projects through the dial and knob portion of the tubular shaft to another indicating disk and an adjusting knob.

A spring upon the shaft serves as a frictioning disk for the knob. The end of the shaft is flattened or squared; and the holes in the rotating coils are similarly shaped to allow the rotating coils to slide on the shaft. The rotating coils are connected with the stationary coils by means of two rings which have overlapping flanges and contacts which engage these flanged rings toward the coils. This is shown in Figure 1.



THE ELECTRICAL SCHEME OF CONNECTION

FIGURE 2: *These two diagrams show the general hook-up of the variable coils which are used in the Kloneck inductance. Various additions, omissions and rearrangements of the coils may be made, however, without destroying the essential character of the invention. Square or circular coils may be also used in place of the semi-spherical ones shown.*

A spiral or worm-threaded shaft secured to a knob on the cover plate and engaging a spiral threaded arm of the coils is employed to obtain the sliding movement of the last coil.

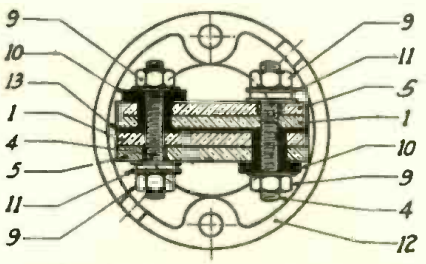
It is obvious that various additions, omissions or rearrangements of coils may be made, if desired. Also, coils which are square or circular in shape may be employed instead of the semi-circular coils, which were described.

Variable inductances and coupling transformers of the types described have a marked advantage over present types of coils. Air core coils, in particular, form small loop aerials in radio signaling and thus produce interaction and interference with other coil actions several hundred feet away, as well as with coils of the same set. For this reason, it is advantageous to employ the parallel, oppositely wound coils which have been described. These coils will not produce an outside magnetic field and are not affected in any way by an outside magnetic field.

A Novel Condenser for Radio Receivers

MARIUS LATOUR, a French inventor and engineer, was recently granted patent No. 1,563,754 for an electrical condenser.

By means of this invention capacities which are shunted by an extremely high resistance may be secured in a piece of apparatus which occupies relatively little space. Low capacities of this type are especially useful in radio receivers where all apparatus is preferably reduced to the smallest practicable dimensions.



THE NEW LATOUR CONDENSER

FIGURE 3: *This new mica fixed condenser was developed to obtain low-capacity effects in relatively small space. The whole structure is held together by means of the two threaded rods.*

The manner in which the cores of the condenser are assembled is clearly shown in Figure 3. The plates are placed inside and are separated by one or more sheets of mica or by any other dielectric which is thick enough to give the desired capacity.

Both ends of a leaf of paper, which has been impregnated with a material which has the desired conductivity, are clamped between plates. These two plates serve as electrodes as well as clamps for the ends of the paper leaf.

The whole assemble is pressed together by means of four nuts which may be screwed on the ends of two threaded rods which are insulated by bushings.

How to Repair Your Radio

HERE are eight simple rules to follow when something goes wrong with the set.

1. Take down the aerial and remove from it all foreign matter such as soot, corrosion, carrier pigeons, Russian propaganda, etc.

2. Try a new cabinet. Many foreign national governments are continually doing this with varied success.

3. Remove the tubes and drop them on the floor a number of times. This is especially advised where it is desired to eliminate microphonic noises. Give the baby a tube and a hammer and watch him socket.

4. Examine the Bee batteries carefully. They may have the hives.

5. When your set squeals do not take it for granted that it is on the hog. It may be caused by a nearby ham.

6. If you cannot tune through the locals and get Italy there is something wrong with the spaghetti.

7. If you are unable to separate stations, get a job as train announcer.

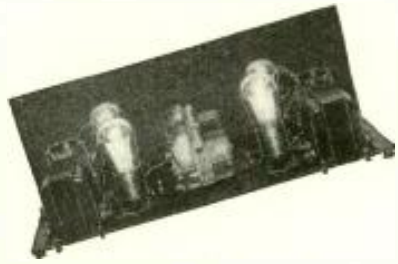
8. Above all, when your set goes phlooey call in a service man. Then you will have something to really worry about.

—ARTHUR L. KASER

Set Builders BOOST THE S-C

4-Tube All Wave Single Control Receiver

Designed by SILVER AND COCKADAY



They Write

"My S-C more than lives up to your claims."
"Assembled S-C in 2½ hours. Worked perfectly."
"S-C wiring harness certainly is a marvel."
"It's absurdly easy to assemble the S-C correctly."
"Amazed that single control works so well without adjustment."
"Bring Chicago into Newark, N. J., with plenty of volume."
"S-C is a wonder for volume and clarity."
"Simplicity and compactness of S-C is absolutely marvelous."
"It's impossible to hook the S-C up wrong."

The designers of the S-C recommend the parts made by the following manufacturers. These parts may be obtained in a complete S-C KIT from any Radio Dealer.

Belden Mfg. Co.
S-C Wiring Harness

Central Radio Laboratories
Centralab Resistance

Polymet Mfg. Corporation
Fixed Condensers, Leak and Leak Clips

Silver-Marshall, Inc.
Variable Condensers, Coil Sockets, Coils, Tube Sockets, Vernier Dial, Mounting Brackets

Thordarson Electric Mfg. Co.
Equiformer Audio Transformers

Poster & Co.
Drilled and Processed Front Panel and Drilled Sub-Panel

Yaxley Mfg. Co.
Rheostat, Jacks, Switch

Universally Endorsed

The S-C Receiver has been endorsed and approved by Radio News, Radio Review, Radio Age, Radio, Radio Engineering, On The Air, Popular Science Monthly, Christian Science Monitor and Newspapers throughout the country. Moreover it is backed by the reputations of its designers —McMurdo Silver and Laurence Cockaday as well as the authority of Popular Radio Magazine.

New Features

In the S-C, single control has been perfected to a remarkable degree. The designers have secured all wave reception through the use of interchangeable coils. S-C volume equals that of many 6 and 7 tube receivers, while reports from S-C owners indicate a consistent range of 1,000-2,500 miles. S-C sensitivity is such that KFI was brought into New York City through a blanket of powerful locals. In quality the S-C is unsurpassed.

Easily Assembled

Anyone can assemble the S-C with just a screw driver and a pair of pliers in a few hours. A specially-designed, multi-color wiring harness eliminates all soldering, unless desired and as one S-C Builder wrote: "Makes it impossible to go wrong." The S-C is adaptable to any cabinet, tubes, batteries or eliminators—in fact to almost every installation condition. It is a marvel of simplicity throughout, which accounts in part for the remarkable endorsement it has received.

S-C MERCHANDISING CO., Inc.

281 S. Peoria St.,
CHICAGO

GET THE S-C BOOKLET FROM YOUR DEALER OR MAIL THIS COUPON

The S-C
Merchandising Company
281 S. Peoria St., Chicago

Gentlemen: Please find enclosed 25c, for which send me handbook of the new S-C Receiver.

NAME_____

ADDRESS_____

Excerpts from Telegrams:

"Tested your RFL-60 within two blocks of local 500-watt broadcasting station, using twenty-five foot wire on floor for aerial. We picked up stations all over the country and when local station came in tuned it out and picked up WSAI at 319 meters. The local station is 270 meters. This is the only set ever tested under these conditions that would tune this station out at any point on dials."—Decatur, Ill.

"We tested one of your new RFL-60 sets here in our building using an antenna about 75 feet long and directly under and parallel with our transmitting aerial. The exceptional selectivity of the Crosley receiver permitted us to tune out our station WTAX, just as easily as we would tune out a Chicago station."—Streator, Illinois.

"An RFL-60 tested in competition with other receivers of much higher price proved its unquestioned superiority. The new Crosley models offer the greatest values on the radio market."—Kansas City, Mo.

"The Model 4-29 is classed with the Trirdyn. Model 5-38 bringing in Pacific points with ample volume, using a Musicone. RFL-60 and 75 are very selective. Have separated distant stations on less than one degree on the dial. Have logged Mexico City and Pacific Coast Stations with plenty of volume."—Miami Fla.

"The RFL sets outstripped much higher priced outfits. These sets bring in Canadian, Cuban and Mexican stations as easily as those on nearby states."—Glasgow, Ky.

What's the idea of keeping a fellow up all night foolin' around with that darned little 4-29?

I've been in the radio game for seven years and was beginning to believe that there wasn't a set in the world that would keep me up late but when that little 4-29 started to pull in Houston, Texas and with such extreme volume I sat up and took notice.

I got California stations with unbelievable volume last night. KFI came in so loud that it could be heard over a block on a Musicone speaker. I've gotten over one hundred and twenty-five stations in only three nights.—Spring Valley, Ill.

The Crosley 5-tube—5-38 *All the volume, selectivity and purity of tone available in the best 5-tube set—plus the Crescendon* **$38**

The Crosley 5-tube—RFL-60 *A set of marvelous performance and beautified by the artistic decorative panel . . . . . .* **$60**

The Crosley 5-tube—RFL-75 *Simplicity and speed in tuning, fidelity of tone and decorative beauty, enhanced by the art panel . . . . . .* **$75**

The Crosley 4-tube—4-29 *In which the Crescendon is equal to one or more additional tubes of tuned radio frequency amplification* **$29**

Prices slightly higher west of the Rockies

By Expressed Opinion of Fans The Greatest Radio Values Ever Offered!

Real performance! Amazing sensitivity and selectivity! Marvelous tonal qualities—inspiring volume. And surpassing beauty!

Read, in the column at the left, the enthusiastic comments of a few of the many radio fans who have *voluntarily* written or wired us their praise.

True radio values—at astonishingly low prices. Hear a Crosley Concert at your nearby Crosley dealer's.

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Powel Crosley, Jr., President

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Over 300,000 of these wonder sets are spreading happiness, education and contentment in homes all over the world.

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