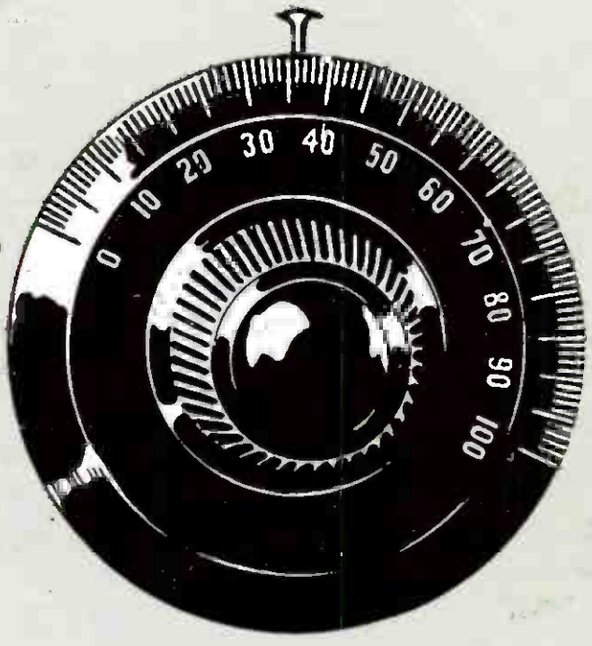
Popular Radio

25¢

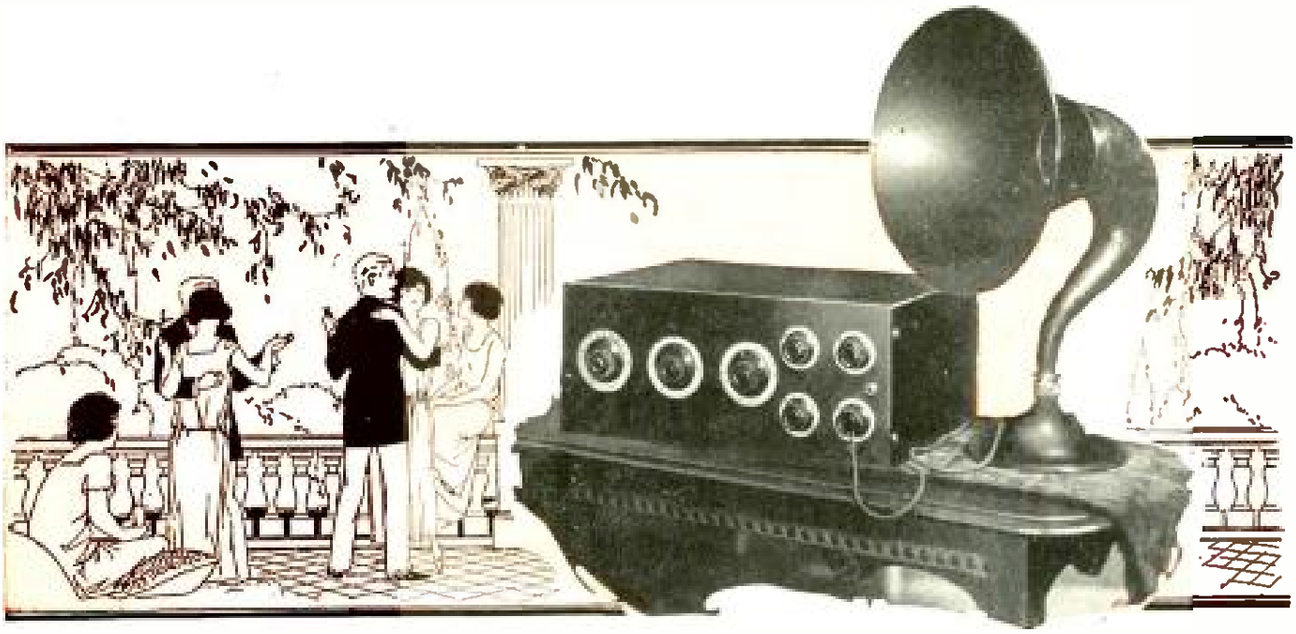
Edited by KENDALL BANNING

JUNE 1924



How to Make a Regenerative BROADCAST RECEIVER for Use with a Short Indoor Antenna

★



Enjoy Radio This Summer-

YOU can get good programs the year round with a *good* receiver — the C & W TELEDYNE.

Dr. Cutting and Mr. Washington have given you 5 vital improvements—greater sensitivity, greater volume, sharper selection, longer range — WITHOUT COMPLICATED, HARD-TO-TUNE APPARATUS.

TELEDYNE is as easily operated — as certain to give you your station as the "old reliable" regenerative sets. No need to "log" stations. Hunt the air at will. A step ahead of neutrodyne.

Cutting and Washington

Ask for a demonstration
at nearest C&W Dealers

THE CUTTING & WASHINGTON RADIO CORP.
Minneapolis, Minn.

The new Cutting and Washington

TELEDYNE

TELE *means distance-* **DYNE** *means power*

Radio Reception
—more perfect this summer!

Tremendous improvements in sending and receiving combine with better programs to provide the best of radio fun!

This is indeed a radio summer! The vital interest of the presidential campaign—waged right in your own home. The glorious and inspiring church services. The important sporting events, market reports, home hints, intensely interesting talks, gay music—all these diversions are brought directly to you.

Why Sending Is Better

Last summer many high power broadcasting stations operated on a single wave length. This summer they are spread over a wave band. You may choose at your will. Sending stations have greatly increased their power and are spreading their programs over many more miles. Broadcasting from interconnected stations includes many people who would formerly have been deprived of the unlimited pleasures of radio.

For sixteen years the Brandes name has consistently stood for service—for skill—and dependability.

Table-Talker - **$10.00**
50c additional west of the Rockies
In Canada - - **$14.00**

Navy Type Headset **$8.00**
In Canada - - **11.00**

Superior Headset - **$6.00**
In Canada - - **7.00**

Why Reception Is Clearer

Sets have been vastly improved. They are more keenly selective, more sensitive, more satisfactory generally. Vacuum tubes have been redesigned, new circuits have been developed. New loudspeakers, assuring accurate and true reproduction, have been put on the market. In fact, the combination of finer programs, stronger sending and clearer reception now makes the mavels of radio an active part of every day life.

All Brandes Products are sold under a money back guarantee by reliable dealers everywhere.

Brandes

The name to know in Radio

POPULAR RADIO

EDITED *by* KENDALL BANNING

CONTENTS *for* JUNE, 1924

(Cover design by Frank B. Masters)

VOLUME V — NUMBER 6

DEPARTMENTS

VOLUME V — JUNE, 1924 — NUMBER 6

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

PAGES WITH THE EDITOR

ONE of the interesting as well as illuminating experiences of an editor's life is to read the letters that come into his sanctum following the publication of each issue of his magazine. Some of the most valuable suggestions for improving POPULAR RADIO have grown out of constructive criticisms in correspondence with readers.

* * *

BUT sometimes the differences of opinion among our readers are so marked—and are expressed with such frank emphasis—that all that the Editor learns from them is that some articles appeal more strongly to one type of fan and other articles appeal more strongly to another type of fan. For instance:

* * *

THE very first letter from a reader to reach us after the April number was issued contained a dig at Don Herold's humorous description of "How I Built a $12.00 Crystal Set, Though 34 Years Old." And the second letter (from L. B. Walton of Kenyon College, Ohio) reported that "the article by Don Herold is delightful." And there we are!

* * *

BUT no differences of opinion on any subject have been more evenly divided than those based upon POPULAR RADIO'S suggestion that the standard left-to-right circuit diagrams be revised to read from right-to-left, in the sequence in which the experimenter builds his set.

"POPULAR RADIO has the right dope. Diagrams drawn from right-to-left are much easier to follow when hooking up your set," votes C. E. Chamberlin, Jr., of Chattanooga, Tenn.

* * *

AND then comes along a satirical protest from A. S. Brown in Norwood, Ohio, who observes; "I am not much on reading diagrams backwards. Perhaps if I could lie on my bed on my back with the diagram pasted on the ceiling I might be able to construct the set all right."

* * *

"I WANT to be the first to thank you for proposing the innovation of showing circuit diagrams to read right-to-left," states E. W. Donnigan of Alden, N. Y. "To me, a novice, it will be most useful."

* * *

ON the other hand, "I am in favor of the schematic drawing as it is," writes Swain Solon of Shenandoah, Iowa. "Why invent a plow that throws the dirt on the left side when it is no better or worse than a plow that throws the dirt on the conventional right side —when both are equally good?"

* * *

THEN, too, there are many fans who take the middle ground and believe, with Herman P. Roth of Olivet, Michigan, that "it makes no difference to me which way the diagrams read."

(Continued on page 6)

Kadel & Herbert

EVEN A BLIND MAN CAN SELL "POPULAR RADIO"

Here is a snapshot of "Blind George" Wittenberg, who runs a newsstand on 42d Street, New York—and listens in at the same time. "I don't keep POPULAR RADIO," *he explains, "I sell it." Here's the proof!*

In radio the Neutrodyne is the ultimate for selectivity and clear, true reproduction, as well as for power and ease of operation.

THOMPSON NEUTRODYNE

means the best radio principle plus the engineering skill of an organization that has been building radio and wireless apparatus for over fourteen years.

The THOMPSON is a factory-built—not an assembled—5-tube Neutrodyne. What this means to you can be demonstrated by any good dealer. Price $150 without tubes or batteries.

THOMPSON MAGNAPHONE

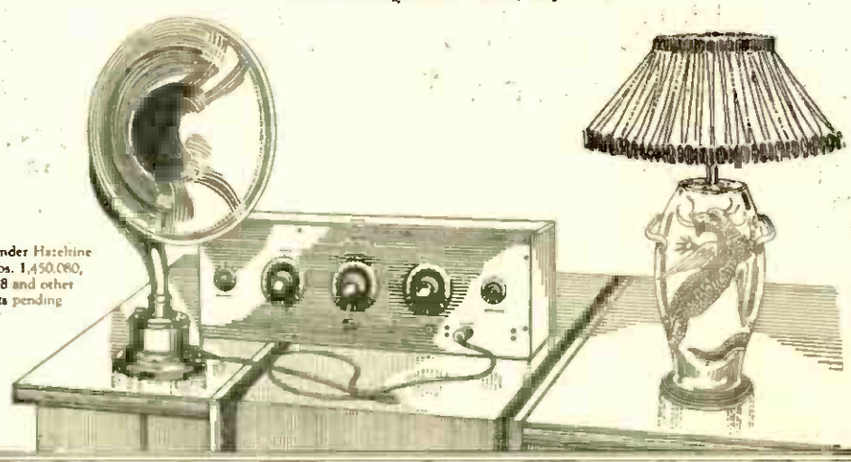
is built upon an entirely new principle that gives purity of tone in any volume—yet no battery current is needed. The THOMPSON MAGNAPHONE is $35 at all good dealers.

R. E. THOMPSON MANUFACTURING CO.

Manufacturers of Wireless Apparatus for the U. S. Army and Navy and numerous foreign governments

150 NASSAU STREET • • • NEW YORK, N. Y.

FACTORY: JERSEY CITY, N. J.



Licensed under Hazeltine Patent Nos. 1,450,080, 1,489,228 and other patents pending

J.C.

PAGES WITH THE EDITOR

(*Continued from page* 4)

THE votes of our readers, as recorded up to July 1, 1924, will settle the question so far as POPULAR RADIO is concerned. If *you* have any opinion on the subject—write to the Editor!

* * *

IT was just one year and one month ago that the famous four-circuit tuner (better known as the Cockaday circuit) was first introduced to the radio world in the pages of POPULAR RADIO. Since that time it has been estimated that nearly 600,000 Cockaday sets have been built—and the number is increasing daily.

* * *

SPORADIC attempts have been made by Esteemed but Disgruntled Competitors to belittle Mr. Cockaday's contribution to the radio fan, ranging from charges that the set "radiates" (which it does *not*) to discussion as to whether or not the set is properly termed a "four-circuit." In the meantime the consistently excellent performance of the Cockaday tuner and its steady growth in popularity continues to give ample demonstration that the set is speaking eloquently for itself.

* * *

AGAIN POPULAR RADIO is being featured in the theater! One of the dramatic successes of the season is "The Show Off," in which the misfortunes of a family are finally recouped by the invention of the bright radio-fan member. "Do you know," writes the charming Regina Wallace, who plays one of the leading roles, "that POPULAR RADIO appears on the stage in one of the acts? That's how much we admire it!"

* * *

"YOUR policy of mentioning specific names of parts in your how-to-build articles is commendable, although one can easily understand the objections of some of the manufacturers. But I think you would fail in getting better sets at work and would indirectly harm the industry if you were to listen to the few who kick."

—F. LANDEG, *Hamilton, Ont.*

* * *

OFFICIAL recognition of POPULAR RADIO keeps coming in from new and unexpected quarters—to the gratification of our technical staff. No more convincing tribute to the scientific status of the magazine can be rendered in France than to be quoted in a publication of the high standards of the *Annales des Postes, Télégraphes et Téléphones* which is the official publication of the telegraph and postal service of the French Government. And in the number for February, 1924 (vol. 13, pages 197-208), the editor has printed complete abstracts of two articles from POPULAR RADIO—Prof. J. H. Morecroft's article on modulation in the July, 1923, number, and John Hogan's article on radio regulation in the U. S., from the same number.

* * *

UP in the conservative Nutmeg State POPULAR RADIO has been entering the schools—and is getting good marks from teacher! Mr. A. Johnson of New Britain, Conn., states:

"It may interest you to know of a rather interesting use to which we are putting your magazine here in a local school. In the chemistry class, a great deal of time is taken up in the studying of the theory of ions and electrons. The writer one day brought in to class a copy of POPULAR RADIO during a study of the construction of electrons, in which was a picture of a model of the very atom we were studying, made by a world-famous scientist. We also had a lively discussion of the Einstein theory which your magazine cleared up for us."

* * *

"I CERTAINLY must write and thank you for the service you are rendering the readers of your magazine in keeping advertisements out of the editorial columns, for that is the weak point of some of the other radio magazines."

—BERNARD KALNEETZ, *Philadelphia, Pa.*

* * *

THE recent activities of certain self-appointed censorship organizations with political influence in ruling off the newsstands some periodicals whose doctrines differ from their own, lead one to speculate what might happen to the scientific magazines in case one school of scientific thought should resort to similar tactics to suppress another group!

* * *

SUPPOSE, for example, that the advocates of the Heaviside Layer Theory similarly suppress the utterances of those who do not share their views—or *vice-versa!* Or suppose that one religious sect, through political influence, bans the writings of another sect? Or that the religious sects should unite to ban all scientific writings generally?

* * *

"YOU bring the progressive and truth-seeking public in touch with the best that is to be had in the field of science in general and radio in particular."

—E. KIEFT, *Gary, Indiana*

* * *

"IT may interest you to know that I have the best receiving set in this city. It is a Cockaday four-circuit set as described in your January issue of POPULAR RADIO, and it outperforms any set in town, regardless of cost. We have several of them here and they are all giving perfect satisfaction."

—JULIAN M. SCOTT, *Hannibal, Missouri*

* * *

AND now for the next number—for July—that will contain the second of the series of articles that will tell how to use your receiver during the vacation season. Better ask your newsdealer to reserve your copy *now.*

Kendall Banning

Editor, POPULAR RADIO

"THE AIR IS FULL OF THINGS YOU SHOULDN'T MISS"

No. 7111
Eveready
"A" Dry Cell
The best
battery for use
with dry cell
tubes

No. 766
"B" Battery, 22½ volts

More Power for Summer Radio

WHEN you take radio away with you—take Eveready Radio "A" and "B" Batteries, the batteries whose great power lasts longer. Remember, summer's the time when radio signals are weaker.

Batteries do get used up in time. The ones you've been using, though partly exhausted, may be satisfactory for the strong winter signals, but are probably inadequate for the weaker summer signals.

For a "B" Battery use the familiar standard 22½-volt Eveready "B" Battery No. 766. It has variable taps for "soft" detector tubes. Put two, three or four in series to provide sufficient power for amplifying tubes.

To light the filaments of your dry cell vacuum tubes for the longest time, use Eveready Dry Cell Radio "A" Battery No. 7111. The Eveready "A" will astonish you by its long-sustained vigor. It is advisable to use two Eveready "A's" connected in multiple for each WD-11 or WD-12 tube—this gives the "economical eighth" ampere drain per cell which insures maximum economy and longer life. For sets employing one to three UV-199 tubes use three Eveready Dry Cell Radio "A" Batteries No. 7111 connected in series.

The greatest electro-chemical laboratory known created these famous dry cell batteries on which radio largely depends. The experience of thirty years in battery making stands back of them.

Buy Eveready Radio "A," "B" and "C" Batteries—lively, peppy, long-lived producers of power.

For your light-weight sets to take camping or on hikes, Eveready has suitable small batteries.

Manufactured and guaranteed by
NATIONAL CARBON COMPANY, Inc., New York, San Francisco
Headquarters for Radio Battery Information
Canadian National Carbon Co., Limited, Toronto, Ontario

Informative and money-saving booklets on radio batteries sent free on request. If you have any questions regarding radio batteries, write to G. C. Furness, Manager, Radio Division, National Carbon Company, Inc., 128 Thompson Avenue, Long Island City, N. Y.

EVEREADY
Radio Batteries
—they last longer

Radio Wherever You Go—New Kennedy Portable Receiver

Here is the famous Kennedy Radio Receiver in a new portable case—a delightful home set that you can take with you wherever you go. In your living room, at camp, by the seashore or touring, this new Kennedy will always give you radio enjoyment at its best. It has a pure musical tone that delights even the most critical—its simplicity of operation makes an instant appeal to every member of the family.

Anyone can operate this new Model III. One station after another can be tuned in *with one single dial.* Each station has its own dial setting, which is always the same no matter where the receiver is located or what type antenna is used. Volume is controlled by the slight movement of a second dial.

The design of Model III is fundamentally correct. Due to exclusive Kennedy engineering developments, it does not radiate—it cannot throw out those howling noises that bother nearby radio listeners and are the cause of the present agitation against radiating receivers.

Price, without accessories, $101.50. ($104.00 west of Rockies.) With Kennedy phones and plug, $111.50. ($114.00 west of Rockies.)

Ask your Kennedy dealer to demonstrate Model III.

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

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS

MODEL III

Carry it Like a Traveling Bag

A MARVEL of compactness—no larger than a traveling bag. The sturdy cabinet is covered with a grain-seal finished Fabrikoid that makes it an attractive piece of home furnitute as well as a practical outdoor set.

Each station has its own dial setting—which never changes, regardless of where you are located or what kind of antenna is used. This is particularly desirable to the summer vacationist, cottager, camper or tourist—as the dial setting outdoors, with a temporary antenna, is the same for any given sration as it is in your own living room.

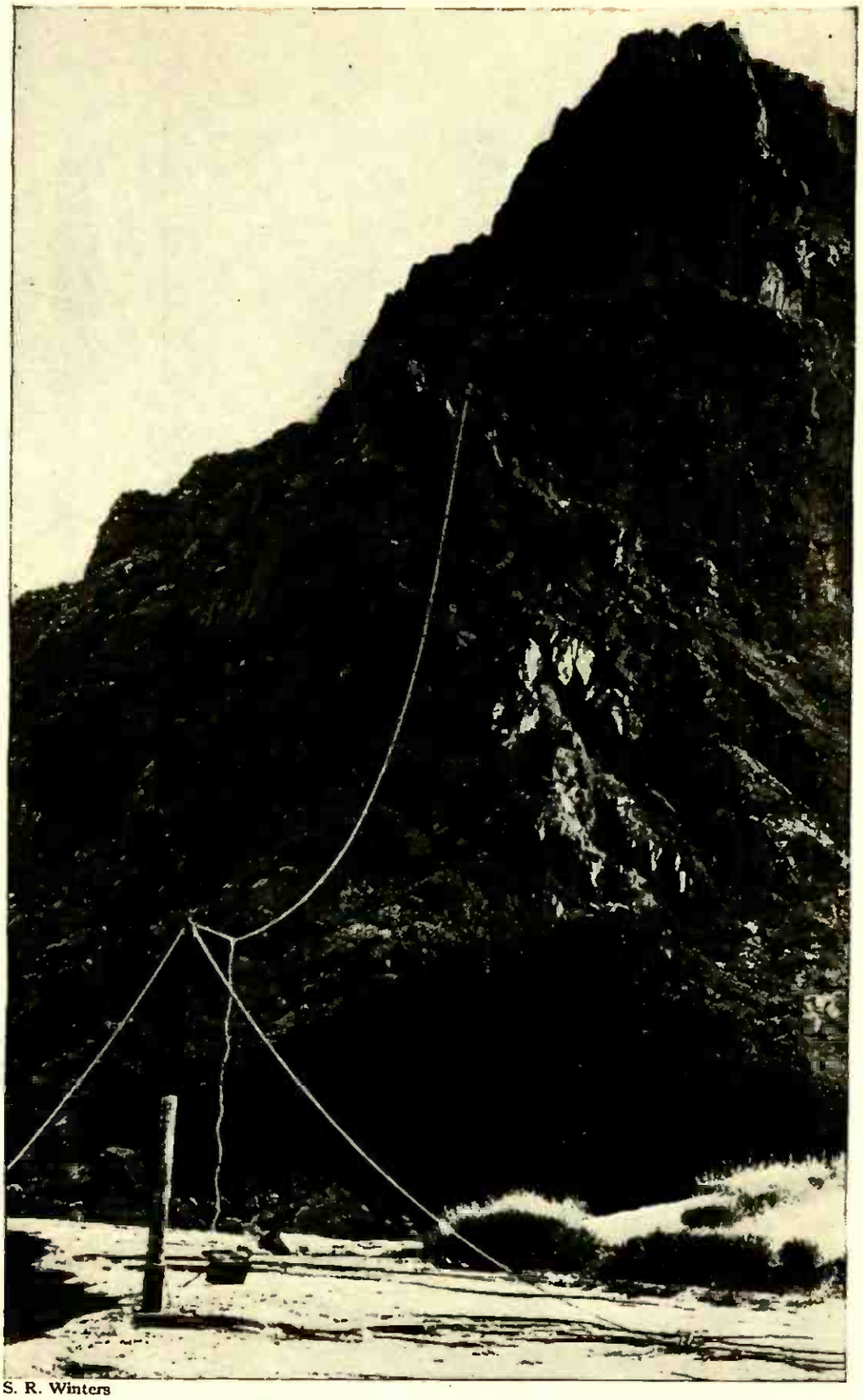
KENNEDY

The Royalty K *of Radio*

The Unique Position Attained by POPULAR RADIO

"POPULAR RADIO, it seems to me, has more of a place and purpose of its own in the radio field than any of the other radio periodicals which have come to my notice. The success it has attained, it has, in my judgment, faithfully earned through its service to the daily increasing number of those interested in radio matters, and I feel it richly deserves an even wider recognition and success."

—DR. ERNEST FOX NICHOLS,
Director, Nela Research Laboratory.



S. R. Winters

An Aerial for the Night

THIS *unique installation is typical of that employed by a group of campers of the U. S. Geological Survey in the Grand Canyon, who moved their headquarters daily during a three months' expedition. The set was a small regenerative receiver; the far end of the antenna wire was attached to a high rock, and the waters of the stream were used for a ground.*

Popular Radio

VOLUME V JUNE, 1924 NUMBER 6

How to Install a Receiver on Your Boat

During the past year or two radio amateurs have learned a great deal from practical experience with radio equipment on pleasure craft. Before you start work to install a set on *your* boat this summer, read this article by—

LAURENCE M. COCKADAY, R. E.

A YEAR ago at this time people who were interested in radio began to wonder what they would do with their receiving sets during the summer. Should they take their sets with them to the country? Would the static (which they had heard so much about) interfere with reception so that the sets would be useless? Could they take their apparatus to camp with them? Could they take them on their boats for cruising trips? And, most important, would the sets work on improvised antennas? If not, what kind of a set *would* work?

Since last spring, however, there has been such rapid development of radio apparatus and the field for radio receiving sets has been so widened that there are now numerous receivers on the market for all purposes. Instead of receivers that had to be installed in houses and which had to be operated with a regular full-sized antenna and good grounds, there are now sets that give satisfactory results with short pieces of wire for antennas. There are other receivers with the antennas built into the set, out of the way and invisible. And there are sets that work on the ground alone.

Development has proceeded so rapidly that we have really efficient portable receivers that are self-contained in a suitcase with batteries, loudspeaker, loop antenna and all. At last, radio is ready for our use this summer—and we should take advantage of the enjoyment it offers when we are resting up and lolling around on a vacation, whether it be on a boat for a fishing trip or in a snug summer cottage tucked away in the hills, touring in an automobile or just merely tramping the country on two legs.

In this article is considered the installation of radio on pleasure boats of different sizes. For this is the time of year when the boats must have repairs made, and it is much easier to lay out the radio installation at the same time and have the carpenter put in any shelves or do such other work as may be necessary while he is on the job. In the next article we will take up the other phases of summer-time radio.

Pacific & Atlantic

RIGGING A "PERMANENT" AERIAL

The mast of a small boat serves admirably as an antenna mast. A small portable set that operates on a loop antenna is, however, more convenient for small craft.

Have you a bungalow up the river, or on the shore of a mountain lake? Then, most probably, you also own or have the use of a canoe, or a rowboat, or maybe a twelve or twenty-foot motor boat. Would it not be a pleasure to lie out in midstream of an evening listening to the strains of a famous orchestra or jazz band? Wouldn't your friends enjoy it? And how about the news of the day? You wouldn't have to trudge back to town for a newspaper; just light your pipe and tune in!

When putting radio on such a craft it would be foolish to try to put up a regular antenna installation. All you need in this case is a portable set—a set that you can carry on board when you start out, and can cover with a tarpaulin if the water is rough or if a storm comes up; a set that you can leave in the boat house, take out on the beach or on the lawn or set going in the bungalow at night. In other words, what you need is a set that will work anywhere—a set with a loop, self-contained batteries (preferably dry batteries) and either a separate loudspeaker or one built into the set.

Don't try to make a permanent installation on such a craft, as it will be a nuisance, will be in the way and won't work satisfactorily at best. Buy a ready-made portable set, ready to work anywhere.*

When you put up such a set on a launch or small boat be careful that it is placed in a position where it will get the least wetting. Water will short-circuit the transformers and other instruments if it gets inside the cabinet, and the operation of the set will be impaired.

Take along replacement batteries and a spare tube or two; except for these no accessories will be needed. Just set up the receiver anywhere you happen to be and listen.

* Some of the ready-made sets that are suitable for this purpose are: De Forest Portable, Westburr Six, Sleeper Monotrol, Bristol Portable, Operadio, Melco, and several other radio-frequency receivers.

Underwood & Underwood

A GOOD TYPE OF RECEIVER FOR A SMALL BOAT

No large overhead antenna is required for a portable set and no connection is needed to the ground. The set pictured here, although it is of the loop type, is too bulky to be practical for a canoe; the loudspeaker and loop should really be incorporated in the cabinet.

The receiving range of these sets varies from 100 to 1,500 miles at night, depending upon atmospheric and other conditions. Daytime ranges are much smaller.

On a motor boat a radio receiver is almost indispensable in summer-time. Such a craft ranges in size from 25 to 60 feet in length and has a cabin and sleeping quarters for two to eight people. While on a cruise in such a boat you *can't* get newspapers; there are periods when the time drags heavily: every one at times gets bored and irritable. Sometimes the engine goes dead, repairs have to be made and conversation lags. This is a logical place and use for radio broadcast reception. With its aid you can keep in touch with the weather man—and this alone is worth while when making a decision as to whether or not to make a try for a more distant port before a storm breaks. The radio will keep you posted for heavy weather; it will also help to while away the time in good weather.

For putting in a radio installation on such a craft there are three courses that may be followed:

First; You may put in a self-contained portable receiver, complete:

Second; You may install a ship-shape antenna and put in a regular standard receiver.

Third; You may install a regular antenna and build and install a receiver.

The first course is the simplest, as the set may be moved from place to place on the boat as desired. The installation requires nothing more than the equipment that has been mentioned previously for use on small craft; merely

carry aboard a portable set (of a recommended type) and use it.

There are some fans, however, who want to have a more pretentious installation. In such a case the boat should be equipped with two short dummy masts about 12 feet high and a flat-top antenna of the inverted L type installed. Such an antenna system is pictured in Figure 1. The exact way to run the wires is shown in Figure 2.

You will notice that the three wires consist really of one piece strung back and forth between the insulators. The lead-in is carried to the deck from the middle wire, which extends aft to the rear spreader, crosses over to the outside end of the spreader, then back for'ard to the first spreader again. The same wire then crosses over to the other end of the for'ard spreader (after being carefully insulated from the lead-in wire by two insulators), and continues on to the aft spreader again on the other outside end, where it is insulated by another insulator.

The two masts should be placed as far for'ard and aft as possible, so as to get the greatest length of antenna. This distance should not be less than 25 feet for good results; the longer the better.

The lead-in wire should be taken in through the deck by means of a deck insulator placed in a position where it will not be in the way or be stumbled over.

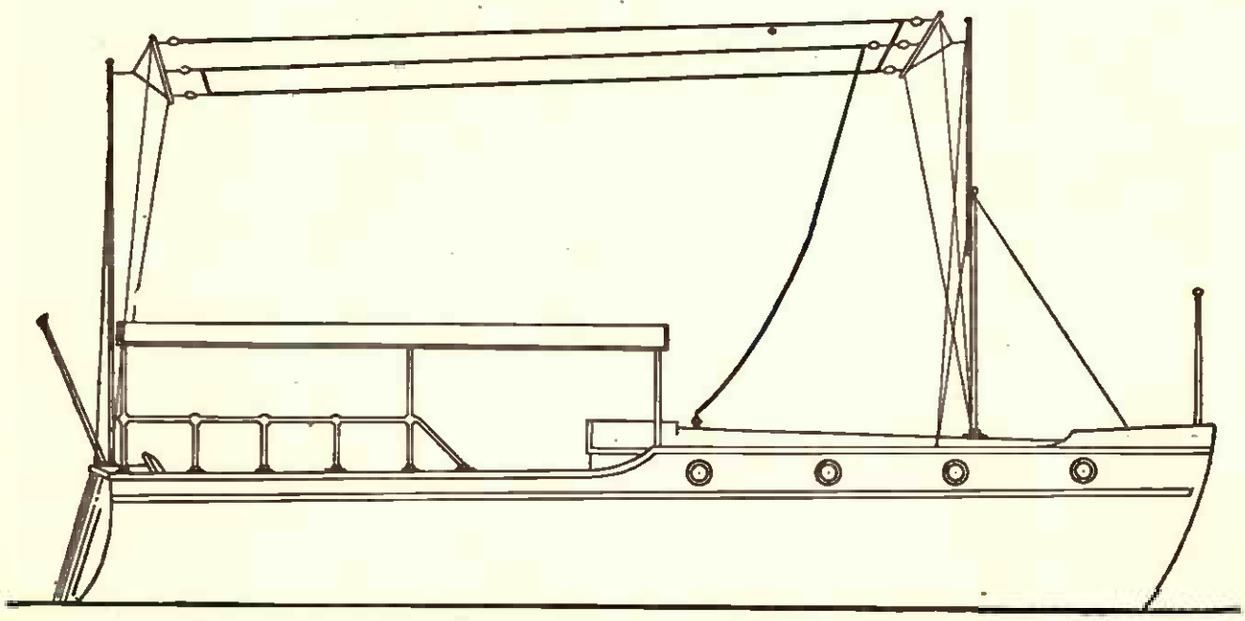
The deck insulator has a metal rod running through it with a binding post on each end. One end is placed outside the cabin and the other end is inserted through the deck and is attached to the antenna post of the receiving set with a piece of wire.

A shelf should be installed inside the cabin, out of the way, for the receiving set, with another shelf located directly below it to hold the batteries.

For a "ground," a wire may be run to the engine base, where it can be soldered on. (See Figure 3.) Or it may be fastened to a copper plate on the outside of the hull.

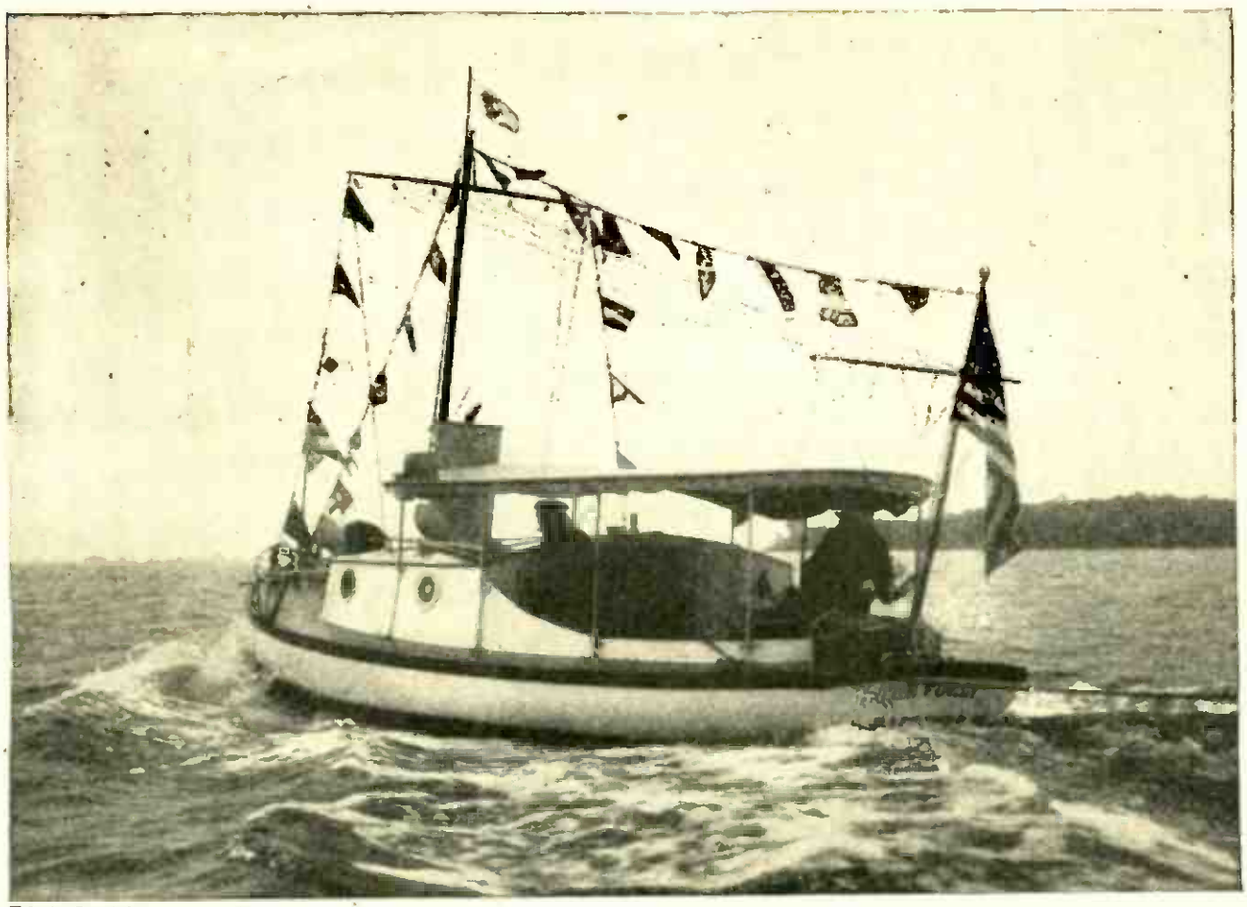
The set used with this antenna and ground system, can be any of a number of makes that are designed for use with short antennas.*

* Some suitable receiving sets for this purpose are: Grebe, Atwater-Kent (radio-frequency), Melco, De Forest, Murad, Radiodyne, Tuska (superdyne), and several other radio-frequency receivers.



THE BEST ANTENNA SYSTEM FOR A MOTOR BOAT

FIGURE 1: *This diagram shows in detail how to put up a receiving antenna on a cruiser type of motor boat. Notice that the antenna is run in a single length in order to obtain the greatest inductance possible in such a short span.*



Edwin Levick

AN EFFICIENT FIVE-WIRE ANTENNA INSTALLED ON A CRUISER

This type of antenna should give satisfactory results when connected to any good regenerative receiver or to a good radio-frequency receiver.

If the antenna is thirty feet long or more, any good three-tube regenerative receiver or any five-tube radio-frequency receiver may be used with good results.

For those who want to build both the antenna system and the set, we recommend that the constructional articles in this magazine be followed.*

For boats in which a thirty-volt lighting system is employed, three cells (6 volts) of the storage battery may be tapped off for lighting the filaments of the tubes. This will eliminate the extra storage battery for the set.

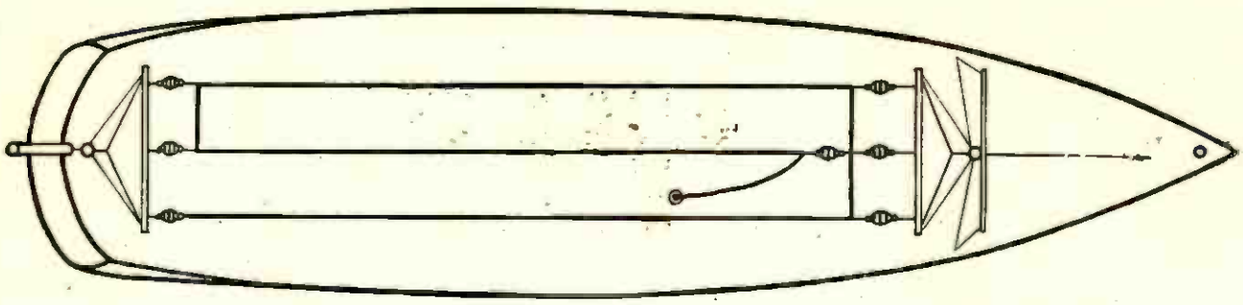
On larger sailing boats (50-footers and up), the metal shrouds may be connected together electrically with copper wire (soldered) and a lead brought down to the set. This serves as an antenna and gives good results.* Otherwise a loop set would be best to use.

The ground, on this type of vessel, should be made by fastening on to the hull (below the water-line) a rectangular piece of copper sheet, with *copper* nails. This plate, thus formed, is connected to the set by soldering to a copper strip run up above the water-line and fastened snugly to the ship's sides by copper nails. (See Figure 4.)

Of course, if the sailing vessel has an auxiliary gas engine the ground may be made, as on a motor cruiser, by connecting to the motor casting.

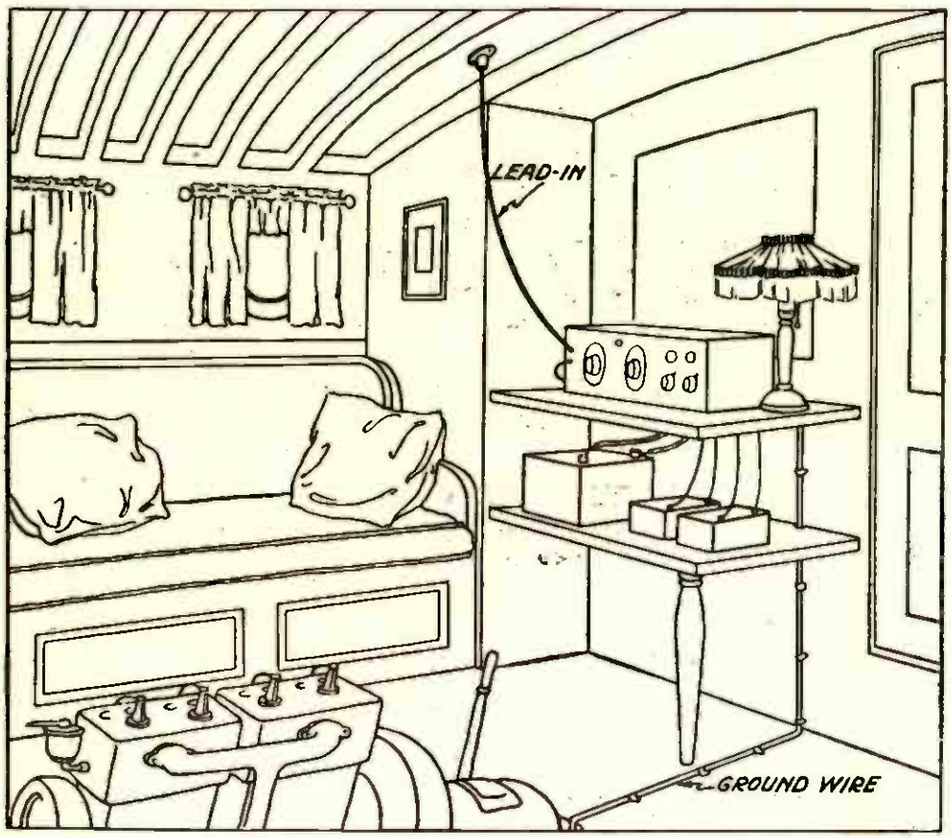
* See "How to Build a Tuned-radio-frequency Receiver," August, 1923, page 132; "How to Build a Non-regenerative Tuned-radio-frequency Receiver," April, 1924, page 378; "How to Build a Regenerative Receiver for Use with a Short Antenna," in this issue. "How to Build the Improved 4-Circuit Tuner," January, 1924, page 23.

* The "shrouds" are the stranded-steel ropes that are used to brace the masts. They run (usually two on a side) from a point a few feet above the water-line up to a short distance from the top of the masts, and, when used as an antenna, eliminate any other wires which would be in the way on a sailing vessel.



THE WAY TO RUN THE ANTENNA WIRES

FIGURE 2: *Starting from the insulator at the lower left end, the wire is brought to the forward spreader, across and back to the rear spreader, and then down the center to the forward spreader, where the lead-in is taken off.*



A GOOD LAYOUT FOR A RECEIVING SET IN THE CABIN

FIGURE 3: *Showing how the shelves can be arranged and how the antenna and ground wires may be run to the set.*

On any kind of larger craft, 75 feet or over, with two masts, a regular installation of a three or four-wire antenna is recommended with almost any kind of set using upwards of three tubes. Any set that gives satisfactory results at home on a land antenna and ground system, will give much better results on a yacht or vessel of this size.*

On this type of vessel, the distance from the part of the cabin where the set is located to the after deck may be considerable; accordingly it would be advisable to have wiring run beneath the deck boarding with a plug for the loudspeaker at the point where it is desired. It may be possible that there would be two or even three places where it would be desirable to run these leads for connecting the loudspeaker, and the various locations used for plugging in

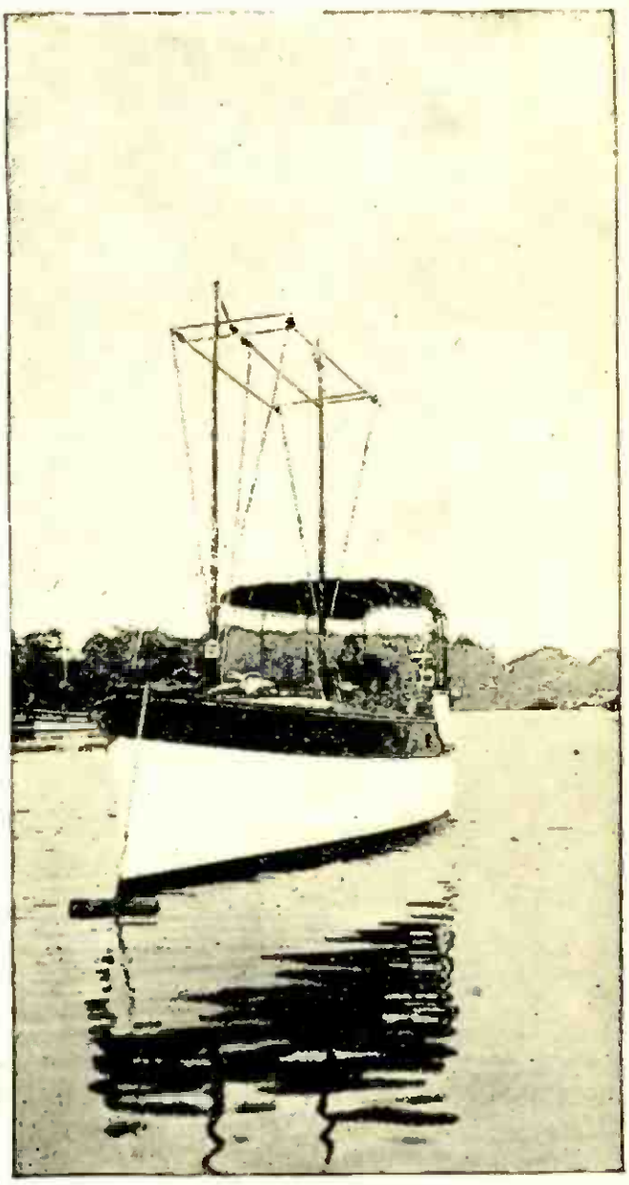
* Some sets suitable for this purpose are: neutrodynes, reflex sets, any type of regenerative receivers, radio-frequency sets, or if a high-class loop set is preferred, the super-heterodyne.

one or more loudspeakers. Tuning, in this case, would be done in the cabin with the headphones, and the loudspeaker lines would be plugged in when the desired station was correctly tuned in.

A simple layout for such a system is shown in Figure 5.

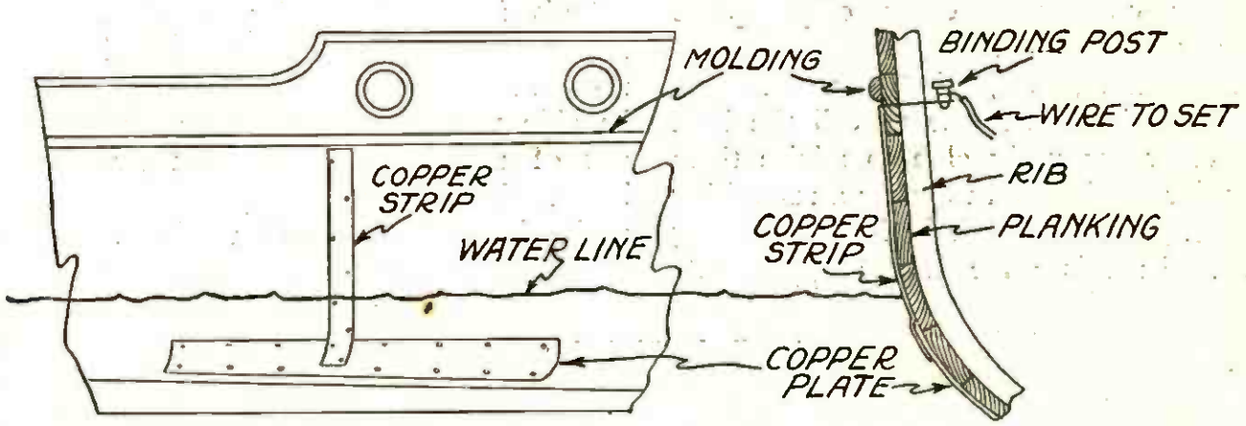
This covers the installation of radio broadcast receiving apparatus on pleasure craft for entertainment purposes.

There is also another phase of the radio situation for small craft that has as yet been given small consideration. There are on land thousands of radio amateurs who use both radio receiving and transmitting sets for pleasure and experimental purposes. Why cannot we have the same kind of license for our pleasure craft, where no commercial exchange of messages would be permitted? This practice would not interfere with commercial radio traffic and it would not interfere with the commercial radio interests' financial returns as at the present time there is no way in which messages may be sent from small pleasure craft and, therefore, no such traffic. If such licenses could be granted, every small pleasure craft could be fitted out with radio transmitting and receiving apparatus (providing the owner or operator could pass the ordinary license examinations), and the stations thus licensed could work on amateur wavelengths; they would really *be* amateur stations just as if they were ashore.



AN IDEAL ANTENNA FOR A SMALL CRUISER

This illustration shows how the antenna arrangements shown in Figures 1 and 2 can be applied to any cruiser.



HOW TO INSTALL THE GROUND PLATE AND COPPER STRIP

FIGURE 4: *These drawings show the manner of fixing a ground plate on the outside of the hull, and how to run the copper connecting strip through the planking into the cabin.*

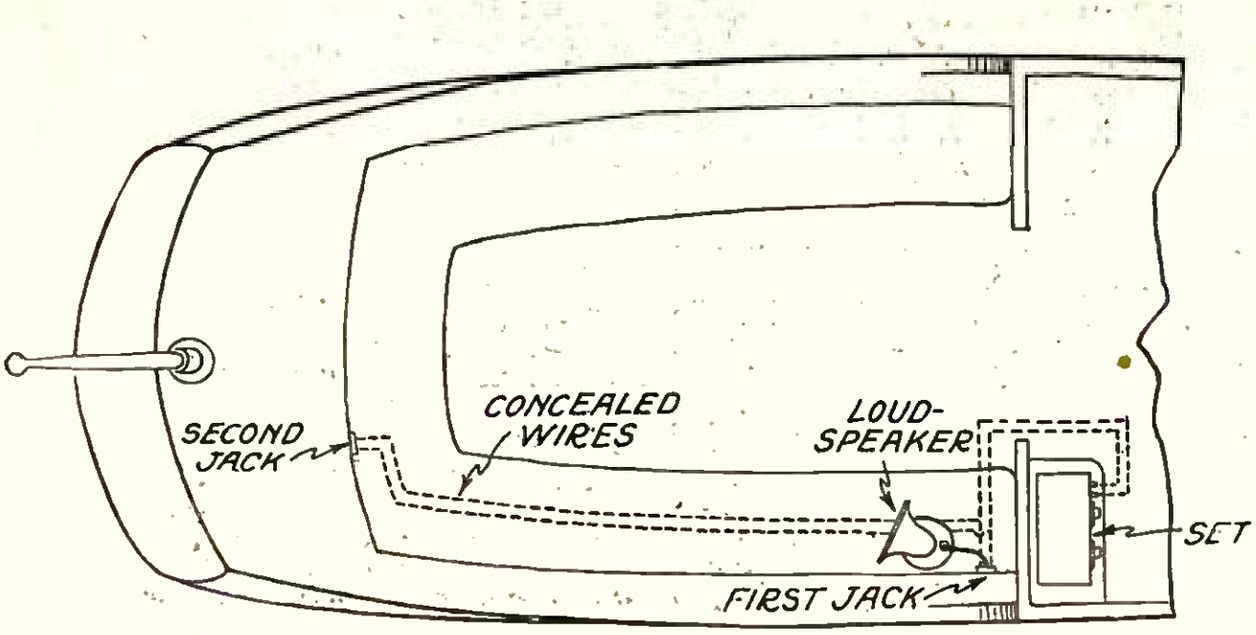


FIGURE 5: *This sketch gives an idea of the plan for running the wires for the loud-speaker to different portions of the deck, so that the music and entertainment can be had where it is desired, without having to move the set around.*

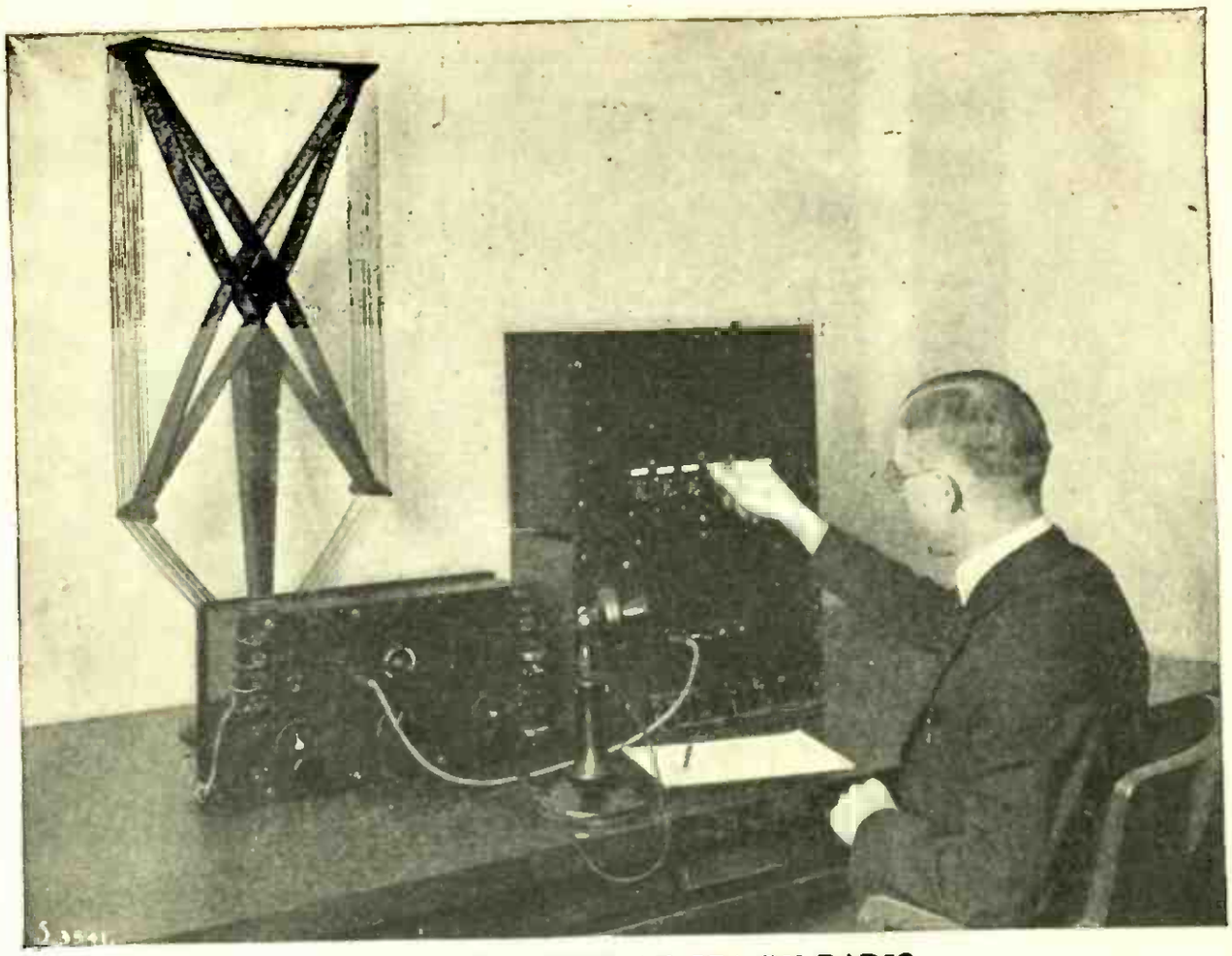
This would permit all pleasure craft, if desired, to be equipped for transmitting to shore or to other small craft, in case of accident, or in case of any other danger; it would also provide for a means of radio direction finding if they were lost at sea in a fog.

The laws of the country require every ship with a specified number of passengers and crew aboard to carry radio equipment. This is considered a necessity for the safeguarding of human life at sea. But during the summer months the waters jeopardize many thousands of lives which could be safeguarded by radio apparatus aboard the smaller craft that carry only up to twenty passengers.

And think, also, what a convenience it would be to be able to call the boat house or the yacht club to advise them of your coming and to order a refreshing supper after a long trip in the burning sun! In this same way arrangements for staying over at a seaside resort could be made, and business men could be kept in touch with land through the home yacht club. Indeed, at the present time there are a number of the larger and more progressive yacht clubs which have radio sections or divisions that are becoming alive to the possibilities of radio and radio broadcasting as an adjunct to the sport of yachting. Some of these clubs have even gone so far as to install transmitting apparatus on the club house, and in a few cases the clubs have cooperated with the owners of boats to help them with their installations.

This is the time of year when the members of yacht clubs should get radio sections started, so that fans will be able to get some of the advantages out of radio as applied to their own boats. Now is the time to start the radio ball rolling—before the season gets too far advanced.

¶ *Every radio fan who lives in town knows what annoyance can be caused by* PREVENTABLE *interference in broadcast reception. How to locate the causes and what you can do about them when you find them will be described in* POPULAR RADIO—*for July.*



"CALLING" A SHIP AT SEA BY RADIO

FIGURE 1: *By merely setting a little switch the apparatus selects the receiving station that is "wanted on the radio" and rings a bell in the same manner as in the regular line telephone. Such a system makes possible the assigning of a telephone number to a ship, so that it might be called from a land station, as a wired station is.*

"Please Give Me the LEVIATHAN!"

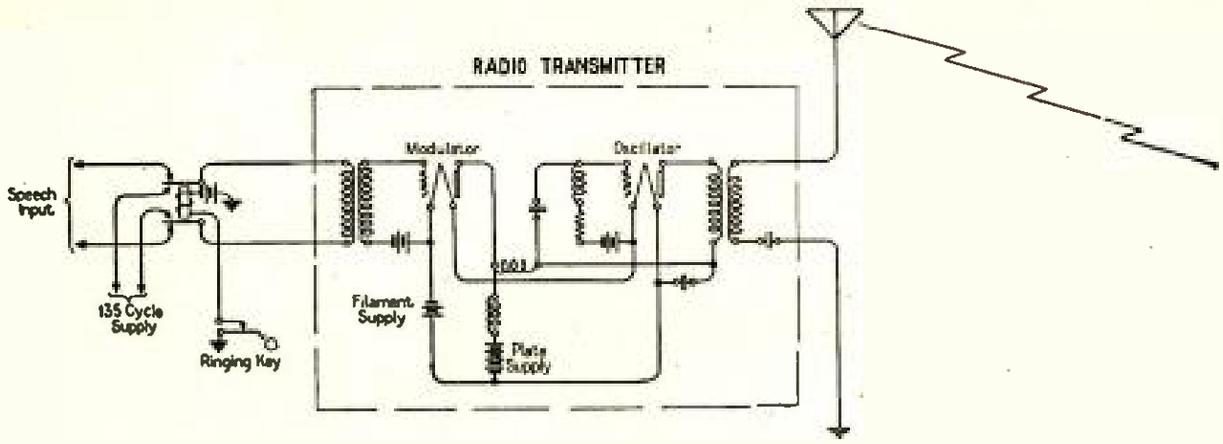
Here is a new invention that enables a radio transmitting station to "call" some particular receiving station by ringing a bell to attract the operator's attention—a device that will vastly simplify communication with vessels.

By R. W. KING

SINCE the advent of radio it has been the dream of the inventor to devise a means of signaling a given station by a ringing bell as is done in wire telephony. Such a scheme would, in many cases, make it unnecessary to have an operator in attendance at all times and would add greatly to the economy and the convenience of operation.

The inventor's dream has been realized. It did not come as the result of long research directed toward that end, but instead it followed from results incidental to other researches.

The radio telephone is destined to find a big application in communication



HOW THE CALL-SYSTEM WORKS

FIGURE 2: *This diagram shows, schematically, how a special signal is sent out from the transmitter (above) and is picked up by all receivers. Only the particular receiver which is "set" for this signal will respond, however, and the bell will ring only at that particular station. A diagram of the receiver is shown on the opposite page.*

with moving objects such as ships, where wire telephony is not applicable.

The new signaling scheme is obviously a big contribution to such a service, for it enables any transmitting station, properly equipped, to signal any one of about seventy-five other stations in the same system without calling the remaining stations. The attention required by the receiving set, then, is little more than caring for an ordinary telephone.

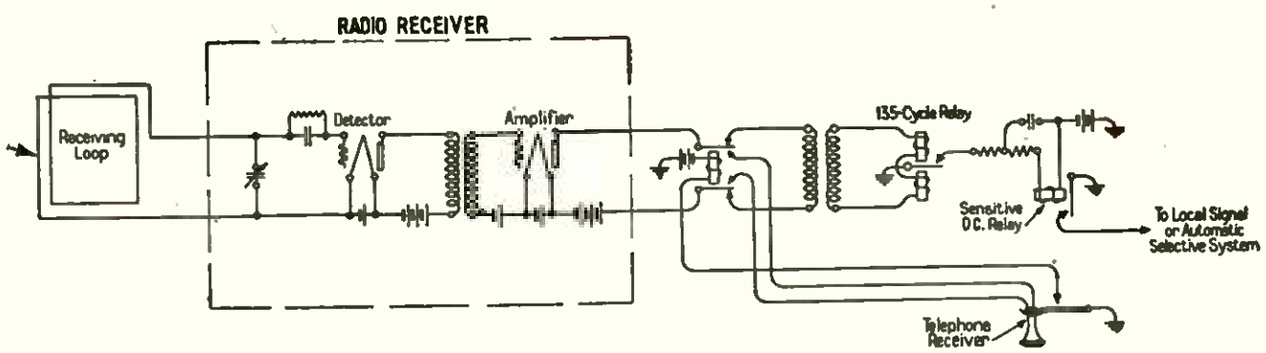
The means whereby this was accomplished have been perfected by C. S. Demarest and M. L. Almquist of the American Telephone and Telegraph Company and L. W. Clement of the Western Electric Company. The apparatus, which can be incorporated as a part of practically any radio system, enables a calling party, by simply turning a key, to call any other party in the system.

The photograph reproduced as Figure 1 pictures an operator in the act of "placing" a call.

When a station is to be called, a code, produced by modulating the radio transmitter currents by a 135-cycle alternating current, is sent out on a specified wavelength. This is received by all stations that are tuned for this wavelength, but only that radio receiver which is set for this particular code will so operate as to ring the local annunciator bell. The ringing code may be likened to a key which in this case is applied simultaneously to several locks, only one of which will be unlocked and opened.

In Figure 2 is shown a simplified diagram of the circuit used. The ringing key causes the 135-cycle current to be impressed on the transmitter instead of the ordinary voice currents. This key determines the code to be sent.

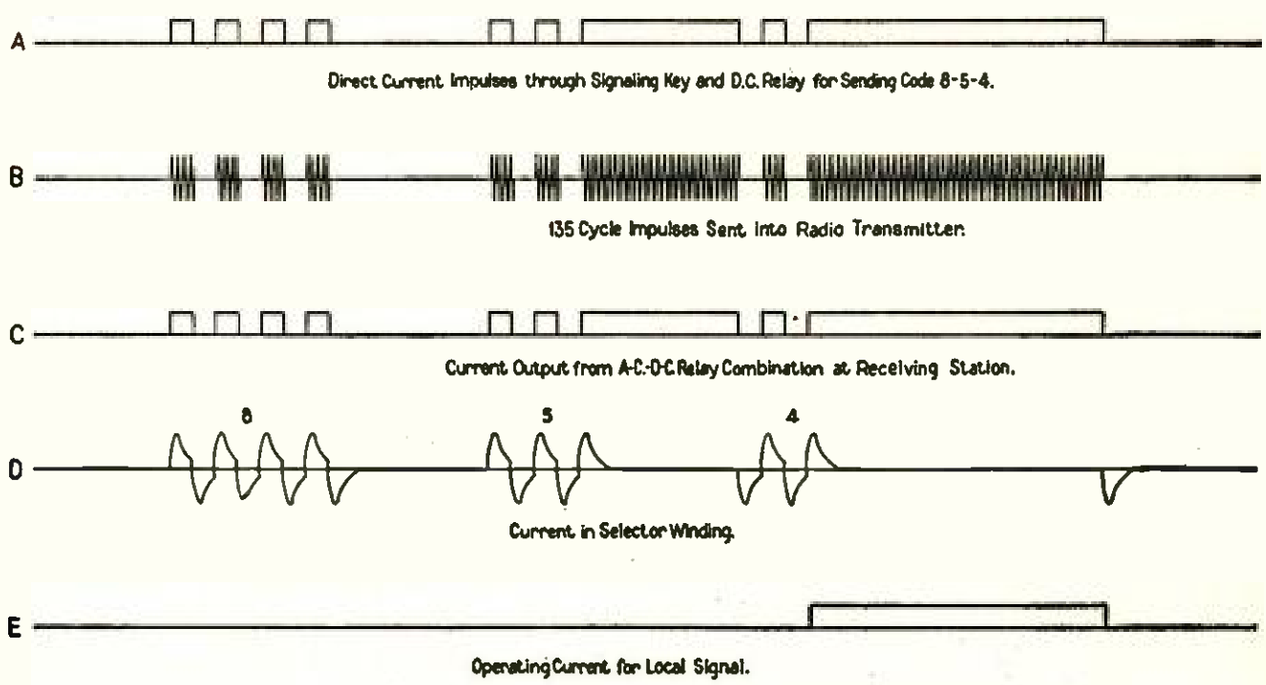
Figures 3A and 3B show the nature of the direct current that flows through the key and also the 135-cycle alternating current impressed on the transmitter corresponding to the code 8-5-4. At all of the receiving stations this is passed through the detectors and amplifiers in the same manner as ordinary speech signals. The resulting current is like that of Figure 3B. This operates the 135-cycle relay and its accompanying direct-current relays so as to produce a series of impulses like that shown in Figure 3C. This alternating-current relay is remarkable in that it will respond to currents as low as .00025 ampere, providing they are of a frequency of 135 cycles, but it is practically unaffected by all the higher frequencies used in transmitting speech or spurious currents such as those resulting from static. A selector located at each station is so constructed that it is operated only by the particular code for which it is set.



In Figure 4 is shown the signaling equipment as an adjunct to standard radio apparatus. The lower cabinet at the left encloses the relays, selector and other apparatus on which the signals are received while in the upper cabinet is the apparatus used in calling.

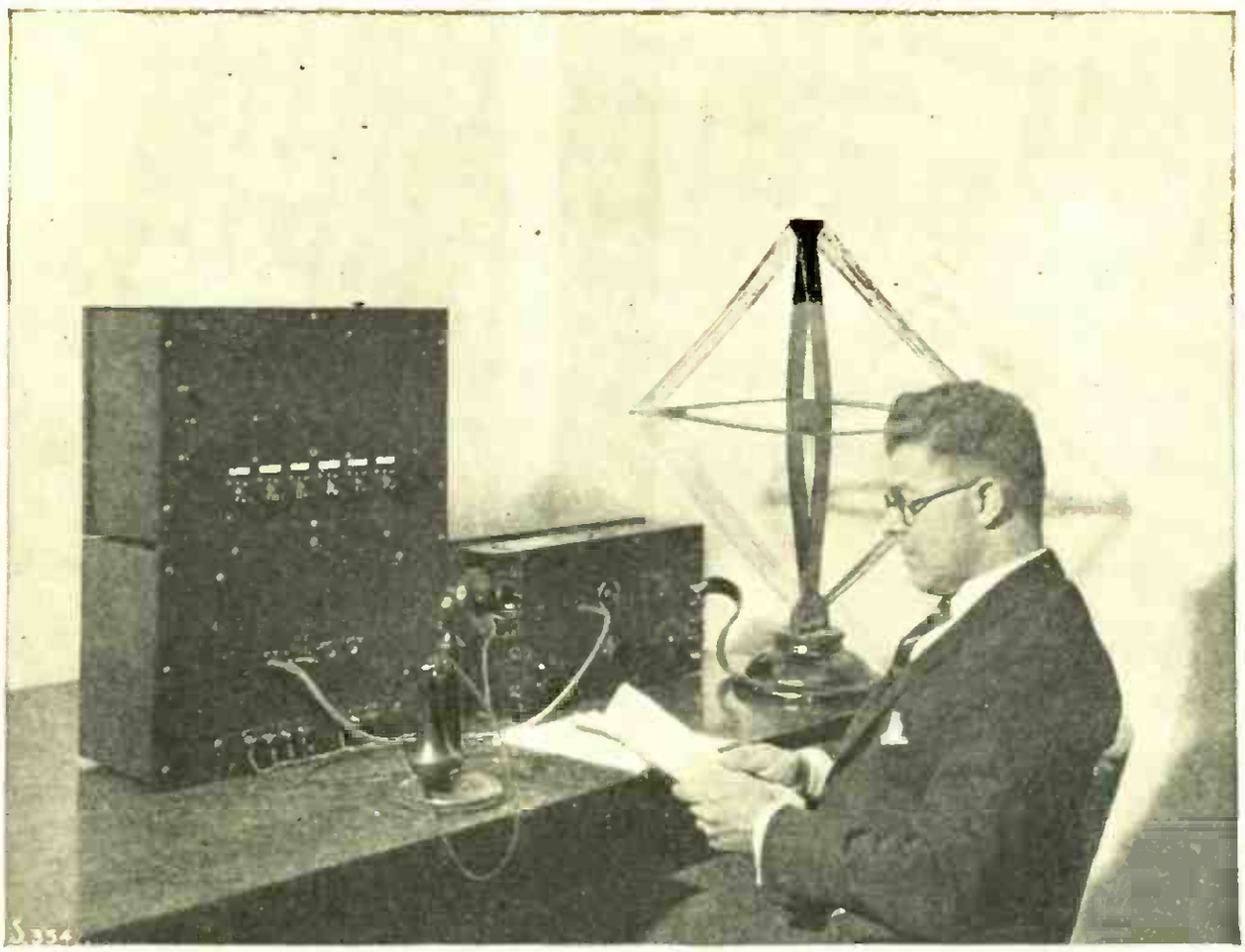
This development is a remarkable example of the cumulative value of research. The different pieces of apparatus involved were developed for other purposes, without any thought as to their possible application to radio. The 135-cycle relay was designed for a system of low-current telegraphy used in conjunction with telephone circuits. The selector and the code sending key came from the standard circuits used for train dispatching while the relays are standard parts of telephone equipment. Had this development been attempted by people outside of the telephone laboratories many new problems would have been encountered, but by combining the experience gained by years of research in both radio and wire telephony, the development followed naturally.

In a test of this signaling system it was shown to be particularly free from interference from outside sources. It



A VARIETY OF "SIGNALING CURRENTS"

FIGURE 3: *Here are some of the graphs of the signaling currents that flow in the various circuits in the transmitter and the receivers. These currents are the "open sesame" for the station that is being called, as they set the relays and ringing apparatus into operation.*



THE SHIP'S OPERATOR NEED NOT "LISTEN IN" FOR HIS CALL

FIGURE 4: *The operator merely sits and reads or otherwise occupies himself until the radio-telephone call bell rings. He can, of course, listen at any time he wishes—but this is no longer necessary.*

was found that the signaling system would continue to function correctly when the interference was many times that which would make conversation impossible. While Figure 2, for simplicity, shows a circuit arranged for one-way speech, it has been developed for two-way conversation.

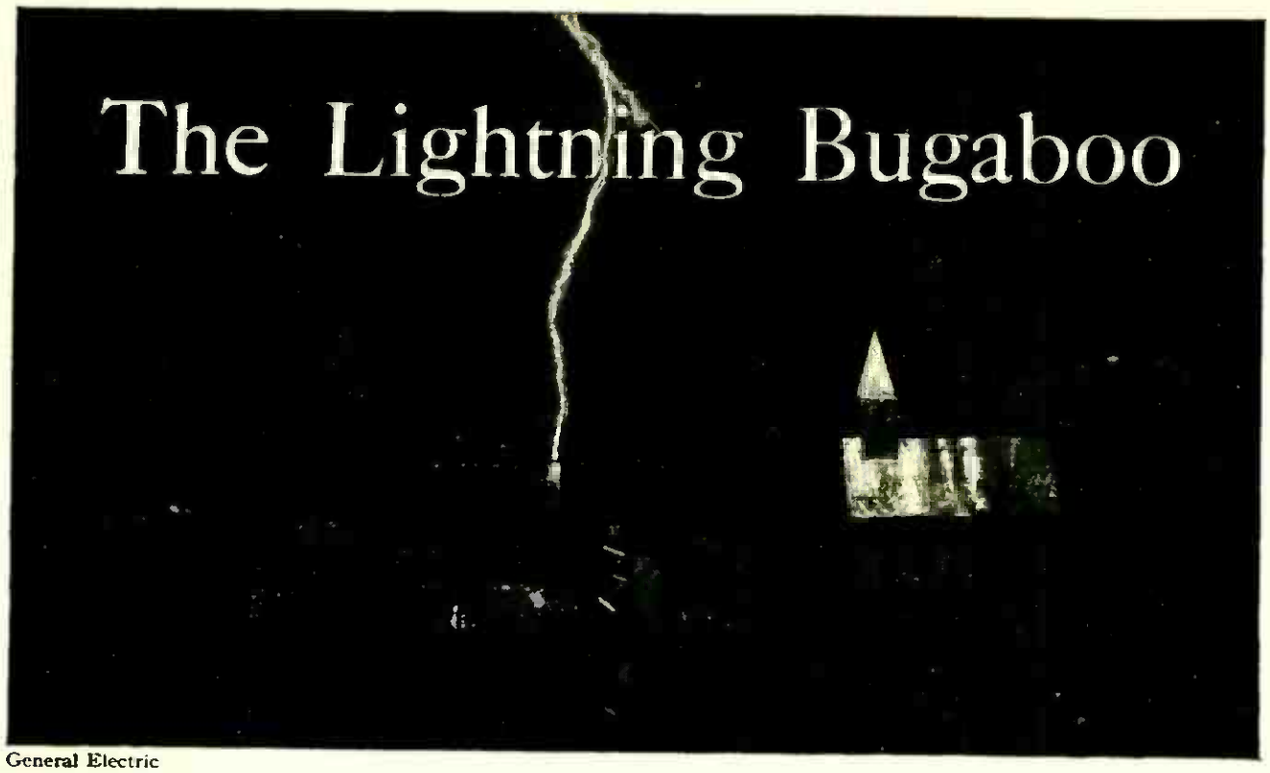
How to Build Your Own Portable Receiver

IN the next issue of this magazine—for July—will be published, for the first time, full and complete details for the construction of the POPULAR RADIO PORTABLE RECEIVER. This is a small, compact 6-tube radio receiving set that operates on a small loop antenna and that can be carried about on your business trips, vacation travels, motor tours, cruises or off into camp as conveniently as an ordinary suitcase is carried. This set, which has been created in the laboratory of POPULAR RADIO, marks a distinct step forward in the development of the small portable receiver—and it may be built by any amateur who has only an ordinary proficiency with tools at a cost for parts not in excess of $100.00, exclusive of tubes, batteries and telephones.

Scientists Tell Us That Within a Year—

1. RADIO *relay systems will be extended so that the same program can be broadcast simultaneously all over the United States—and perhaps in Europe as well.*
2. THE *election of presidents will turn largely on speeches that are broadcast over the whole country.*
3. A SYSTEM *will be adopted by which inter-denominational religious services will be broadcast to the whole country every Sunday.*
4. A RADIO *record will be perfected so that programs can be received automatically all day—and run off later when desired.*
5. THE *first broadcasting of pictures by radio television on a commercial basis may occur, and a "picture receiver" simple enough to be built by amateurs may be announced.*
6. A NEW *circuit that eliminates static will be perfected.*
7. AMATEUR *transmission will be carried on more and more on the short waves, and long distance transmission will be attained on from 20 to 50 meters.*
8. APPARATUS *for the production of directed beams of radio waves will be announced for the use of amateurs as well as for the purpose of relaying broadcast programs.*
9. THE *waves sent out from living nerves will be detected by radio apparatus—thus opening up a whole new field of scientific work in physiology and psychology.*
10. THE *theory of the crystal detector will be discovered and new crystals of great sensitivity will be produced.*
11. TRANSOCEANIC *amateur tests will be extended to Asia, Africa and South America.*
12. EXPLORATION *of the upper air will yield new facts about the Heaviside Layer and a new theory of fading and of long-distance transmission.*
13. A SINGLE-TUBE *receiver capable of operating a loudspeaker on a loop antenna and having less distortion and greater volume than any present multi-tube receiver, will be developed.*

The Lightning Bugaboo



General Electric

A radio antenna creates absolutely no danger from lightning. On the contrary, an antenna may be an actual protection against a bolt striking your house as it allows a part of the atmospheric electricity to leak away slowly and harmlessly. The author of this article—who was formerly president of the Institute of Radio Engineers—has had years of experience both with lightning and with antennas—and he has never seen an antenna struck by lightning!

By ROBERT HENRY MARRIOTT

SOME people are afraid to have radio receivers because they imagine that lightning will strike their antenna and kill them.

I imagined that too—twenty-five years ago. But experience in radio changed my mind.

Indeed, my former instructor in physics, Dr. B. F. Thomas, at Ohio State University, said he believed that time might prove radio antennas to be a protection against lightning, because the antennas might serve as a gradual leak for the electricity in the neighboring atmosphere and keep it from being built up to the danger point. My practical experiences have confirmed his belief. You might say that a lightning cloud is like a snowball picking up charges as it rolls along, until it breaks of its own weight. If your antenna has already picked up all of the charges in your neighborhood, nothing will be added in your neighborhood to cause the break.

Some of my experiences with lightning and antenna in various parts of the United States and Alaska and on ships have been interesting and exciting, but none of them have been injurious to me. For instance:

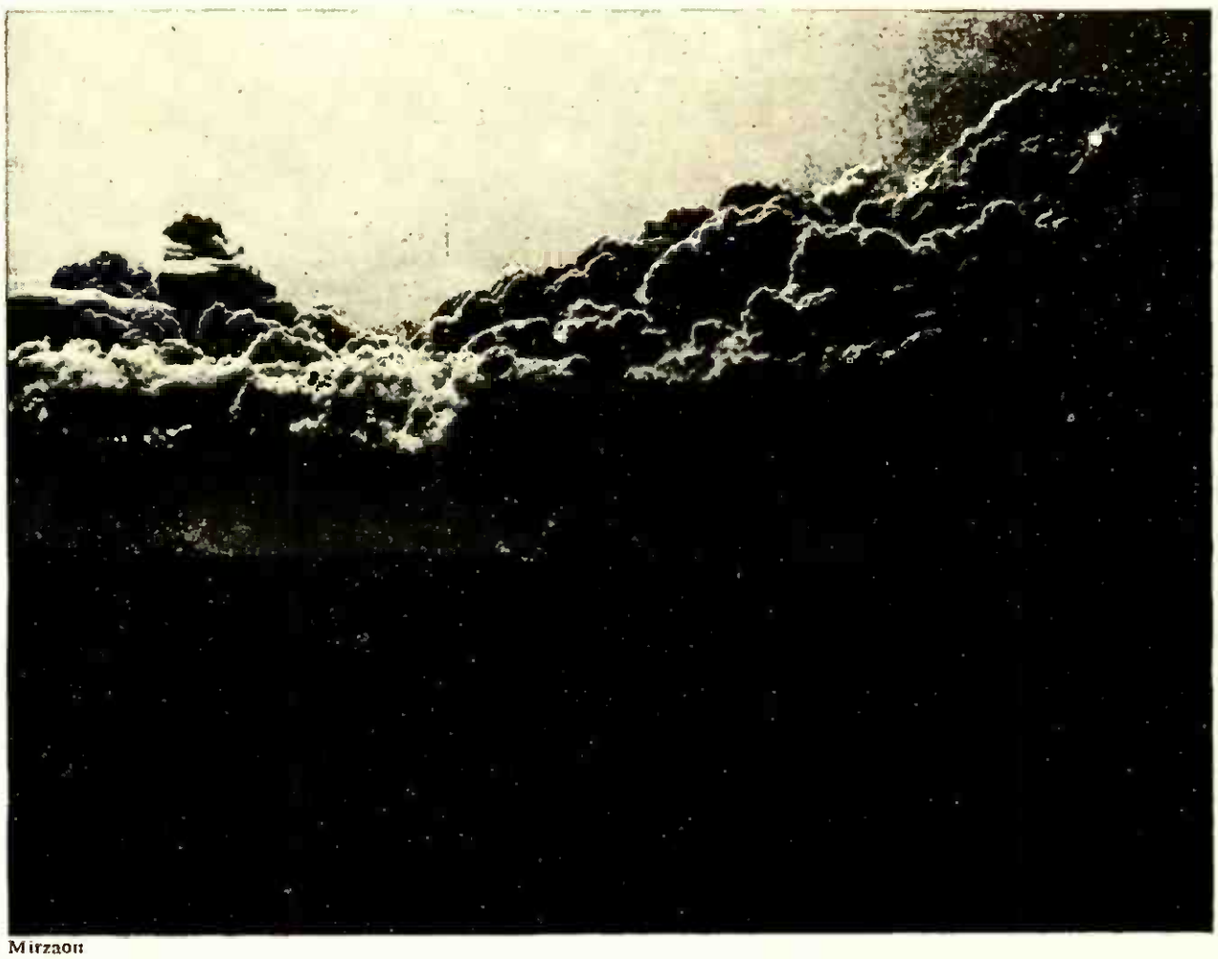
In 1901, I was on a ship that was not equipped with radio when a wooden mast was struck by lightning. Since then I have had to do with the radio on perhaps three thousand ships, commercial

ships under many flags and navy ships. To the best of my knowledge, none of their antennas were ever struck by lightning.

In 1905 one of the stations I was building was at Altman, Colorado, about two miles above sea level. Violent rain and lightning were quite regular there, as at other places along the top of the Rocky Mountains, on summer afternoons. To the observer at Altman the lightning appears to be striking in a circle around him because he is so high above the surrounding country and can see so many miles in all directions. One afternoon the lightning was so unusually violent that I thought maybe it would be just as well to leave the radio station and make my observations from the window of the saloon about fifty feet away, from which position I could see into the radio station.

When the lightning flashed near-by I tried to count the seconds until I heard the sound. This was to estimate the distance. (You know that light travels almost instantly and sound travels only about a thousand feet a second.)

Some flashes and reports were too close together for me to count a second and two or three flashes and reports seemed to occur almost at the same instant. After one of those close ones, the transformer house across the street from the radio station began to smoke like an old-fashioned meat house. It was the power company's transformer burning up. Yet with all of that lightning the radio antenna apparently was entirely untouched.



Mirzaoff

WHERE ELECTRIC CHARGES GATHER TO MAKE LIGHTNING

Masses of cloud act as collectors of atmospheric electricity; finally the charge becomes so great that a spark passes from the cloud to the earth. That is lightning. A wire raised into the clouds will bring down electricity almost any time, as it did in the famous experiment of Benjamin Franklin with his kite.

Kadel & Herbert

"NO SHIP'S ANTENNA HAS EVER BEEN STRUCK BY LIGHTNING"

This, says the author, has been his experience in a long acquaintance with radio at sea. The antenna wires serve as a path through which electric charges on the ship can leak away instead of accumulating to the danger point.

The same year at Pueblo, Colorado, I was within five feet of an antenna that was two hundred feet high, when lightning struck a wooden house that was about a quarter of a mile from the wireless station and only about fifteen feet high.

Reports of lightning striking antennas have been numerous, but on investigation the evidence indicated that the reports emanated from induction or direct discharge from the wireless station's own transmitters, or induction from lightning (static) or sometimes only the imagination.

One of the odd cases occurred at the Altman Colorado station. Naturally the radio operators thought that if lightning would strike an antenna at any place, it would be at Altman. And an operator did abandon that station and came in to Denver and reported that lightning had struck the antenna and burned up his receiving tuner. On investigating the station, however, I found that he had shifted the antenna around to another position. How he made the shift without getting killed I do not know, unless it was because the 2,300-volt power line he pulled it over happened to be better insulated where the antenna touched it at the time than where the antenna touched it later. For, later a guy wire stretched and let the antenna sag so that it touched the power line, and in this way electric power went through the antenna and thence through the receiving tuner until the tuner windings burned up and made a gap in that electrical path to ground.

Making contact with light and power wires is something to look out for. It is not good practice to put an antenna over or under any power or lighting

wires. If the receiver circuit is a metallic circuit to ground, almost any low or high-power circuit would burn it up if the antenna made contact with the power wire.

Do not fear being killed by lightning *via* a radio antenna. However, you should have a so-called "lightning arrester" on your antenna for quite other reasons.

The so-called lightning arrester for radio antennas probably should be called a "by-pass for static," because that is probably its chief use. Under some conditions static can cause a fire or destroy the sensitiveness of a detector or give a shock that might conceivably cause a very old or very nervous person to die from fright. I naturally would not take hold of an antenna wire when there was a thunderstorm overhead.

On the Atlantic Coast, in Texas and mountain regions I have used antennas of about the same kind and gotten daily static discharges to ground of about one-sixteenth of an inch for many hours of the day, and longer discharges for shorter periods. On the Pacific Coast from Southern California to Alaska there is much less static. For about ten days in August in one place in Alaska, we were unable to detect any static at all. In the United States static is strongest along the Rockies; next strongest along the Atlantic Coast and weakest along the Pacific.

A wire two hundred feet high apparently gives nearly a two-inch discharge to ground at any place in the vicinity of a thunderstorm. And the small broadcast receiving antenna might discharge a half inch to ground and in doing so might jump through cotton insulation that was very dry and cause a little fire. Or the static might jump in a way that would carry over a short-circuiting current from filament batteries or "B" batteries or battery-charging arrangements, and the electric power from batteries and power lines can burn up wires or insulation and cause a fire. The lightning arrester should prevent such results from static.

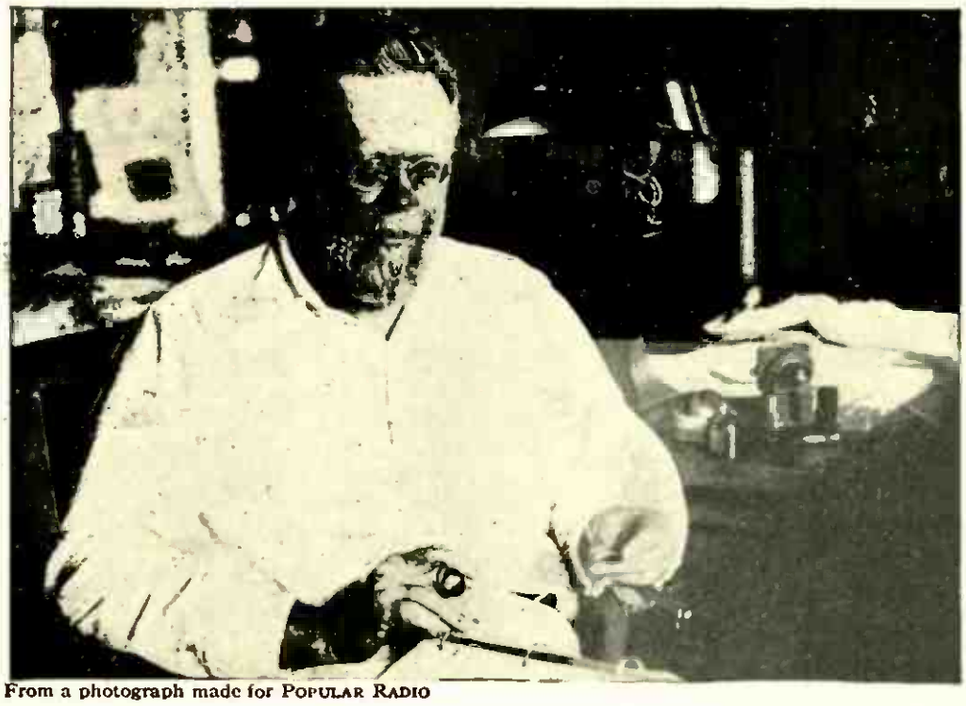
Static is usually induced from lightning or from smaller electrical discharges occurring at some place else. Sometimes static is direct discharges from the atmosphere. Fogs, snow, dust, smoke and steam often discharge to antennas and cause little sparks from the antenna to ground, if there is a gap in the circuit. Those discharges to the antenna are miniature parts of lightning from which real lightning is built up when the charge-carrying atmosphere contracts into a cloud having an outside surface much smaller than the total of all of the surfaces of the little particles.

When a thunderstorm is approaching the static induced in the antenna is capable of jumping farther and farther to ground. As the storm moves away the distance the spark will jump gets smaller. People have occasionally been hit by such static while handling the antenna side of their receivers and have said they were "nearly knocked down by lightning." When a person says that he was "knocked down by electricity" it probably means that he jerked away so quickly that he lost his balance and fell over. An electrical condition that could actually pick a man up and slam him down would probably nearly burn him up.

I have received numerous static shocks from antenna. Some of the sparks that have hit me were probably two inches long. None were the least injurious.

I have sampled the effects of big and little lightning and big and little antennas over the United States without injury to myself. And as it did not hurt me, I do not believe it will hurt anybody else.

¶ *What is "resistance" in radio? What is "inductance"? What is "capacity"? These questions will be answered in terms that the beginner can understand in a new series of articles in* POPULAR RADIO.



From a photograph made for POPULAR RADIO

Why the Broadcast Listener Should Not Be Taxed

An opinion on the broadcasting problem by one of the world's foremost scientists

IF the broadcasting situation is let alone it will settle itself on economic grounds and far better than any laws can settle it. For what will happen is this:

As soon as sales of radio apparatus begin to fall off so that the manufacturer will not bear the expense of broadcasting so easily, the manufacturers will get out more highly selective apparatus and broadcasting will be carried on somewhat after the method of sending and receiving by the "Yale lock" method (U. S. patent 715,203, which expired December, 1919) or some one of half a dozen other methods. This, in turn, will create a new market for receiving apparatus. When this market is filled, the manufacturers will get out apparatus which will give good results only from their own broadcasting stations when their particular types of apparatus are used.

In like manner the new markets will be developed one after the other, and each may be sold to saturation before the next is taken up. In some respects it will develop just like the automobile business; no one would use a 1905 machine today if he got it for nothing.

Leaving the present situation alone will result, too, in immense improvement in broadcasting and wireless generally. It must be remembered that the fact that America is so far ahead of other nations in wireless *is due entirely and solely to the radio amateurs.* The fact that they were not hampered by dozens of laws (and they deserve great credit for blocking off all the mischievous legislation that has been proposed) allowed them to get in on the game; they are the ones who built up the market and provided the incentive to commercial broadcasting.

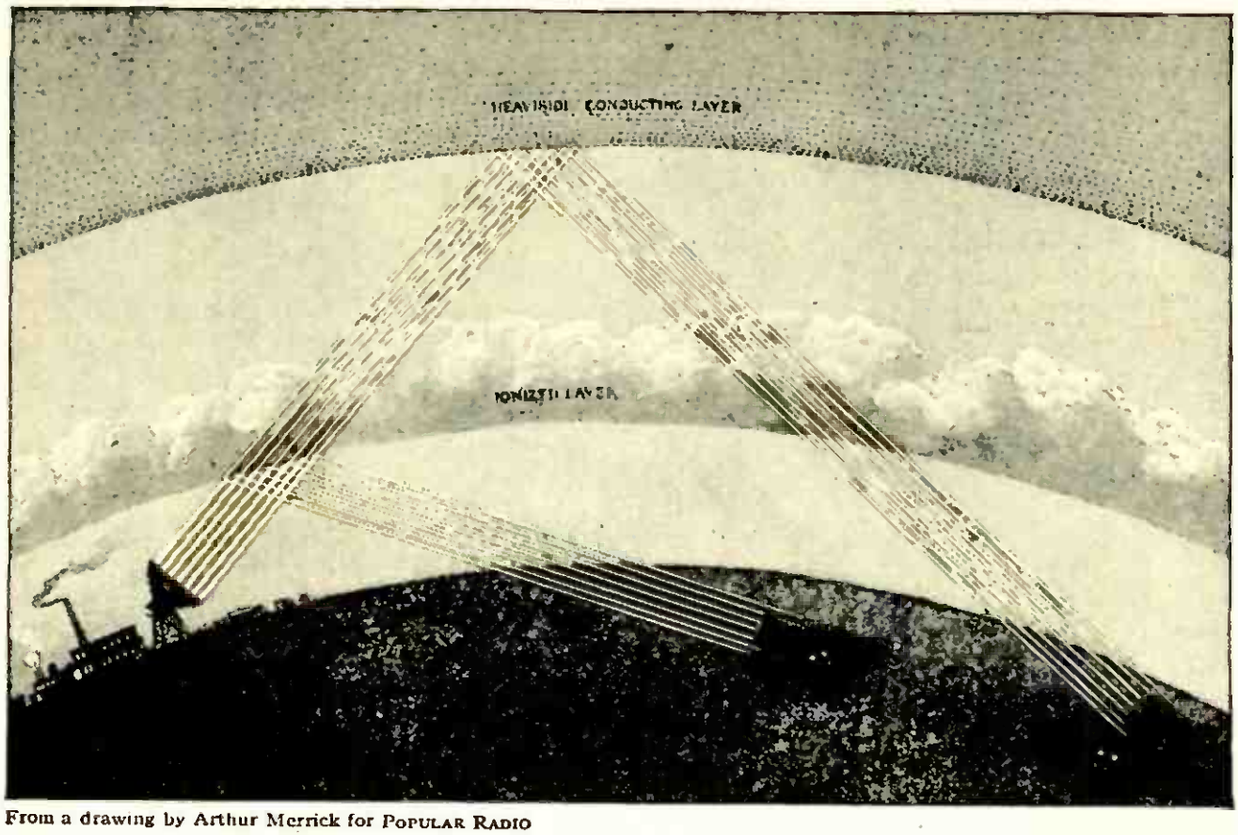
It may be objected that if there is no regulation and taxation all amateurs can listen in. Let them; they are entitled to all consideration, and when they get money enough they will be the best customers for the latest type of receiving apparatus.

If the broadcasting companies insist on taxation and rentals they will not only kill their business but will set back radio development for thirty years.

Still another reason for leaving the situation alone is that we have altogether too many paid government officials now. We shall soon be in the position of those islanders "who gained a precarious livelihood by taking in each other's washing." And this phase of the problem is no joke. Each government official has a family of (say) three others beside himself to be supported by taxes. Consider the percentage of government officials in your own community; if it is six percent, multiply that by four; then reflect that when four men sit round a lunch table, three of them are supporting the fourth and his family in order that he may tell them what they must not do. If you take into consideration the actual figures and not the six percent that I have assumed, you will be surprised.

So for all these reasons I believe the matter should be left to settle itself naturally on economic grounds. In fact it would have settled itself long ago but for officious meddling.

Reginald A. Fessenden.



From a drawing by Arthur Merrick for POPULAR RADIO

HOW EXPLORERS MAY SEARCH FOR SECRETS OF THE UPPER AIR

Very short radio waves may be used soon to study the conditions in the inaccessible regions of the earth's atmosphere. Beams will be reflected more or less completely from conducting layers and may be detected and measured by portable receiving outfits equipped with condensing parabolic reflectors.

How Short-Wave Radio May Help the Weather Man

High up in the air there exists a mysterious something that radio engineers call the Heaviside Layer. Weather men suspect that this same region of the atmosphere may have much to do with thunderstorms and other weather changes. One way that scientists foresee to study this upper part of the air is by directed beams of very short radio waves. Waves less than two meters long have been used for telephony by General Ferrié and Commandant Mesny of the French Army. This article tells how these new "radio ripples" will prove useful in scientific work.

By E. E. FREE, Ph.D.

ALTHOUGH the use of shorter and shorter waves has been so pronounced a feature of recent advances in radio science, it has usually been considered impossible to reduce the length of useful waves much below 100 meters.

This is not because the shorter waves are unobtainable. As long ago as 1917 Gutton produced continuous waves 1½ meters long by means of vacuum tubes. A little later Barkhausen and Kurz* succeeded in producing waves only ½

*"The Shortest Waves Producible with Vacuum Tubes," by H. Barkhausen and K. Kurz, *Physikalische Zeitschrift* (Leipzig), vol. 21, pages 1-6 (January, 1920).

meter long. On the other hand Dunmore† in the United States and Franklin‡ in England have studied standing waves of short wavelength and have obtained good results down to waves only three meters in length. Among the damped waves, short wavelengths have been realized for some time, including waves like those used in the original experiments of Hertz and, more recently, the waves produced by the American physicists Dr. E. F. Nichols and Dr. J. D. Tear§, waves measured in centimeters and millimeters and which constitute the shortest radio waves so far produced by man.

But the experiments with waves as short as 1½ meters, while of the greatest scientific importance, did not provide for the practical use of such unusually short waves in radio communication. The amount of power emitted by the transmitter was too small. Signals were not readable in a receiving apparatus located at any considerable distance from the transmitter.

A number of research laboratories, both here and abroad are working actively on this problem of short-wave radio and it is violating no confidence to say that the results already are most promising. Modified tubes are necessary and the experimenter is compelled, also, to give careful consideration to even the smallest details in the design of his circuits. The time necessary for electrons to move through a wire or through space for a distance even so small as a hundredth of an inch becomes a vital factor of the problem when frequencies that approach a million kilocycles are under consideration.

Important steps toward the utilization of short waves are embodied in recent experiments carried out under the direction of General Gustave Ferrié and Commandant René Mesny of the French Army.* Practicable transmitting and receiving apparatus has been developed for waves with a length of 1½ meters

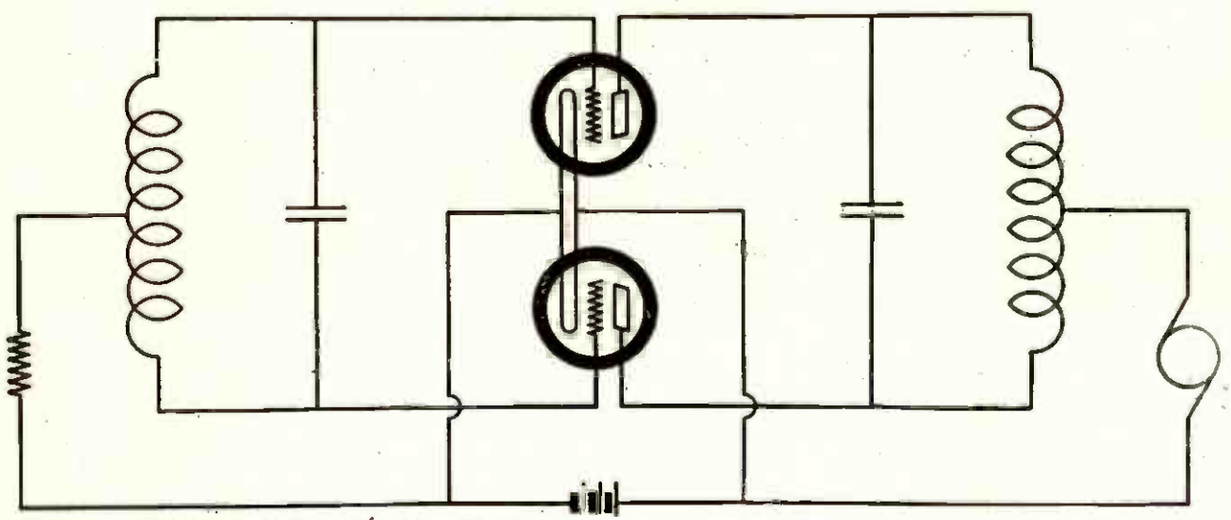
† "Directive Radio Transmission on a Wavelength of Ten Meters," by F. W. Dunmore and F. H. Engel. U. S. Bureau of Standards, Scientific Paper No. 469, April 11, 1923; *also*

Dunmore and Engel, "A Method of Measuring Very Short Radio Wavelengths and Their Use in Frequency Standardization." *Proc. Inst. Radio Engineers*, vol. 11, pages 467-477 (October, 1923).

‡ "Directive Radiotelegraphy with Very Short Waves," by C. S. Franklin. *Wireless World* (London), vol. 10, pages 219-255 (March 20, 1922).

§ "The Shortest Radio Waves Ever Produced by Man," by E. F. Nichols. POPULAR RADIO, vol. 4, pages 22-29 (July, 1923).

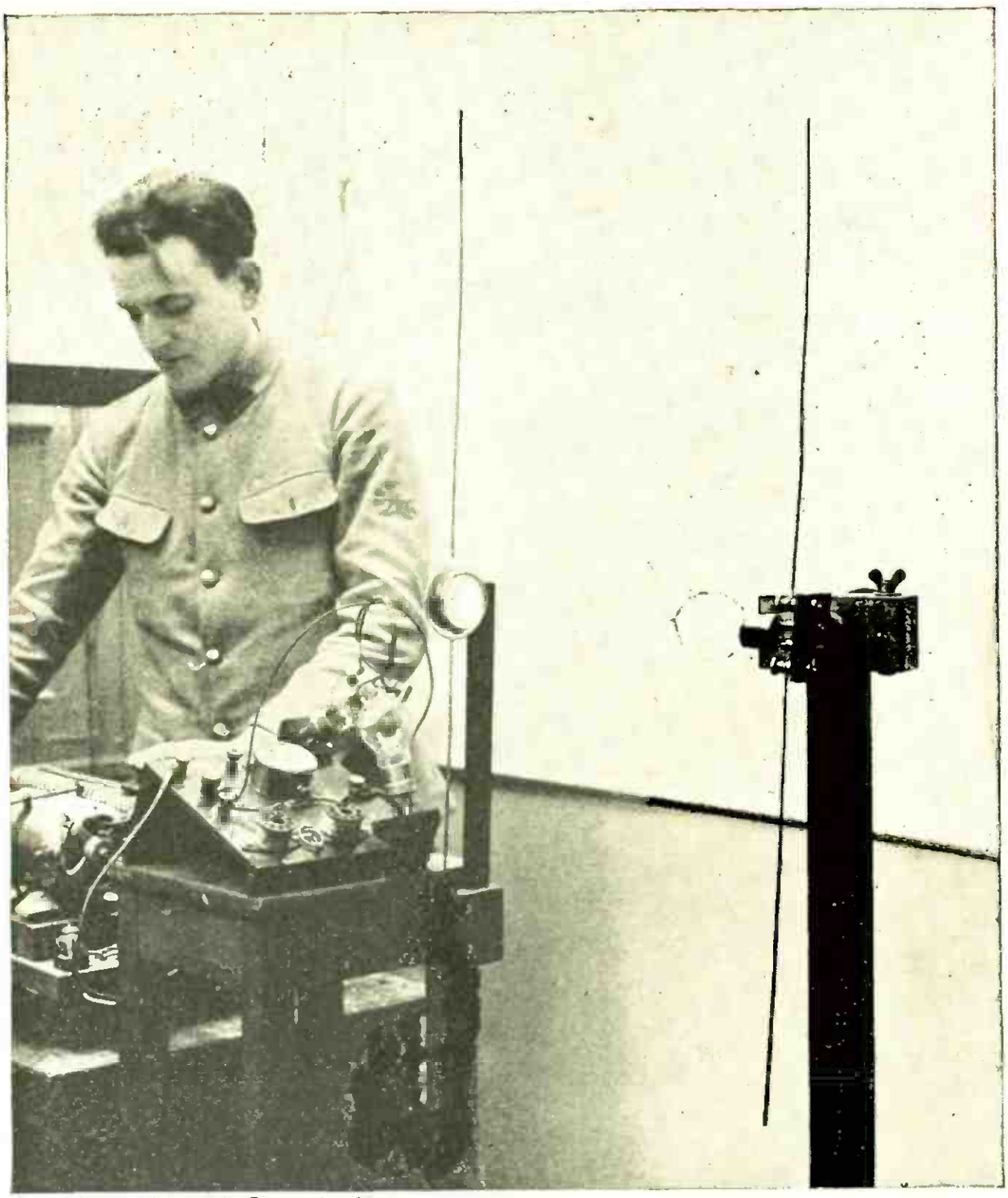
* "The Very Short Waves," by René Mesny. *L'Onde Électrique* (Paris), vol. 3, pages 25-37 and 99-110 (January and February, 1924).



Redrawn from a diagram in *L'Onde Électrique* (Paris)

HOW THE TWO TUBES ARE CONNECTED IN COMMANDANT MESNY'S SHORT-WAVE GENERATOR

Note the symmetrical mounting of the two tubes, so that very high-frequency oscillations can be produced. The frequency attainable by this device is limited only by the time necessary for the electron stream to move across the space inside the tubes.



From a photograph loaned by Commandant Mesny

HOW THE 1.5-METER WAVES WERE PRODUCED

The generating apparatus is on the board at the left of the picture. Note the two tubes, the inductances and the condenser box. The first vertical wire (with the ammeter at its center) is the transmitting antenna. The vertical wire at the right contains a detector lamp and serves as the receiving antenna. This is the outfit used in the laboratory experiments by General Ferrié and Commandant Mesny.

(about 5 feet). These very short waves have been used successfully for radio telephony over distanecs up to 2 kilometers (1¼ miles).

In the oscillator used for transmission the usual vacuum tube is replaced by two tubes, mounted symmetrically. The circuits are arranged to reduce as much

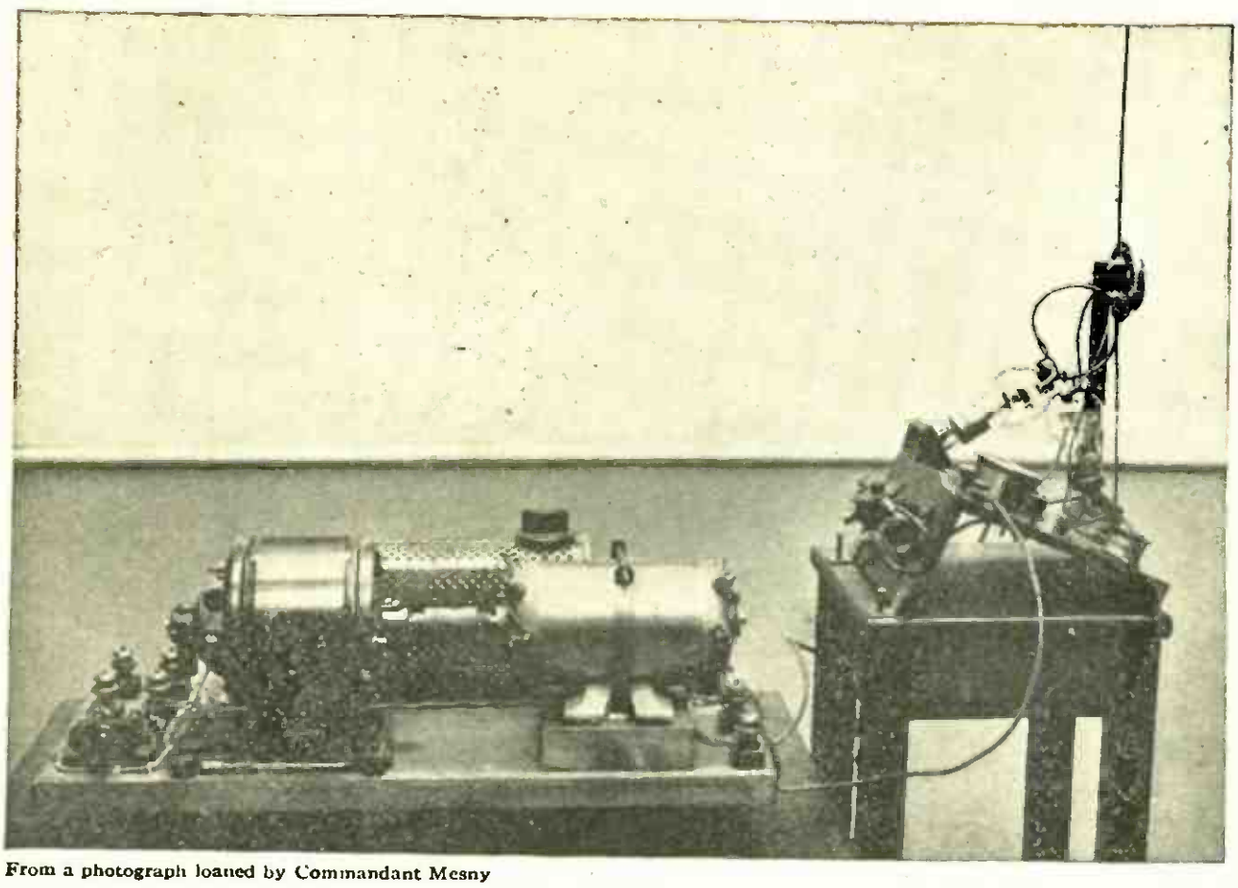
as possible the path which must be followed by the high-frequency oscillations. The generation of high-frequency waves, corresponding to 200,000 kilocycles or more, is thus rendered no more difficult than the generation of waves of ordinary frequencies.

Waves as short as 1.2 meters (250,000 kilocycles) have been obtained successfully, but for the operation of the apparatus in actual radio communication waves of 1.5 meters to 1.6 meters (200,000 to 187,500 kilocycles) have been employed.

The production of waves still shorter than 1.2 meters is theoretically possible, but is limited by the internal construction of the vacuum tubes. The tubes used were a simple modification of those ordinarily employed for radio telephony in the French military service. Their construction is such that the time required for the electrons to pass from the filament to the plate is of the order of one one-hundred-millionth of a second. So soon, therefore, as one reaches frequencies in the neighborhood of 200,000 kilocycles this internal characteristic of the tubes becomes an important factor limiting the operation of the apparatus.

The antenna used is very simple; it is merely a vertical wire the length of which is one half the wavelength that is being used. For example, for a 1.5 meter wave the antenna may be a single wire .75 meter long.

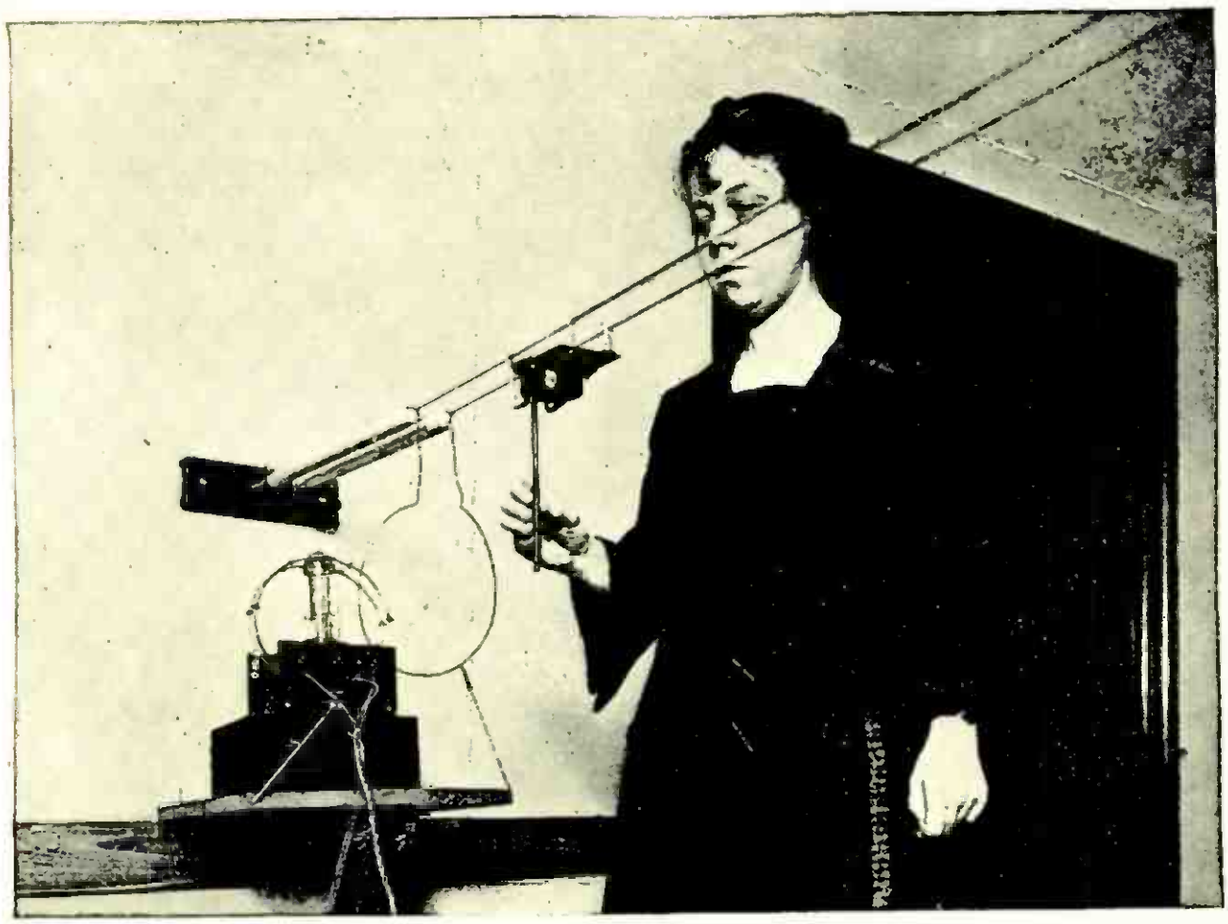
This transmitter, using waves approximately 1.5 meters long, has been used in tests of telephone transmission between two suburbs of the city of Paris at three o'clock in the afternoon with entire success. Even when both the transmitter and the receiver were located in a forest at a distance of 500 meters from each other, transmission was still possible in spite of the absorp-



From a photograph loaned by Commandant Mesny

THE SHORTEST-WAVE BROADCASTING STATION EVER BUILT

This is another view of the transmitting equipment shown on page 549. The power is supplied by the motor generator shown in the foreground. Behind it is the regulating rheostat. At the right is the oscillator itself and the vertical-wire antenna.



From a photograph made for POPULAR RADIO by Harris & Ewing

AN AMERICAN EXPERT IN SHORT-WAVE RADIO

Miss G. Hazen of the United States Bureau of Standards, who has assisted Mr. Dunmore of that Bureau in his work with waves ten meters long and less, is here shown with the short-wave transmitter used in the Bureau's method of establishing wavelengh standards by means of standing waves on two parallel wires. (This method was described in the issue of POPULAR RADIO *for February, 1924, page 209.)*

tive effects originating from the trees.

This was accomplished, Commandant Mesny reports, with antenna currents in the neighborhood of 80 milliamperes. With larger currents it is probable that the communcation range for apparatus of substantially the same design can be extended to 15 or 20 miles, perhaps much more than this.

The great advantage of these very short waves in radio communication lies in the fact that they may be concentrated with ease into directed beams. The well-known work of Mr. Dunmore and Mr. Engel of the United States Bureau of Standards, using ten-meter waves, has already been referred to and this points the way to what can be done with still shorter waves.

The open air radio-telephone experiments of General Ferrié and Commandant Mesny do not appear to have included any work with such directed beams, but laboratory experiments carried out by them with their 1.5 meter wave transmitter do include some interesting experiments with the reflection of waves from metallic mirrors.

For the conduct of these experiments a short-wave transmitter consisting of a single vertical wire is placed fifteen or twenty feet in front of a metallic screen which serves as a mirror for the waves. Into the space between the transmitter and the mirror there is then introduced another vertical wire, containing a lamp. This wire serves as a reception antenna. With the small distances employed, the current produced in this reception wire is sufficient to make the lamp glow

whenever the wire is in the proper relation to the system of standing waves in the space between the transmitter and the mirror.

This wire and lamp serve, therefore, as a means of exploring the forms of the original wave and of the reflected wave, just as the human eye serves to explore the behavior of the waves of light. Experiments with the device indicate that the reflection of radio waves and the interference of the reflected and the original wave obey, in this instance at least, much the same laws as do the waves of light.

For the production of concentrated beams the flat metallic mirror is replaced by one that is curved. It is in the form of one side of a cylinder with its axis vertical. Mirrors of parabolic section may be employed as well, as they were in the experiments of Dunmore and Engel.

There is every reason to believe that devices of this kind will serve to give us very soon a much clearer understanding of the nature of radio-wave propagation than we have had hitherto. We will have "radio telescopes" as we now have optical telescopes. We will be able to carry out with radio waves those experiments on interference, on spectral analysis, on polarization and on other phenomena, the investigation of which in the case of light waves has been so useful to the progress of science.

There is, for example, the pressing problem of how radio waves are absorbed by obstacles, such as buildings, trees and mountains. Light waves, we know, are frequently absorbed in definite "absorption bands." A certain wavelength of the light, or a certain group of wavelengths is absorbed and removed from the beam of mixed waves. The other wavelengths that happen to be present are allowed to pass. Materials, as we say, are "transparent" for some wavelengths of light; "opaque" for other wavelengths.

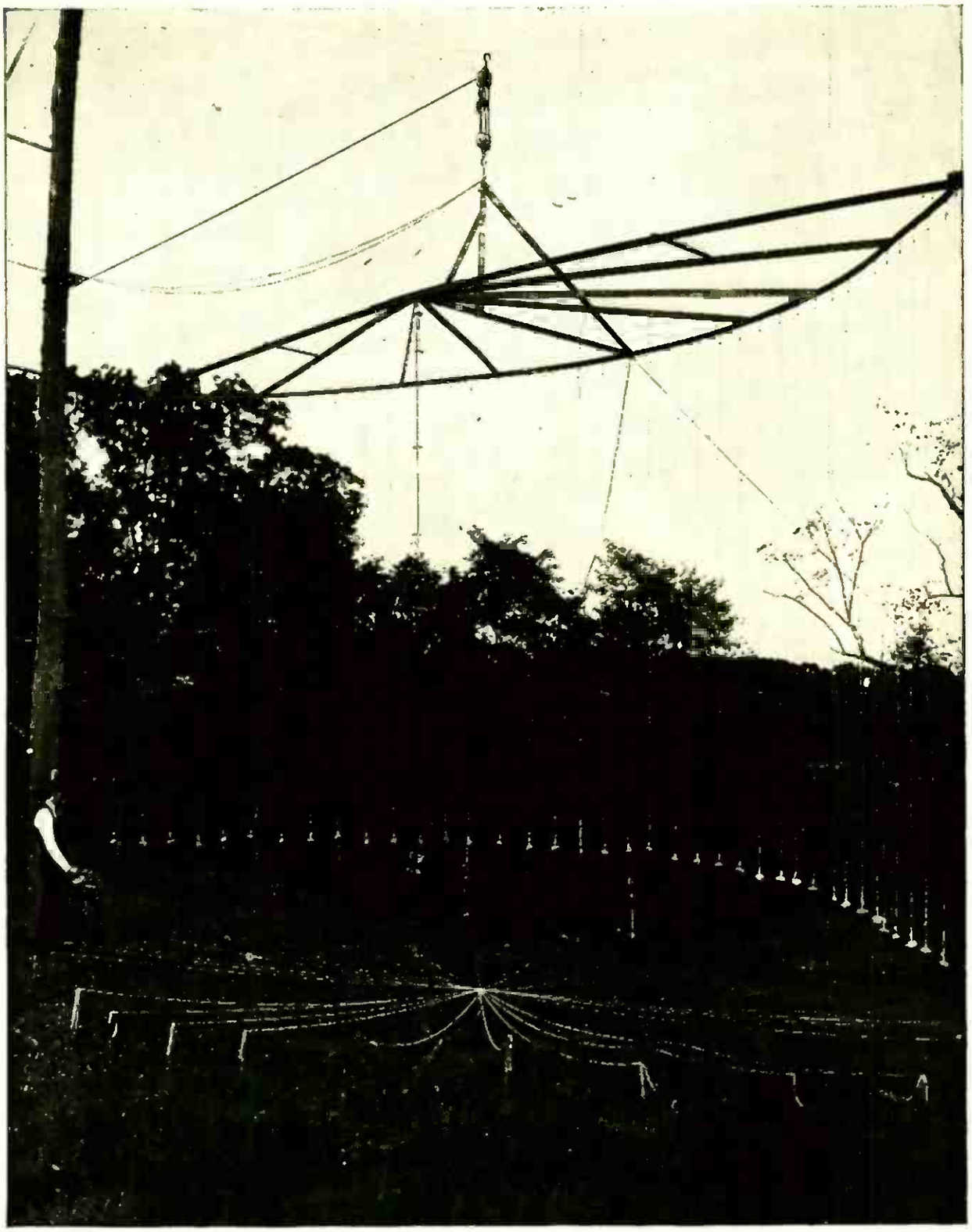
Do radio waves behave in this same way or differently? Do steel buildings for example, absorb *all* radio waves alike or does each particular building have its own definite absorption band which it will take out of the transmitted wave, leaving unimpaired the other wavelengths that happen to be present.

The second of these possibilities seems to most radio engineers nearer the truth than the first, but we must admit that the real truth about it is unknown. Experimentation on such matters using waves in the ordinary range of wavelengths is almost impossibly difficult. The very short waves are much easier to work with. When we can employ beams of half-meter waves as freely as we now use the broadcasting waves, then we may expect to discover the principles that control the relations of radio waves to such objects, just as we now know the principles that regulate the propagation, absorption and bending of light.

We will be able then, to *predict* the absorptions and deviations of the waves from a proposed broadcasting station as accurately, we may hope, as the opticians can now predict the exact characteristics of a lens intended for a camera or a telescope.

But perhaps the most immediate benefit that we may expect from the use of these short waves will be found in the scientific study of the electric properties of the atmosphere. We know from the phenomena of fading, as well as from the considerable deviation of waves that cross a continent, that the atmosphere plays an important role in the propagation of electromagnetic waves. For example, the great distances covered by such waves are attainable only because of the presence in the upper part of the atmosphere of that conducting region that we call the Heaviside Layer.

The availability of the very short waves will permit us, from now on, to multiply our observations on these phenomena of propagation as well as to



Bureau of Standards

The Ten-meter Reflector of the Bureau of Standards

This reflector was built by Mr. F. W. Dunmore of the Bureau of Standards for his work with directed beams of radio waves ten meters long. The transmitter proper is the small box suspended in front of the wires; the wires themselves are hung from a parabolic support and each wire is tuned separately to exact resonance with the wavelength, the tuning being done by lengthening or shortening the wires. With this reflector Mr. Dunmore was able to direct nearly all the energy of the radio wave in one direction, very little energy passing through the wires.

organize new observations on fading. There will be required only the installation of a number of short-wave transmitters, the cost of which will be low.

The very short waves will permit us to produce at will directed beams of radio waves. These beams can be pointed upward into the atmosphere at selected stations. Movable receiving stations will permit the determination of the exact places where (if anywhere) these beams return to the earth. From such data, if we know fully the characteristics of the waves themselves, we can deduce much valuable information concerning the materials—ions or electrons or what not—that occupy the layers of our atmosphere which are inaccessible to us directly.

Every radio fan realizes nowadays how important are these upper levels of the air, fifty or sixty miles over our head, to radio transmission. They are important also to the study of earth magnetism, to the theories of atmospheric electricity (including, of course, the theories of the cause of static) and to many other pressing problems of terrestrial physics.

And to take a more familiar example, it is probable that these upper levels of the air have much to do with the mysterious causes of what we call weather. The causes of storms, their tracks as they move over the earth's surface, the rain or snow or hail that they drop down on us as they pass, all these matters of everyday interest and importance contain, the scientists confess, much more of mystery than they do of discovered and certain fact.

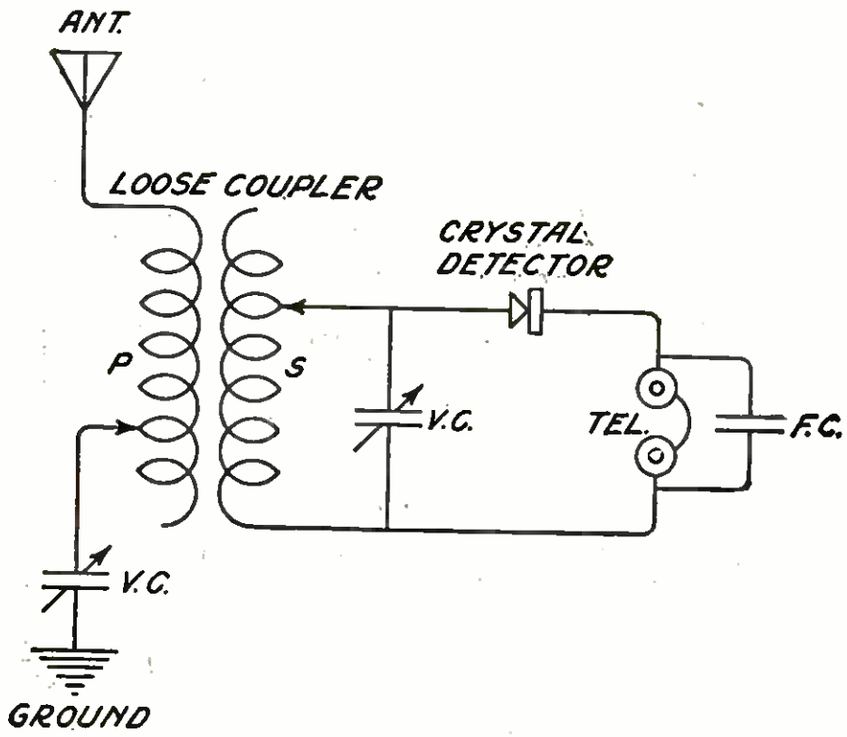
There is every reason to believe that if we can get more complete and dependable information about the true conditions in the upper levels of our atmosphere we shall be able to take a great step in advance in explaining the weather and, what is of much more practical importance, in predicting it.

Radio science is opening a new chapter in meteorology, a chapter that promises much in the way of scientific discoveries, as well as in applications that are directly practical.

© Western Electric.

PICKING UP AND TAKING DOWN A BROADCAST SPEECH

Students of shorthand are advised by Miss Helen Kearns of Newark, New Jersey, that excellent training may be had by the simple expedient of taking down at home the talks that come in by radio—and that the "varied styles of delivery" assures valuable practice.



INDUCTIVELY COUPLED CRYSTAL RECEIVER

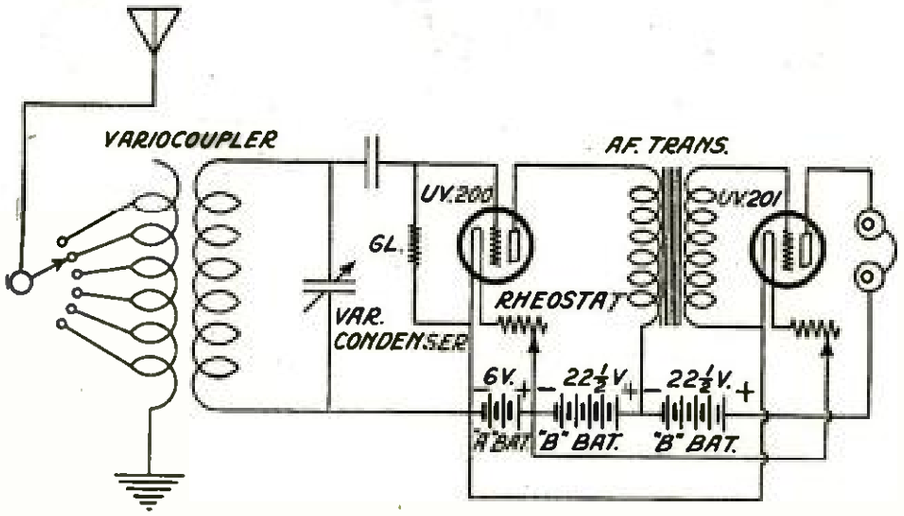
Cost of parts: Not more than $22.00.
Selectivity: Good.
Operation: Fairly simple.
Construction: The whole set can be constructed on a board and wired up in an hour or two.*
Approximate range: 15 miles.
Outstanding feature: The sharpest tuning crystal receiver that it is possible to make.

(See POPULAR RADIO, August, 1922, page 293, for constructional details.)

100 BEST HOOK-UPS

INSTALLMENT NO. 7

IN this series of hook-ups is being published—for the special benefit of the radio novice who is undecided as to just what circuit he wants—100 of the best radio receiving circuits, each thoroughly tested. The approximate ranges given here are averages based on actual records made with receiving sets throughout the country. During the summer the actual ranges may fall to 50 percent of the value given, while in the winter, in the best of conditions, the actual ranges may exceed the values given by as much as 500 percent. All of these circuits have been described in detail in previous issues of POPULAR RADIO.

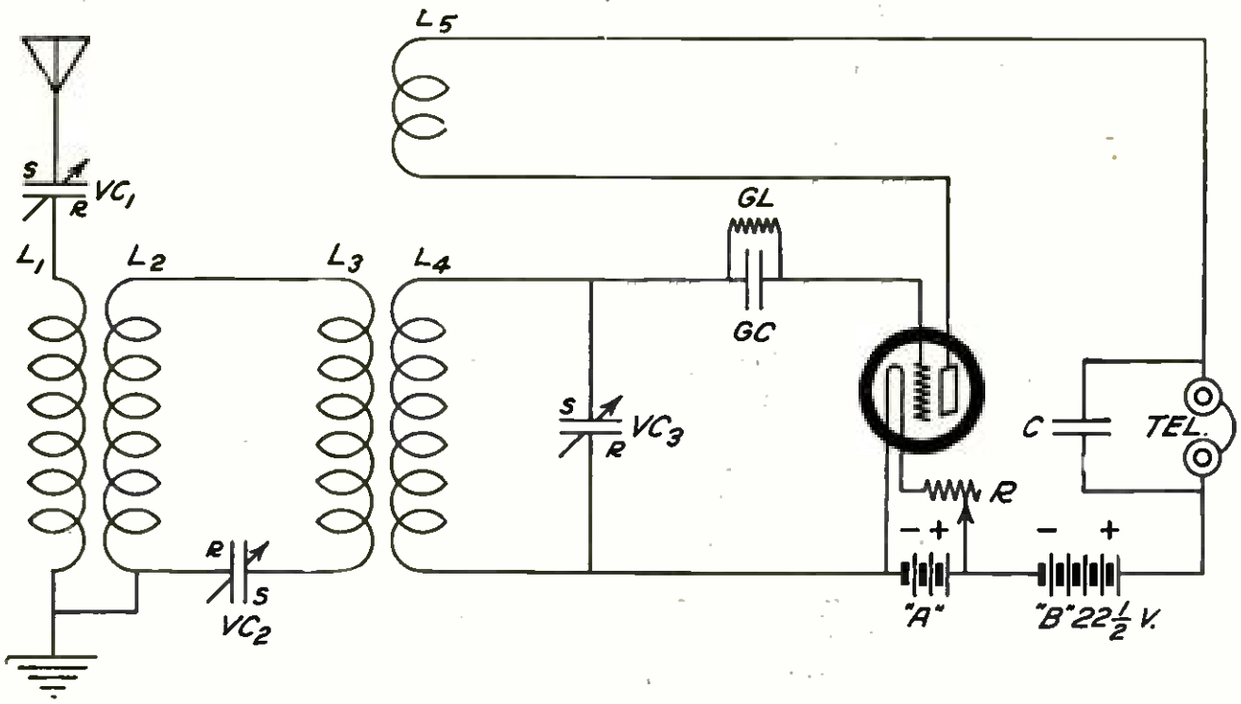


INDUCTIVELY COUPLED, VACUUM-TUBE RECEIVER WITH ONE STAGE OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $28.00.
Selectivity: Fairly good.
Operation: Simple.
Construction: Easy to make.*
Approximate range: About 100 miles.

Outstanding features: The added stage of amplification increases the operating range considerably and makes the local programs more enjoyable for use with a number of headphones.

(See POPULAR RADIO, October, 1922, page 147, for constructional details.)

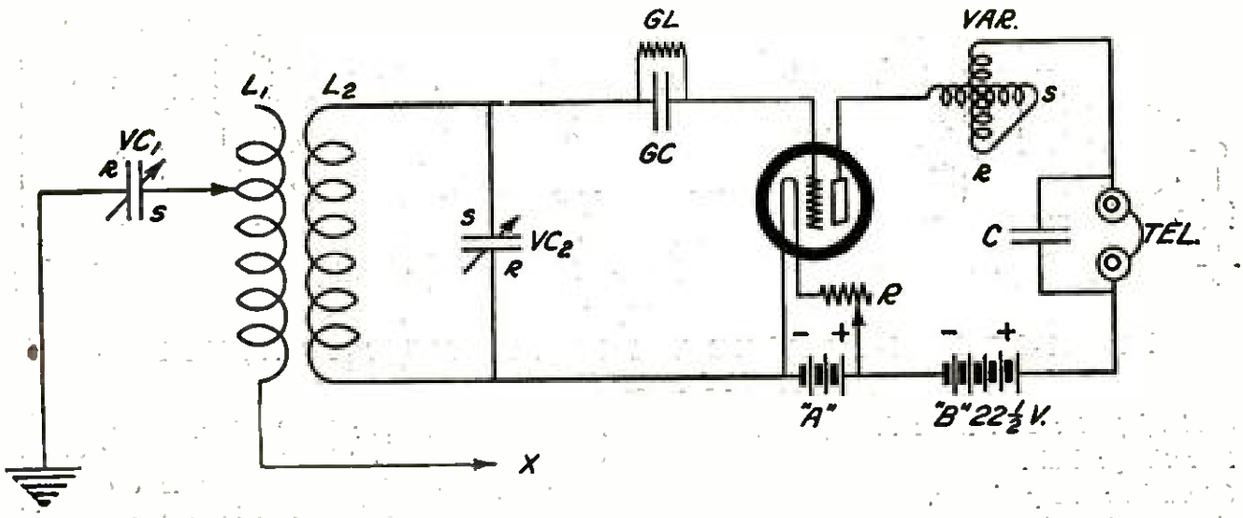


A REGENERATIVE RECEIVER WITH AN INTERMEDIATE CIRCUIT TO REDUCE RADIATION

Cost of parts: Not more than $30.00.
Selectivity: Very good.
Operation: Rather complicated.
Construction: Just an ordinary acquaintance with tools and some ability in wiring up the electrical circuit is necessary.*
Approximate range: 500 to 1,000 miles.

Outstanding features: The receiving system used here makes use of an intermediate, resonant circuit for loosening the coupling between the antenna circuit and the grid circuit so that radiation will be prevented. The loose coupling employed makes for sharp tuning.

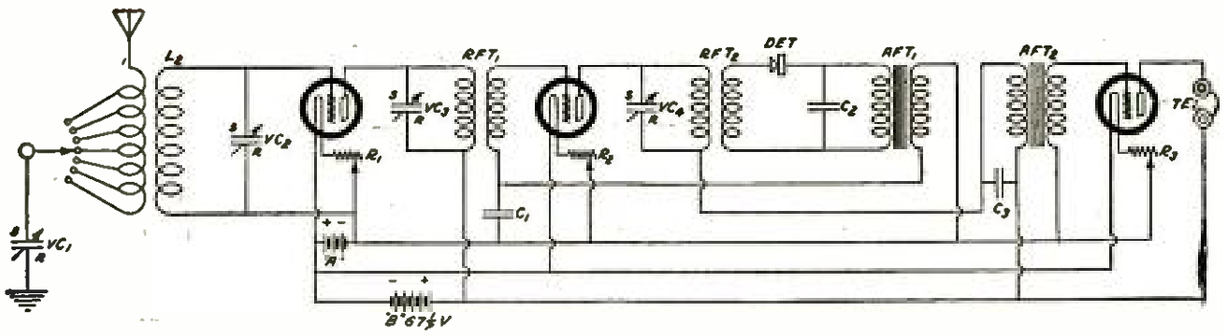
(See POPULAR RADIO, March, 1924, page 292, for constructional details.)



A SIMPLE REGENERATIVE RECEIVER FOR USE WITH TWO GROUNDS

Cost of parts: Not more than $30.00.
Selectivity: Excellent.
Operation: Not especially complicated. The ground circuit is tuned by means of a variable condenser; likewise the secondary circuit. The plate circuit of the detector tube is tuned by means of a variometer and this controls regeneration.
Construction: Not complicated.*
Approximate range: Local.
Outstanding feature: No antenna is necessary. Just use two grounds; one may be the water pipe and the other the radiator system or the gas pipes.

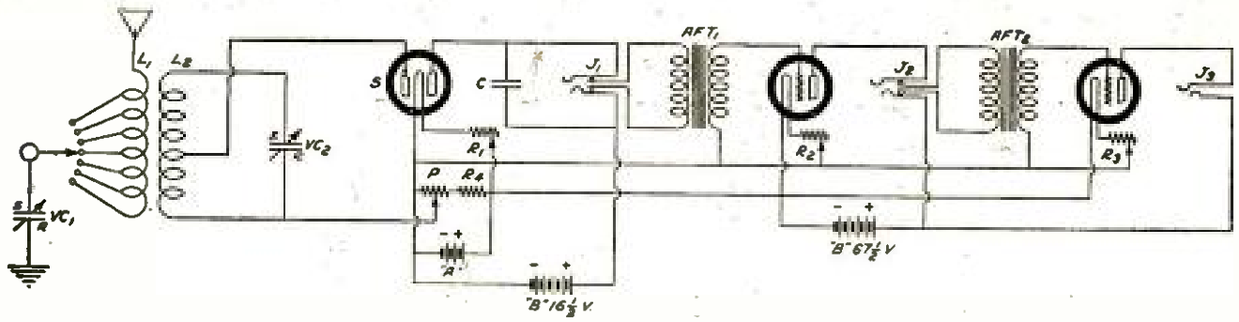
(See POPULAR RADIO, November, 1923, page 373, for constructional details.)



TWO STAGES OF TUNED-RADIO-FREQUENCY AMPLIFICATION, CRYSTAL DETECTOR AND TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $60.00.
Selectivity: Very good. Tuning is accomplished entirely by means of variable condensers.
Operation: Rather complicated. The tuning should be done by logging the settings for the various wavelengths.
Construction: Not a simple set to make. Some experience in making sets should be had before attempting construction.*
Approximate range: 2,500 miles.
Outstanding features: Only three tubes are used. One stage of audio-frequency amplification is reflexed.

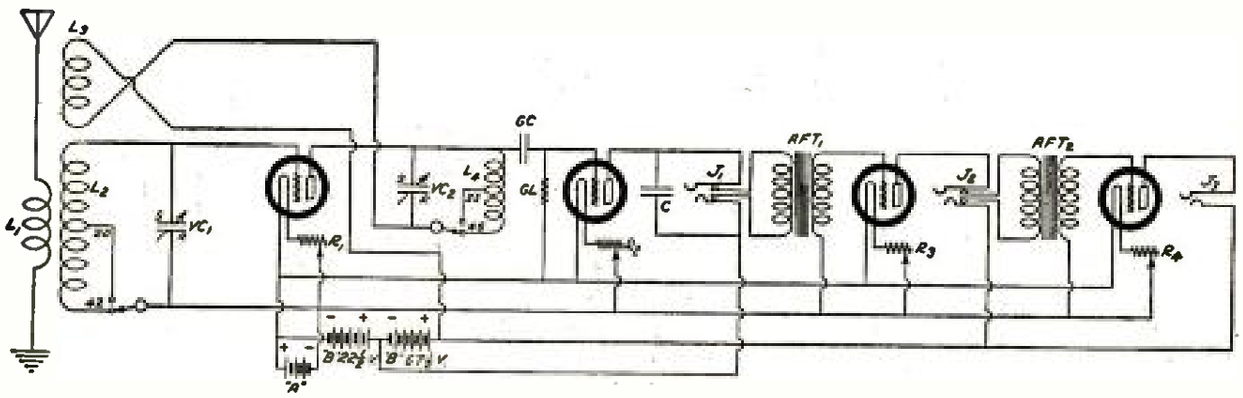
(See POPULAR RADIO, January, 1924, pages 80-81, for constructional details.)



DONLE DETECTOR CIRCUIT WITH TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $38.00.
Selectivity: Fair.
Operation: Very simple.
Construction: Not hard to put together.*
Approximate range: 1,000 miles.
Outstanding feature: This circuit uses the new type of sodion tube which is extremely sensitive but which cannot oscillate or radiate.

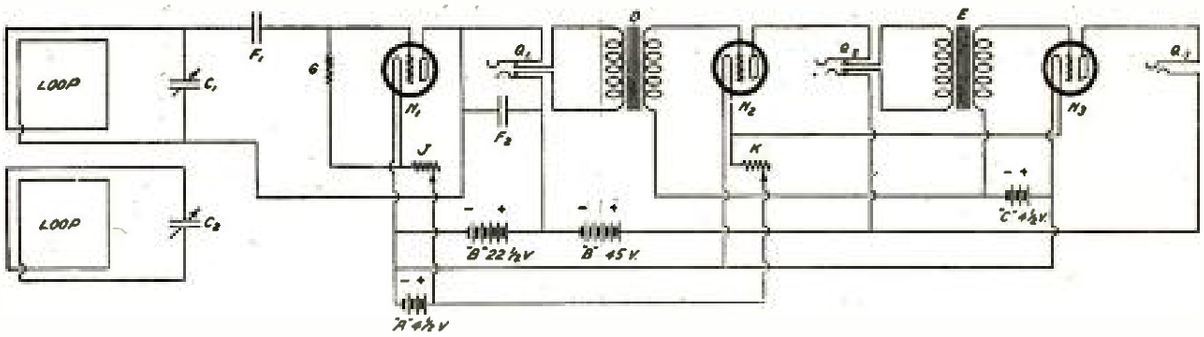
*(See POPULAR RADIO, *March, 1924, pages 294-295. for constructional details.)*



THE SUPERDYNE CIRCUIT WHICH EMPLOYS A REVERSED-TICKLER FEED-BACK FOR ELIMINATING REGENERATION

Cost of parts: Not more than $47.00.
Selectivity: Excellent.
Operation: Rather complicated. The operator will have to get used to the proper adjustment of the tickler before he will get good results, but when this has been learned, the set will function nicely.
Construction: Fairly complicated.*
Approximate range: 2,000 miles.
Outstanding features: Excellent selectivity and sensitivity.

*(See POPULAR RADIO, *March, 1924, pages 296-297, for constructional details.)*

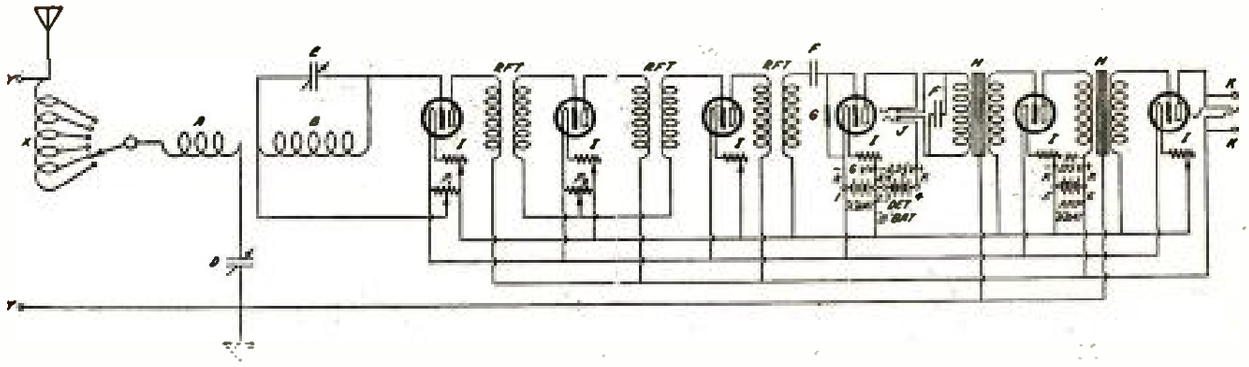


FOUR-CIRCUIT PORTABLE RECEIVER

Cost of parts: Not more than $50.00.
Selectivity: Excellent.
Operation: Simple.
Construction: Not difficult.*

Approximate range: Local.
Outstanding feature: All parts mounted in a cabinet, including loops, batteries and tubes.

(See POPULAR RADIO, February, 1924, page 152, for constructional details.)



THE DX CIRCUIT WITH THREE STAGES OF RADIO, DETECTOR AND TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than $60.00.
Selectivity: Very good.
Operation: Fairly simple.
Construction: Complicated.*

Approximate range: 2,500 miles.
Outstanding feature: The addition of the radio-frequency amplification to the original DX set improves the sensitivity greatly without complicating the tuning control.

(See POPULAR RADIO, April, 1923, pages 310-311, for constructional details.)

¶ *Some of the amazing possibilities that are opened up by the application of electromagnetic waves to transportation.*

Special Press, London

ONE PRESENT USE FOR ELECTROMAGNETIC WAVES

The conquest of friction by electromagnetic forces has already been accomplished inside the vacuum tubes used by Sir Joseph J. Thomson to investigate the movements of atomic particles. Professor R. Everett is explaining to Sir Joseph one of the electromagnets used in this work.

Rapid Transit by Radio

Passengers may be carried from Chicago to New York in five minutes. Freight may be hauled across the continent for a few cents a ton. These are some of the things that speculative science hopes for from the application of electromagnetic waves to transportation.

By THOMAS ELWAY

WOULD you like to leave your seaside cottage in Atlantic City each morning at a quarter before nine and fifteen minutes later be at your desk in New York, ready for work?

Or if your home and business is in the middle west, would you like to step into the Radio Express two or three evenings a week and be whisked in a few minutes to the door of a Broadway theatre, whence you could return after the show in time for a good sleep in your own bed?

Of course, you would. A gentleman who loved the open no less than he did the Great White Way remarked once

that the ideal existence would be to live in Texas in the daytime and in New York at night.

Well, why not?

If we want these things let us get them. They can be done. There is better than an even chance that before you and I are dead they will be done. And radio may help to do them.

The only thing that stands in the way of doing them tomorrow is friction.

To haul a railway train from Chicago to New York requires a great deal of power. Tons of coal must be burned. tons of water must be evaporated into steam. scores of men must handle and rehandle this coal and water; all in order that the necessary hundreds of horsepower be available each second to keep the train in motion.

All this power is dissipated in friction; friction of the wheels on the rails, friction of the axles as they turn in their oiled boxes, friction of the air as the train forces its way through it. If there were such a thing as a frictionless railway train you could put it on a level track at Chicago, give it one good shove and send it all the way to New Orleans. If there were no such thing as air friction New Yorkers would not need to mail their letters to Jersey City; they could stand on the dock and throw them over.

Friction is our Old Man of the Sea. Gripped on the back of our civilization he takes his toll of money and of time from every article we buy and every act we do. The copy books are wrong. It is friction—not procrastination—that is the thief of time.

Consider the city worker who commutes. Two hours a day, twelve hours a week, he pays to Old Man Friction. Even if he lives inside the city he spends an hour or so a day moving about in street cars; an hour that could be shortened to five minutes if our Old Man could be shaken off.

In the United States the daily waste of time in merely moving people around totals much more than 20,000,000 working hours; a tribute of ten or twenty million dollars daily to Old Man Friction from this one source alone.

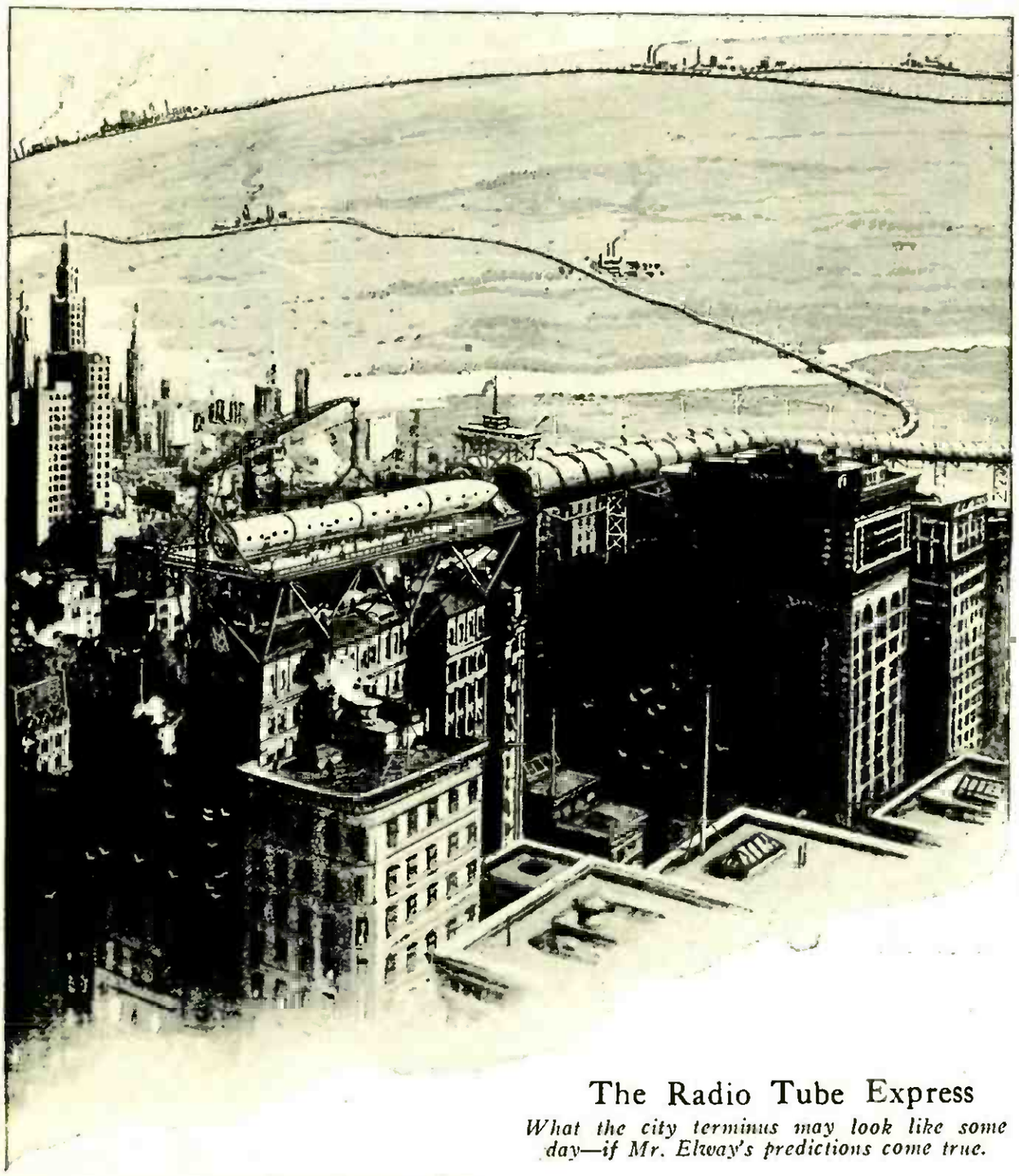
In other ways the cost of friction is still more appalling. Take only one example; the cost of transporting food. Apples that bring fifty cents a barrel in Maine sell for five cents each in New York. An orange for which the California grower gets a fraction of a cent sells for a dime on the eastern seaboard.

Some of this difference goes to middlemen but Old Man Friction gets most of it. If there were no friction the growers could take their oranges up to the crest of the Rockies and *roll* them to New York.

The troubles of the American farmer, troubles so serious that President Coolidge has given them his personal attention, are due in the main to the high cost of transporting farm products. Old Man Friction causes them. Our coal, the engineers say, threatens to run out. Old Man Friction eats it up. The cost of transportation is the chief obstacle to

1,000 Miles an Hour on the Radio Express!

INDEED, *a speed ranging from* 10,000 *to* 20,000 *miles an hour would be entirely within the realms of possibility for a passenger-carrying car propelled in an air-tight tube by electromagnetic forces. This "electromagnetic express" could travel from San Francisco to Boston in* 20 *minutes!*



The Radio Tube Express

What the city terminus may look like some day—if Mr. Elway's predictions come true.

From a drawing made by Arthur Merrick for POPULAR RADIO

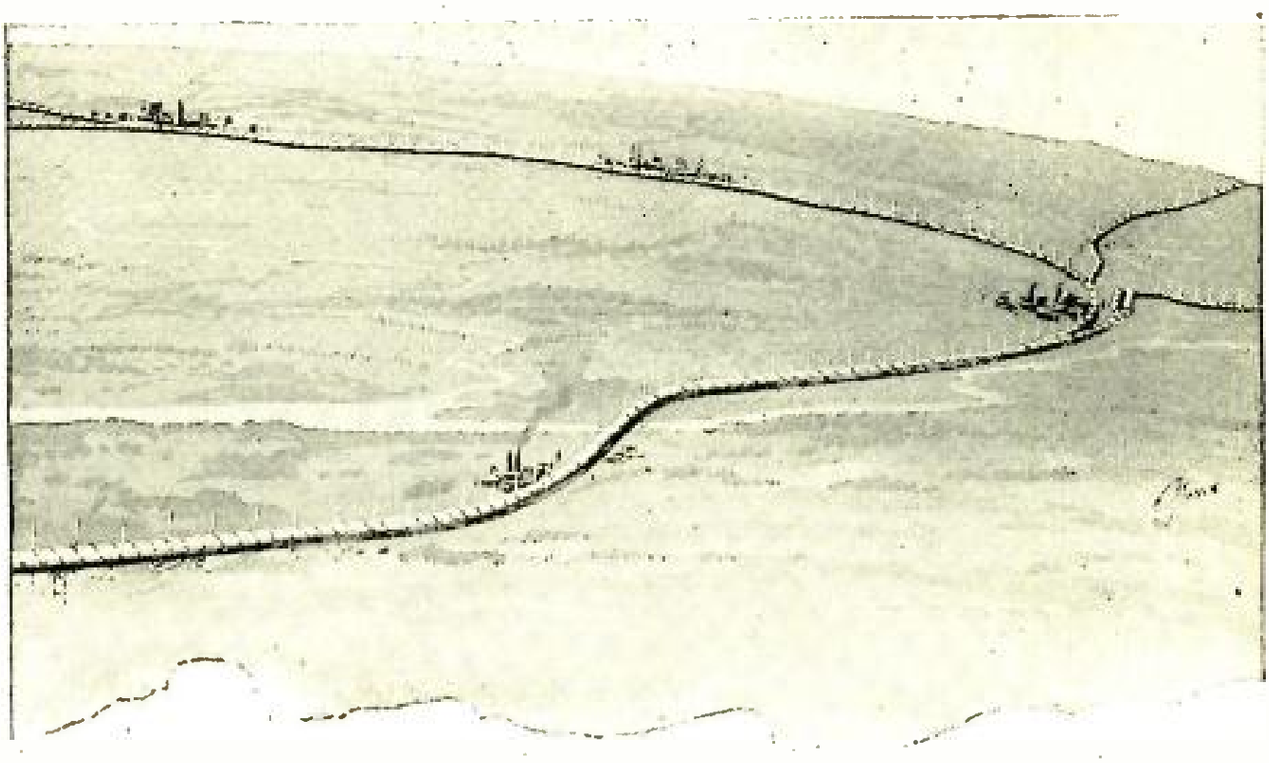
a lower cost of living and more happiness for everybody. Old Man Friction stands in the way.

"Granted," you say. "But what are we to do about it? Friction is a fact of nature, as inescapable as cold or gravity or the need of breathing air."

Not a bit of it. Friction is *not* inescapable. There are many ways in which science may be able to get rid of most of it; for example, we might invent a frictionless metal for rails and bearings.

But one of the most promising ways, so far as transportation is concerned, is likely to be the Radio Tube Express.

It would be more exact, perhaps, to call this the Electromagnetic Express, for the electromagnetic waves upon which the idea depends are somewhat different from the waves used in broadcasting though they belong to the same family. These waves can be used to



shoot freight and passengers through frictionless tubes.

You can make a small model of the system for yourself. Take some insulated copper wire and wind it onto a porcelain tube like a lead-in insulator, or onto a wooden spool with a hole in it. The hole should be about a quarter of an inch in diameter. The size of the wire does not matter much. Wind on enough turns of it so that there are eight or ten layers of the wire.

Now get a round rod of iron, like a large nail, of a size that will fit loosely inside the hole in the coil of wire. Insert one end of this iron rod into the coil, so that it goes about half way through the coil. Then pass a heavy direct current of electricity through the wire. The iron rod will suddenly jump all the way inside the coil, being pulled in by the electromagnetic waves which the current produces. This device is a familiar one in electrical engineering, being used, for example, in the electromagnetic circuit breaker, in the regulator for arc lamps and in many other items of electrical equipment.

But suppose that this small coil of copper wire were really a great tube reaching from New York to Chicago. And suppose that the electric circuits in the wire wrapped around it were so arranged that they produced a moving electromagnetic field; a field that travelled along the tube continually in the direction of Chicago. If, then, you dropped a piece of iron into the open end of the tube at New York that iron would be pulled along the tube all the way to Chicago, just as the small piece of iron was pulled inside your model coil.

Replace the piece of iron in the New York-Chicago tube by an iron car filled with passengers or freight, and you see what the radio tube express would be like.

There would be no wheel friction or rail friction to bother this express, for the car would be suspended in space by the electromagnetic forces. It would not touch the tube at all. Air friction could be eliminated by making the tube air-tight and pumping all the air out of it, so that the air-tight and air-filled car flew along in a vacuum. Air locks at the two ends would permit passengers to enter and leave and safety devices would be provided to prevent suffocation

in case of any untoward accident.

The speed of such a device would be virtually unlimited. A thousand miles an hour would be easy. Ten thousand or even twenty thousand miles an hour is probably quite possible. San Francisco to Boston in twenty minutes; New York to Washington in the time a street car needs to go one block; such are the promises of transportation through electromagnetic tubes!

Of course, these tubes would not be cheap to build, nor would they be costless to operate. There is no promise of getting transportation for nothing. But they would eliminate the *main* cost of transportation, the cost of friction. They would take the Old Man off the back of the world.

The scientific and engineering difficulties are less serious than the one of first cost. Small tubes on this principle have been built already. One was proposed some years ago for transporting mail in cities. An electromagnetic gun, working in the same way, was invented during the war and a model of it was built.

These are small beginnings but they are enough to point the way. Remember the history of the electric railway. The first one was shown as a curiosity in Berlin in 1879, less than fifty years ago. A few years before that an obscure professor in Germany had built himself a little model car that ran by electric batteries.

Everybody, the professor included, thought of this little car as a toy. To haul a man in one would have cost something like eighty dollars a mile. It was cheaper to hire a horse or a hundred horses than to use such a car. To build an electric railway on this basis would have cost many billions of dollars.

Nevertheless, electric railways were built and they did not cost billions of dollars. They proved to be cheaper and more practicable than anybody foresaw. Perhaps the express service in electromagnetic tubes will come to practicability in the same way.

There is one thing, I am convinced, which we may confidently expect. If our great-grandchildren do not ride to work at a thousand miles an hour in electromagnetic expresses and shoot their oranges east from California in radio tubes, it will be because these same things have been done in some better way.

Old Man Friction is a load that Civilization must shake off. And Civilization will do so.

The First Announcer to Introduce American Programs to South America

Station KDKA at Pittsburgh has been heard so consistently in South America that the directors of that station have decided to put on regular programs in Spanish for the benefit of listeners in our sister continent. Señor D. Santini, who served as announcer when the first of these programs was broadcast recently, was born and educated in the Argentine Republic, though he is now a radio engineer in the United States.

How *to* Make Your Own Grid Condensers

By GORDON D. ROBINSON

Do you know that a unique condenser may be made with the help of your electric fan? Merely twist together two lengths of insulated wire; the copper conductor will form the plates and the insulation will take the place of the dielectric.

HAVE you a few feet of magnet wire and a small lump of paraffin? If you have, you can make yourself all the grid condensers you need with no expense and little work. You do not even have to be particular about the size of wire; almost anything from No. 24 to No. 36 will do. If you have it, use double cotton-covered magnet wire; thinner insulation will give somewhat more capacity, but won't stand as much voltage.

Suppose that you want to make a grid condenser for a detector tube. This is how to do it:

Take about twenty feet of magnet wire (any size that you have handy), and double it. Get out the sewing machine, the electric fan, the old spark-gap motor or anything else you have handy that revolves rapidly. Fasten the two ends of the piece of wire to the revolving shaft and hold the rest of the wire out straight so that it can be twisted. Now start the motor, or whatever you are using, and run it until you have a twisted pair with several twists to the inch. If you follow these instructions properly you will now have about ten feet of twisted pair. In order to get two separate conductors and to get rid of any broken insulation at the ends, cut off six inches or so from each end of the pair. With several thicknesses of paper or tape carefully insulate each wire at one end of the pair, beginning with the insulated ends and wind the two wires on a match stick, leaving just enough wire unwound to connect the condenser where wanted. Now dip the wire into hot paraffine and keep the paraffine hot until the insulation stops bubbling. Let the paraffine cool until it is about to solidify before you take out your condenser. When the wax has finally set you have the finished condenser.

Can these condensers be made to be used with power tubes? They certainly can. Several months ago the author made two such condensers from about No. 26 double cotton-covered magnet wire; since that time these two condensers have been used in the grid circuits of two quarter K. W. tubes with

entire satisfaction. The exact voltage applied to these condensers is not known, but it was found that when working at full power as much as two amperes was indicated by a hot-wire ammeter in the common grid circuit of these two tubes.

The capacity of a condenser of this type is determined principally by the length of wire used. For a given length of wire, and kind of insulation, various sizes of wire will give nearly the same capacity. If the condenser is used with a power tube, use only double cotton-covered magnet wire not finer than No. 28.

The Radio-Grouch

THIS is a wonderful age. By simply turning a few knobs I can let a lot of total strangers into my house. A man's home is no longer merely his castle; it is a Chautauqua.

* * *

A RESIDENT of rural Connecticut can now enjoy all the discomforts of New York life without suffering any pain in his New England thrift.

* * *

IT is a wonderful thing to sit in a Minnesota farmhouse and personally hear a European statesman explain why they can't pay us what they owe us.

* * *

A WASHINGTON man is now sending pictures by radio. The one I saw made me very happy. I was glad I didn't know the man personally. I hope they don't carry this too far. A great advantage of the radio concert is that you can hear the singing without seeing the singer's mouth.

* * *

ANOTHER good thing is the sleeping accommodations. The Metropolitan Opera House has never done the right thing by our sleeping classes. The seats are narrow and uncomfortable. For all the sleep you get you might almost as well be in a Pullman. With the radio all this is changed. You can get yourself comfortably stretched out, turn on a good German opera and have a refreshing evening. The radio is the finest cure for insomnia that has come into the world since Gibbon wrote "The Decline and Fall of the Roman Empire."

* * *

No wonder statesmen love to broadcast. It's a wonderful thing to be able to talk to people who can't talk back.

HOWARD BRUBAKER

* * *

From a photograph made for POPULAR RADIO

THE AUTHOR TESTS THE RECEIVER

In testing the set in the laboratory, a short length of wire was strung up around the picture moulding for use as the antenna and another piece of wire was attached to the radiator. The volume of signals was remarkable.

HOW TO BUILD A

REGENERATIVE RECEIVER

—For Use With an Indoor Antenna

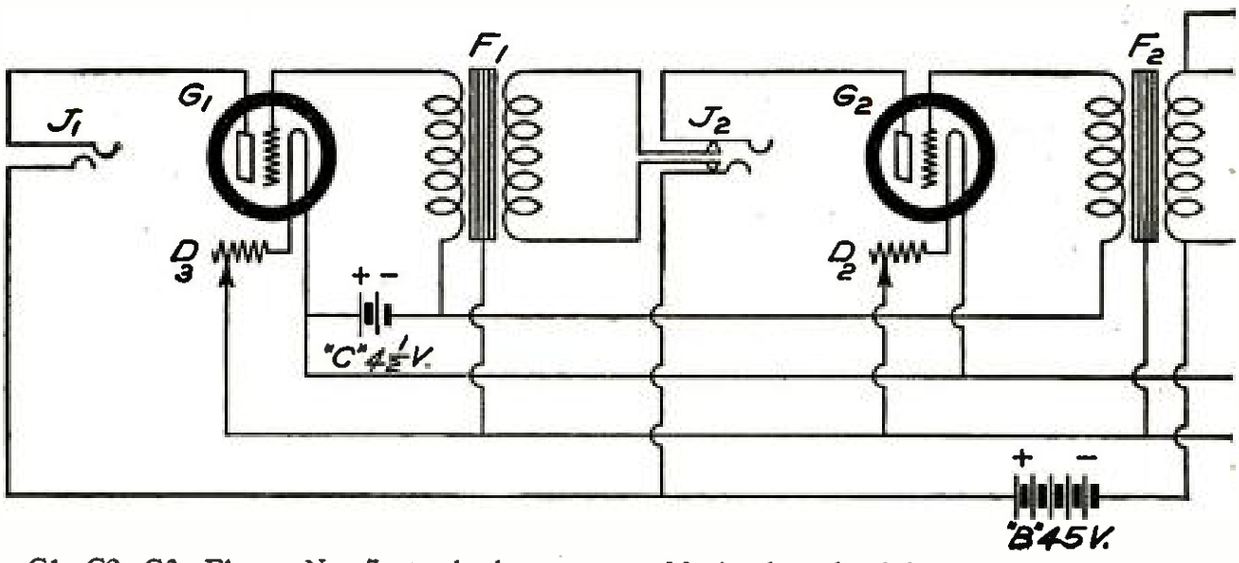
This article has been prepared for the special benefit of the radio fan who is so situated that he cannot install or use to advantage the standard type of outdoor aerial.

By ADRIAN M. TOBIAS

COST OF PARTS: *About $55.00*
RECEIVING RANGE: *Up to 1,500 Miles*

HERE ARE THE ITEMS YOU WILL NEED

A—Inductor (dimensions and winding data are given in the text of article);
B—Bradley leak, variable ½ to 10 megohms;
C—Thordarson condenser, 13-plate variable with vernier, approximate capacity, .00025 mfd.;
D1, D2 and D3—Amsco improved 20-ohm rheostats;
E—Coto-coil No. 8,000 variometer;
F1—Thordarson super transformer, 3½ to 1 ratio;
F2—same, 6 to 1 ratio;



G1, G2, G3—Fleron No. 7 standard porcelain sockets;
H—Amplex grid-denser—small variable condenser;
J1—Saturn phone jack, single-circuit;
J2—Saturn phone jack, double-circuit;
K—composition "B" battery binding-post block;
L—New York Coil Co., mica-fixed-condenser, .00025 mfd.;
M—hardwood sub-base;
N—composition panel;
O—Eby binding posts;
P and P1—Radion hard rubber dials; 4-inch diameter;
stock cabinet, 7 inches by 18 inches, as shown in Figure 7. Necessary connecting wire, varnished-cambric tubing, wood screws, etc., etc.

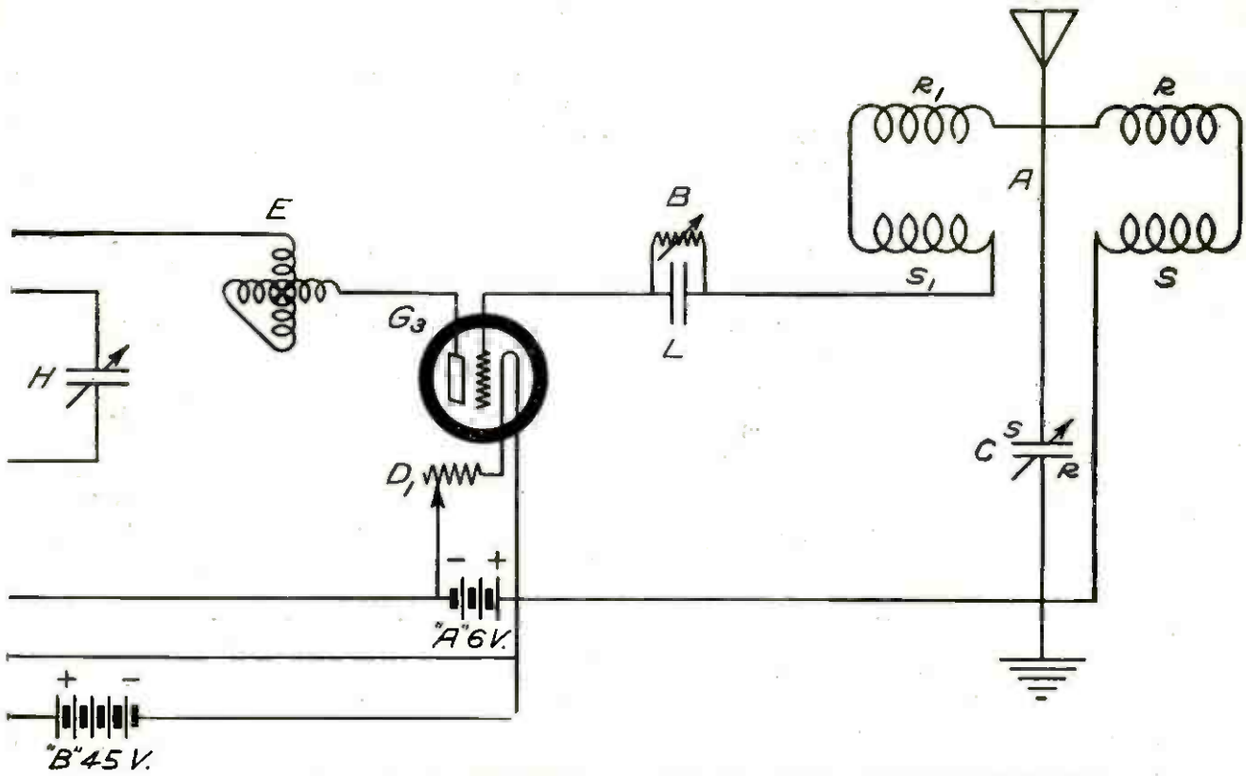
TO find a suitable location for a good outside antenna with the necessary lead-in, and outside ground connection through approved lightning arrester, has become a serious problem. Congested city districts especially preclude the possibility of finding an open space sufficient in area to get the proverbial hundred-foot run, free from obstructions. To find a really good location on *any* city apartment building could be likened to the historic search of Diogenes.

In view of these conditions, some form of interior antenna or collector seems to be the logical answer. However, the usual three-tube receiver, when operated with wire strung around a room, loses so much of its sensitivity that loudspeaker reception on fairly distant stations is usually out of the question.

The writer was confronted with the conditions here outlined and has experimented with a circuit employing three tubes that gives loudspeaker reception on stations up to 1,000 miles or so. A length of about fifty feet of bell wire strung around the picture moulding of two rooms is sufficient for the antenna.

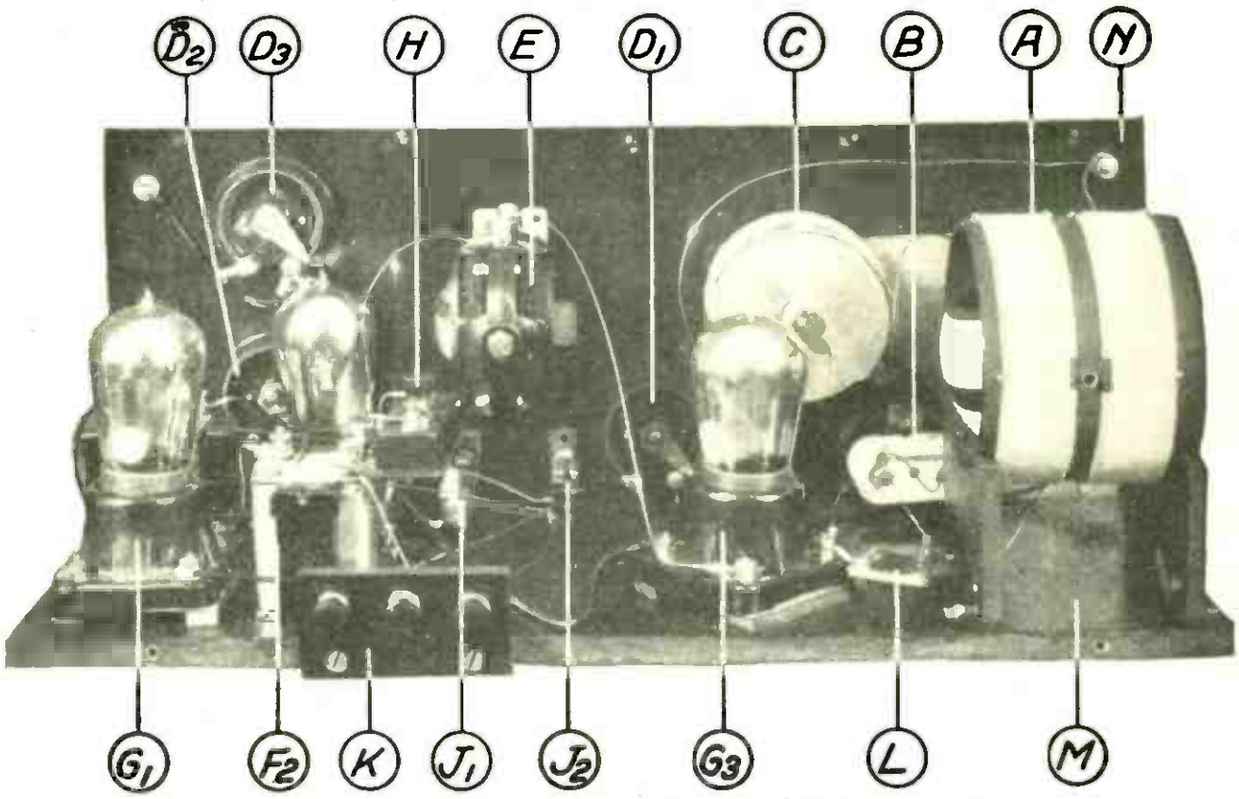
POPULAR RADIO has repeatedly set forth the several qualities that a radio set must have in order to be considered in the popular class. These qualities may be enumerated as follows:

1: It must be selective;
2: It must be sensitive;
3: It must be easy to construct;
4: It must be inexpensive;
5: It must be easy to operate.



THE ELECTRICAL WIRING DIAGRAM FOR THE RECEIVER

FIGURE 1: *This includes all the connections for the various instruments and parts that go to make up the completed set. All the parts are marked with designating letters which are repeated in the text and the list of parts. The diagram reads from* RIGHT TO LEFT *to facilitate wiring.*



THE REAR VIEW OF THE SET

FIGURE 2: *This picture shows the general arrangement of all the instruments fastened to the panel or to the base. The exact locations for the instruments are given in Figure 3.*

The circuit described in this article will easily choose between, or separate, stations with a difference in operating wavelength of only five meters. In New York City, for example, when station WHN is operating, WDAP in Chicago can be tuned in on a loud-speaker without interference. Both stations are in the 360 meter class. (Point No. 1.)

This set is highly sensitive—as is evidenced by the fact that it gives loud-speaker reception up to 1,000 miles on an indoor antenna. (Point No. 2.)

Ease of construction is a relative term. This set is no harder to construct than any other double-circuit receiver. (Point 3.)

Low cost of construction is also relative; the cost of building the set here described, however, compares favorably with the cost of building any three-tube regenerative receiver. (Point 4.)

The operation of this set is really simple and the set will give good results. (Point No. 5.)

In the building of such a set careful attention to the constructional details is highly important.

The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of the transmitter may easily determine how to mount the instruments in the correct places and connect them properly in the electric circuit. The same designating letters are used in the text and in the list of parts at the beginning of the article.

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

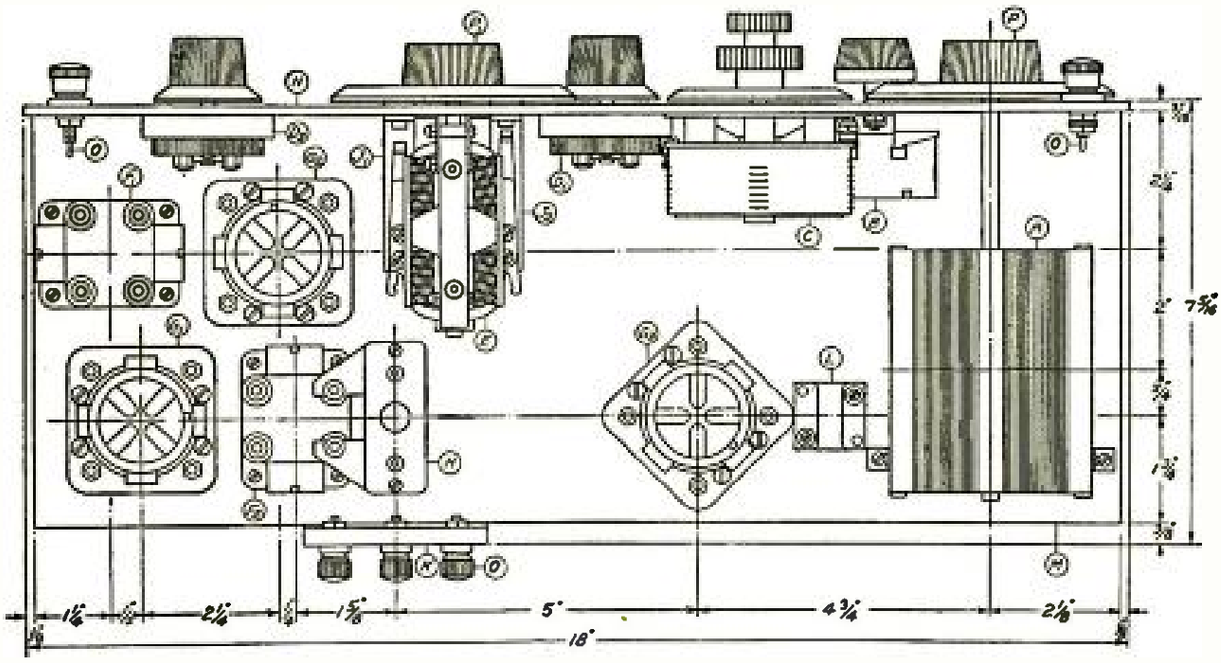
How to Construct the Set

It is presumed that the prospective builder is provided with an assortment of small tools before he attempts to build a radio set. Having the necessary tools, use the utmost care in mounting each and every part and above all, *do not hurry*. Consider every operation as vital and thus avoid disappointment.

When all the necessary parts and materials have been obtained, prepare the panel as the first operation. A stock size 7-inch by 18-inch panel, N, is usually cut to size so close to the specified measurement that no "dressing up" will be necessary.

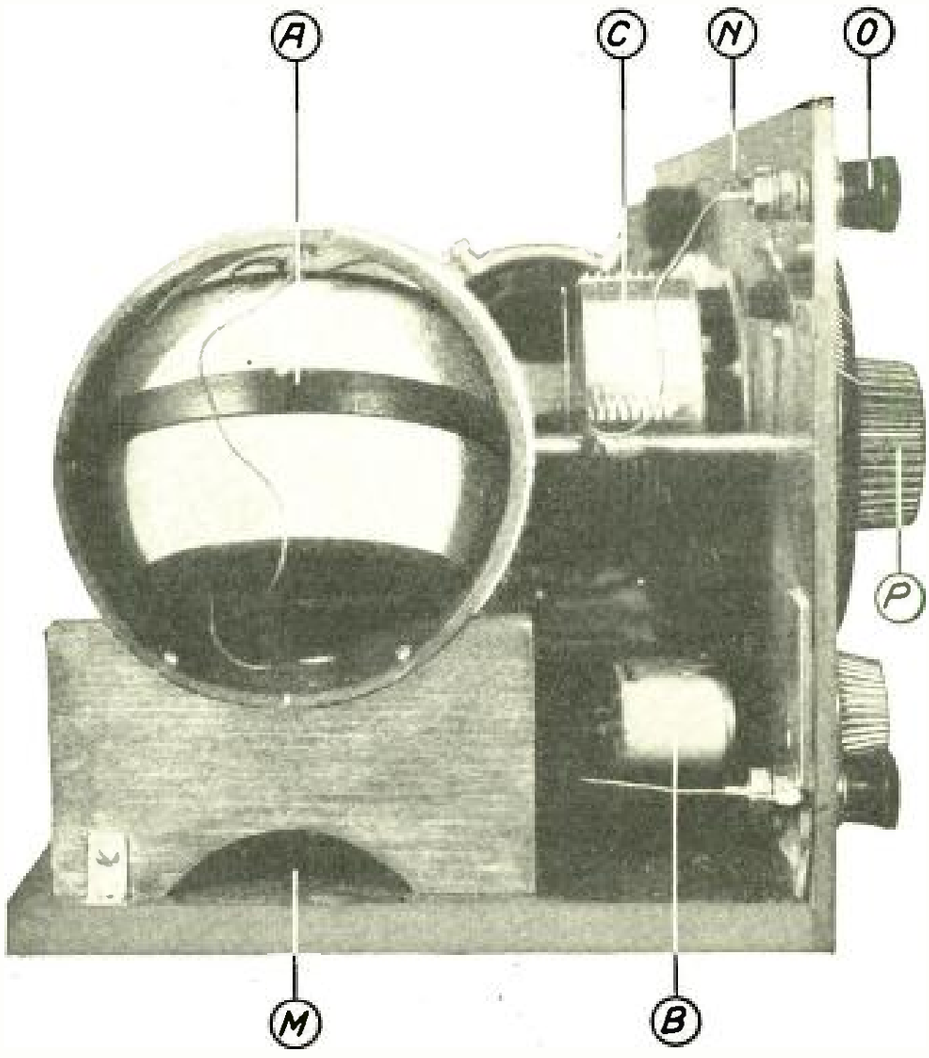
Lay out the holes on the panel with a center punch as shown in Figure 6. For the larger holes such as those for shafts, jacks, etc., it is a good plan to use a smaller size drill first (about a No. 34), and then follow up with the proper sized drill.

The holes outlined in the diagram with a double circle should be countersunk so that the flat-head machine screws, used for fas-



THE WORKING DRAWING FOR CONSTRUCTION

FIGURE 3: *Here are shown the correct positions for the various instruments. The positions are given center to center, for all instruments.*



THE SET AS SEEN FROM THE LEFT

FIGURE 4: *This diagram shows the way to mount the inductor, the variable condenser and the grid-leak and binding posts for the antenna and ground connections.*

tening the various instruments, will be flush with the panel. The panel diagram does not give the size of holes to be drilled because the builder will be best guided by the size of machine screws that usually accompany the parts. However, it is good practice to drill a 5-16 inch hole for all ¼ inch shafts (excepting for the inductor shaft), thus assuring ample clearance. Use care in drilling and handling the panel to avoid scratches on the polished surface.

The sub-panel or base M should be cut from thoroughly dry, yellow poplar or white wood ½ inch by 6¾ inches by 17¾ inches. (See Figures 2, 3, 4 and 5.)

Next, mount the grid-leak B on the panel by means of two screws.

Then mount the two jacks, J1 and J2, the three rheostats, D1, D2 and D3, and also the four binding posts, O, as shown in Figure 3. The variable condenser C, the plate variometer E, and the inductor A are not mounted until after the panel is attached to the base by means of 5 wood screws.

Attention should now be given to the mounting of the parts on the wooden base. Begin with the connection block K (see Figures 3 and 9) for supporting the three "B" battery binding posts. Use soldering lugs under the nuts on these binding posts and bend them down at right angles to make it easier to solder the leads to them, when wiring. After attaching this block to the base, mark the location of all screw holes for mounting the transformers F1 and F2, and the three tube sockets, G1, G2 and G3. Use an awl so as to provide an easy means of putting in the wood screws that hold these parts to the base. Before attaching the transformers, F1 and F2, scrape the finish from around the screw-holes or the bases (looking down from the binding post marked "plate" on each transformer). This will make a good contact spot, for the small soldering lug (placed under the mounting screw) which will provide for grounding the cores of both of the transformers.

The next job will be to construct the inductor A, see Figure 8.

To begin with, proper materials for making the inductor are essential and should include

the following: a No. 2 (Radion) hard-rubber tube, which is 4 inches in (outside) diameter, and 3½ inches long; one No. 012B (Radion) hard-rubber rotor; one 8-inch length of brass rod, ¼ inch in diameter; a small spool of No. 20 DCC copper wire; two 7-inch lengths of about 16-strand, silk-covered, "pig tail" wire, and a dozen round, hardwood toothpicks and some ¼-inch cotton tape.

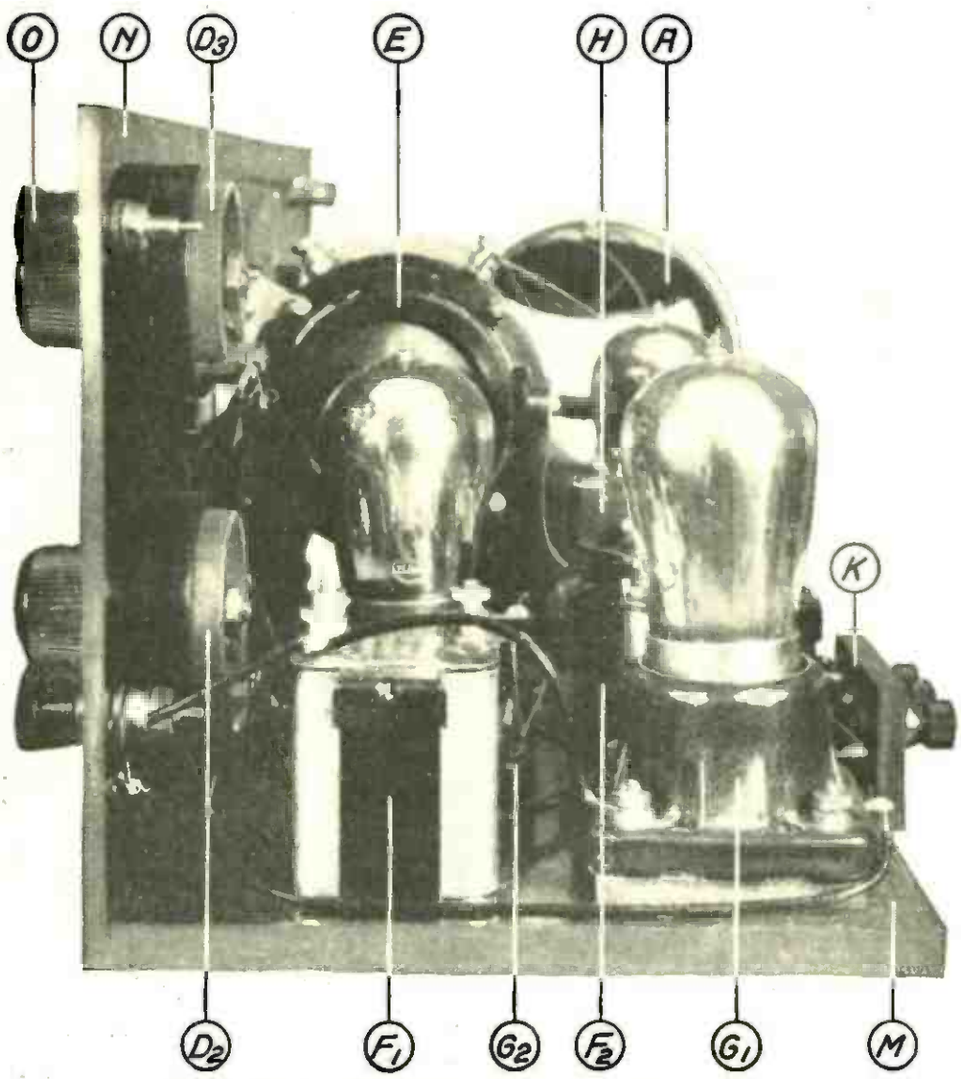
Begin by drilling the ¼-inch holes in the rubber tubing for the brass shaft that passes through the tubing and rotor. Locate these holes correctly (midway between the ends of the tube and exactly at right angles to the axis) for there is only a small clearance between the rotor and the tubing.

There should be a ⅜-inch space left between the two stator windings. Therefore, draw two pencil lines around the tubing so that they will pass within 1/16 inch of the edges of the holes for the brass shaft. These pencil lines should be concentric with the axis of the tube and will form guide lines for the first inside turns of the stator windings.

Have ready about a dozen pieces of the ¼-inch dry cotton tape cut into ½-inch lengths; also cut about a dozen of the toothpicks in half.

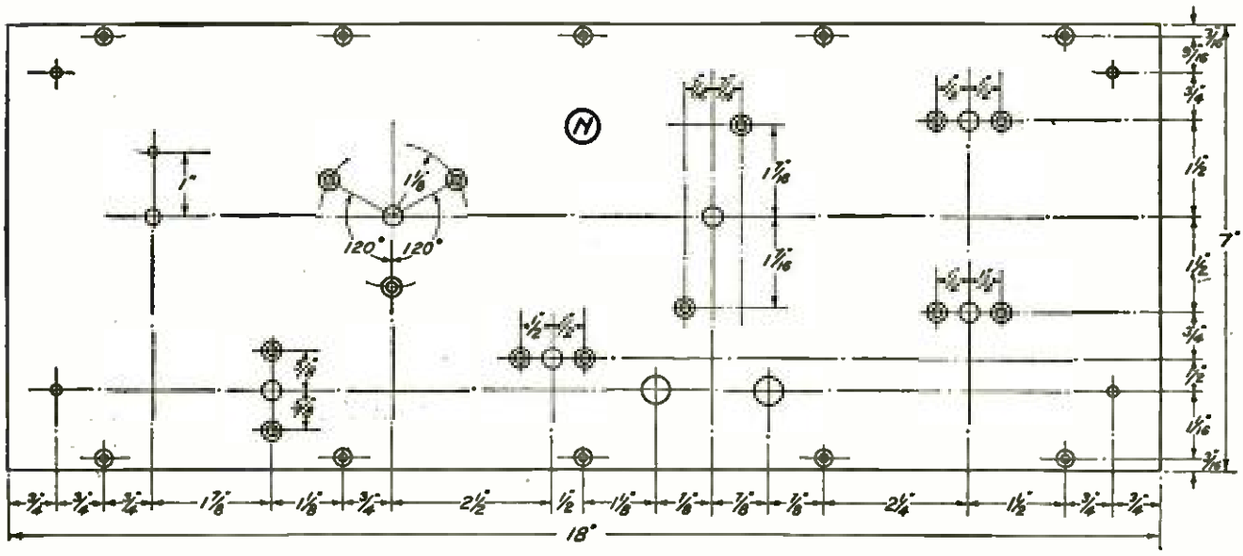
Next, mark one of the shaft holes so that this side will be known as the front, and viewed thus, the right-hand stator will be the grid winding and the left will be the ground winding. Now drill two small holes ¼ inch apart, on the guide line, for the start of the grid winding. These holes should be made with a No. 48 drill and should be located horizontally on the bottom of the tube.

Start winding the grid stator with a clockwise motion (looking at the tube from the right end) and place three pieces of the cotton tape so that the wire passes over them about in the middle. These three pieces of tape should be spaced equally around the periphery of the tube. When one complete turn is wound on, fold the loose end of the cotton tape back over the first turn, so that the second turn will hold it fast. (See Figure 9.) This prevents the wires loosening up. Then continue until 25⅛ turns have been put on and finish the winding by drilling a small hole with the same-sized drill, pull the wire through



THE SET AS SEEN FROM THE RIGHT

FIGURE 5: *This view shows the position for the transformers, the tube sockets, the variometer, the filament rheostats and the two binding posts for the "A" battery.*



THE DRILLING PLAN FOR THE PANEL

FIGURE 6: *This drawing shows where to drill the holes for the screws and shafts of the instruments which protrude through the panel. The holes outlined with a double circle should be countersunk so that the flat heads of the screws will set flush with the panel.*

and wedge in the hole with a piece of hardwood toothpick driven securely in. Leave a piece of wire, about six inches long, projecting on both ends of the winding.

Now drill two other holes near the finish of the winding, spaced around the periphery in the same manner as the cotton strips, and insert pieces of toothpicks to prevent the windings from loosening or slipping.

Now proceed in the same manner to wind the ground stator.

When these two are completed, the next job will be to prepare and wind the rotor coils. It will be found that the rotor ball has a center rib running around its circumference, that is, 5/8 inch wide. This will have to be dressed down with a penknife and sandpaper to 3/8 inch, to make room for the 25½ turns of No. 22 DCC wire.

As hard rubber works easily, this can be done with a good sharp pocketknife. Begin winding by drilling hole at outside edge and midway between shaft holes. Secure this start with hardwood pin, leaving about ¼ inch free end of wire on inside of rotor and wind in same direction as stator. Put on 25½ turns, drill through and pin this inside end of first half of rotor. About 2 inches free end is required on inside of rotor. Wind the other half of the rotor, starting on opposite edge from winding of first half, which will bring the two loose 2-inch free ends on inside of rotor at right angles to each other. These 2-inch ends are the terminals of the two halves of rotor and terminate at rib of rotor.

Clean all ends of the windings ready for soldering and then mount the rotor inside of the tube by means of the brass shaft. Take one turn around brass shaft with both of the 2-inch free ends inside of the rotor and solder securely to the shaft.

Conclude connections by soldering the two 7-inch lengths of "pig tail" to the stator and rotor terminals. One end goes to the outside terminal of the grid stator and the other end goes to the outside terminal of the rotor winding. The other 7-inch length is used to tie together the outside terminal of the ground stator winding and the outside terminal of the other half of the rotor winding. The inductor is now finished and ready for mounting in the set.

Shielding the inductor is optional, although recommended, as even slight body-capacity effect is annoying in such a selective tuner. A thin sheet of copper, cut as shown in Figures 2 and 4, is sufficient. Cut an opening about 5/8 inch in diameter where the inductor shaft projects through the panel N and mount the variable condenser C directly over the shield, as this forms a grounded connection for the rotary plates of the condenser. Use a large size washer on the ground binding post for making contact with the shield.

Next, attach the plate-circuit variometer E to the panel N and mount the tuning inductor A on the wood base. Attach a dial to the plate variometer E, and one to the condenser C and also to the inductor A. On account of the flexible connections on the shaft and the rotor of the inductor, some form of stop is necessary. Insert a 4-36 machine screw in a tapped hole located on the panel N 1 inch up from center of rotor-shaft hole. (See Figure 4.) This machine screw should be about 3/8 inch in length and should be inserted from the back of panel. It serves to hold the sheet copper shield securely to the panel (use thin brass washer under head) and provides a good stop for the inductor by engaging with the slot found in the back of 4-inch hard-rubber dial. Use care in mounting the inductor, so that the shaft may move freely, covering the entire scale shown on the dial. When the instruments have been mounted the set is ready for wiring.

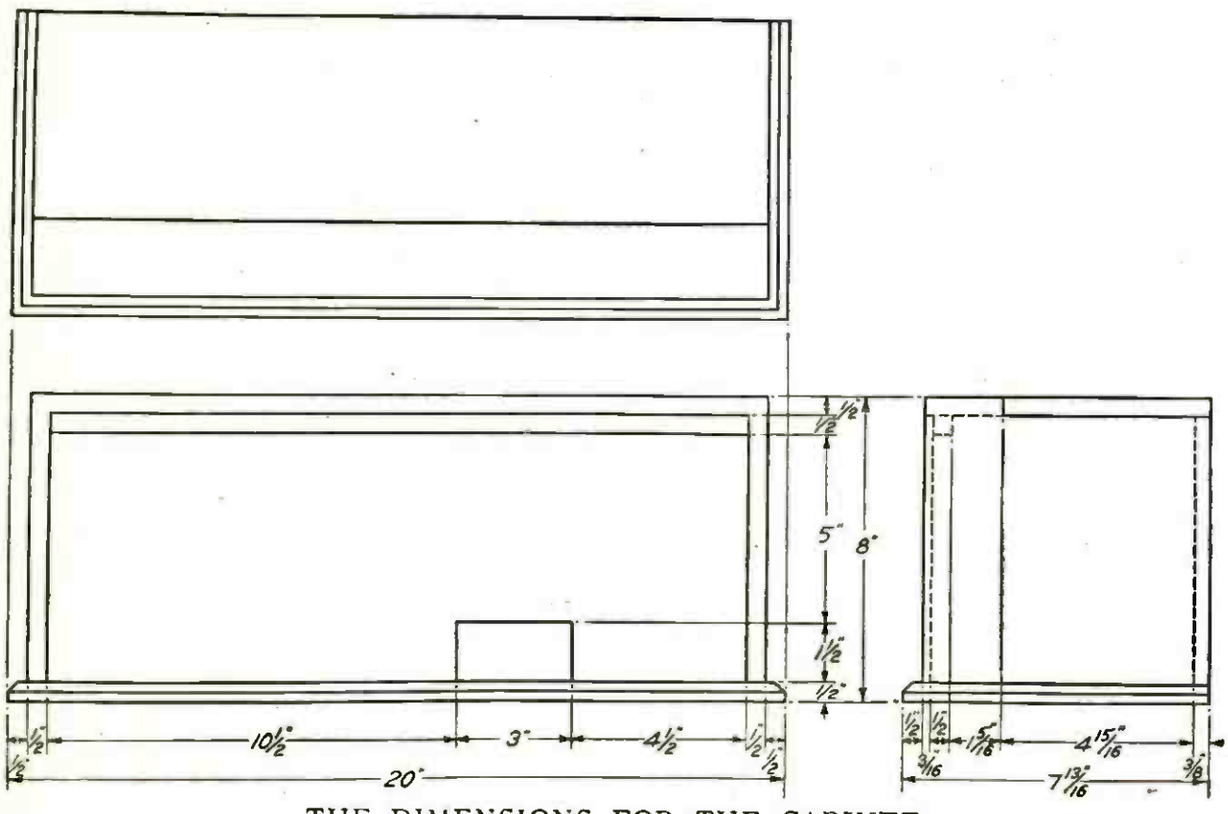
How to Wire the Set

It is recommended that No. 18 SCC be used for all wiring. Cover the "A" battery leads (only) with varnished-cambric tubing. For all other wiring remove the cotton covering and use the bare wire.

Begin winding at the positive "A" binding post. If soldering lugs are used, put one under each screw (nearest the "off" position) on each amplifier rheostat. The two lugs for grounding the transformer cores should be placed under the screws for fastening the transformers F_1 and F_2 to the base and should have the tips bent up or offset so that when the wires are soldered to them they will be about ¼ inch above the base. Allow a sufficient length of wire to reach from the positive "A" binding post without a break to these lugs. Slip on a piece of tubing long enough to reach to the soldering lug on the upper or second-stage rheostat D_3. Solder to this lug. Continue in this manner to first-stage rheostat D_2, and then to the lugs at the base of each transformer and then on to the negative "B" binding-post lug. From this point run direct to the positive F binding post on the detector-tube socket G_3. Continue the positive "A" battery circuit by attaching leads from each amplifier rheostat and run direct to the positive F binding post of the two amplifier tube sockets G_1 and G_2. The negative battery connections are made by running from the negative F on the detector socket G_3 to the rheostat D_1 and thence along the panel under the jacks J_1 and J_2 to the negative "A" binding post. Next, begin with the negative F binding post of the second-stage tube socket G_1 running a wire to the negative F terminal on first-stage socket G_2 and on to the negative "A" binding post. Connect the two negative filament binding posts on the transformers with a lead around to the negative "C" battery and from the positive "C" battery run a wire over to the negative "A" binding post. This concludes the "A" battery or filament connections.

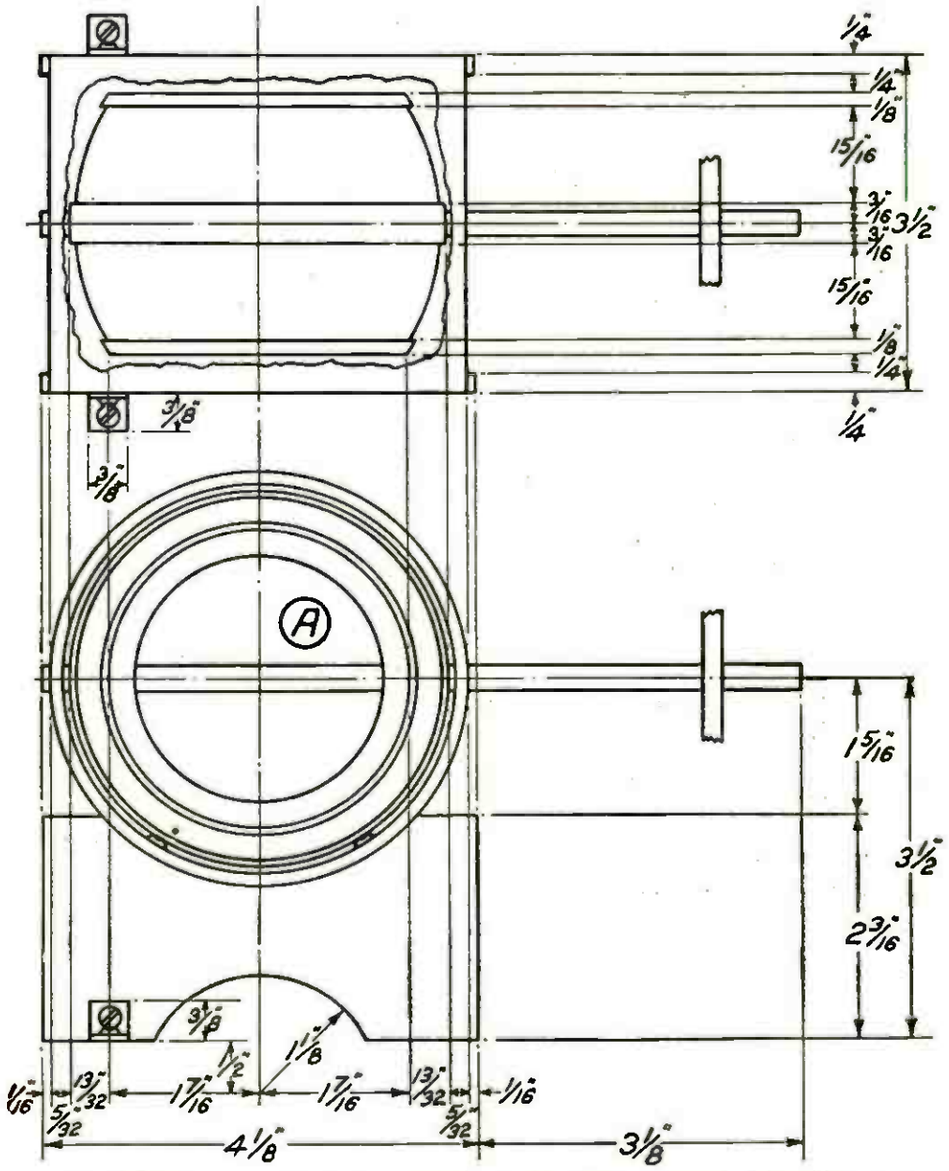
All plate battery leads are made with bared wire. The transformers and tube sockets are so placed that short leads can be made from the grid posts on the tube sockets to the respective posts on the transformers. After these two connections have been made, attach a lead to the plate binding post of the second-stage tube socket G_1 and solder it to the bottom tip or blade of the single-circuit jack J_1. Then solder one end of another wire to the top tip of the same jack and thence to positive "B" amplifier binding post. Attach a lead to second tip from bottom on the double-circuit jack and go from here direct to the B+ post on the second-stage transformer F_1. A lead is then soldered to third tip from bottom on double-circuit jack J_2 and taken direct to the binding post marked P on the second-stage transformer F_1. Then bring a lead from the top tip of the same jack, direct to the plate terminal of the first-stage tube socket G_2.

Finish the wiring job by soldering a short



THE DIMENSIONS FOR THE CABINET

FIGURE 7: *This drawing (which contains the top, front, and side measurements for the hardwood cabinet) may be turned over to a competent cabinet worker who can build it from these instructions alone.*



THE MECHANICAL DIMENSIONS FOR THE INDUCTOR

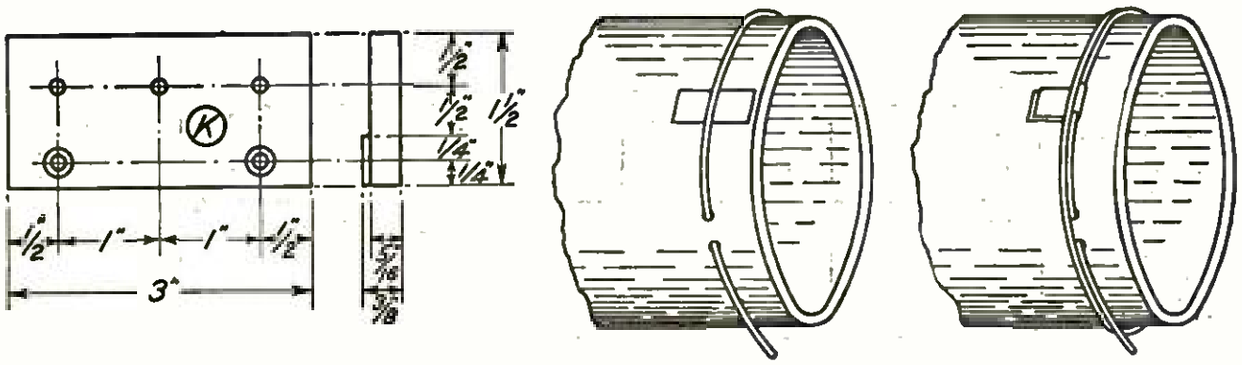
FIGURE 8: *The top diagram shows the inductor as seen from above; the lower diagram shows the inductor as seen from one side and contains the measurements for all the parts including the rotor, the stator, the wooden base and the brass shaft.*

lead to positive "B" detector binding post and carry this lead to the B+ binding post of first-stage transformer F_2. Mount the grid-denser H and carry a lead from the binding post marked P on the transformer F_2 to the plate variometer E and from the other terminal of the variometer run a wire to the plate post on the detector-tube socket G_3. Connect the variable condenser C in the circuit with a lead running from stationary-plate binding post to the antenna binding post on the panel N. Next, attach a short length of "pig tail" wire to the antenna binding post and solder the other end to the inductor shaft. The lead from the inside winding of the left-hand stator is now soldered to the ground binding post. The inside terminal of the right-hand stator is now attached to the grid condenser L. Now attach a short wire (not over ¾ inch long) to the grid post of the detector-tube socket G_3 and solder the other end of this to the lug on condenser L. Finally, solder leads from the grid-leak to the lugs on the grid condenser and the wiring is complete. Check over the connections carefully to be sure they coincide exactly with the wiring diagram in Figure 1.

How to Operate the Set

After every detail of wiring and assembly of parts is completed, the set is put into its cabinet. It is fastened securely by two 1¼ inch No. 7 flat-head, brass wood-screws inserted through the back of the cabinet into the wood base, and five ¾ inch No. 4 flat-head, brass wood-screws inserted, at top of panel, into the cabinet.

The binding posts on the connection block K will now protrude through the slot cut for them in the back of the cabinet.



THE CONNECTION BLOCK AND THE METHOD OF SECURING THE WINDINGS

FIGURE 9: *This diagram contains, at the left, the dimensions for the small binding-post panel for the "B" battery connections, and at the right the way to start the winding on the inductor—by folding a small piece of cotton tape to keep the first wire from slipping out of place.*

Put the set in operation in the following way:

Provide a permanent inside antenna of ordinary annunciator wire or stranded, silk-covered wire of a color to match interior decorations. Preferably about 30 to 50 feet of either can be concealed back of the picture moulding. String the wire continuously *away* from the set by dropping down from the moulding through a doorway into another room, rather than running a large loop around the four sides of one room.

Of course, if you are anxious to get the set going quickly, just throw 15 feet or more of bell wire on the floor, or out of the window, with one end attached to antenna binding post.

The ground connection is made to a steam radiator or a cold-water pipe and to lower left-hand binding post of the set.

The upper right-hand panel binding post should be connected to positive "A" battery (6 volts).

The lower right-hand panel binding post is then connected to negative "A" battery.

Attach the negative "B" battery lead to the first post at the right, on connecting Block K at rear of set.

To the middle post attach detector positive "B" battery (45 volts).

To the remaining post, attach amplifier positive "B" battery (90 volts). The "B" batteries consist of two 45-volt sections connected in series with a tap in the center (45 volts) for the detector plate.

With all rheostats in the "off" position insert a UV201-a tube in the detector socket G3.

Insert two UV-201-a tubes in the remaining sockets G1 and G2.

If telephones are used, the plug should be inserted in the first jack J2 and the rheostats D1 and D2 turned up about half or three-quarters of the way. Next, turn the grid-leak knob B (clockwise) until slight compression is noted.

Then set the grid-denser H by turning knob (clockwise) until fairly strong compression is felt in turning.

See that the main dial of the variable condenser C is set somewhere near 18 or 20.

The plate variometer dial P1 should be set at about zero.

Rotate the inductor dial P very slowly until you hit your first station—bringing up the regeneration by rotating dial P1.

As condenser C is also an element of the tuning, rotate the vernier for clearing up the signal.

Then go back to dial P, this time holding the rubber end of an ordinary lead pencil against the panel at an angle and engaging the edge of the 4-inch dial. A slight twist in either direction gives a splendid vernier effect.

The detector rheostat should be set just below the oscillation point and the control of oscillation is obtained by an adjustment of the grid-denser H.

Keep the filament turned fairly high, thus requiring a lower value of plate inductance for stable operation. A certain combination of these two adjustments will bring in the signals clearer, and with the least distortion.

It will be found that there is a "best combination" of inductance and capacity for the different wavelengths. When these points are found—make a record of them, for it is then a simple matter to tune in the various stations.

Practical Pointers for Experimenters

BEGINNING *with the next issue,* POPULAR RADIO *will publish, each month, a new department that will contain helpful hints for readers who build the sets described in this magazine.*

¶ "Why risk life, money and time on North Pole explorations?" asks the layman of the scientist. Here is one answer.

From a drawing by Arthur Merrick for POPULAR RADIO

WILL WE RUN THE WORLD'S MACHINERY WITH

Radio Power from the Pole?

Everybody knows that the frozen north contains great stores of coal. But nobody knows how to get it out and bring it down to civilization. The author of this article—himself both an arctic explorer and a radio expert—here proposes the most plausible method that has yet been suggested for using this now useless store of power.

By LIEUTENANT COMMANDER FITZHUGH GREEN, U. S. N.

ONE black arctic night in February, 1915, at Etah, North Greenland, I sat toiling over an old-fashioned Telefunken spark gap with nothing between me and a howling blizzard except the thin walls of our ten by fifteen radio shack. New York was nearly 3,000 miles south; and the sun had been gone since October 19th. Allen, our radio expert and my only companion, had taken leave of me some hours before. He was bound for the main headquarters near the glacier. I was alone.

Suddenly above the pounding of the wind and the hiss of drifting snow I heard a strange sort of scratching sound.

My hair seemed to rise. At once I knew what to expect. One of the huge polar bears that were always prowling about had discovered our tiny refuge. And since bears are very hungry at this season of the year, especially when violent wind disturbs their winter slumbers, I at once prepared for a fight.

I made sure that my Winchester .35 had a full magazine and that one round was in the barrel. I cocked it carefully and extinguished the light.

The scratching became more insistent. Polar bears are clever. I think one could pick a lock if he had a little practice.

The outer door creaked. Then its latch snapped. A furry mass plunged in and landed with a thud at my very feet.

It was not a bear at all, but the radioman, Allen. Gasping for breath and badly frost-bitten he told me that he had been unable to reach the base and had been nearly blown into the Sound in his frantic efforts to reach the shack again.

"This part of the world is certainly no place for radio!" he concluded with an emphatic shake of his head.

By now he is willing, no doubt, to eat his words. For it begins to look as if the North Pole were going to be a very important factor in the development of radio physics and related phenomena.

Five arctic expeditions are scheduled to leave by the first of next July. Our dirigible *Shenandoah* flight would have made a sixth. Also France was planning to send her dirigible *Dixmude* north at the time it was struck by lightning in the Mediterranean. MacMillan, as all radio fans know, is now at Etah, Greenland; Rassmussen is in Coronation Gulf, above Canada. And Amundsen's ship, the *Maud*, is drifting north of Siberia frozen fast in the Polar ice pack.

The principal aim of all these expeditions is to explore the 1,000,000 square

From a photograph made for POPULAR RADIO

"RADIO-EQUIPPED EXPEDITIONS NORTHWARD ARE MATTERS OF IMPORTANCE TO RADIO SCIENCE"

Indeed, the problem that civilization faces in our rapidly diminishing coal supply may conceivably be met by explorers and radio engineers when the underground fuel supplies near the poles are finally tapped, believes Lieutenant Commander Green, of the Naval War College at Newport, R. I.

Gilliams

"POWER FOR RUNNING FACTORIES WILL BE SENT BY RADIO"

So states Professor A. M. Low, the distinguished British scientist and engineer. In the February, 1924, issue of POPULAR RADIO *he described some of the future possibilities of radio—among them the promise of power transmission over directed beams of radio waves.*

miles of unknown Polar Sea just north of Alaska. Other work will consist chiefly of scientific investigation of the aurora and of terrestrial electromagnetic phenomena peculiar to the far north.

One look at the globe shows that the land area and population of the earth are mostly concentrated about its northern axis. Of the nearly two billion people in the world about 1,500,000,000, or seventy-five percent of the whole number, are clustered on the upper portion of the ball on which we live.

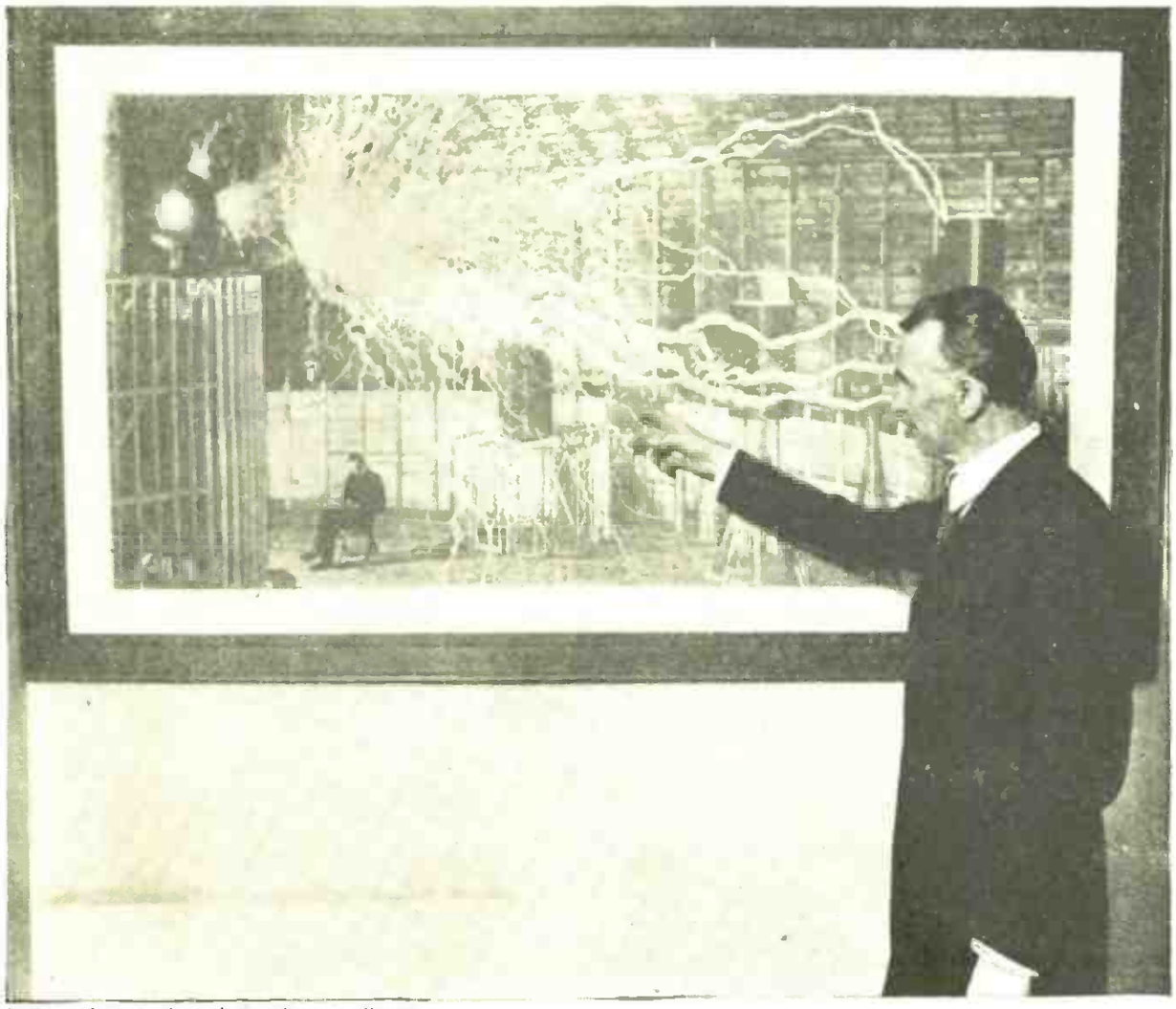
Hence, if new land is discovered this summer in that huge blank space that the map shows beyond Point Barrow, that land will be remarkably well situated for easy broadcasting to at least seventy-five percent of the population of the earth. It promises to become a world-relay point, like the present relay station at Hastings, Nebraska.

Two important facts indicate that world-wide broadcasting from such a central station in the Arctic is by no means a flight of fancy:

First, it has been unofficially announced that at the next International Radio Congress plans for a world-wide musical program within a certain narrow band of wavelengths will be seriously considered:

Second, the "Listeners' Vote Contest" polled by the Chicago stations WJAZ, KYW and WDAP, indicates that music is the overwhelmingly popular choice of their vast invisible audience; out of 263,410 votes received, over seventy-five percent demanded a daily diet of music.

But new land in the Polar Sea will mean far more than just a possible



From a photograph made for POPULAR RADIO

THE MAN WHO FIRST SENT POWER BY RADIO

Back in 1900 Nikola Tesla not only produced electric discharges thousands of times more powerful than any produced before, but he sent power enough to light electric lamps, by radio, at distances of hundreds of feet. Only the lack of a way of directing the beams of radio power in a single direction prevented the development at that time of practical methods of power transmission without wires. This problem of directed radio beams is now in a fair way to be solved.

location for a broadcasting station.

There was a period, millions of years ago in geologic history, when a moist and torrid climate prevailed not only in the tropics but at the Poles as well. Dank vegetation covered lands where ice-caps now climb thousands of feet into the sky.

With the passing of time this vegetation became buried; then was metamorphosed by heat and pressure into coal and oil. Sledging through Ellsemere Land a thousand miles north of the tree line MacMillan and I found naked seams of fine black coal exposed. The navy has a vast oil reserve in north Alaska which contains a lake of almost pure vaseline.

The land which Amundsen may discover on his transpolar flight in July will undoubtedly hold even greater deposits of raw fuel. But, hemmed in as it will be by a vast desert of ice, that fuel can never reach a market as such. Nor, for the same reason, can it ever be converted into ordinary forms of electric energy, such as could be conducted by wire to the mainland. The ever-shifting ice pack forbids any such man-made expedient.

Radio provides the only answer. Incalculable power won from the enormous fuel deposits of the frozen north can be made available to civilization only through the medium of radio power conveyance.

We must not be too skeptical of this hope. Edison, with all his optimism, is alleged once to have denied vigorously that we could ever carry electric current from distant water-power to our cities. Now California is a network of high-tension lines.

Indeed, we may be already in sight of the goal of radio power. Recent experiments with high frequencies, 300 kilocycles and over, have given phenomenal results. On wavelengths under 200 meters, and with absurdly small power, amateur stations have covered distances beyond the range of all but the largest professional sets. It is reported that regular daylight transmission between Paris and Nice has been obtained on a wavelength of 56 meters, or about 5,500 kilocycles. Marconi has gone beyond 100 miles by telephone at a wavelength of 15 meters, a frequency close to 20,000 kilocycles.

It is here that we cross the trail to future arctic power transmission. For Marconi has built a parabolic reflector which, with such wavelengths, confines their energy to a very much smaller beam. Indeed, he has thereby reduced the usual 360-degree spread of radiated waves to the almost miraculously small sector of 3 degrees.

In like vein we may imagine radio engineers developing, either by high frequency or by some other means, a radiant kinetic energy capable of being transmitted without appreciable loss from a distant source of power to a suitable receiving station close to civilization. At the latter point will be located some form of transformer for converting the incoming torrent of high-pressure waves into usable power, just as is now done with high-tension currents brought from the high Sierras to the great agricultural valleys of the Pacific Coast.

In still another way north-polar physics, as they concern radio, command attention. Remember that our earth is an oblate spheroid, a ball slightly flattened at its poles. For the same reason —centrifugal force—the atmosphere is tremendously more oblate. Near the poles its depth is many times less than at the equator, a fact that may help to explain the mysterious aurora borealis.

It has even been suggested that the aurora is the manifestation of a natural power just as a waterfall is the visible sign of water-power.

In any event the departure of these radio-equipped expeditions northward this summer is a matter of substantial importance to radio science. Not only may an entirely new field of work be opened up, but study of the radio conditions in high latitudes—such as MacMillan has been in this winter—may lead us to understand riddles that still baffle the Marconis of the world.

A HEADPHONE TO EVERY SICKBED

Every one of more than five hundred beds in the three Pittsburgh tuberculosis hospitals is equipped with a radio headset, so that any patient may listen in at any time without disturbing the neighbors.

Dr. Radio, Interne

An order has just gone out to equip all beds in all Government hospitals with radio headsets. How this unusual form of installation works in actual practice has been successfully demonstrated by the hospitals in Pittsburgh—and is told in the following article.

By HARRY A. MOUNT

IT was at Station WCAE, Pittsburgh. The singer was an experienced concert artist, but it was her first radio "appearance." As the announcer introduced her and the piano accompaniment began her hands trembled so that the music sheets she held shook. Her voice was weak and strained. It not infrequently happens that the most experienced singers experience this new form of stagefright when first they face the microphone in the deadened interior of a radio studio. When the singer had finished the number she sank into a chair.

"Oh!" she said. "That was the most awful experience I have ever had."

Luckily she was given a chance to compose herself, for another artist went "on the air" for a few minutes. We

stepped out of the studio into the reception room to wait.

"It's uncanny," she said. "If I could only see or hear my audience or just had some sort of a picture of them in my mind."

"I'll give you a picture of part of your audience," I volunteered. "Just imagine a long row of white beds in a screened room; on each pillow a white face. But there are smiles, for at the head of each bed a pair of radio telephones are attached and most of them are in use."

That day I had visited most of the large hospitals in Pittsburgh and I assured her that the sound of her voice eased no less than five hundred beds of pain that night, and perhaps a thousand, in hospitals of Pittsburgh alone.

Nearly every hospital in the city has radio equipment of some kind. Most of it has been donated. There is also probably the most complete hospital radio equipment in the world in the three city-owned tuberculosis hospitals. Each bed (and there are more than five hundred) has, as part of its permanent equipment, a pair of telephone head receivers.

The equipment in each of the two smaller of these hospitals consists of a single radio receiving set installed in the basement. Batteries, charger, and a power amplifier are part of this equipment. From this set run wires to all parts of the buildings. One of the patients is trained as operator and it is his duty to keep the set running day and night, whenever there is anything to

OLD DR. RADIO IN THE CONVALESCENT WARD

Every afternoon and evening the men patients in the ward maintained by the Carnegie Steel Company in St. Elizabeth's Hospital in Pittsburgh are entertained by a different sort of ether wave than that to which patients are ordinarily accustomed.

be heard. The patients may listen in at any time merely by placing the telephones on their ears. In addition there is a loudspeaker which can be moved to any part of the buildings for special uses.

Twice a week there is a movie show for the patients and the loudspeaker furnishes music; it is used in the schoolroom for the little patients; occasionally, when requested, it is placed in one of the wards so that all of the patients may hear without the headphones. Again it furnishes an evening's entertainment for the doctors or nurses. The largest of the tuberculosis hospitals has two receiving sets and three loudspeakers, beside the headphones.

The proposal to install this radio equipment in the tuberculosis hospitals met with strenuous official objection at first, but, chiefly because part of the equipment had already been ordered, one of the smaller hospitals was equipped as an experiment. Now all are equipped —and no one is better pleased than the official who originally made objections.

"I think if anyone tried to take the radio out now," said one of the doctors, "we would have a mutiny on our hands."

There had been ample ground for the official objection too. In Pittsburgh, as in most other cities, there are a number of hospital installations which cannot be counted successful. In several instances expensive sets have been donated to the hospital with only a loudspeaker for receiving; such an outfit can seldom be used in a ward. If one of the patients is too ill to listen, all must forego the pleasure of doing so.

But there are exceptions.

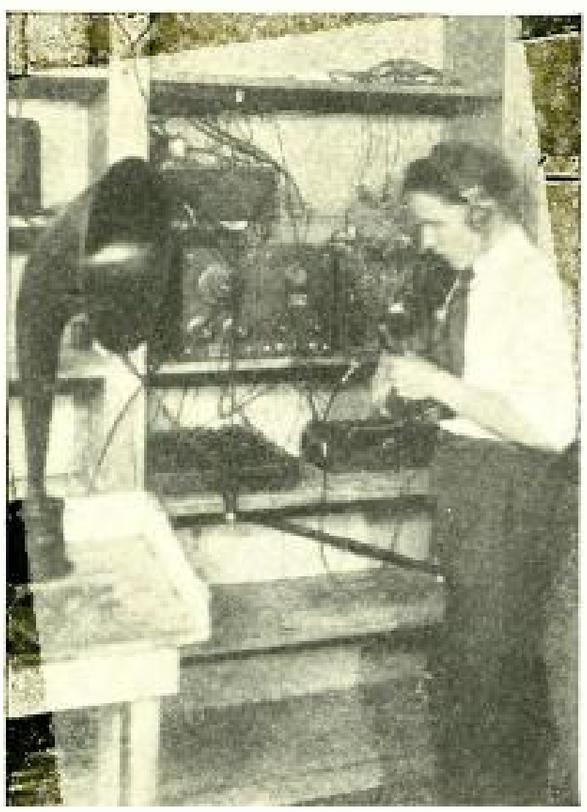
At St. Elizabeth's Hospital the Carnegie Steel Company maintains an industrial ward and the company has installed, in a sun room, a fine radio receiving outfit with a loudspeaker. Most of the patients are convalescent from accidents and the radio is kept busy nearly every minute of the day.

The receiving apparatus in this case is enclosed in a glass-front case which is kept locked. The hospital electrician has the key and he makes the necessary adjustments. There is a switch on the outside of the cabinet so that the patients can turn the set on and off.

It is important that the patients should not be allowed free access to the receiving apparatus.

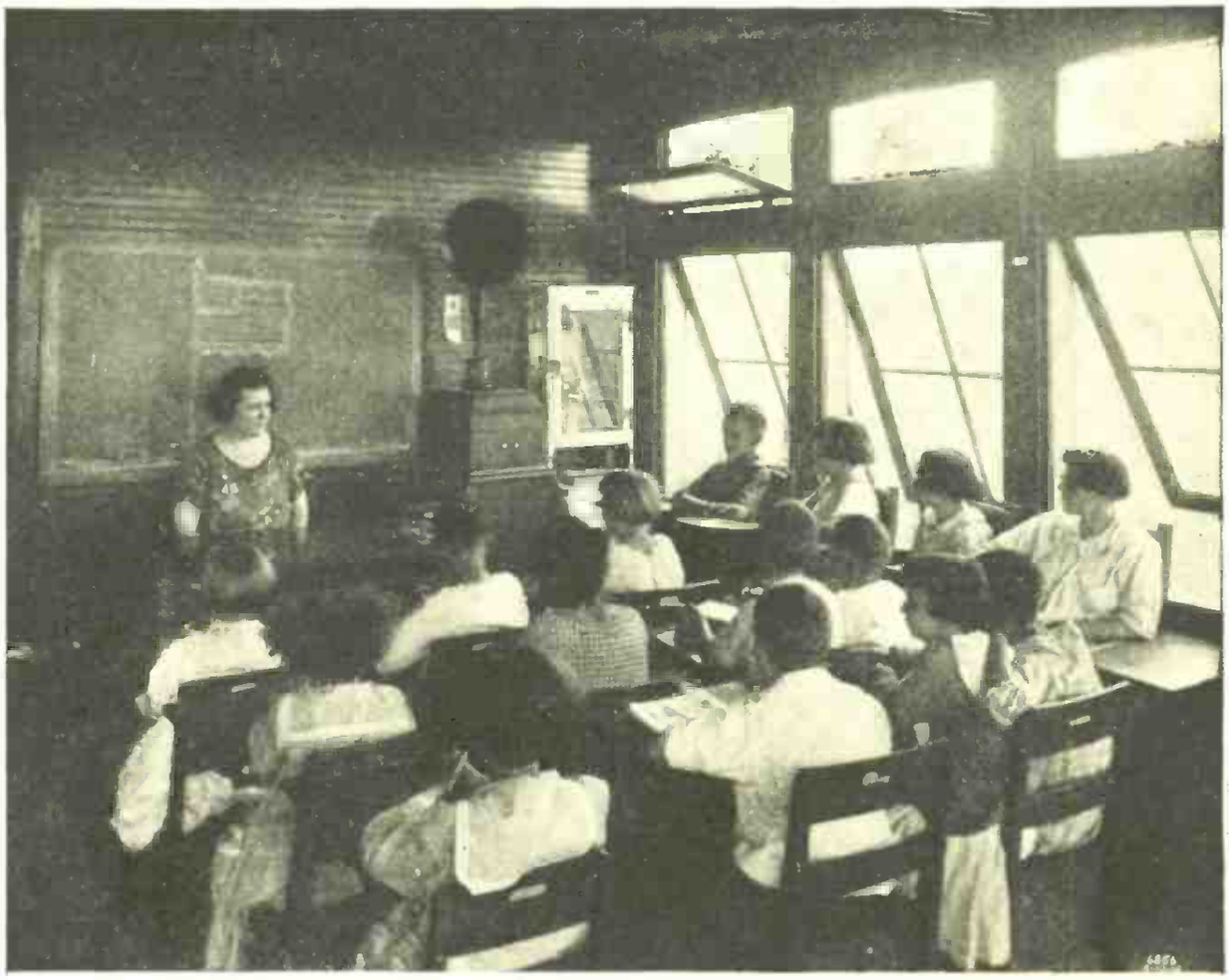
"Yes," said the superintendent of one large hospital, "we have a fine radio set, but the patients break so many parts the upkeep is too much. I am letting them go without it for a while."

In another hospital a fine radio set had been installed in the chapel, where it was used only on Sunday morning to receive broadcast church services. Someone had "borrowed" a couple of the vacuum tubes, the batteries had run



THE RECEIVING APPARATUS

The receiving apparatus and power amplifier that serves the three Pittsburgh tuberculosis hospitals is located in a basement room; from this set wires lead to all parts of the buildings. One of the patients is trained as an operator and no one else is allowed to touch the apparatus. The telephone transmitter is used to make announcements to the patients between numbers.



The little tubercular patients who attend school at the Bedford Farms Hospital in Pittsburgh can either go out and play between lessons—or listen in on radio.

down and it was useless. It could not be moved from the chapel for fear of offending the donor.

At the Marine Hospital there is a radio set in the Red Cross hut, and it not only furnishes nightly entertainment for a group of disabled veterans of the World War, but music for frequent dances.

Aside from the radio sets owned by the hospitals, every institution visited had from one to five patients who had had their own radio sets installed at their bedside.

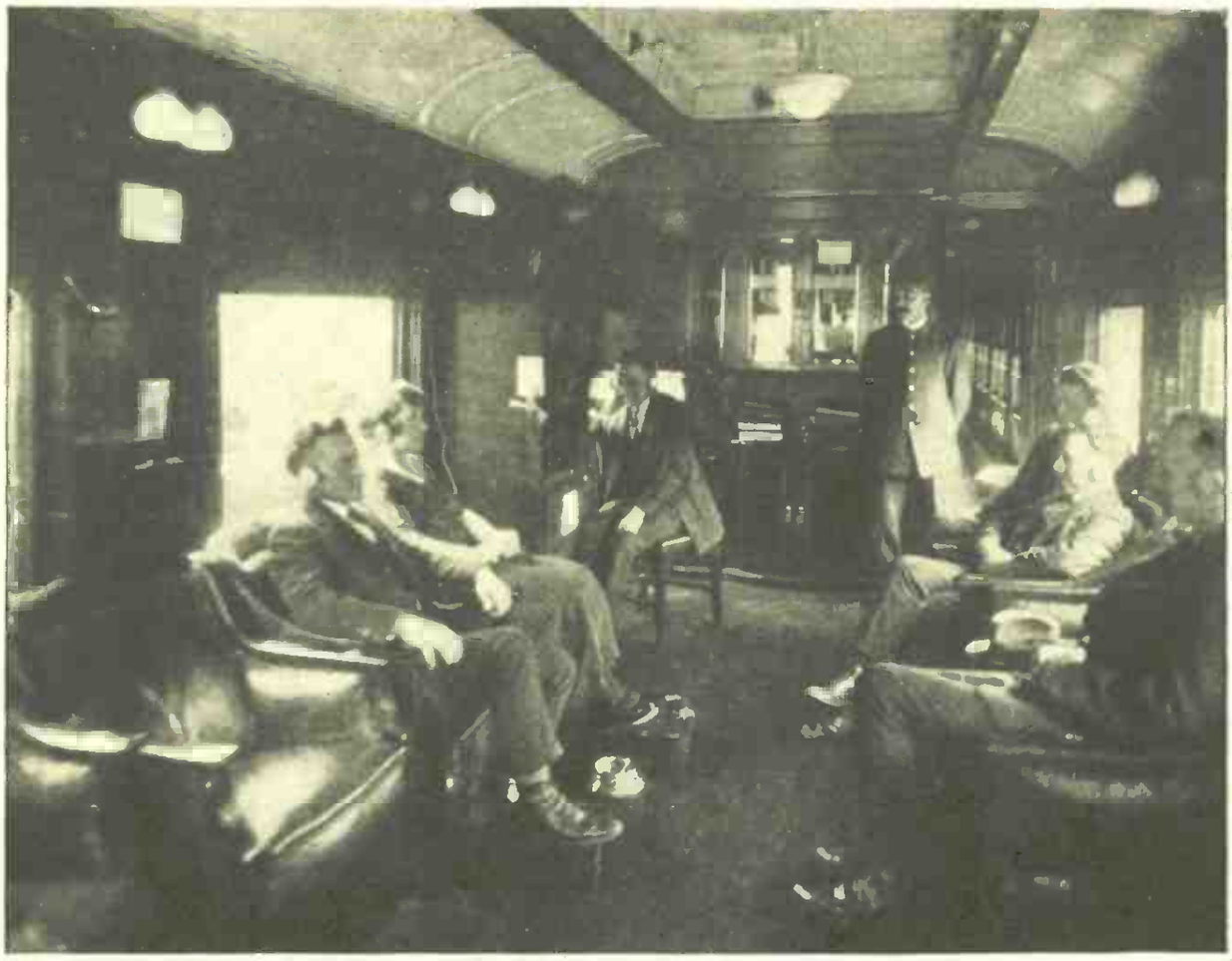
"And so," I said to the singer, "you may be sure that at least five hundred sick folks, all over Pittsburgh, are hearing your voice when you sing."

At that moment the studio director summoned her for her second number. I went to the operating room to hear how her voice "came through" this time. It was strong and clear. I looked through the glass door into the studio—not a sign of nerves!

"I was singing for *them*," she said, when she came back into the reception room.

The telephone bell rang and one of the studio attendants answered. He called the singer.

"One of the patients at the Bedford Farms Tuberculosis hospital would like to speak to you," he said.



A RECEIVING SET ON A MOVING TRAIN

One of the unusual uses to which the railroad company is putting radio is to enable its passengers to listen in while traveling. Many of its transcontinental trains are already equipped with receiving sets—with one loudspeaker and twelve pairs of headphones to a car.

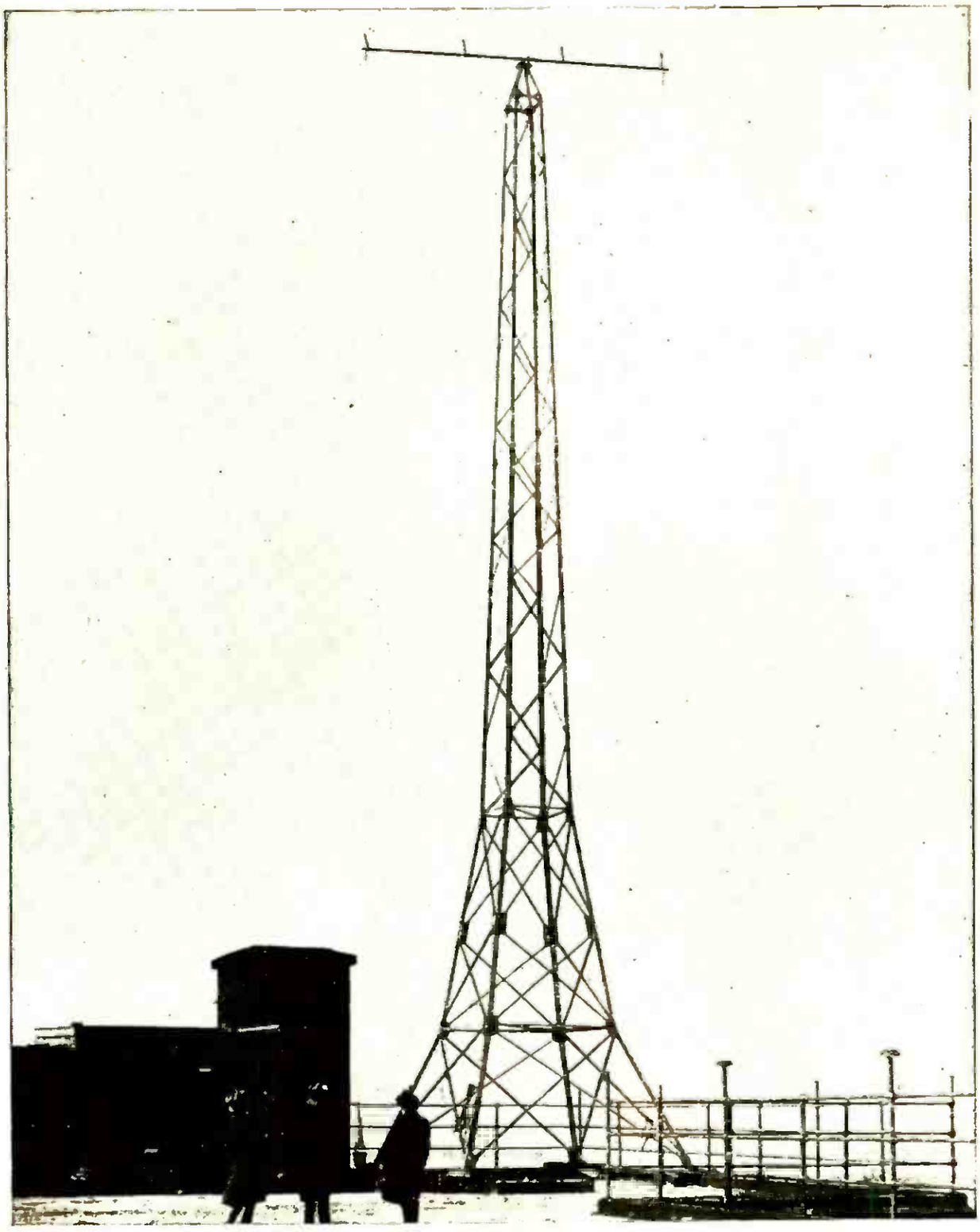
A Railroad Rides the Ether Waves

The unique and significant experiment that is being made for bringing half a continent within a proposed radio net.

By J. M. McMULLEN

ONE of the most remarkable experiments ever attempted with radio has recently been announced by the Canadian National Railways, whose 140,000 employees are scattered from the Gulf of St. Lawrence to Vancouver and from the Great Lakes to Hudson Bay. According to Sir Henry Thornton, president of the railroad, radio will be used for keeping this army of workers in touch with the plans and policies of the management through the medium of 140,000 receiving sets—one to every employee—and a chain of broadcasting stations.

The technical problems of this unique program are under the supervision of Vice-president W. G. Robb, who has created a special radio engineering department to handle the undertaking. No



One Link in the Proposed Chain of Broadcasting Stations

This is station CKCH, which is now nearing completion; it is claimed to be the most powerful station in Canada. It is located in Ottawa and will be operated by the Canadian National Railways as one of a contemplated chain of stations. The antenna towers are 155 feet apart and stand 300 feet above the ground.

other business organization has ever utilized broadcasting to weld together so large and widely scattered an organization as this; even with the titanic strides that have marked the radio industry never has any plan been contemplated for installing at a single stroke 140,000 receiving sets. A recent estimate placed the number of receiving sets in Canada at 100,000; the plan of the Canadian National Railways will double this number within a few months.

The plan provides for establishing a chain of radio broadcasting stations from coast to coast; for equipping all transcontinental trains on the system to receive radio programs; for installing radio receiving sets in all hotels owned or controlled by the company and for perfecting a scheme whereby radio receiving sets will be placed within the means of every employee of the company.

The railroad now has under construction a powerful broadcasting station in Ottawa. This station will be tied in with the large station at Montreal so that any program from either station can be broadcast simultaneously and heard throughout the eastern part of Canada. After the completion of the Ottawa station other stations will be established at such intervals across the continent that the president of the railroad will find it possible to address all of his employees at one time. It is his opinion that he should broadcast talks to his men in their homes at least once a week, and that other officials should send messages to them by the same route in the meantime. The aim of these talks will be to acquaint the employees with the purposes and ideals of the management, to keep them informed of any developments on the system, and to provide entertainment and education.

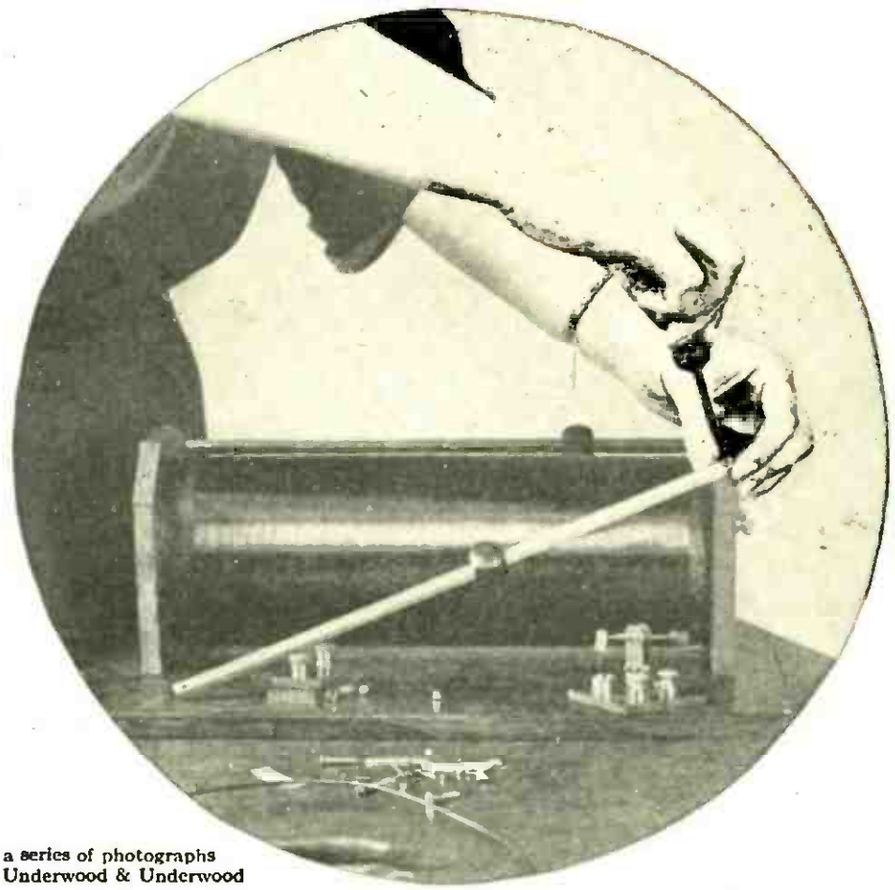
How to put 140,000 receiving sets into the homes of the workers is one of the big problems that Mr. Robb and his engineers are working out. Complete details still remain to be announced, but the scheme will take on much the same form as the stock-purchasing plans used on a number of the railroads in the United States. For example, if John Smith wants a radio set, the company will take enough interest in seeing that he gets it to offer him one at a wholesale price—with the understanding that its cost is to be deducted in small installments from his pay check. There will be no attempt to force him to purchase a set; but the inducements will be such that he cannot well afford to miss the opportunity.

The interest of the company will not stop with the installation of the receiving sets in the homes of its employees; arrangements are already in effect whereby the radio engineering department answers directly by mail any questions pertaining to installation or operation of radio receiving sets.

But of special importance to the thousands of radio fans in the United States who spend a portion of the year hunting or fishing in Canada, this announcement means that the time is not far distant when even with a portable receiving outfit visitors to the "wilds of Canada" will be able to listen in on the radio world.

An Efficient Two-tube Receiver for $45.00

To MEET *the demand for a popular-priced radio set that will meet the needs of the average broadcast listener who wants clarity of reception combined with reasonable distance,* POPULAR RADIO *has developed a simple and easy-to-make receiver that is regarded by experts as a distinct step forward in the design of the two-tube set. It will be described in detail in another of the popular "how-to build" articles—in the August number.*



From a series of photographs
© by Underwood & Underwood

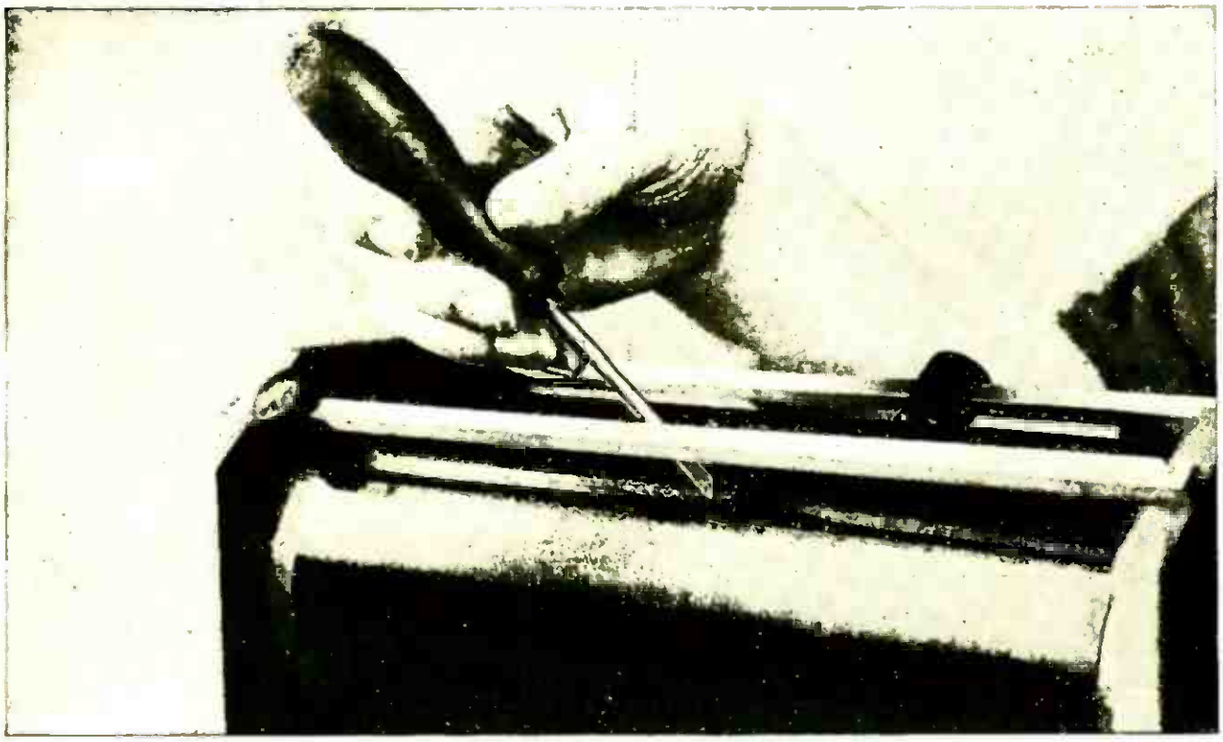
PUTTING ON THE SLIDERS

1 *After winding a ten-inch section of No. 26 enameled wire on a tube 3½ inches in diameter and fastening the tube to two wooden ends and a base, the tuner should be fitted with two slider rods and two sliding contacts. These are fastened with two screws each to the wooden ends.*

How to Make a Two-slide Tuner

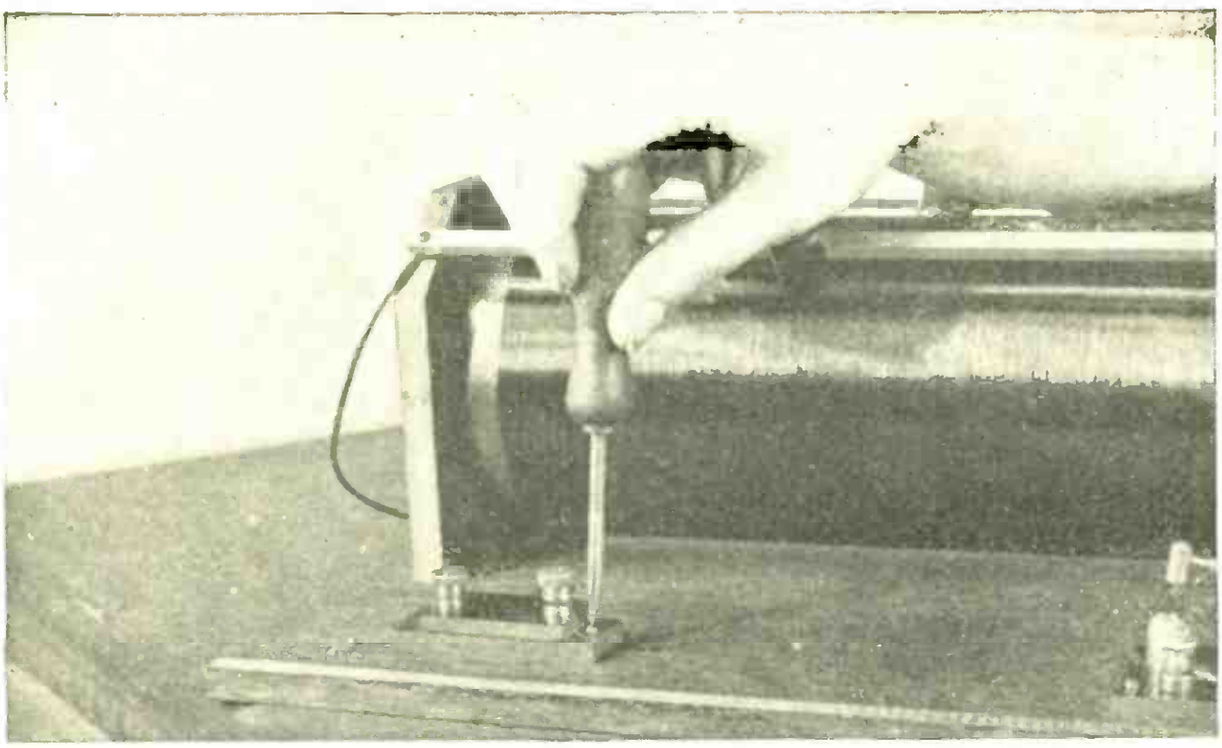
—told in pictures

FROM England comes this interesting series of pictures; with the accompanying explanatory instructions they should enable the novice to assemble a small crystal receiver that will cover a wide range of wavelengths and enable him to "pick up" all the broadcasting and government stations in his vicinity within a range of fifteen miles. The captions tell how to do it and the pictures show the different operations and the results.



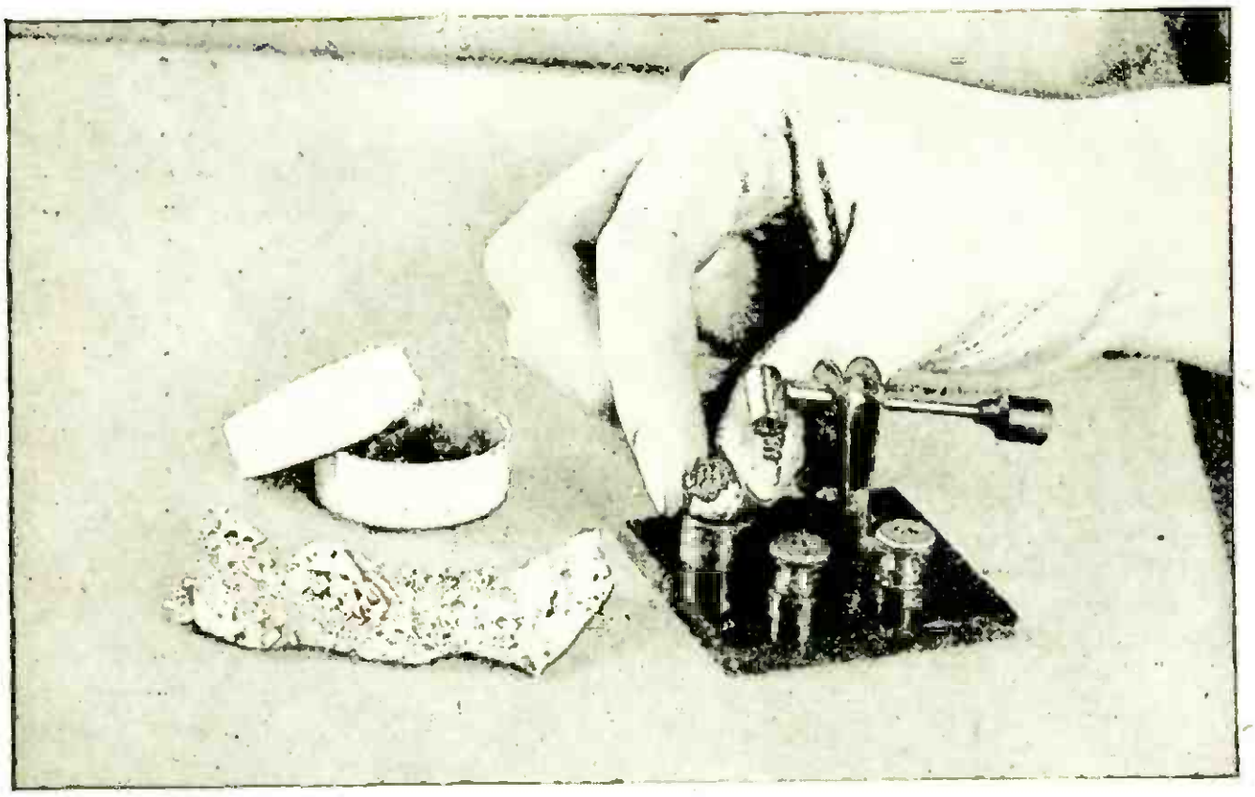
HOW TO PREPARE THE CONTACT PATH FOR THE SLIDERS

2 *With a sharp screw-driver scrape away the enamel coating on the wires in the path of the sliders so that the sliders can make proper contact with the individual wires.*

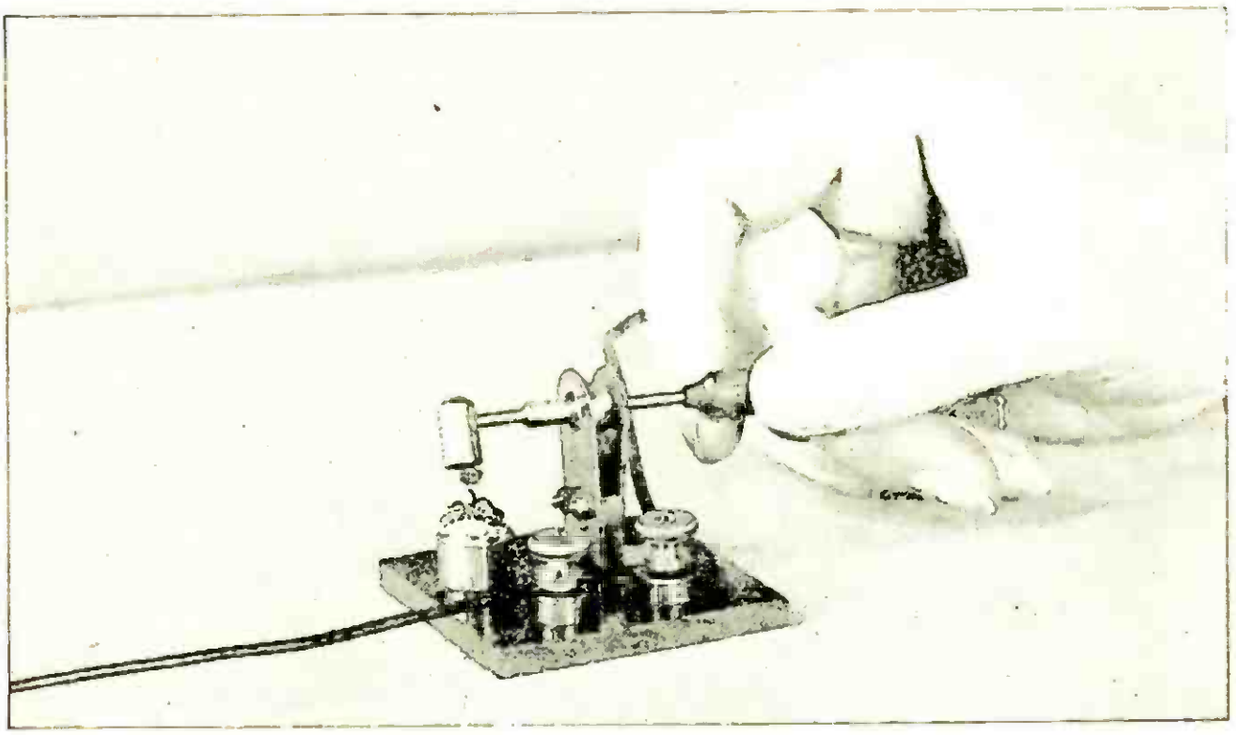


HOW TO FASTEN THE TELEPHONE CONDENSER IN PLACE

3 *Next, place the fixed telephone condenser on the wooden base in a convenient position and connect the end of the slider rod to the left-hand binding post with a piece of wire.*



4 PUTTING THE MINERAL IN THE DETECTOR
Place a piece of galena or some other crystal in the detector cup and make it fast.



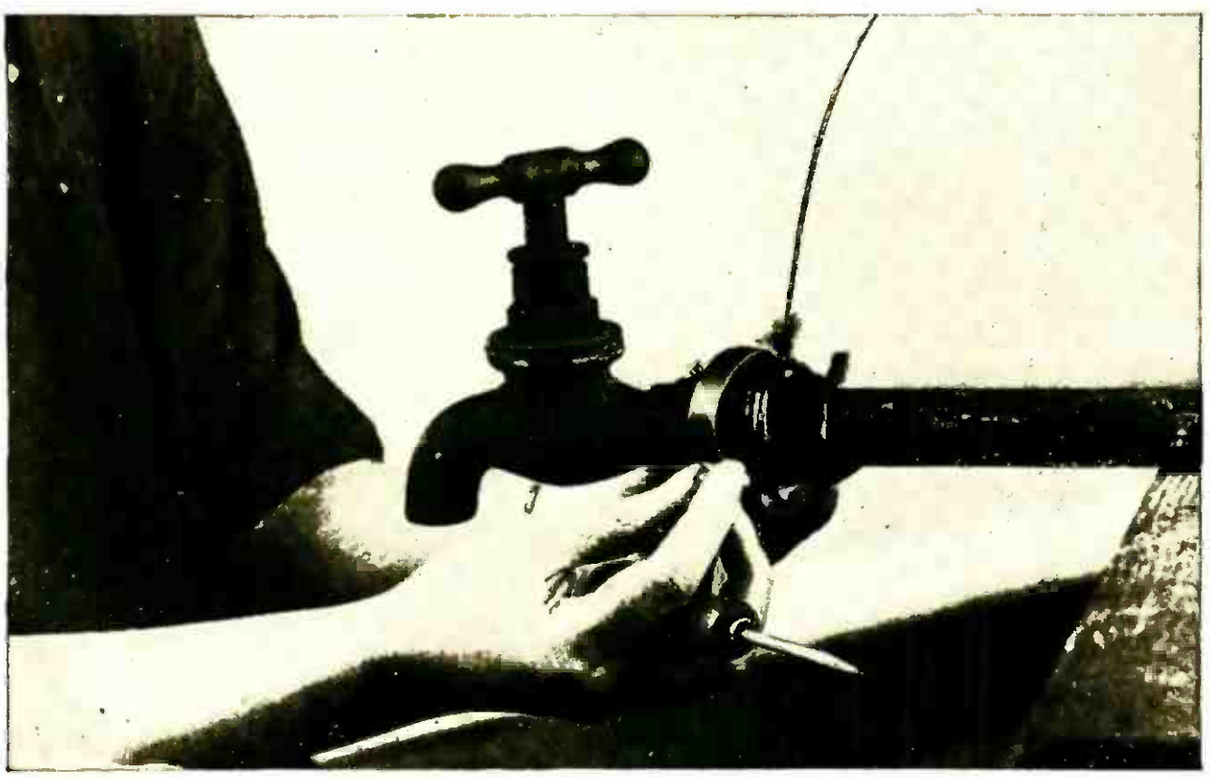
5 HOW TO ADJUST THE DETECTOR
The crystal detector is fitted with an adjusting arm with which the sensitive spot on the crystal is located when the set is placed in operation.

HOW TO MOUNT THE DETECTOR

6 *The detector is then screwed to the wooden base at the right of the set so that it will be convenient to adjust with the right hand, while tuning the set with the left hand.*

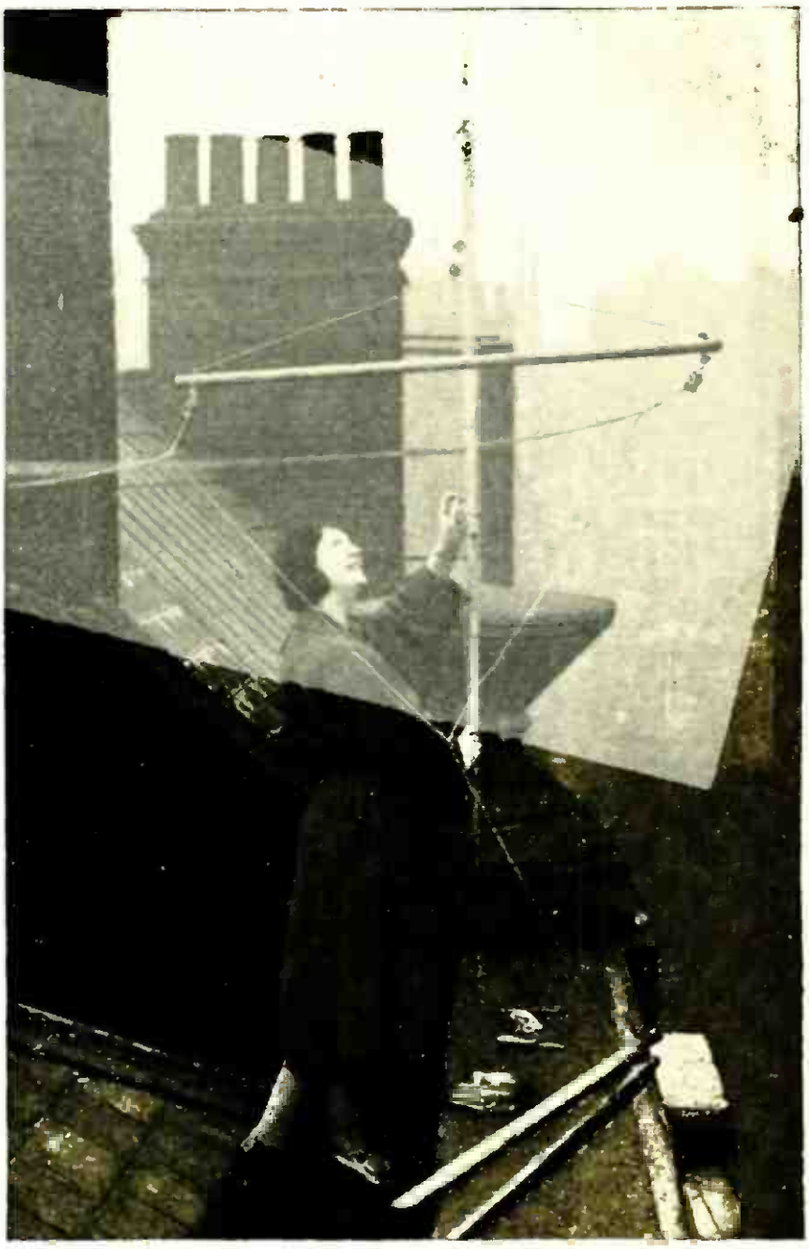
FASTENING THE GROUND WIRE

7 *A wire is fastened on the water pipe and run to the set and fastened to the binding post shown in (11) which is in turn connected to the right-hand end of the coil of wire on the tuner, and to the right-hand binding post of the detector.*



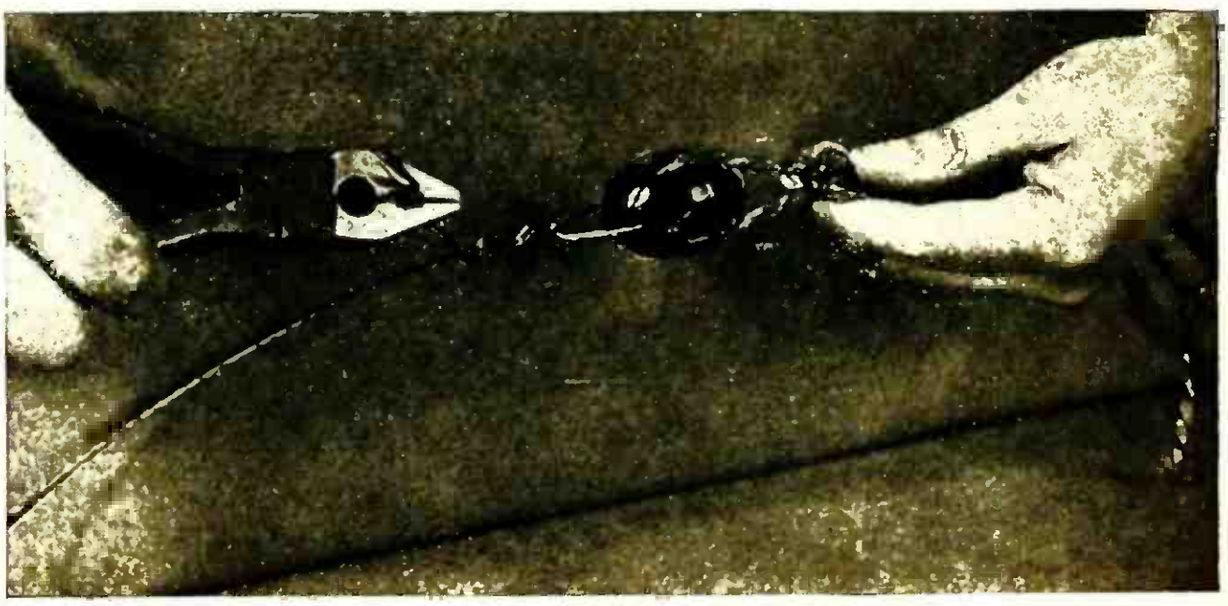
ERECTING THE ANTENNA

8 *A two-wire antenna with insulators on each end and using an old broomstick for the spreaders should do the trick. The lead-in wire should be connected to both wires and run down over the side of the roof.*



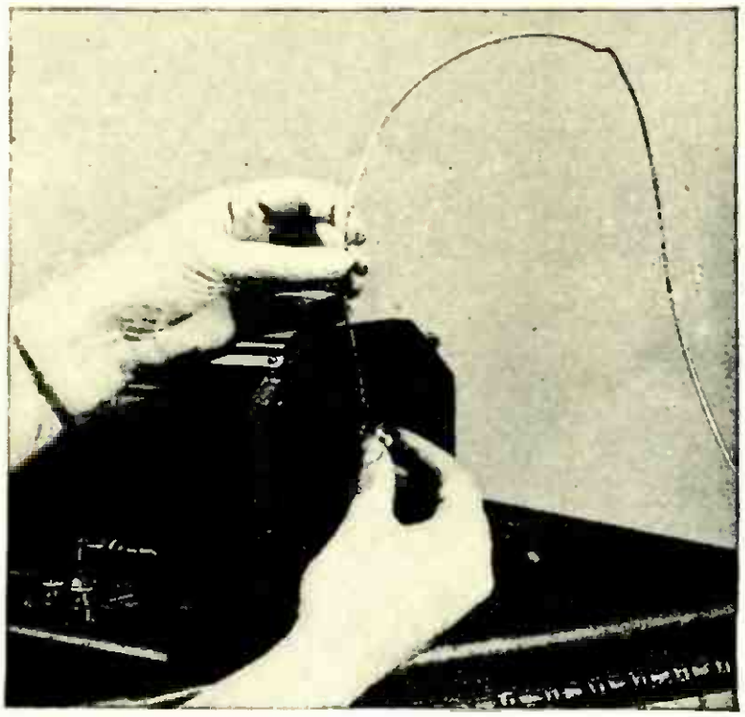
HOW TO STRING THE INSULATORS

9 *The wires should be fastened to the insulators with a rope connected to the insulator for attachment to the spreaders.*



HOW TO JOIN THE WIRES

10 *Wrap the lead-in wires around the antenna wires securely (with a pair of pincers) and then solder them together.*



CONNECTING UP THE GROUND WIRE

11 *This was explained in Figure 7. The antenna lead-in wire should be connected to the rear slider rod.*

TUNING IN

12 *After the telephones have been connected across the telephone condenser, and the right-hand binding post of the condenser connected to the left-hand binding post of the detector, the set is ready for use. Tuning is done by "pushing the sliders."*

Catching Radio Waves on the Trap Lines

By H. F. MULLETT

UP north, among the lonely spruce woods of the Canadian Northwest and a hundred miles from the nearest city, is a little log cabin occupied by Eldon Lockhart and Felix Calma.

But overhead among the tall timber that almost shuts out the blue skyline there is a thin wire line, forty feet in the air, with ends inside the log building, connecting with a radio receiving set that was built by Lockhart, without previous experience. A turn of the knob—and the solitudes are peopled by the magic of voices and the lilt of a thousand instruments. A whole world of news and music stands just outside that lonely cabin door!

Lockhart is twenty-one. He traps in the winter, and studies land surveying in the long winter evenings—when he isn't listening in over his radio set.

It was out on a Saskatchewan homestead that Lockhart first got his liking for the radio. He listened in on a small crystal set, filled with enthusiasm for this wonderful thing that was to end his solitude. "I'll have one of those sets this winter when I go out on the trap line," was his thought.

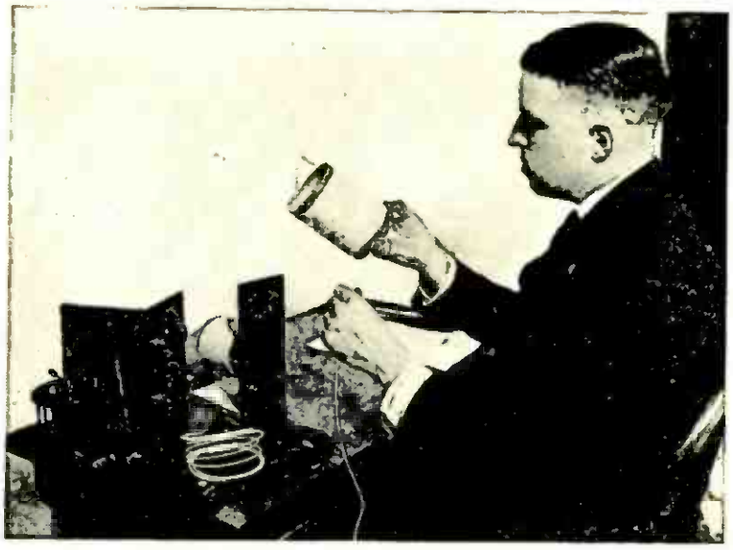
So, when he went into the woods, Lockhart carried with him, in addition to his outfit of steel traps, blankets, rifle, and grub, a diagram of a single-circuit regenerative receiver and the parts. He had never examined a tube-set before, and in putting his set together he blew out his WD-11 tube. This caused a month's loss and some long trips back to the nearest mail point from which a letter could be sent.

However, the set was all ready at last, and the two trappers, both unused to fishing for wavelengths, listened in, quite appalled at the howls and screams that filled the little cabin. More turning of dials, and the delighted amateurs heard:

"This is station KGW, of Portland, Oregon."

Since then, they have picked up over sixty stations.

This spring, the Canadian government will install a $50,000 sending set at Edmonton, the capital of Alberta, and will equip police posts in the northland with receiving sets. From Edmonton to the Arctic Ocean—over two thousand miles of rough territory, inhabited only by a few white men, trappers, traders, prospectors and police, and by bands of wandering Indians and Eskimo—radio waves will be sent out to end forever the solitude of that vast wilderness.



HOW TO CALCULATE THE WIRING OF COILS

ARTICLE No. 3 of a new series of short articles that contain useful facts—summarized for your notebook. This installment tells about the sizes and resistance of wire used in radio work.

By E. E. FREE, PH.D.

WHEN a wire is referred to by a certain number, as, for example, "No. 16 or No. 28," this number means the "gauge" of the wire. It is a way of specifying the thickness. It would be much more convenient and scientific simply to set down the diameter of the wire in thousandths of an inch or in millimeters, but years ago engineers got into the habit of specifying the sizes of wires and rods and plates by the particular slot or hole in a "gauge plate" into which the wire or other thing would fit. The habit has persisted. These slots or holes were numbered, hence the present numbers used to designate the sizes of wire.

Many such systems of gauges have been in use in different countries and at different times. In the United States, for use with copper wire, only one of these systems has survived. This is the American Standard or "Brown and Sharpe" gauge, often referred to as the "B. and S." gauge. The numbers in it are purely arbitrary, like the width letters for shoes. The gauge numbers do have, however, a mathematical relation to each other such that an increase of three numbers means a decrease of the cross-section of the wire by just one-half; which means, in turn, a doubling of the electrical resistance of each foot of the wire.

It is useless, however, to bother about remembering this mathematical relation. The table printed with this article gives the numbers in the Brown and Sharpe gauge, with the diameters of the wires in "mils," one mil being one thousandth of an inch. In this table, for example, number 18 wire is seen to have a diameter of 40 mils, which means that its thickness is 40 thousandths, or one twenty-fifth of an inch.

In many of the books you will see tables of "circular mils." This is the *square* of the diameter of the wire in mils. For example, number 18 wire equals, in circular mils, the square of

40, or 1,600. Note that this is *not* the area of the cross-section of the wire, for the wire is circular instead of square and the area of its cross-section is not the square of its diameter but must be calculated from the geometrical formula for the area of a circle.

Fortunately the possible confusion about the circular mils has little importance in radio calculations as circular mils are not much used by radio writers. The best thing to do is to use always the *diameter* of the wire in mils. If figures are given in circular mils take the square-roots of the numbers and you will have, in all cases, the diameters of the wires in mils.

The electrical resistance of a copper wire depends on its cross-section. In the table are given the resistances of wires of the different gauge numbers for direct current at ordinary room temperatures. In practice these resistances must be considered merely as approximate values, since the resistance of wire varies slightly with the hardness or softness of the wire, with the temperature and sometimes with other things. The figures in the table are close enough for all ordinary purposes.

Bear in mind that these resistances are for *direct* current. For ordinary alternating currents, such as are used in power work or in house lighting, the resistances are about the same, but for radio-frequency currents the resistances are quite different because of the skin effect. It is impossible to give a general table for resistances at radio frequencies since the frequency, the nature of the winding, the character of insulation on the wire, the tube that it is wound on and even other factors, may affect the measured resistance of a coil.

THE SIZES AND PROPERTIES OF DIFFERENT KINDS OF COPPER WIRE

B. & S. Gauge	*Diam. Mils.*	*Feet Per Pound*	*Ohms Per Foot*	*TURNS PER INCH*			
				Bare	*S.C.C.*	*D.S.C.*	*Enameled*
8	128	20	.00064	7.8	7.3	....	7.7
9	114	25	.0008	8.7	8.2	....	8.6
10	102	32	.0010	9.8	9.2	....	9.6
11	91	40	.0013	11.0	10.3	....	10.8
12	81	50	.0016	12.3	11.5	....	12.1
13	72	63	.0020	13.8	12.8	....	13.5
14	64	80	.0026	15.6	14.3	....	15.1
15	57	100	.0033	17.5	15.9	....	16.9
16	51	127	.0041	19.6	17.9	18.3	18.9
17	45	160	.0052	22.2	20.0	20.4	21.3
18	40	200	.0065	25.0	22.2	22.7	23.8
19	36	260	.0082	27.7	24.4	25.2	26.5
20	32	320	.0104	31.2	27.0	28.0	29.7
21	28.5	408	.0131	35.1	29.9	31.0	33.1
22	25.3	515	.0165	39.5	33.9	34.4	37.2
23	22.6	650	.0208	44.2	37.6	37.9	41.5
24	20.1	820	.0262	49.7	41.5	41.8	46.5
25	17.9	1,030	.0330	55.8	45.7	46.1	52.1
26	15.9	1,300	.0416	62.8	50.2	50.8	58.5
27	14.2	1,640	.0525	70	55	55	65
28	12.6	2,060	.0662	79	60	61	73
29	11.3	2,600	.0834	88	65	66	82
30	10.0	3,280	.105	100	71	72	91
31	8.9	4,140	.133	112	77	78	103
32	8.0	5,230	.167	125	83	84	115
33	7.1	6,570	.211	140	90	91	130
34	6.3	8,330	.266	158	97	99	145
35	5.6	10,480	.335	178	104	106	161
36	5.0	13,200	.423	200	111	114	180
37	4.5	16,600	.533	222	118	121	204
38	4.0	21,000	.673	250	125	128	227
39	3.5	26,500	.848	285	135	137	256
40	3.1	33,400	1.070	322	141	145	286

For use in winding coils and in calculating the amount of wire needed for them the tables of turns per inch will be found useful. This means linear inch, along the coil, one layer deep. The figures are approximate only, as the wire made by different manufacturers differs slightly. "SCC" means "single-cotton-covered;" that is, a wire wrapped with one layer of cotton insulation. Similarly, "DSC" means "double-silk-covered" wire, having two layers of silk insulation. There are also "double-cotton-covered" and "single-silk-covered" wires but they are little used in radio work. Enameled wire, having a thinner and transparent insulation, is much used in radio.

Wires of unusual shape, as, for example, square bus-wire, are usually specified by the number of the round wire to which they are equivalent in electrical resistance. This means that such wires have the number of the round wire having the same cross-section. A number 16 bus-wire, which is a common size for wiring radio sets, has as much copper in it per foot as has a number 16 round wire. There will be, therefore, about 1,275 feet of such wire in a pound.

In England an entirely different set of gauge numbers is sometimes used for wires. It is called the "British Imperial Standard Wire Gauge," frequently abbreviated to "S. W. G." A few British publications use the Brown and Sharpe gauge just as we do, but if the gauge system is not specified it is safe to assume, in British work, that the S. W. G. system has been used. This system is also used more or less in other countries, though in France it is customary to specify, also, the diameter of the wire in millimeters. A millimeter is one thousandth of a meter or about .04 inch. One millimeter equals 39.37 mils, and one mil equals .0254 millimeter. These figures permit easy conversion of either one into the other.

The B. and S. gauge, the S. W. G. system, the measurement in mils and the similar measurement in millimeters are the only four ways commonly used to specify the size of copper wires. But for iron and steel wires three other gauges are sometimes used; the Roebling gauge (also called the Washburn and Moen gauge), the Birmingham gauge and the Stubs steel-wire gauge. The Stubs *iron-wire* gauge (as contrasted with that for steel wire) is the same as the Birmingham gauge. All this is rather complicated but it has, fortunately, little application to radio as these gauges are not used for copper wires.

The approximate relations between the two gauges that are used for copper wires are given in the following table:

No. 10 S.W.G. (British) equals No. 8 B. and S. (American)
No. 14 S.W.G. (British) equals No. 12 B. and S. (American)
No. 18 S.W.G. (British) equals No. 16 B. and S. (American)
No. 22 S.W.G. (British) equals No. 21 B. and S. (American)
No 26 S.W.G. (British) equals No. 25 B. and S. (American)
No. 30 S.W.G. (British) equals No. 28 B. and S. (American)
No. 34 S.W.G. (British) equals No. 31 B. and S. (American)
No. 42 S.W.G. (British) equals No. 38 B. and S. (American)

These relations are not exact, but give an idea of the relation between the two gauge systems. For the exact diameters of wires in the two systems, as well as for details concerning exact resistances and the like, it is necessary to consult the more comprehensive tables in the handbooks of electrical engineering.

Save These Articles for Reference!

This series of articles includes statistical tables that are of practical value to the radio experimenter—particularly to the amateur who designs his own sets. The preceding articles of this series include:

"How to Convert Wavelengths into Kilocycles" - *November*, 1923
"How to Make Power Calculations" - - - - - - *March*, 1924

"THE MONOPOLISTIC CONTROL OF RADIO IS A REALITY"

The author of this article writes from the point of view of the owner of both a broadcasting station (WLW) and of a manufacturer of radio apparatus.

Should There Be a Monopoly of Broadcasting?

How the threatening control of radio stations by one organization may menace the right of free speech.

By POWEL CROSLEY, JR.

WHAT would a monopoly of broadcasting mean to the American public?

The manufacture, sale and license of broadcasting stations is confined entirely to the Western Electric Company—and of course the American Telephone and Telegraph Company—under some agreement that they have made with the other members of the Radio Corporation of America.

It is said that the Westinghouse Electric and Manufacturing Company is permitted to operate three broadcasting stations, probably without limit as to power. The General Electric Company and the Radio Corporation itself reserved the right to operate three broadcasting stations each. The balance of the broadcasting is entirely under the control of the American Telephone and Telegraph Company. Taking the stand that they are, of not permitting any independent broadcaster to utilize more than 500 watts, and being in absolute control of the wire systems to tie together their various stations, the telephone company has what amounts to complete control of the broadcasting situation in this country.

At the same time no limitation as to broadcasting power is to be observed by the telephone company or by the other powerful affiliated organizations.

In perhaps a year, or maybe in five years, they will have developed transmitters with which the owner of a crystal set or its equivalent in San Francisco can hear broadcasting stations in New York City. It is not beyond the realms of possibility. What will happen then?

There will be a few powerful stations in this country controlled by the same organization; censoring every word, curtailing the freedom of speech—that right so dear to the American public. This becomes, then, an actual attack upon the First Amendment of our Constitution, which provides for the right of free speech.

Nor is the question of power the only indication of monopoly. The control of land wires is in the hands of the American Telephone and Telegraph Company. A monopoly of all land telephonic transmission may be necessary for the good of service, yet this same monopoly is imposed upon every inde-

pendent broadcasting station. Charges for remote control, pick up and for broadcasting can be, and are, set at whatever figure may be desired by the telephone companies.

For example:

When David Lloyd George visited and made a tour of this country, he made a talk in Indianapolis. I desired to broadcast his speech from Station WLW, which necessitated a tie-in by wire from Cincinnati to Indianapolis. I asked the cost and was told that the expense would he $800 for twenty minutes. In the case of President Coolidge's speech in the east, arrangements had been made by the Rotary Clubs of America to have a certain independent broadcasting station in Chicago tie-in by wire so that the people in the mid-west could also hear the message. But no wires were available for the purpose. Here was a case in which the great American public was deprived of the opportunity of listening to the head of their nation.

There should be only one restriction upon a broadcasting station—its inability to render service. No broadcasting station will find it possible to exist for a long time unless it gives the type of programs that the public wants. When a broadcasting station ceases to create "good will," its value to those who maintain it ceases to exist and it becomes a liability instead of an asset.

Of course, it is obvious that the American Telephone and Telegraph Company is not planning to control broadcasting for nothing. It admits that it is better able to handle the job of broadcasting than anyone else. But what will happen if it gets complete control? Will it continue to maintain this service without any charge? No. There is already an organization in New York formed to collect voluntary subscriptions from the public to provide funds to supply talent to the American Telephone and Telegraph Company's stations. As soon as broadcasting is completely controlled, a means will be devised to collect money from the radio listeners so that its stations can be maintained at a profit.

What is the solution of this problem? Shall any organization, no matter how large and powerful, be allowed to dominate the air? Shall it be permitted to exercise the functions of government in regulating broadcasting stations?

If any one is to designate who shall be allowed to broadcast and who shall be allowed to use greater power, should not this function be in the hands of the Government?

The monopolistic control of radio, which now not only threatens but is a reality, is based upon our present patent law. The question is this. Should the purchase and control of patents be allowed to create a monopoly in a thing so vital to every American as is radio broadcasting?

Kadel & Herbert

"The American Telephone and Telegraph Company has not attempted and does not desire a monopoly of broadcasting," is the official statement given out recently by Mr. H. B. Thayer, the president of that company.

CONDUCTED BY KENDALL BANNING

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Congress Passes the White Radio Bill

A STEP forward in the development of radio in this country was taken by the United States Senate on April 7, when it passed the White Radio Bill—long advocated by POPULAR RADIO—without a single dissenting vote. This action not only establishes the authority of the Government to act in straightening out much of the confusion that has retarded the growth of the radio interests, but tends to lessen materially the dangers that have threatened of a monopoly on broadcasting—as pointed out in the article on page 599 of this issue.

Using the Loop as a Ground

TO the listener who is more concerned with the clarity of reception than with mere distance, the following tip from an amateur in Milford, New Hampshire is of special interest and value:

A water pipe or similar ground connection is the common method of installing receiving sets. It is well known, however, that several insulated wires stretched under the antenna and connected to the ground binding post of the set may be used instead and with excellent results. Such an arrangement is known as a counterpoise, and although always used as a ground by broadcasting stations is little used with receiving sets, mainly owing to the fact that it takes up too much room. With the limited yard space of the city or village dwelling the counterpoise is usually impossible.

As an experiment it occurred to the writer to try a loop (similar to the well-known loop antenna) as a capacity ground for a three-tube, regenerative set. It was made by framing together in the form of a cross, two strips of pine, five feet long. Brass pins or nails can be driven in the outer ends of the strips, about one inch apart, and pointing slightly outward. The wire is then wound on these pins in a spiral, beginning at the inner pin. At least ten or twelve complete turns should be used, which will call for something like 130 or 140 feet. In my case, the wire used was ordinary antenna wire, not insulated.

This loop was placed in a horizontal position in the basement of the house, practically under the set, and supported on a box at a height of about three feet from the cellar bottom. The ground wire running from the set to the water pipe was disconnected, and a lead wire from the loop attached in its place.

Considerable doubt existed in my mind as to the success of the device, but somewhat to my surprise it was found that the stronger stations came in readily and in good volume. The results were so pleasing that a two-point switch was later arranged near the set, so that the set could be grounded on either the loop or water pipe at will by the simple throwing of this switch.

For very distant stations, or with very weak signals, the water-pipe ground is better; but for the nearer stations, the loop is preferred.

The main advantage is the suppression of much, and most of the time, all, of the noise caused by weak "strays" and by the induction hum from light-wires and motors. With this noise eliminated, all signals are heard better, even though they are not as strong.

—A. L. KEYES

"It might be interesting for an experimenter to test two points," adds Mr. Keyes:

"*First:* Will the loop function as well in a vertical position as in a horizontal, and is there any directional effect when vertical?

"*Second:* Would more wire add to its efficiency?"

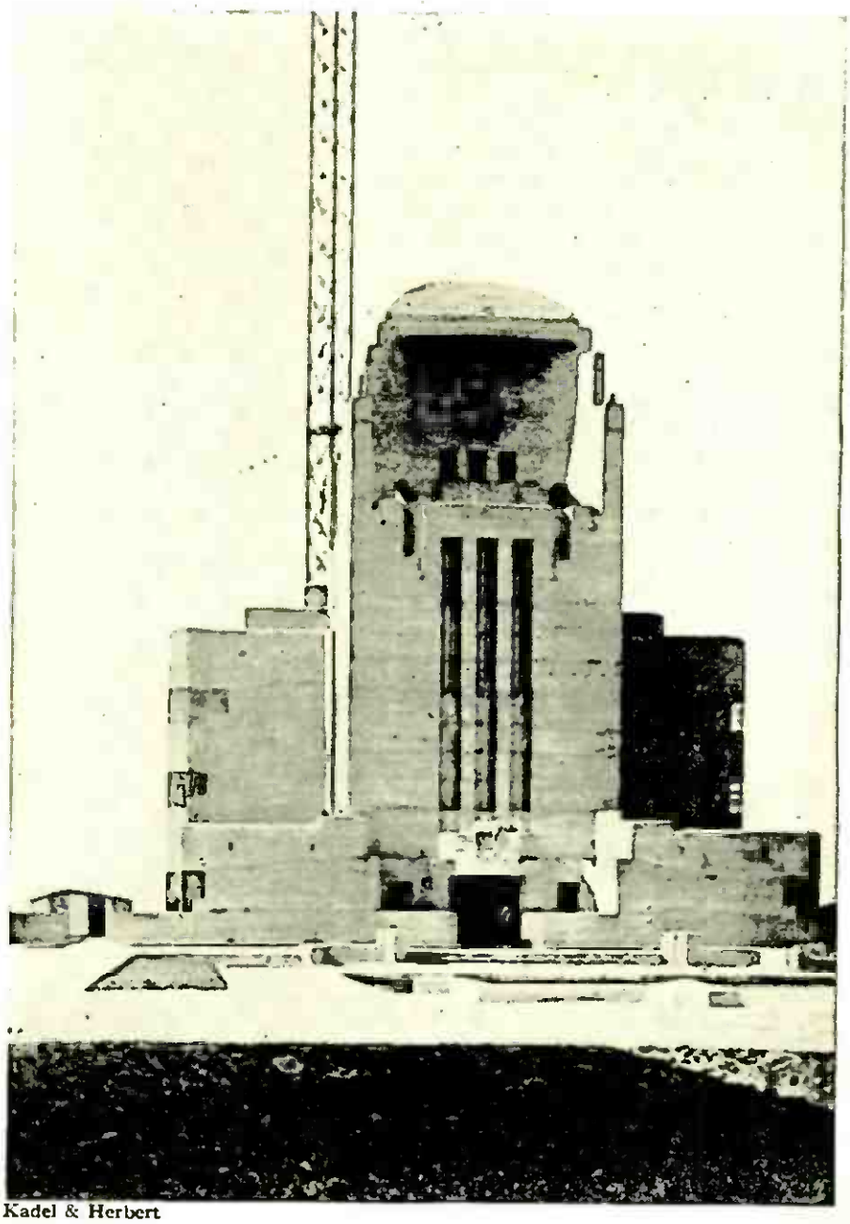
How to Make a Variable Condenser Without a Panel

HERE is a practical little idea from an ingenious radio experimenter; it has the added virtue of being an inexpensive one:

A variable condenser designed for panel mounting can readily be attached to a base-board instead, by means of two brass brackets or corner braces just large enough to hold the condenser clear of the base, when attached to the brackets with the machine screws that come with the instrument. If the lower half of the brackets is attached to the base-board with wood screws, so as to extend back under the condenser, it will be found that a three-inch dial almost obscures the brackets from view. The resulting job is both neat and substantial and is especially satisfactory when testing out a new circuit.

The brackets can be purchased for a few cents at any hardware store.

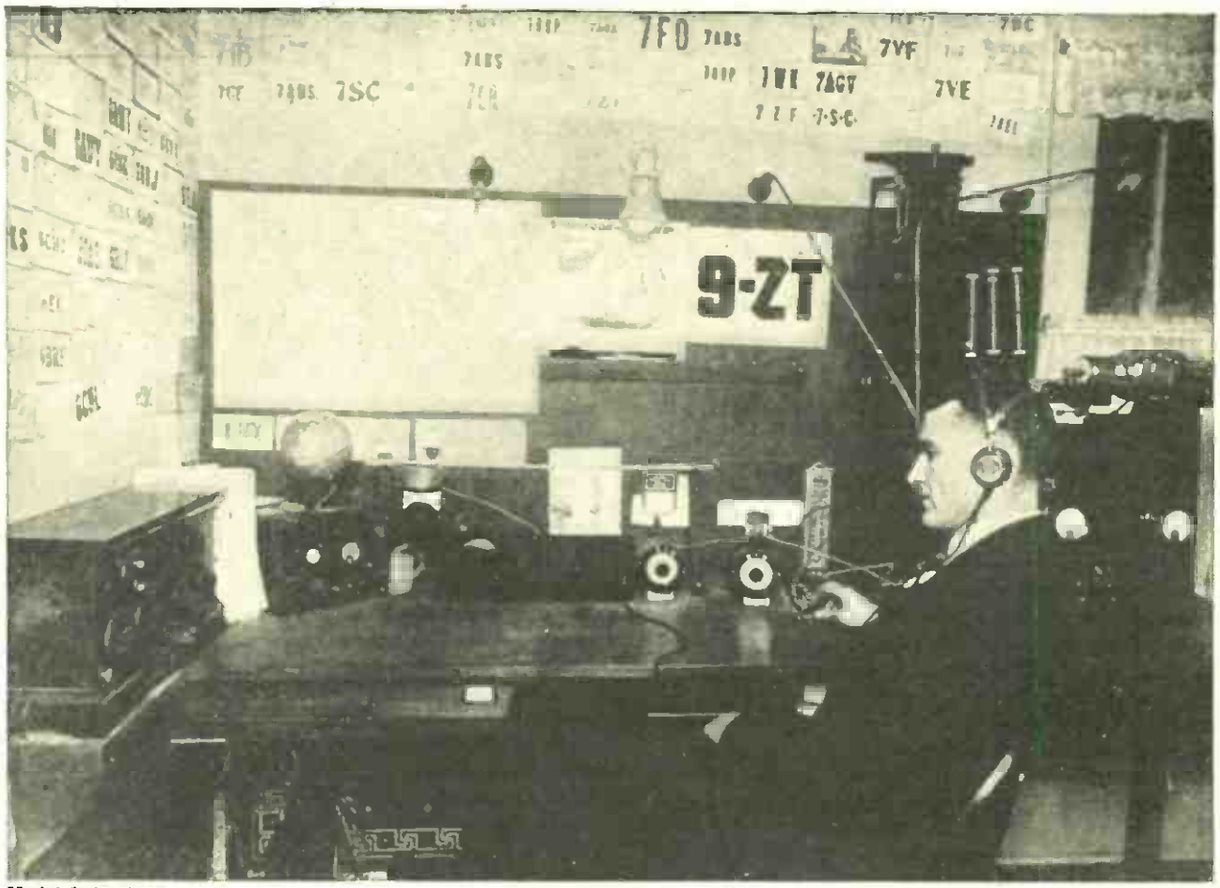
—DEANE S. KINTNER



Kadel & Herbert

RADIO EVOLVES AN ARCHITECTURE OF ITS OWN

This remarkable structure houses the new radio station at Kootwijk, Holland. It is built of concrete, and a pool of cooling water is located in front of and behind the building.



Kadel & Herbert

"THE BEST AMATEUR RADIO STATION IN THE UNITED STATES"

Station 9ZT, owned and operated by Don Wallace of Minneapolis, Minnesota, is officially entitled to this appellation by virtue of winning the much-coveted Hoover Cup for 1923. The cup is awarded every year to the amateur station that, in the opinion of the Amateur Radio Relay League, is the most efficient.

These Messages Came in Through the Back Door

THE fact that the longest way round may be the shortest way home, in radio as elsewhere, is illustrated by a report of what happened to some recent messages sent from the American Line steamship *Minnekahda:*

The messages were on commercial business, cleared from the *Minnekahda* as she was steaming east from New York and were sent directly to San Francisco, so that approximately 3,000 miles of distance were covered, overland, in addition to the distance at sea.

The sending operator gave no indication of his reason for transmitting direct to San Francisco, but called the KFS station there directly and went ahead with the matter in the usual fashion. His sending apparatus, the receiving operator said, was heard clearly and sounded like a small arc set. It was supposed in San Francisco that the continous-wave reception stations on the Atlantic coast were busy at the time, and that the business was offered to San Francisco for that reason.

Reception was on an eight-foot loop aerial. The messages were forwarded by land line from San Francisco to their addressees in New York and New Jersey, so that they traveled nearly 7,000 miles to reach destinations only 600 or so miles distant from the sending ship, crossing the continent once by radio and once by telegraph.

Some mystification was expressed by at least one recipient as to the reason for a message from east of New York coming *via* San Francisco.

Although it is not uncommon for vessels to report their positions, when off New York, to the KFS station, so far as known the instance cited is the first of transmission of commercial business from ships in the Atlantic to mainland points by way of San Francisco. The night after these messages were handled, the *Minnekahda* reported her position to San Francisco from a point 915 miles east of Ambrose light, thus establishing communication with a ship's set, over a distance of approximately 4,000 miles, three quarters of which was overland.

—D. R. LANE

How "Off-stage Noises" Are Made in the Radio Drama

THE popular "radio drama" is apparently becoming established as an institution, and with its development is coming, not only a new crop of radio dramatists and radio actors and actresses, but "off-stage noises" that form such an important feature of the new type of play that appeals to the mind through the ear alone. Here are some of the tricks used in simulating familiar noises.

Did you know that the realistic rain effect you heard during the broadcast production of "The Fortune Hunter" was caused by the rolling of dried peas through a paper tube?

Would it have detracted from your enjoyment of "The Storm" to have known that the forest fire was produced by means of a plumber's gasoline blow torch, the breaking of match sticks and the crushing of paper? The torch produced the effect of rushing wind and flame, and matches and paper, brought close to the microphone, sounded like the crackling of burning tree limbs.

Successful transmission of a dramatic production by radio is dependent upon sound properties. Atmosphere is created and action is simulated by sound, the devices varying with the needs of a particular production.

At Station WGY, where the radio drama has long been a popular weekly feature, special pains are being taken in the preparation of a play for the ether to see that maximum sound results are obtained. Considerable experimenting is necessary to produce the sound desired. Two of the most frequently used sound properties are the door and the bell board.

The bell board consists of a convenient arrangement of five bells of different tones and a buzzer. All are connected to dry cells and may be operated by the pressure of a button. There are door bell, telephone bell, an alarm bell which may be sounded for fire, ambulance or as a burglar alarm. A clock chime is in the group, as is a tap bell.

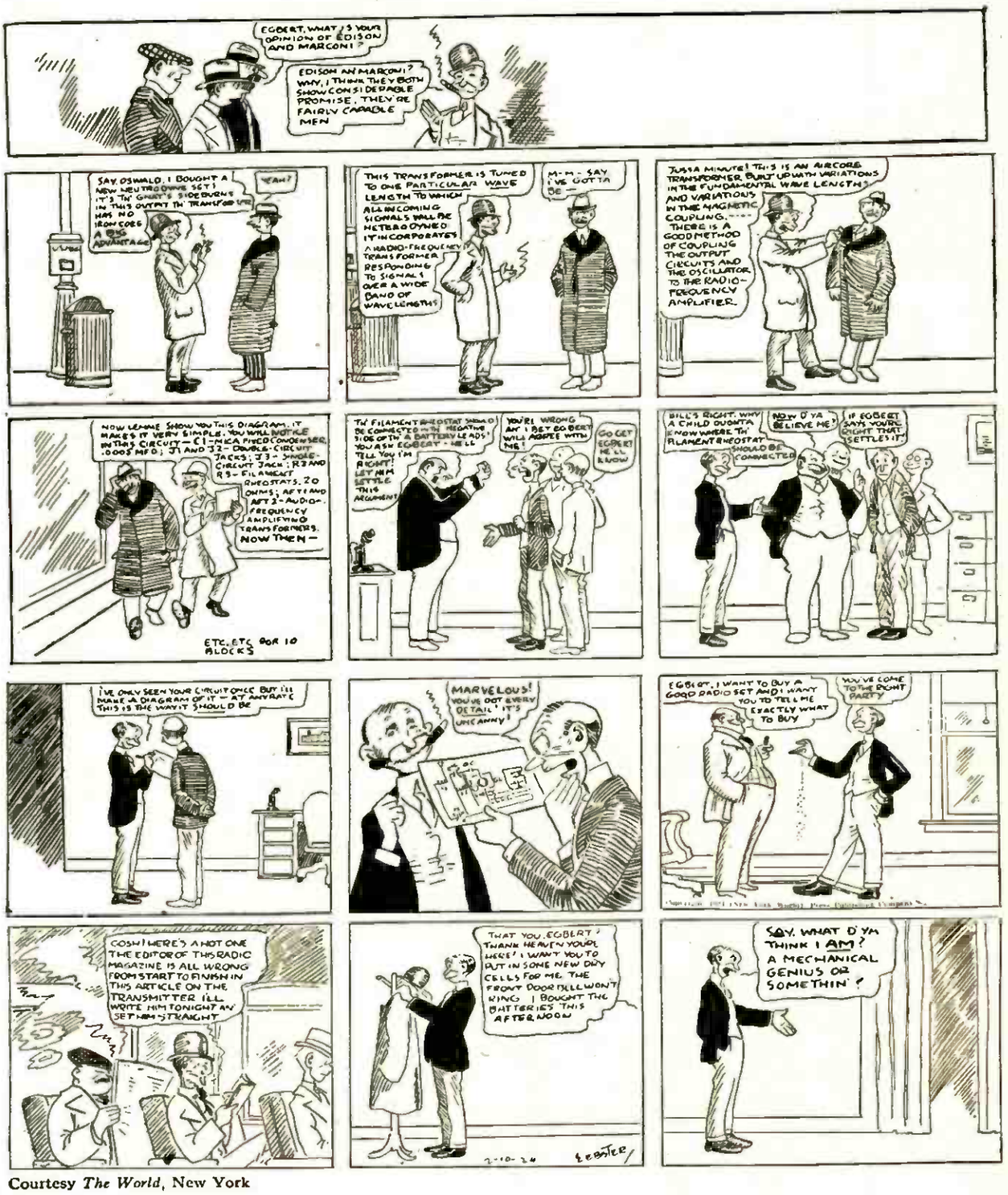
Probably no property is more important than the portable door and door frame, for it is only by the closing of the door, in interior scenes, that the entrance or the exit of a character may be conveyed to the radio listener. The door is one of the peculiar conventions of the radio drama. Whereas in the home a softly closing door is considered desirable, it is quite important in the radio drama that the sound of the door and clicking of the lock be loud enough to actuate the microphone. The WGY door is made of thin oak and has a peculiar resonant quality.

—W. T. MEENAN

General Electric

HOW "SOUND ATMOSPHERE" IS PRODUCED IN BROADCAST PLAYS

Here may be seen the door bell, telephone bell, clock chimes, bell buzzer and door-frame that constitute the noise "props" at station WGY.



Courtesy *The World*, New York

"POPULAR RADIO" LANDS IN THE COMIC STRIP

When Old H. T. Webster, one of the cleverest of our cartoonists, whose drawings are syndicated all over the United States, set out to take a good-natured fling at the radio fan, he naturally picked out the world's fastest-growing magazine for the inspiration for his technical dialogue. Readers of POPULAR RADIO *may recognize some of the "conversation" that was borrowed for the occasion from the pages of this magazine.*

CONDUCTED BY LAURENCE M. COCKADAY

Does the Four-circuit Receiver Radiate?

QUESTION: In a recent issue of *Radio Broadcast* appeared an announcement of the "How far Have You Heard?" contest; one of the conditions of the contest was that the set should be of the non-radiating type. I inquired if my four-circuit set was eligible; the editor replied: "The standard four-circuit Cockaday set is an habitual offender as to radiating. We do not recommend its use." His comment is a direct contradiction to Mr. Cockaday's statement, and directly at variance with my own experience with it.

Please let me know if the four-circuit tuner radiates.

WALTER I. REDMOND

ANSWER: The four-circuit tuner does *not* radiate. This is because the coupling between the regenerative circuit and the antenna circuit is looser than in any other type of modern receiver.

An interesting test was recently made with a five-tube loop receiver; it was found that with the four-circuit tuner oscillating (a condition which is never used when receiving) signals could be picked up from it at a distance not greater than 20 feet away. This was the case whether the antenna and ground were connected to the tuner or not. This test proved that the antenna circuit was loosely coupled enough to prevent radiation, and that the signals picked up were from the secondary circuit coils themselves.

There are two families in New York City who use four-circuit tuners and both of their receivers are connected, in series, on the same antenna, as the landlord would not allow more than one antenna on the roof. Of course, the antenna circuit in this case is untuned, but they experience no trouble whatever from radiation.

Local Interference

QUESTION: I am located near a telephone exchange in my home town which uses a vibrator of some sort for "ringing." I have tried my antenna in all positions and still whenever I listen in I have to do so through an aural barrage of buzzes. My set (and a number of my friends are troubled in the same way) picks up the vibrations of the buzzer system, and reception is spoiled. Of course we have all got used to it and it doesn't bother us so much now, but when a new listener comes into my station, he notices it and wonders if all radio is like that.

This condition has kept a lot of really interested people from buying radio receiving apparatus in my town and I am wondering if you have ever heard of such a trouble and any means for eliminating it?

I will be glad to try anything, and the telephone company says they will cooperate with us if it doesn't interfere with their service. Do you know of anything that would cut down the radiation of the buzzer impulses *at the exchange?* We have tried everything at our receiving stations but it seems that the only way to do it would be to eliminate the signal at the exchange itself.

WILLIAM N. ANDREWS

ANSWER: The shunting of the ringer contacts with 2 to 4-microfarad condensers should cut down the sparking and the radiation enough to eliminate or, at least, reduce this interference to a point where it is no longer objectionable.

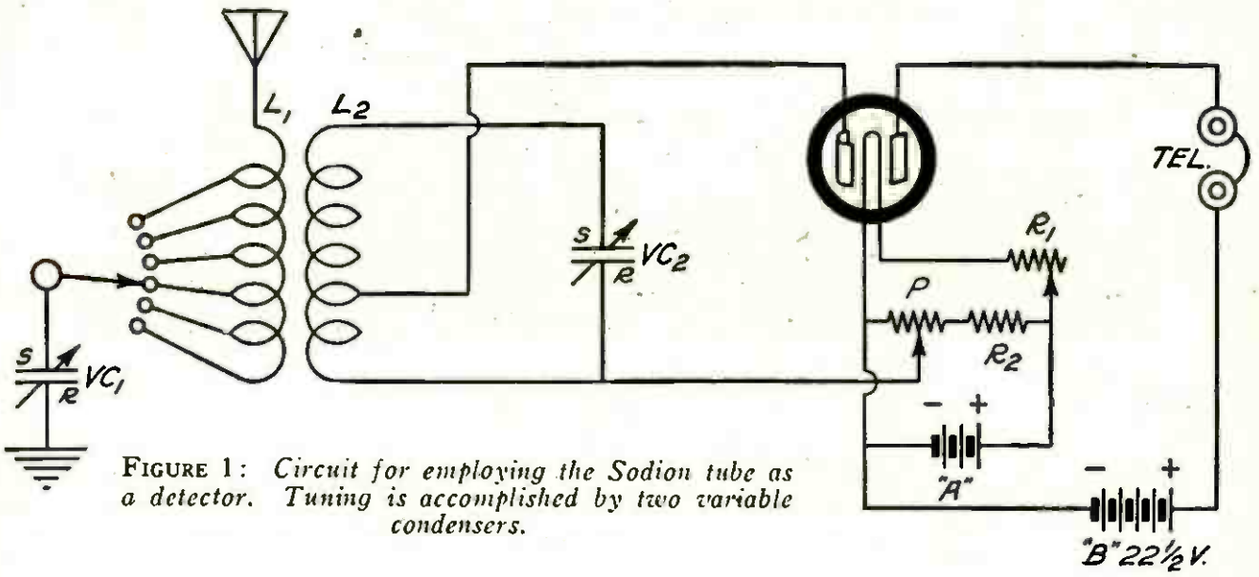


FIGURE 1: *Circuit for employing the Sodion tube as a detector. Tuning is accomplished by two variable condensers.*

Circuit for the Sodion Tube Detector

QUESTION: Please give me a diagram for the Sodion tube and the parts I will need for a single-tube set. I have the Connecticut 44-ohm potentiometer and the 100-ohm resistance to go in series with it, but I want to make the set myself.

Will you give me the necessary information?

S. B.

ANSWER: You will find the circuit diagram in Figure 1. The parts you will need are the following:

L1 and L2—primary and secondary windings for the fixed coupler;
VC1—variable condenser, .001 mfd.;
VC2—variable condenser, .0005 mfd.;
P—potentiometer, 44 ohms;
R1—filament rheostat, 20 ohms;
R2—fixed resistance, 100 ohms;
TEL—telephones.

The coupler may be made in the following way. Wind 42 turns of No. 18 DSC copper wire on one end of a composition tube, 6½ inches long and 3½ inches in diameter. Take off taps on this winding every 6 turns. Then prepare the secondary coil L2, starting ½ inch from the end of the first winding, with the same size of wire, and winding on 60 turns, with a tap at the 10th turn for the connection to the collector plate terminal of the sodion tube.

In tuning, the condenser VC1 and the taps on coil L1 control the antenna wavelength, while the condenser VC2 controls the secondary wavelength. The potentiometer P is used as a sensitivity or selectivity control, and will help in tuning in distance and in discriminating between stations operating on wavelengths not widely separated.

Regenerative Receivers on an Indoor Antenna

QUESTION: Is it possible to use an ordinary regenerative receiver on an indoor antenna strung around the picture molding?

If so, please tell me what kind of receiver will do and give the details for making such a set.

A. V. STUART

ANSWER: This is possible. Almost any good regenerative receiver can do this for local reception up to 500 miles or so.

There is an article in this issue which tells you just how to do the whole job of building and installing a set of this type.

Licenses for Receiving Equipment

QUESTION: Do I have to obtain a license to operate a receiving set in this country?

H. K.

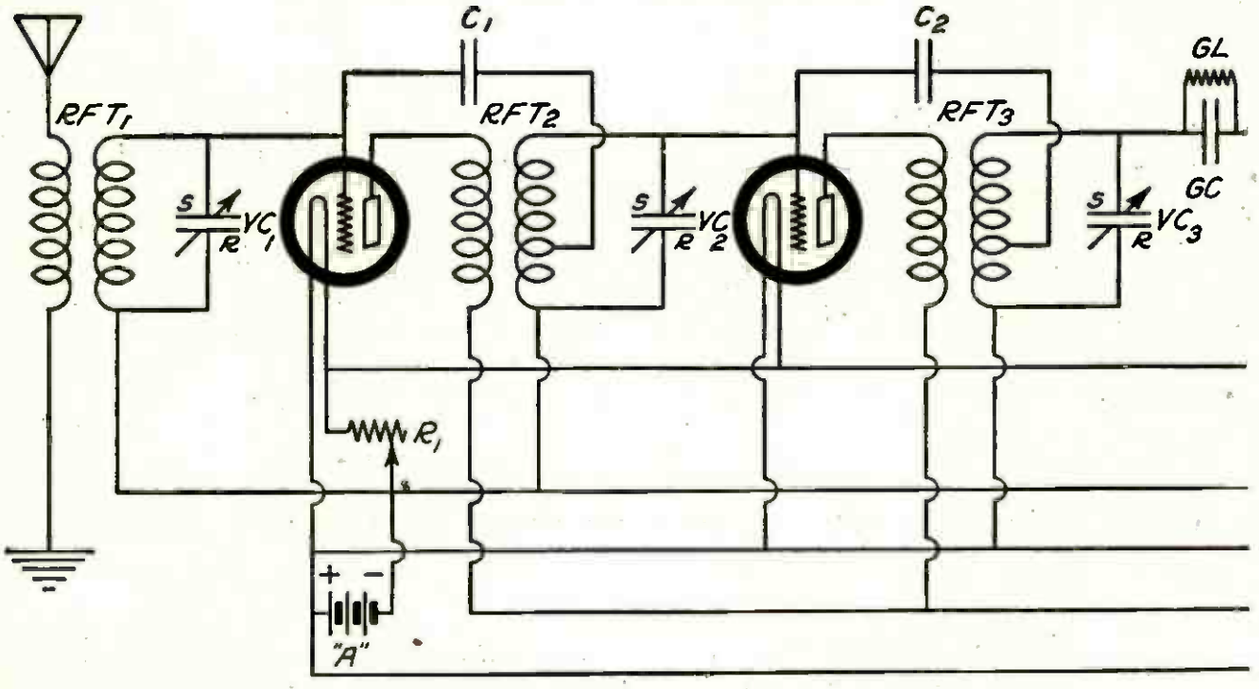
ANSWER: No. No license is required in America. In some foreign countries, however, a license is issued and a tax is levied on all receiving apparatus.

Rheostat Resistances for Two Tubes

QUESTION: What resistance rheostat will I need for controlling two UV-201-a tubes in parallel?

I. STERN

ANSWER: Use a filament rheostat of 20 ohms resistance.



The Wiring Diagram for the Neutrodyne

QUESTION: Will you please give me the latest hook-up that you know of for the neutrodyne? Also I would like to get a list of the parts that will be necessary for constructing the set. I want to use two rheostats; one for controlling the amplifier tubes and a separate one for the detector tube. What size panel do I need?

ARTHUR BENTON

ANSWER: The diagram is shown in Figure 2. The parts you will require are the following:

RFT1—neutrodyne coupler;
RFT2 and RFT3—neutroformers;
VC1, VC2 and VC3—variable condensers, .00035 mfd;
R1 andd R2—filament rheostats, 6 ohms;
C1 and C2—Neutrodon condensers (compensating condensers);
GC—mica fixed condenser, .00025 mfd.;
GL—grid-leak, 2 megohms;
J1 and J2—telephone jacks, double-circuit;
J3—telephone jack, single-circuit;
C3—mica fixed condenser, .0005 mfd.;
AFT1 and AFT2—audio-frequency amplifying transformers.

The use of four hard tubes for the amplifiers, and one soft tube for the detector, is recommended. The set can be built into a 7 by 26-inch panel and cabinet.

What is an "L" Antenna?

QUESTION: What kind of an antenna is an L antenna? Is this a one-wire antenna? I was told I should put up an L antenna 100 feet long with a 30-foot lead-in, I think it was. What does all this mean? I have just bought a set but don't know how to put it up.

S. D.

ANSWER: An "L" antenna is one whose general form follows the shape of an inverted letter L. String a 100-foot length of wire between two horizontal supports and bring the near end down to your room. The wire should be insulated at both ends.

Coupling Between Two Receivers

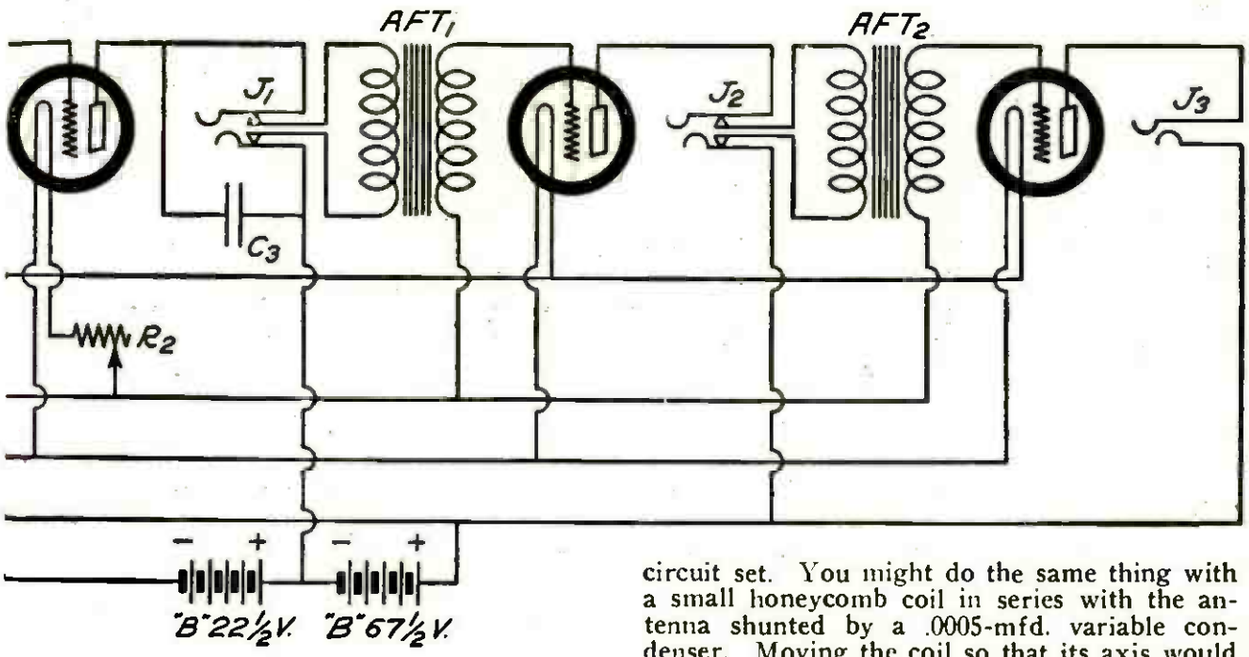
QUESTION: While experimenting with a crystal set this evening, I discovered what seemed to me to be a very strange phenomena.

I had my antenna and ground fastened to a crystal set, consisting of a variometer, condenser and detector. I was listening with the phones to station KHJ, near-by, at Los Angeles.

Just below and about a foot in front of the crystal set was a four-circuit tuner, which I built from your specifications. This set had batteries and a loudspeaker attached to it but no antenna or ground connections.

While listening in on the crystal set, I was listlessly fooling with the rheostats on the four-circuit set, and lighted the tubes. Immediately the horn began to

FIGURE 2: *The neutrodyne circuit employing two stages of tuned-radio-frequency, detector and two stages of audio-frequency amplification.*



function, in just as good shape as if the antenna and ground connections were attached to the four-circuit set.

Now, what I would like to know is, how the crystal set could radiate the energy across the foot or more of space between the two sets, with so much efficiency, if at all. I thought that crystal sets could not radiate.

Both the sets happened to be tuned to the same wavelength, for the same station. Can you throw any light on this experience?

A. E. WILKINSON

ANSWER: A crystal set does not radiate in the same sense that a regenerative, single-circuit receiver will do.

What you experienced was simply a case of extremely loose coupling (magnetic coupling) from the coils of the crystal set to the coils of the four-circuit tuner. This is due to the susceptibility of the four-circuit tuner to extremely loose coupling. The designer of this set has been able to use a coupling distance (between the antenna coil and the stabilizer and secondary coils) of as much as twelve feet and still get fine reception. This also increases the selectivity to such an extent that it may become too sharp in tuning.

You will notice, that if you lift the cat-whisker off the crystal, you will still be able to pick up the signals with the four-circuit set just as well.

This proves that you are using merely a tuned antenna circuit with loose magnetic coupling between it and the coils in the four-circuit set. You might do the same thing with a small honeycomb coil in series with the antenna shunted by a .0005-mfd. variable condenser. Moving the coil so that its axis would be in line with the axis of the coils in the four-circuit tuner will allow you to use a coupling distance as great as that across a whole medium-sized room.

Tubes Needed for DX Reception

QUESTION: How many tubes would it be necessary to use in order to get occasional reception on winter evenings over a distance of 3,000 miles, say, two or three nights a week.

J. F. D.

ANSWER: This depends upon local conditions, upon the ability of the operator to tune properly and upon the type of receiver used. We can only give you a general answer. There are several sets of various types that ought to be suitable for what you want, and these use from five to eight tubes each.

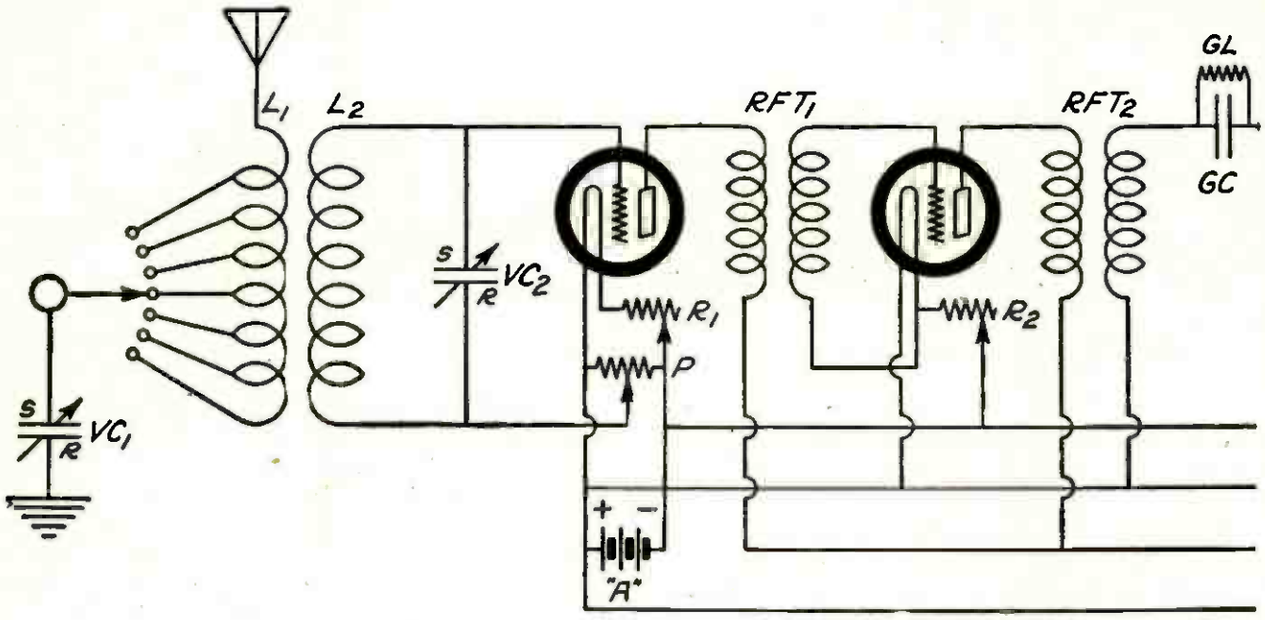
Distortionless Amplification

QUESTION: In your opinion, what is the form of audio-frequency amplification that distorts the least?

JAMES M. RIKER

ANSWER: The form of amplification that is least susceptible to distortion is one that is aperiodic as to frequencies lying within the audible range.

Such an amplifier is the type known as a resistance-coupled amplifier. Of course, this type of amplifier does not give the same amount of amplification per stage as the transformer-coupled type, but it is, or can be made, *free from all distortion.*



Transformer-coupled Radio Frequency

QUESTION: I have a Simplex variocoupler and two Cardwell condensers, that I have just taken out of an elaborate single-circuit set after reading of all the distortion and trouble I was causing in the ether around my house. I had one condenser in series with the antenna and the other across the stator coil.

I have taken the whole set apart, including the two-stage audio amplifier, and am going to change and build a transformer-coupled, radio-frequency set with five tubes. I don't want to make a tuned-radio-frequency set, as yet, because I am afraid it might be too hard for me to make and tune.

So, if you can give me the proper hook-up to use I will start in and build the set, leaving the more complicated set for the future when I may have gotten enough experience to build it. Please tell me the parts I will require for the complete five-tube set.

JACK WRIGHT

ANSWER: We have drawn the circuit you want in Figure 3. You should have no difficulty in making and operating a set of this type.

Below is a list of the instruments you will need to make the set:

L1 and L2—primary and secondary coils of a good variocoupler;
VC1—variable condenser, .001 mfd.;
VC2—variable condenser, .0005 mfd.;
RFT1 and RFT2—radio-frequency transformers;
C—mica fixed condenser, .0005 mfd.;
GC—mica fixed condenser, .00025 mfd.;
GL—grid-leak, 2 megohms;
J1 and J2—telephone jacks, double-circuit;
J3—telephone jack, single-circuit;
R1, R2, R4 and R5—filament rheostats, 20 ohms;
R3—filament rheostats, 6 ohms;
P—potentiometer, 400 ohms;
AFT1 and AFT2—audio-frequency amplifying transformers.

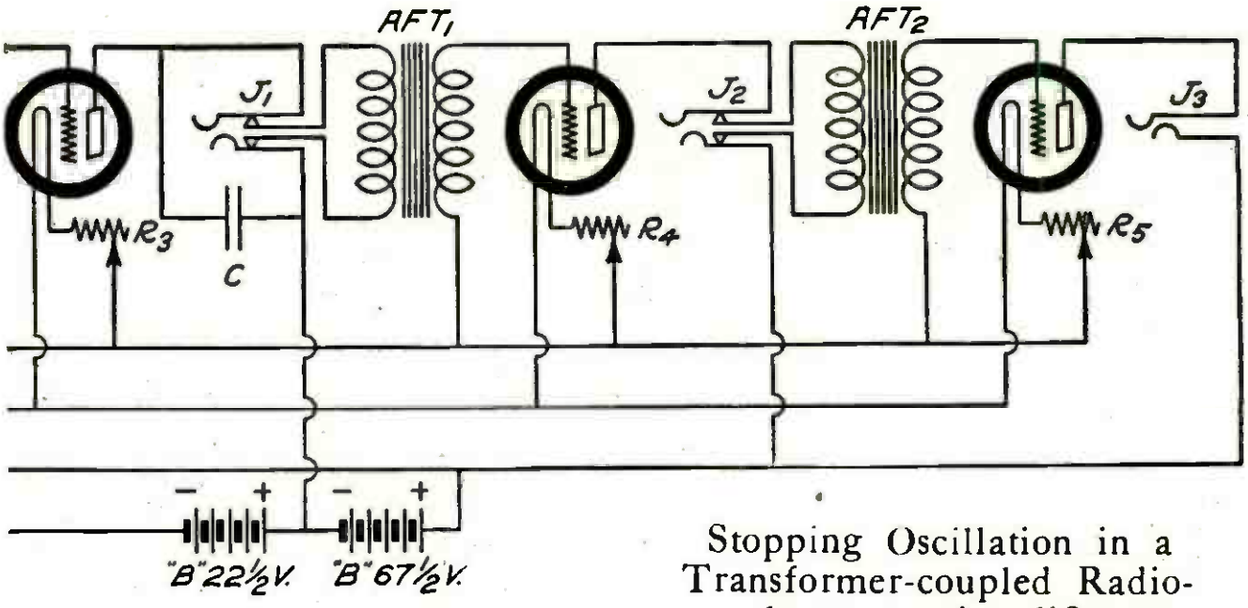
Of course, you will need suitable sockets for the tubes. The tubes recommended for the amplifiers are De Forest tubes or Cunningham C-301-a tubes or Radio Corporation UV-201-a tubes. The detector should be a soft tube such as a UV-200 or a C-300.

The potentiometer should give a nice control for regeneration in the first stage of radio, and the second stage is fixed by attaching the grid return from the transformer at such a potential that the second tube will regenerate somewhat, but will not oscillate. For sharp tuning, place the secondary coil L2 at as nearly right angles to the coil L1 as possible to receive signals of suitable strength. This loosens the coupling.

Avoiding Annoyance from Single-circuit Receivers

QUESTION: How can I learn to tune my single-circuit receiver properly so that I will not disturb my neighbors on the floor below? They tell me I interfere with them, and ask me why I don't learn to tune it right. I really would like to know, because I don't like to bother anybody, but I don't seem to be making any

FIGURE 3: *Two stages of transformer-coupled, radio-frequency, detector and two stages of audio-frequency amplification.*



progress in learning by myself, and they came up last night during the President's speech and asked me to shut down. I did this and went downstairs with them and heard the speech perfectly. Have you ever published any information on this subject? R. B.

ANSWER: You will find the information you require in the article, "How NOT to Tune the Single-circuit Receiver," in the April, 1924, issue of POPULAR RADIO.

Where to Use Bare Bus-wire

QUESTION: Should bus-wire be covered with insulated tubing such as is popularly termed "spaghetti"?

WILLIAM AUSTIN

ANSWER: In wiring up circuits, such as the detector circuit, the wiring for a radio-frequency-amplifier, the antenna circuit, and, in fact, any circuit through which radio-frequency currents are flowing, the bus-wire should be used bare without any insulating covering. This is because the wiring can all be soldered rigidly in place. The dielectric, in this case, is air, which, as is well known, has a lower dielectric loss than any other material used as an insulator.

In audio-frequency circuits, such as the wiring of an audio-frequency-amplifier, the tubing can be used without appreciable losses. This is because the dielectric loss amounts to practically nothing at low frequencies.

In general, where any rigid type of wiring is used, it is better not to use insulated tubing except where two wires cross or run too close to each other for safety. Usually, however, the wiring can be arranged so that this does not happen.

Stopping Oscillation in a Transformer-coupled Radio-frequency Amplifier

QUESTION: I have built a five-tube set using two radio-frequency transformers of a well-known make and have trouble in eliminating oscillation in the radio-frequency amplifiers. I am using C-299 tubes throughout. Can you tell me how I can help this and control regeneration better than by filament control?

ED. BISHOP

ANSWER: A simple method would be to use a potentiometer connected across the "A" battery with the lever of the potentiometer connected to the grid return on the loop or secondary of the variocoupler in the first stage of radio-frequency amplification. Then by turning this you will be able to make the grid of the first tube either more positive or negative, with respect to the filament and thus control regeneration to a nicety.

Connect the grid return on the second stage between the rheostat and the filament of the second tube. This will eliminate oscillation in the second stage.

The filament rheostats of the radio-frequency amplifier should be connected in the negative side of the filaments.

Variable Grid-leak for Regenerative Detector

QUESTION: Will a variable grid-leak help any in place of a fixed 2-megohm grid-leak in my regenerative receiver?

DONALD SHARP

ANSWER: It will help considerably.

BROADCASTS

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

CONDUCTED BY DAVID LAY

Radio on Amundsen's Polar Trip

THE decision of the United States Navy not to send the great airship *Shenandoah* on her proposed flight to the North Pole this summer will not interfere, it is announced, with the plans of Captain Roald Amundsen for his exploration of the polar lands by airplane. The airplanes used will be equipped for landing on either ice or water and each will be provided with radio so that communication with the ship acting as base of supplies will be continuous. This ship, in turn, will be equipped with radio apparatus powerful enough to permit regular communication with civilization.

* * *

Philadelphia Police Automobiles to be Continual Listening Posts

IF you see a Philadelphia automobilist bearing down on you with earphones glued to his ears he is not a radio "nut," merely one of General Butler's new radio cops. All police autos are to be equipped with radio receivers and an occupant is to be required to listen all the time so that news of crimes or of sudden emergencies can be broadcast instantly to the force.

* * *

Feeling Radio with Sensitive Fingers

MISS HELEN KELLER, the famous woman who was born blind, deaf and dumb and who learned, nevertheless, to speak, and to talk and read with her fingers, has discovered that she can "hear" a radio concert by placing the tips of her fingers against the diaphragm of a headphone. The peculiar rhythms of different orchestral instruments and of the human voice were quite distinguishable, Miss Keller says, in this way. Furthermore, the meaning and thrill of the music was also communicable much as though it had been actually heard. Miss Keller is no doubt the possessor of the most highly trained and sensitive fingertips in the United States; her long experience in using them to read and talk with can have had no other result. Nevertheless, it may well be that her experience is not exceptional and that many persons who are totally deaf, even to the telephone or the radio, may be able to enjoy radio concerts in this way, by the "feel" of them on the vibrating diaphragm. There may be an opportunity here for the inventor. It ought not to be difficult to devise a diaphragm which would magnify this rhythmic feel of the voice or of music. Possibly even the ordinary tones of spoken words could be made perceptible and understandable in this way to persons who are incurably deaf.

* * *

Portable Sets Prohibited in Japan

THE government regulations for radio listeners in Japan, where broadcasting is just now beginning, are so severe that the development of a radio public is likely to be prevented altogether. For example, no one may possess a portable set of any kind, although sets may be fixed permanently to a specified boat or automobile.

* * *

How Many Radio Listeners Are There?

THE present radio audience is estimated by Mr. O. H. Caldwell of *Electrical Merchandising* (New York) as numbering over 8,000,000 persons. He predicts an audience of 15,000,000 by the end of 1924.

* * *

A Sea-going Fire Alarm by Radio

WHILE a ship was making her way out to sea recently from the harbor of New York City a ship's officer saw a fire on one of the docks along the shore. He spoke to the radio operator, the operator broadcast an alarm from his transmitter. This alarm was picked up by the radio receiver at Police Headquarters and relayed at once to the Fire Department, where it arrived in advance of the alarm from the signal box on the street.

Radio a Boon for Crippled Workmen

"RADIO is opening up a new field of usefulness for those who are crippled from the waist down," states Miss Sylvia Harris, the head of the employment department of the Institute for Crippled and Disabled Men of New York, who has placed more than fifty crippled boys in radio assembly work. "It has been found," she states, "that crippled men are more satisfactory in this work than the average able-bodied man of the same mechanical ability."

* * *

Radio Time "Ticks" Save Much Worry for Ship Captains

IN the old days the captain of a ship had to have a timekeeper whom he could absolutely trust. The chronometer was the most important instrument aboard ship. Thousands of dollars were paid for especially good ones. If the captain was forced by any disaster to abandon his ship the chronometer went with him, carefully guarded by hand so that it would not suffer the faintest jar. An error of a few seconds in the chronometer might throw a captain entirely off his course and pile up his ship on the rocks. Nowadays this is unnecessary. A ship can be navigated, if need be, by an ordinary good watch costing perhaps ten or twelve dollars. The reason for the change is the prevalence of daily radio time signals. Such signals are sent out nowadays by scores of radio stations all over the world. Ships on every ocean can pick them up daily and correct the chronometer by which, together with observations of the stars or the sun, one's position at sea is determined. Probably no single service of radio to transportation has been as valuable as this one.

International

BROADCASTING A LOVER'S HEART PALPITATIONS

Dr. Phillips Thomas is the inventor of the ultra-audible microphone, the invention of which enables scientists to hear sounds that are otherwise inaudible. The noise that a fly makes while walking, the thunder of a moth's wings while in flight, the sounds of the honey bee, all are revealed with the aid of the Thomas microphone, which was first described in POPULAR RADIO *for April, 1923. Dr. Thomas is shown above, broadcasting from station KDKA the heart palpitations inspired by a lover's kiss. These palpitations, recorded in the ultra-audible microphone, were plainly heard by the crystal set receivers in England as re-transmitted from Manchester, England.*

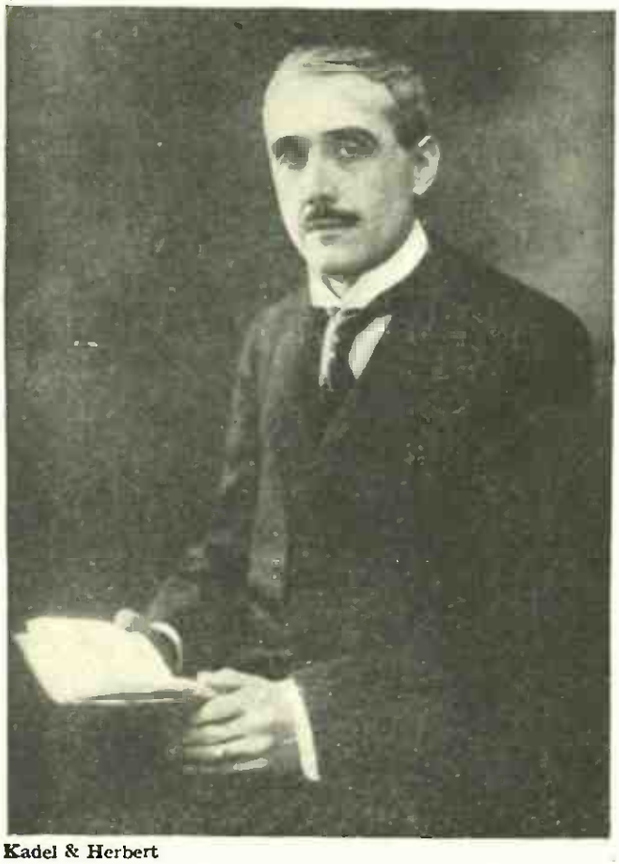
Amateur Receives Gold Medal for Transatlantic Feat

M. LEON DELOY, of Nice, France, the man who spanned the Atlantic on a 100-meter wave and who described this feat in the February (1924) issue of POPULAR RADIO, has received the gold medal of the Lakhovshy Foundation in recognition of this exploit and of its potential importance to the science of radio communication.

* * *

A New Record in Radio Relaying

ON March 7, 1924, six radio stations in New York City, Pittsburgh, Schenectady, Hastings, San Francisco and London (England) co-operated in broadcasting simultaneously the program of the Annual Alumni Dinner of the Massachusetts Institute of Technology, given in the ballroom of the Waldorf Astoria Hotel in New York. The program was first picked up and sent out by WJZ in New York City. From WJZ the material went by special land wire to WGY at Schenectady; here it was broadcast and was picked up by KDKA at Pittsburgh. KDKA retransmitted it on two wavelengths; the regular wavelength of 326 meters and also on the short wavelength of 94 meters now used by this station for relay work. This short wave was picked up by KFKX at Hastings, Nebraska, and relayed to KGO in Oakland, California. The same short wave reached the British stations through station 2AC at Manchester, which acted as the pick-up station for that side of the Atlantic. It is estimated that more than 50,000,000 people could have heard the program had they been listening.



Kadel & Herbert

EXPERT IN ATOMS BECOMES A FRENCH "IMMORTAL"

The Duke de Broglie, a nobleman who is world-famous among scientists for his studies of atoms, has been elected to the group of "immortals" in the French Academy of Sciences. It was the Duke de Broglie who invented the radio telephone used for submarine work during the war.

* * *

Radio Listeners Vote "Wet."

IN a radio voting contest held recently by Station WJAZ, Chicago, on the subject of national prohibition, over 47,000 votes were cast by telegraph at the voters' expense, the telegraph bill totalling over $30,000. The result was more than two to one in favor of modification of the Volstead act.

* * *

Radio Sleuths to Have Automobiles

IT is announced from Washington that the district radio inspectors are to be provided with automobiles, each equipped with portable direction-finding equipment. It will be easier, then, to track down illegal transmitting stations or points of troublesome interference from any source.

* * *

What is Your Score at "Radio Golf"?

THE new game of "radio golf" has taken hold of Washington. The object is to log as many DX stations as possible, and with as great a mileage as possible, during a specified period of time. Official "score cards" have been printed and circulated and an instrument called a "golfmeter" has been devised to show at a glance the mileage of a received station.

* * *

More Than 2,000,000 British Radio Fans

LATEST estimates of the number of radio listeners in Great Britain run from two million to three million. Less than a year ago the number was probably under 100,000. The great increase of interest is ascribed to the installation of a number of additional broadcasting stations, both for relay use and for independent broadcasting. A large part of the area of England can now hear one or more stations on a cheap crystal set.

* * *

What We Spend on Radio

ROGER W. BABSON, the economist, has told the *Crosley Radio Weekly* that he estimates the expenditures of the public on radio for 1924 as over $350,000,000. In Washington's time this would have been enough to run the whole country for years.

Kadel & Herbert

INSPIRATION FROM THE ETHER

Mr. Ivan Andre, a distinguished European painter now visiting the United States, takes his radio set along whenever his work requires him to make sketches from nature. He uses two stages of radio-frequency amplification, detector and two stages of audio-frequency amplification, all arranged by reflex, so that three tubes do the work. The loop is in the lid of the case.

Balloon Antennas Proposed for Lifeboats

THE London periodical, *Engineering*, suggests that all lifeboats on ocean liners be equipped not only with small radio transmitters (as many now are) but with a small balloon ten or twelve feet long and capable of lifting the end of an antenna wire 200 or 300 feet into the air. This would permit radio communication over much greater distances in case of a disaster at sea. Gas for inflating this balloon would be stored, in compressed form, in a steel tank in each boat.

* * *

How to Test Your Wave Meter

THE standard frequency signals sent out by WWV, the radio station of the United States Bureau of Standards, are to be continued at intervals throughout the year. The frequencies transmitted will range between 166.5 kilocycles (about 1,800 meters) and 2,000 kilocycles (150 meters). Details concerning the dates of transmission, the frequencies to be used, the manner of transmitting the signals and the like may be secured by addressing the Bureau of Standards, Washington, D. C. But do not burden the Bureau with unnecessary correspondence; do not write unless you really have some reason to know.

The New Profession—Radio Entertainer

MAJOR GENERAL GEORGE O. SQUIER thinks that appearance before the microphone will soon be a separate profession, instead of a side line for actors, orators or musicians who earn their livings mainly in other pursuits. "The stars of the ear," says the general as quoted in the New York *Times*, "in 1935 will receive salaries comparable to those the stars in the movies—the stars of the eye—receive in 1924."

* * *

Amusing Theatre Crowds by Radio

IN London theatres the crowds seeking seats in the gallery are admitted nearly two hours before the commencement of the performance. One of the problems of the theatre management has been always to keep these patrons of the higher levels amused while they had to wait. If not amused to their satisfaction they were far too likely to amuse themselves by audible remarks concerning the personal peculiarities of the more aristocratic patrons who filtered in below as the evening went on. One London manager has solved this difficulty by radio; a loudspeaker installed in the gallery entertains the "gods" until it is time for the play to begin.

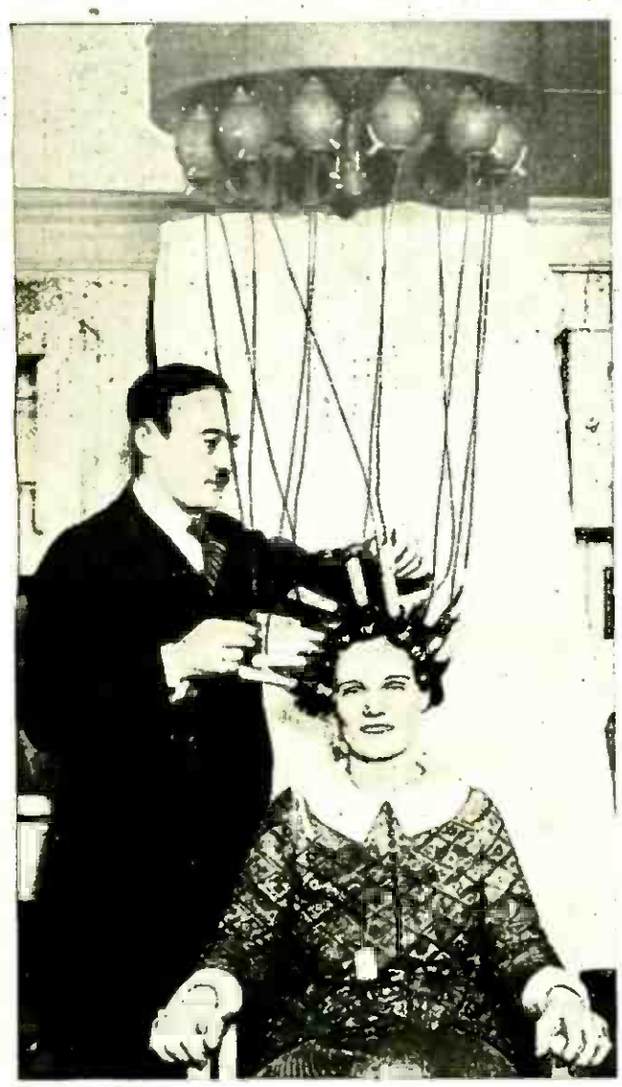
Another Project Spoiled by Radio

AFTER WGY had broadcast recently the "Get-rich-quick Wallingford" play that contains the famous incident of the carpet-covered tacks, the manager of the station was astonished to receive a visit from an excited lady who accused the station of having ruined her commercial prospects by broadcasting the secret invention upon which she had been engaged for months.

* * *

How Many Farmers Have Radio Sets?

A SURVEY by the Illinois Agricultural Association has showed that only about 10 percent of the farmers in 73 Illinois counties have installed radio sets. Considering the fact that every farmer ought to have a radio set, and doubtless would have one if he could afford it, this survey indicates that the "saturation point" of the radio market on the farms has not even been approached. Probably the trouble is that the farmers cannot pay for an expensive set and that the cheap sets which they can pay for will not bring in any stations if the farm is more than a few miles from town.



Kadel & Herbert

ETHER WAVES THAT MAKE THE HAIR WAVE

Ether waves—in the form of electromagnetic induction—heat up the iron cores of the curlers and produce the desired "permanent wave" of the hair.

* * *

Sunday Listening a "Crime" in New Jersey

A FORGOTTEN "blue law," resurrected recently in New Jersey by advocates of a restricted Sunday, forbids nearly everything that modern people do on the first day of the week. Movies, music, street cars, gasoline filling stations, restaurants—all come under the ban. It is even illegal to listen to the radio, whether or not the music originates in another state. The fine, however, is only one dollar.

* * *

A New Station to Reach All England

A PROJECT is on foot in England to cover the whole country with a single broadcast from a new station to work on high power and on a wavelength of 1,600 meters. This will not replace the present short-wave stations but will supplement them. How long will it be before a similar project to reach all the United States with a single broadcast station will be proposed here? There would be many advantages in it if the wavelength used were high (or low) enough to prevent interference with the usual broadcasting range. For example, an address by the President could then be broadcast from the single station to the entire country.

* * *

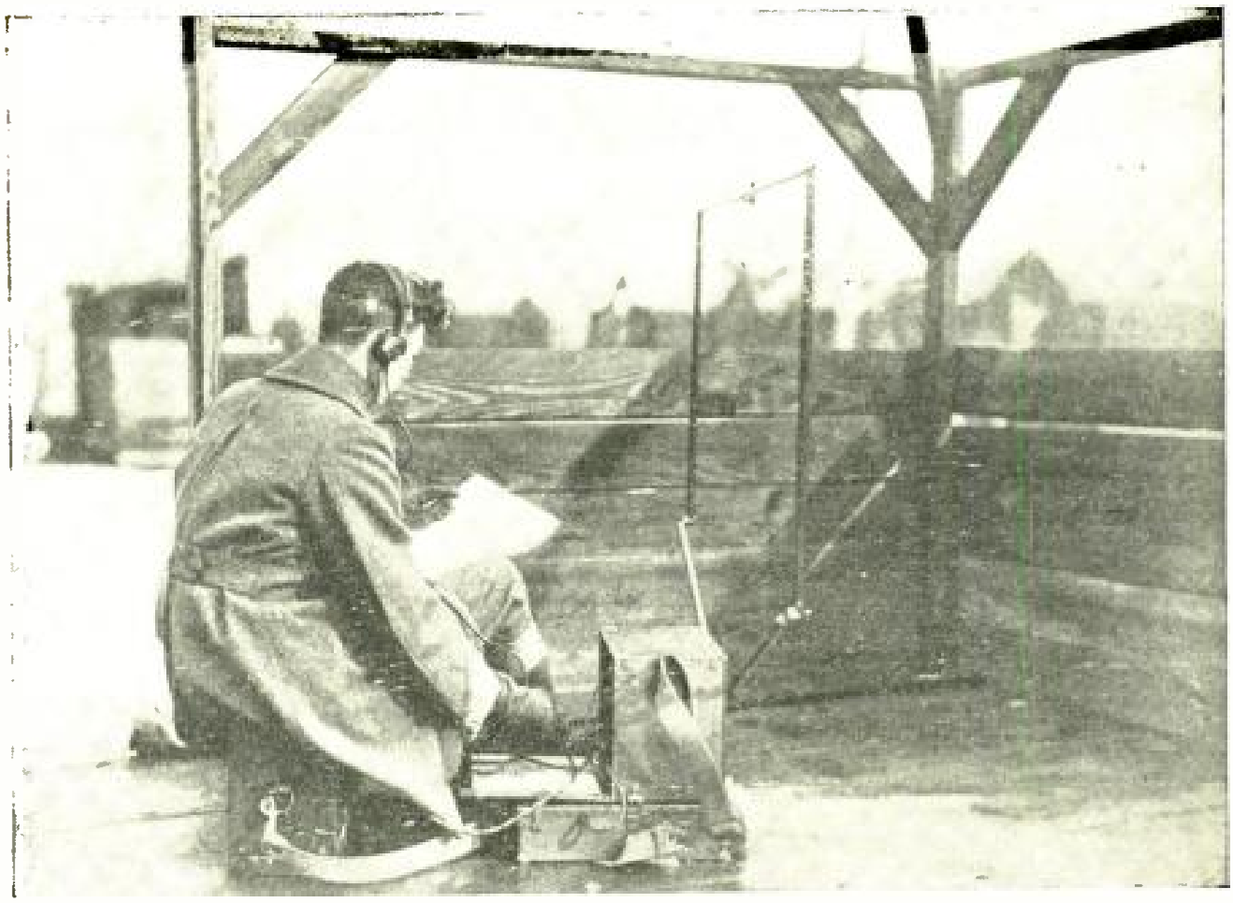
Radio Audience Splits Evenly on Capital Punishment

ANOTHER instance of the efficiency of radio in obtaining an immediate reaction from the public on questions of the moment in public affairs was the vote of WEAF listeners on the recent debate between Warden L. E. Lawes of Sing Sing Prison and Senator William Love of New York State. The question was the retention or abolition of the death penalty for criminal acts; 48 percent of the voters favored capital punishment and 52 percent were opposed to it—a division so close that the vote must be considered essentially a tie.

* * *

A New Form of "Radio Heckler"

A "RADIO VANDAL" has made his appearance in Kansas City, according to the Democratic City Central Committee, which offered a reward of $500 for the arrest of the fan who interfered with the broadcasting of political speeches from Station WOQ during the heated city campaign. It was reported, that some one used an oscillator attached to an antenna for "hashing up" the politician's speech.



Kadel & Herbert

THE LATEST KIND OF PORTABLE LOOP

This new loop antenna was developed at the Camp Vail laboratories of the U. S. Signal Corps for use with the portable sets recently perfected by the army. The wires are inside a collapsible tube which can be folded up when not in use.

Thought Transference by Radio?

Two radio experiments have been conducted recently on the problem of thought transference. The speaker at the broadcasting station announces that he is concentrating his attention on a certain number or on a word or on some other single thing. All the listeners are asked to endeavor to receive, by thought waves, the unnamed idea which the announcer has in his mind. Of course this is not a *radio* experiment, it is merely the familiar telepathy experiment in a new setting. All that the radio does is to serve as a means of reaching more hearers and hearers who are located over a wider area.

* * *

Radio Detector from a Lump of Coal

An unnamed navy officer quoted by Carl H. Butman has described some experiences with detectors back in 1906 when tubes were unknown and when the movable catwhisker was one's only resource. To avoid the dislocation of the catwhisker by the jars of gun fire this officer took a lump of coal and drove into it an ordinary steel needle. It worked—perhaps the first fixed crystal detector ever constructed. Signals were faint but readable. With what we know about the accessories of crystal reception perhaps the lump-of-coal detector might be worth trying again.

* * *

What is "Television"?

Mr. C. Francis Jenkins, familiar to readers of Popular Radio as the inventor of the famous "radio movies," complains about the loose use that is coming to be made of the word television. It has been used, he remarks, for all forms of transfer of sight-images to a distance whereas it ought to be applied (as is the word "telephone") only to such transfers as take place by wire. For the transmission of pictures or sights by radio Mr. Jenkins suggests the new word "radiovision," analogous to "radiophone."

* * *

Two-Way Amateur Communication with Australia

American amateurs, as well as American broadcasting stations, were first heard in Australia some time ago. Now an Australian amateur, Mr. E. H. Cox, 3BD, of Elsternwick, has been heard by a Japanese amateur resident in the United States, Mr. Y. Ito of 6ACW. The editor of the *Radio Journal* (Los Angeles) has confirmed the claim.

Wanted—a List of Radio Clubs

So many inquiries are being made for a list of radio clubs that the National Radio Chamber of Commerce has decided to compile one. The secretaries of all such institutions, here and abroad, who desire to be included are invited to communicate with Tresham D. Gregg, Secretary of the National Radio Chamber of Commerce, 165 Broadway, New York City. The following facts are desired:

the name of the club or associatoin;
its general purposes;
the number of its present members;
the date and place of next annual meeting;
the name and address of secretary.

* * *

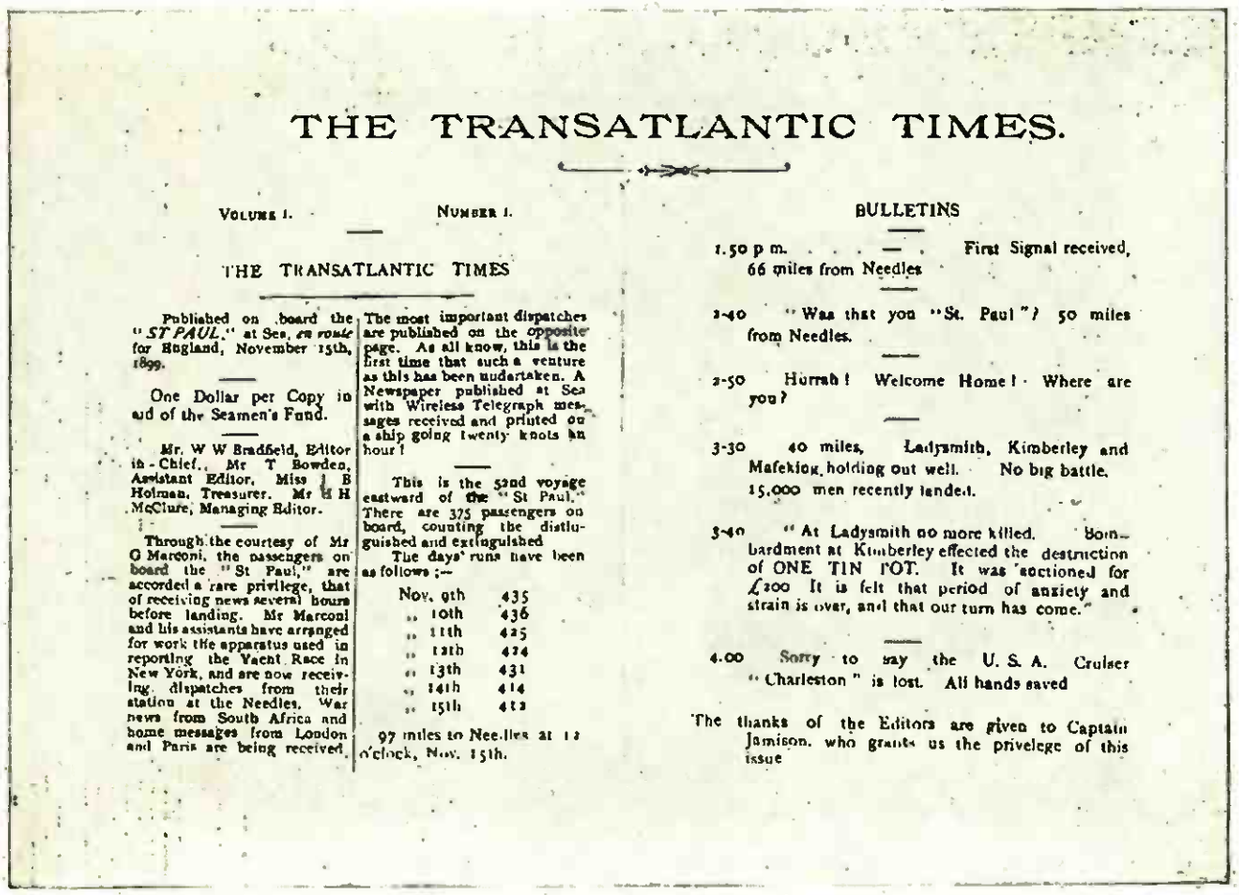
"Libel by Radio"

FOR the first time in history police have been asked to probe an alleged "libel by radio." The unique incident occurred "somewhere in Texas" recently when a police bulletin was broadcast about a well-known Texan who was sought by the Dallas police. The radio broadcaster had no reason to doubt the authenticity of the bulletin, and broadcast the name of the well-known Texan. Dallas police reported later that the father was listening in when the description was broadcast; he instantly went to police headquarters and demanded an explanation. He was informed that his son was not sought and was not suspected of an offense. Detectives now are attempting to discover the author of the description. The local broadcaster is unable to explain how the description happened to be included among the numerous notes given him by the police. The police suspect that the libel was broadcast by a secret sending station that received good pay for broadcasting the scandal.

* * *

Radio and the Country Church

THE circuit rider, once so familiar a figure in rural America, seems to have become less common with the years. Many rural churches, we are told, have been closed or are used only seldom because of the difficulty of securing preachers. Radio promises to solve this difficulty, as it has solved so many other problems of isolated communities. Receivers are being installed in such churches so that sermons from the city pulpits, addresses from presiding bishops and similar material can be made available to the most inaccessible community. It is reported, also, that a broadcasting station is to be installed at the Vatican and that the spoken words of the Pope are to be sent, by relay broadcasting, to all the Catholic churches in the world.



THE TRANSATLANTIC TIMES.

VOLUME I. NUMBER 1.

THE TRANSATLANTIC TIMES

Published on board the "ST PAUL," at Sea, *en route* for England, November 15th, 1899.

One Dollar per Copy in aid of the Seamen's Fund.

Mr. W W Bradfield, Editor in-Chief., Mr T Bowden, Assistant Editor, Miss I B Holman, Treasurer. Mr H H McClure, Managing Editor.

Through the courtesy of Mr G Marconi, the passengers on board the "St Paul," are accorded a rare privilege, that of receiving news several hours before landing. Mr Marconi and his assistants have arranged for work the apparatus used in reporting the Yacht Race in New York, and are now receiving dispatches from their station at the Needles. War news from South Africa and home messages from London and Paris are being received.

The most important dispatches are published on the opposite page. As all know, this is the first time that such a venture as this has been undertaken. A Newspaper published at Sea with Wireless Telegraph messages received and printed on a ship going twenty knots an hour!

This is the 52nd voyage eastward of the "St Paul." There are 375 passengers on board, counting the distinguished and extinguished.

The days' runs have been as follows:—

Nov. 9th	435
,, 10th	436
,, 11th	425
,, 12th	424
,, 13th	431
,, 14th	414
,, 15th	412

97 miles to Needles at 12 o'clock, Nov. 15th.

BULLETINS

1.50 p m. — First Signal received, 66 miles from Needles

2-40 "Was that you "St. Paul"? 50 miles from Needles.

2-50 Hurrah! Welcome Home! Where are you?

3-30 40 miles, Ladysmith, Kimberley and Mafeking holding out well. No big battle. 15,000 men recently landed.

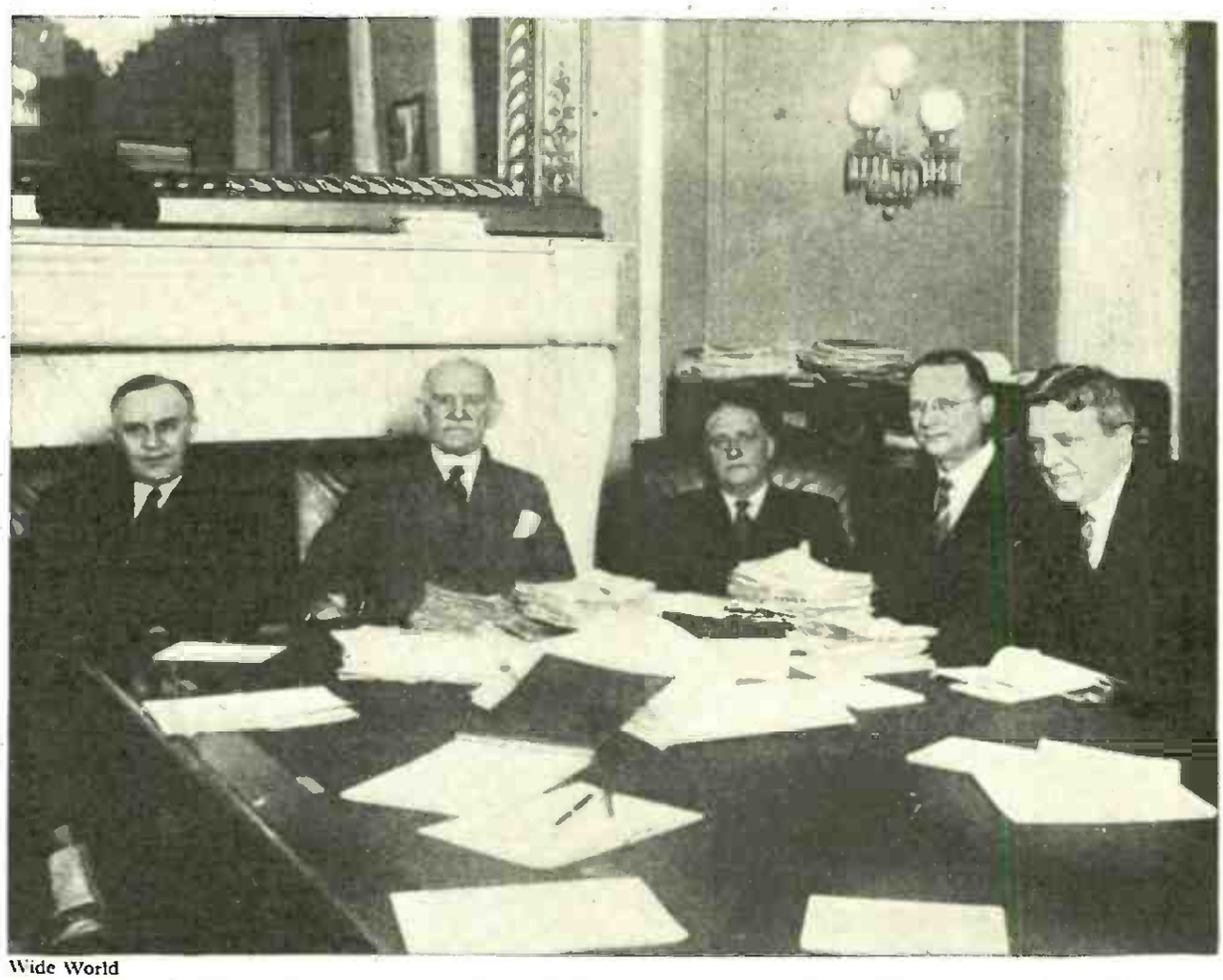
3-40 "At Ladysmith no more killed. Bombardment at Kimberley effected the destruction of ONE TIN POT. It was auctioned for £200 It is felt that period of anxiety and strain is over, and that our turn has come."

4.00 Sorry to say the U. S. A. Cruiser "Charleston" is lost. All hands saved

The thanks of the Editors are given to Captain Jamison, who grants us the privelege of this issue

THE "FIRST RADIO NEWSPAPER"

Unless evidence is furnished to the contrary, this little news sheet, published as far back as November 15, 1899, holds a unique record in the journalistic world. It was printed on the steamship ST. PAUL, *and contains the first printed news items ever received by "wireless."*



Wide World

WHERE THE FIGHT FOR "THE FREEDOM OF THE ETHER" BEGAN

Before this Senate Patents Committee (left to right, Senators Brandegee, Ernst, Robinson, Brussard and Dill) the first hearings were held on the Dill Bill to amend the copyright laws that would permit the free use of copyrighted music by radio broadcasting stations.

530 *Broadcasting Stations*

THERE are now about 530 licensed broadcasting stations in the United States. Of this number, 14 are operated by manufacturers of radio apparatus, 27 by religious organizations and about 100 by educational institutions.

* * *

Reaches 99 Percent of the World's Inhabitants

ACCORDING to E. F. McDonald, president of the National Broadcasting Association, 170,000 replies to a voting contest were received by one station in Chicago. Advertising experts estimate the ratio of replies to those reached was one in fifty, thus giving the single station a theoretical audience of 8,000,000. The Chicago stations reach 99 percent of the world's population, he added, Java alone being out of the zone of receiving, as indicated by correspondence.

* * *

Are You a "Middlebrow"?

THE radio audience is commonly divided into the "high brows" who like grand opera and symphony concerts and the "low brows," who don't. But a correspondent writes to *Popular Wireless* (London) protesting against this classification. More than half of the people, he thinks, are really neither high of brow or low; they are what he christens "middlebrows." They like something from all classes of music; a little jazz, a little classical music, a little dance music, once in a while an old-fashioned song. Too much of any one thing is—too much.

* * *

Special Dramas for the "Talking Movies"?

DR. LEE DE FOREST, himself the inventor of one kind of talking motion picture, the phonofilm, believes that we will need special radio dramas. The motion picture drama, he points out, is never a mere photographic reproduction of a stage play. The screen has its own criteria, quite different from those of the spoken drama. The plays themselves must be an entirely different kind of dramatic production. The talking movies will develop, Dr. De Forest believes, still another new form of dramatic writing and a new technique.

Radio Invades Land of Romance

ROMANCE gathers about names. Zanzibar, Singapore, the Seven Cities of Cibola—such names sound alluring, whatever the places may be like. Another is the Vale of Kashmir. And now this last one yields to radio. Communication being difficult in that country, a radio service is in operation between the cities of Jammu and Srinagar.

Kadel & Herbert

THIS INSULATOR WILL STAND A STRAIN OF 52,000 POUNDS

This remarkable high-power arc tower insulator is used at the 500-watt radio station at Annapolis, Maryland; beside it stands Chief Electrician A. H. Johnson, U. S. N.

Love Finds a Way—By Radio

ACCORDING to a dispatch from Nova Zembla two of the residents of that isolated Arctic island decided recently to get married. But there was no official on the island who had legal authority to marry them. What to do? Someone thought of the radio station. Thence all parties repaired, the Russian commissioner at Archangel was secured on the ether, the necessary questions and responses were passed over the radio waves, and the certificate was transmitted to the happy couple in the same way.

* * *

Broadcasting the Sound of Heart Beats

WHEN the radio stethoscope of Professor R. B. Abbott (described in POPULAR RADIO for February, 1924, page 204), was tried recently from Station KSD of St. Louis, the sound of the beating heart was heard in Canada, in San Antonio, Texas, on the Atlantic Coast, and at Fresno, California, thus covering almost 100 percent of the area of the United States. This heart beat could have been heard by more than 100,000,000 people, which is probably a record for the number of persons that had a chance to hear a single heart.

* * *

Some Statistics on Radio

MAJOR GENERAL JAMES G. HARBORD has recently stated that there are in the United States about 3,000,000 radio receiving sets; 10,000,000 listeners; 543 licensed broadcasting stations; 250,000 persons directly and indirectly connected with the industry; 3,000 manufacturers of radio apparatus; 1,000 wholesale dealers in radio sets; 20,000 retailers of all kinds who handle radio equipment; 1,000 newspapers carrying radio programs and radio news departments; 2,500 country weeklies which feature radios; 50 exclusively radio periodicals; 50 magazines with radio sections; 250 popular and technical books written on radio, and 7 trade papers devoted exclusively to radio.

* * *

A Radio-equipped Fire Patrol

THE roadster used by the superintendent of police and fire signals of Dallas, Texas, is equipped with a radio apparatus in order that the driver may pick up fire alarms while driving about the city streets. Under this system it is possible for the superintendent of signals to keep in touch with the central fire station, although he might be several miles away in a distant section of the city. An incident which proved the value of the innovation developed recently when Superintendent Garrett was speeding across a concrete viaduct on his way to a fire in the western outskirts of the city; an alarm was turned in from the extreme eastern edge of the city eleven miles distant. Superintendent Garret quickly visited the first fire and informed his chief that a blaze had developed in another section, thereby permitting him to properly divide various fire fighting companies.

CONDUCTED BY ALBERT G. CRAIG

Mounting Inductive Instruments in a Radio-frequency Circuit

IN making up the design for a set, place the inductive instruments, such as variometers, variocouplers, coils, and radio-frequency transformers, in such positions that they are not near either the surfaces of the wooden sides of the cabinet or the panel material. Also be sure that the metal parts of condensers or audio-frequency transformers are not placed within the fields of these radio-frequency instruments.

If you take these precautions, you will find that you will get much better results on account of the elimination of any possibility of hysteresis or eddy-current losses.

Adapters for Dry-cell Tubes

IF you have a set that uses the larger type of tubes, of course, the easiest way to convert it into a dry-cell set is to use adapters.

If, however, you intend to build a set for the dry-cell tubes, it would be advisable to use smaller sockets that will fit the dry-cell tubes *without* adapters.

If you *do* use adapters in a set be sure that they are made of good insulating material. Also be sure that they *fit* the sockets you are using. Be sure that the dry-cell tubes fit *them;* otherwise, you will experience trouble from poor contact in either the filament circuit or the grid circuit.

Adapters work perfectly satisfactorily in audio-frequency work, but the added capacity introduced between the tube elements is a detriment to radio-frequency work. This added capacity is due to the extra capacity between the metal contact pieces in the adapter itself.

Make Neat Soldering Jobs

BEFORE you try to wire up your first set, it would be advisable to practice soldering some spare wires together so that you learn to do a neat job and thus avoid spoiling the instruments you have procured for the set.

Use soldering paste or flux sparingly and do not allow it to run onto the windings of instruments or onto the insulation.

Use only enough solder to make a fast joint.

Use an electric soldering iron.

Short Connections

IN laying out a receiver, place and turn the instruments so that the connecting wires may be as short as possible. At the same time, do not overcrowd the instruments.

Put a Pan Under Your Storage Batteries

DON'T let the acid spill from the storage battery onto the carpets. It will eat a hole. Keep the battery on a rubber pan or mat. These can be obtained in radio supply stores.

Ratios for Audio-frequency Transformers

So many amateur builders are mystified by the numerous specifications of various ratios for audio-frequency transformers that a word about their use will be timely.

These specifications include ratios from 3 to 1 to 10 to 1. By ratio is meant the ratio of the secondary turns of wire to the primary turns.

High-ratio transformers are used, often, in single-tube reflex sets, with a crystal detector, and in some cases where only one stage of audio-frequency amplification is used. However, a high-ratio transformer, if it is not carefully designed, will produce distortion.

Lower ratio transformers are used advantageously in the second or third stages of audio-frequency amplifiers.

For best results transformers of 5 to 1 ratio are recommended in the first stage and not more than 3½ to 1 for the second or third stages.

When Should "Spaghetti" Be Used?

"SPAGHETTI," or varnished-cambric tubing, should be used wherever two wires must be brought close together, or cross each other and where there would be a chance of a short circuit. Its use, however, should be discouraged wherever possible for radio-frequency circuits, such as in a radio-frequency amplifier or in a detector circuit. In audio-frequency circuits, especially on the high-voltage plate leads, it is advisable to prevent wires touching and spoiling the batteries. It can be used on the filament connections.

Metal Shields on Panels

DON'T use extensive metal shields on the back of panels. If you do, you may lose some efficiency on account of inter-capacity between instruments. If you must shield an instrument use a small one that shields the instrument in particular, without forming a capacity (to other instruments) which might be harmful.

When to Use "C" Batteries

WITH ordinary six-volt tubes, used as amplifiers, the correct, free grid potential may be maintained by connecting the filament rheostats in the negative lead from the filament to the "A" battery, and by connecting the grid return from the transformers to the negative "A" battery terminal. This will suffice for all plate potentials up to ninety volts. If more than this plate potential is used a "C" battery should be used. The amount used should be determined by trying out "C" battery voltages from 1½ volts up to 9 volts, according to the amount of plate voltage applied to the tube.

Small dry-cell tubes, used as amplifiers, should have "C" batteries connected in their grid circuits when more than 45 volts plate potential is applied.

To determine the correct amount, obtain two 4.5-volt "C" battery units and connect them in series, in the grid circuit, between the transformers and the negative filament. Then try the various taps on the batteries until the best results are obtained.

The "C" battery should always be connected with its negative terminal toward the grid.

Keep Radio Receivers Dry

DON'T leave the window open above your radio set. If it happens to rain, water may get in on the coils or transformer and cause trouble due to short circuits.

Radiation from Direct-coupled Regenerative Receivers

Do not allow your set to whistle while tuning it for distant stations. This will produce oscillations in the antenna circuit which will radiate and cause interference for your neighbors.

CONDUCTED BY DR. E. E. FREE

How Electrons Move Through Wires

WHEN an electric current flows through a copper wire what happens, really, is that a stream of electrons is passing through it. The copper itself is made up of atoms, billions on billions of them arranged in a more or less fixed pattern or framework, like a lot of billiard balls strung on criss-crossed wires.* These copper atoms themselves contain electrons but it is not these atomic electrons that carry the electric current. The current-producing electrons are *loose* ones; they drift around in the empty space between the atoms of copper. When more of these loose electrons drift toward one end of the wire than toward the other end we say that a current is flowing.

This point of view is the one now held by the majority of scientists but there is still much uncertainty about the details. It is probable, for example, that the thing which we call electric "resistance" is due, really, to the opposition offered by the atoms and by their permanently bound electrons to the passage through them of the loose electrons that drift around at will and that make electric currents. But just *how* is this opposition manifested? Is it a mere jostling of the loose electrons against the more massive atoms? Or is it an electric attraction between the electrons and the atoms? Or is it (as seems, indeed, to be the most probable) an actual exchange of position from time to time between the free electrons and the atomically bound ones?

This last idea would be a good deal like the children's game in which most of the children form a ring with one extra child inside (or outside) of it. This extra child tries, according to some ritual prescribed by the rules, to break into the ring. If he does so another child is forced out.

This, it seems, may be what happens among the atoms. An atom of copper, for example, has 29 electrons belonging to its "ring." Suppose a new, loose electron drifts up from outside. It may be, the scientists think, that this new electron will displace one of the 29 bound electrons in the copper atom and will take its place. Then the ousted electron drifts on in its turn as a "loose" one. The mechanism of electric conduction in wires would be determined, therefore, not only by the jostling of the loose electrons against the relatively unmoving atoms, but also by the rules that control the electronic "game"; that control, that is, the displacement of a fixed, atomic electron by an arriving loose one.

But all these ideas are really little more than guesses. The plain fact of the matter is that we do not know how the electrons move through wires. The movement of a direct current of electricity in a wire is still a mystery that all our theories leave unexplained.

Therein lies the importance of a comprehensive investigation that has been begun in the physical laboratories of Cornell University. It is planned to take the one electrical phenomenon of resistance and to study this very accurately for pure substances and over a wide range of temperatures. The first installment of this work has been done on the so-called alkali metals; sodium, potassium, lithium, caesium and rubidium. The results have just appeared from the pen of Dr. Charles C. Bidwell.*

While this study will have its main value in that it supplies, for the first time, complete and accurate information as a basis for theorizing, it possesses, also, one feature of immediate interest. It shows how the melting of the metal affects the resistance to the passage of electrons.

Dr. Bidwell finds that the electrical resistance of these metals *increases* just before they

* This idea of the structure of metals like copper was explained in detail in the article entitled "700,000,000,000,000,000,000 Electrons for a Cent" in POPULAR RADIO for January, 1924, page 41. The modern theories concerning the fixed electrons, the ones that are bound inside the structure of the atoms themselves, were explained in the article entitled "Bohr's New Theory of Atoms" in POPULAR RADIO for April, 1924, page 319.

* "Electrical Resistance and Thermoelectric Power of the Alkali Metals," by Charles C. Bidwell. *Physical Review* (Corning, New York), vol. 23, pages 357-375 (March, 1924).

begin to melt. This happens while the metal still seems to be solid. But evidently the atoms in it have begun to shift around a little. They are commencing to leave the fixed positions that they occupy in the rigid solid. And they begin, then, to offer more resistance to the loose electrons that are moving through them. This circumstance, and especially the numerical details that Dr. Bidwell offers concerning the temperature at which it occurs, ought to prove of value to the theorists who are endeavoring to unravel the secrets of the motion of electrons in wires.

Incidentally, some recent experiments of Dr. A. T. Waterman of Yale, have led to an estimate, believed to be fairly accurate, of the number of these loose electrons that exist inside metallic wires.* This number turns out to be about 100,000,000,000,000,000 electrons in each cubic centimeter of metal at the temperature of melting ice. There would be about 50,000,000,000,000 such free electrons in a piece of copper wire the size of an ordinary pin head.

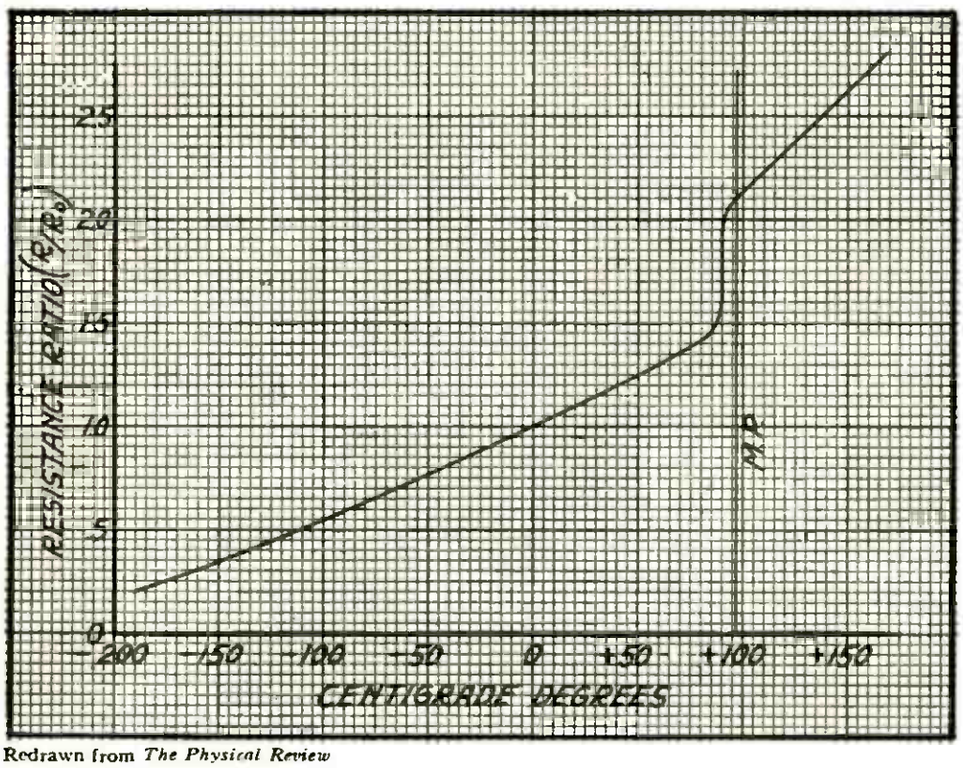
Large as this is, it is only a minute fraction of the total number of electrons in the wire. There are, in fact, some twenty million fixed electrons for each one of the loose electrons. If you imagine all the people in the two states of New York and Pennsylvania standing each in a certain fixed place and one lone man wandering around among them as the only movable individual, you will have a pretty fair picture of what existence must be like for each loose electron in a copper wire.

* "The Variation of Thermionic Emission with Temperature and the Concentration of the Free Electrons Within Conductors," a paper read before the meeting of the American Physical Society, Cincinnati, December, 1923; published in abstract in the *Physical Review* (Corning, New York), vol. 23, page 299 (January, 1924).

Radio is Being Tested for Mine Rescues

EVERY few weeks the newspapers carry huge headlines announcing that somewhere a mine has caved or exploded and that dozens or hundreds of unfortunate miners are entombed, no one knows whether alive or dead. The efforts of the United States Bureau of Mines have gone a long way to decrease the toll of human lives that these mine disasters demand, but one problem of mine rescue work has not yet been adequately solved. This is the problem of communicating with the buried men after a disaster has occurred.

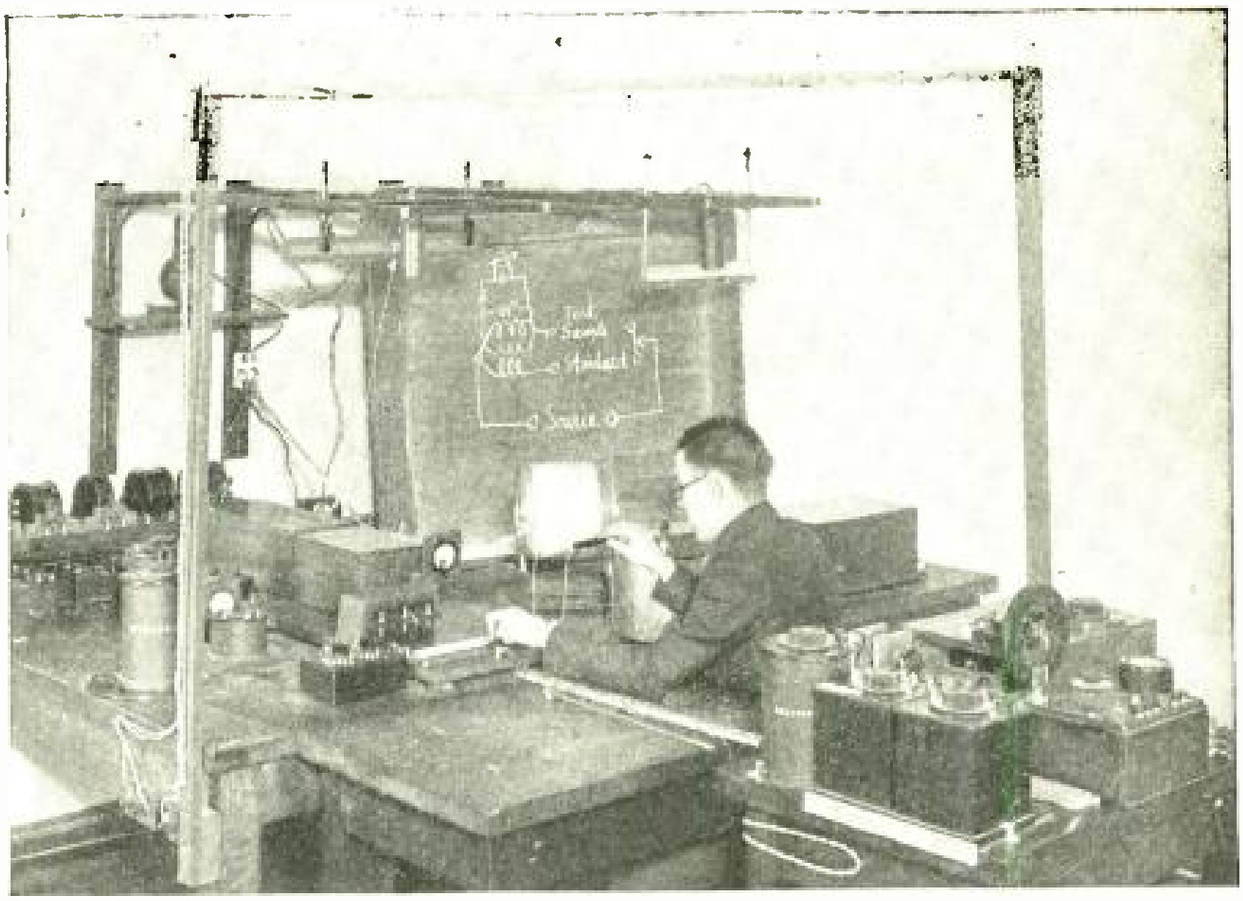
It commonly happens that the explosion or fire or whatever caused the disaster destroys the usual means of communication, such as bell-wires or wire telephones. The rescuers who enter from the surface seldom know where the entombed men are or whether they have sufficient air or even how many of them are still alive. There is great need, therefore,



Redrawn from *The Physical Review*

WHAT HAPPENS TO THE ELECTRONS WHEN A METAL MELTS

This curve shows how the resistance of a piece of metallic sodium changes as the temperature rises from nearly 200 degrees below zero to well above the temperature of boiling water. The line marked "M.P." indicates the melting point. Note that the risistance increases sharply just before this line is reached, indicating the softening of the atomic structure inside the metal.



Bureau of Standards

MEASURING EFFECTIVE CAPACITY, INDUCTANCE AND RESISTANCE

The arrangement and behavior of the electrons inside the metal of the wires determine the properties of electric circuits. This shows the balanced transformer set used at the Bureau of Standards for the rapid measurement of radio capacity, inductance and resistance.

for some emergency method of communication that will not be put out of commission by any ordinary accident.

The officials of the Bureau of Mines, suspecting that some application of radio might furnish an answer to this problem, are making a study of the possibilities of radio for mine use. The first report issued is by Mr. J. J. Jakosky of the Pittsburgh Station of the Bureau and deals with the possibility of using the well-known ground-telegraph or "T. P. S." system developed by the Signal Corps of the United States Army.*

The conclusion reached by Mr. Jakosky is that the T. P. S. system can be used underground and may prove to be of value in some instances. There are, however, some serious difficulties arising from the fact that this system is subject to much interference from accidental sources or ground currents, such, for example, as leakage currents from electric railways or from power lines.

More important still, this system requires the use of telegraphic code and it cannot be expected that among every group of entombed miners there will be an individual who understands the code. The final radio system for underground rescue work will probably have to be a system permitting the use of the voice and not requiring an expert operator at either end. This conclusion Mr. Jakosky points out. The search for such a system will be continued by the Bureau.

Should the Amateurs be Permitted to Use Short Waves?

THIS question is raised editorially in a recent issue of *QST*, the official organ of the American Amateur Relay League.* At present the amateurs are restricted to the band between 150 and 200 meters, except for those few individuals who are fortunate enough to possess a special experimental license.

There are many reasons for believing that a limited permission to the amateurs to use waves between 150 and 50 meters would result in important scientific advances, as has been the

* "Underground Signalling for Mines by the Ground-conduction or 'T. P. S.' Method." by J. J. Jakosky. United States Bureau of Mines (Washington, D. C.), Reports of Investigations (mimeographed), no. 2576, 11 pages, issued February, 1924. The T. P. S. system of signalling as employed on the surface of the ground by the Signal Corps was described in POPULAR RADIO for May, 1924, page 490.

* "The Short Waves," editorial, *QST* (Hartford, Connecticut), vol. 7, no. 8, page 7 (March, 1924).

case, indeed, whenever the thousands of experimentally inclined amateurs in America have been permitted to turn themselves loose on any subject.

A recent remark of Dr. W. H. Eccles, President of the Radio Society of Great Britain, in an address to that Society, is of interest. After referring to the recent successes of amateurs in spanning the Atlantic on the 100-meter wave and to the prospective use of these waves in exceedingly practical ways, Dr. Eccles said:*

"In wireless, as in many other pursuits requiring concentration and skill, the best results are often achieved by men who are not brought up to work at it for a living. This holds good in yachting, in cricket, in marksmanship and in many other sports. It holds still further, in my opinion, in the sciences and in the applications of science; and, especially, in the scientific hobbies, including, of course, amateur wireless, which, in addition to its fascination as a sport, possesses, also, the qualities of immediate importance in commerce and of utility in national emergency. It is quite conceivable that these discoveries of the properties of short waves may be of great commercial service, and certainly might be of immense military significance in time of war."

The greatest untouched field of radio today is the field of short waves; not only the waves down to 50 meters but those even below this limit. The greatest agency for radio investigation in the world is the existing body of American amateurs. We think, with *QST*, that it is worth while to bring this opportunity and these men together. What is the Government going to do about it?

How Fast Are Radio Waves?

THE books say that radio waves move with the speed of light, 186,329 miles a second. It must be admitted, however, that this is really an inference rather than a proven fact.

We know that radio waves are much like light (probably *exactly* like light) except that their wavelength is longer. Several experiments have been performed, beginning with the one of Hertz, to prove that the speed of the radio waves was also the same as the speed of light. These experiments have shown that this is true—within the limits of experimental error. This last phrase is the joker. The limits of experimental error in the measurement of radio speeds have been too wide. It has remained possible that the speed of radio might not be *exactly* the speed of light.

The difference, were any found, could scarcely be important in practice. Undoubtedly the speed of radio is ample for all useful purposes. But there are theoretical reasons why scientists want to know for certain and so a recent experiment was organized between Washington, D. C., and Poland.

This experiment was demonstrated recently before a gathering of scientists in the Cosmos Club, at Washington, by Captain R. H. Ranger of the Radio Corporation of America.* From a transmitting key operated by Captain Ranger in the meeting room an electric impulse was sent by land wire to the transmitting station of the Radio Corporation at New Brunswick, New Jersey; thence by radio to the receiving station at Warsaw, Poland; thence by land wire to the Polish transmitting station; thence by radio back again to Riverhead, Long Island; and thence by another land wire to a receiver on the same table as the transmitter in the Washington lecture room. The time needed for the circuit was .046 second.

The same experiment was carried out again at the Bureau of Standards with the most precise measuring instruments. When allowances were made for the effects of the land-wire portions of the circuits and for all other disturbances, the speed of the radio waves worked out to be very close to its theoretical value. Doubtless further refinements of the apparatus, especially the elimination of all the land lines, will give us before long a definite proof that radio does have *exactly* the speed of light.

The Best Kind of Ground Connection

IT is remarkable how little quantitative data exists concerning some points of radio engineering that have great practical importance. One of these points is the efficiency of different types of grounds. Most of the information about this is general information; useful enough, no doubt, but easily improvable in quantitative accuracy.

One bit of quantitative work on this subject has appeared recently.† Experiments at Baden, Germany, reported to the Swiss Association of Electricians, show the great differences in the ground resistance produced by the nature of the soil and by the shape of the ground-plate.

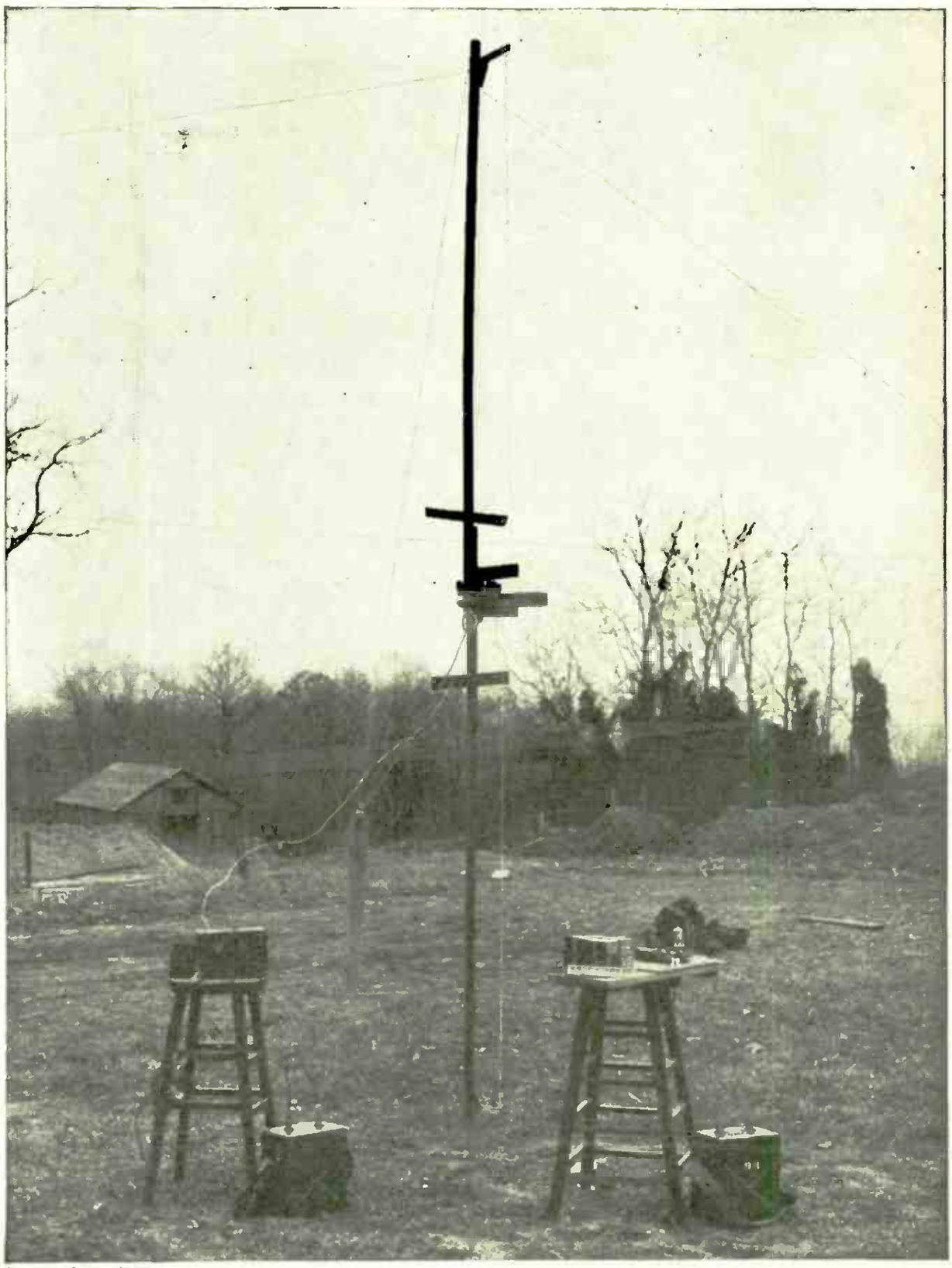
In gravelly soil, a plate of copper about two feet square, surrounded by a little garden soil, showed a resistance of from 100 to 163 ohms. The same plate surrounded by charcoal instead of by garden soil had a resistance of 154 to 264 ohms. A copper ribbon about ⅛ inch wide and 60 feet long, buried in the same garden soil had the much lower resistance of from 25 to 61 ohms.

The greatest difference came, however, when the soil of the neighborhood was clay instead of gravel. In this case the resistance shown by a copper ground-plate surrounded by charcoal was only 11 to 17 ohms; while the long

* "The Importance of the Amateur," by W. H. Eccles, an address to the Radio Society of Great Britain, January 23, 1924. Printed in the *Wireless World* (London), vol. 13, pages 620-623 (February 13, 1924).

* It is described by Carl H. Butman in his *Washington Radio Service* for the week ending March 17, 1924.

† Experiments of Schliesser, quoted from Bulletin No. 8 of the *Association Suisse des Electriciens* in *Annales des Postes, Télégraphes et Téléphones* (Paris), vol. 13, page 195 (February, 1924).



Bureau of Standards

SHOULD AMATEURS BE ALLOWED TO WORK WITH THIS ANTENNA?

This is the antenna and receiving set used by the engineers of the United States Bureau of Standards in their experiments with radio transmission at a wavelength of 10 meters. The tuned vertical wire serves to pick up the received energy. Many radio engineers are now urging that qualified amateurs should be permitted to experiment with these unusually short wavelengths.

copper ribbon showed the still smaller resistance of 3.25 to 5 ohms.

The more usual type of ground, three six-foot iron rods driven completely down into the soil at the points of a triangle six feet on each side, gave a resistance of 4.5 to 7 ohms.

Does the Sun Act Like the Filament of a Vacuum Tube?

SCIENTIST'S have suspected for some time that the sun is a great astronomic source of electrons, that uncountable billions of these electrons are driven off from the hot sun every second, just as the electrons are driven out of the hot filament of a vacuum tube. Some of these electrons are received by the earth. There is, therefore, a real analogy between the solar system and our familiar vacuum tubes.

The sun represents the filament. It is a source of electrons. The earth represents the plate; it receives the electrons. The empty space between us and the sun represents the vacuum of the tube.

This solar vacuum tube has a multiplicity of plates, one for each of the planets. There is another difference in that the plates are not connected by wire conductors either with each other or with the filament, that is, with the sun. Nor is there in the astronomic system any visible analogy to the grid.

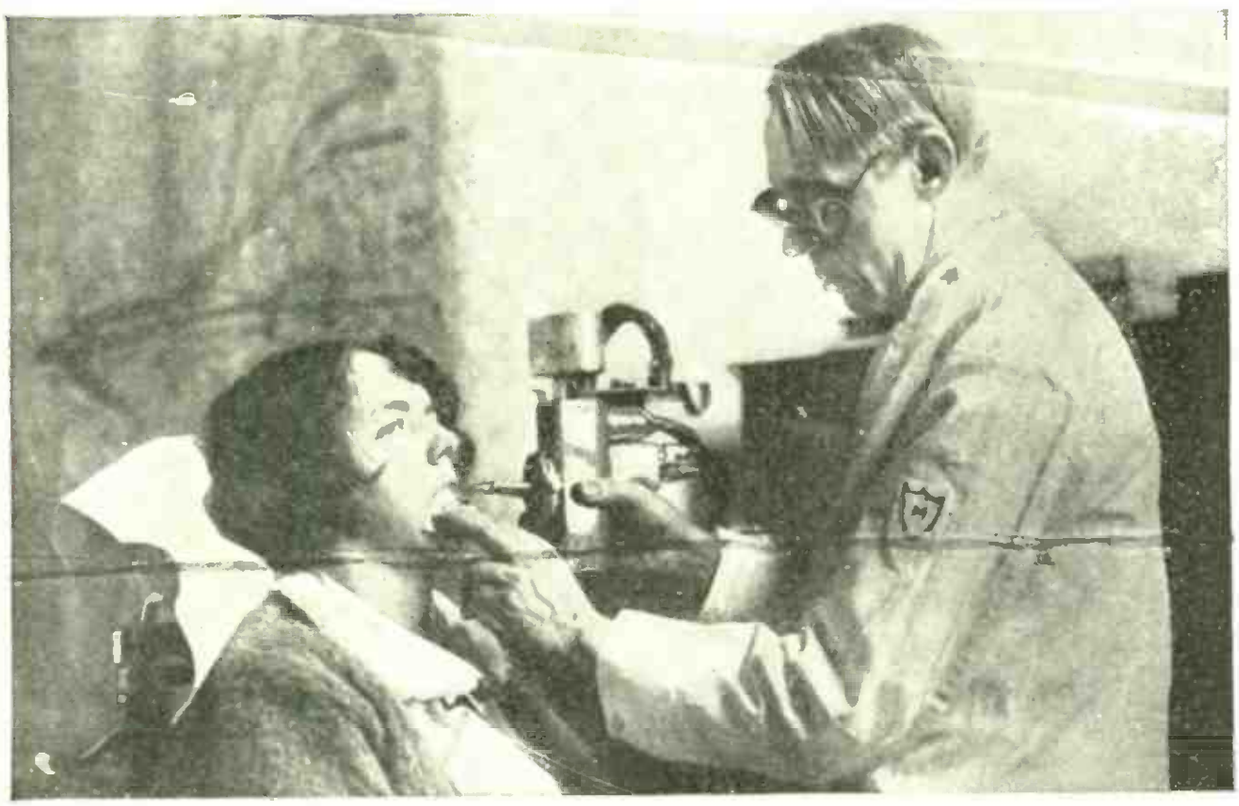
But in spite of these obvious differences, the analogies are considerable. For example, the rules worked out for the space charge in a vacuum tube probably apply quite well (of course, with the proper modifications) to the electric conditions between the earth and the sun.

One of the deductions from these ideas is the theory that there must be a layer of free electrons, a kind of "electron gas," immediately around the sun. We know that there is such an atmosphere of electrons around the glowing filament of a vacuum tube whenever the electrons are not drained away too rapidly by a positively charged plate.

Over a year ago Dr. J. Q. Stewart of Princeton University suggested the existence of such an atmosphere of free electrons around the sun.* He suggested, also, that this layer of electron gas would be thick enough and dense enough to be opaque to light. It follows that we do not see the real sun at all. We cannot see it. All that we see are the shining geysers of hot gas that manage to get high enough above the real surface of the sun to shine through the great cloud of electrons that surround it. It is as though the electrons in a vacuum tube escaped so thickly that they entirely hid the visible glow of the filament.

More recently Professor A. H. Compton,

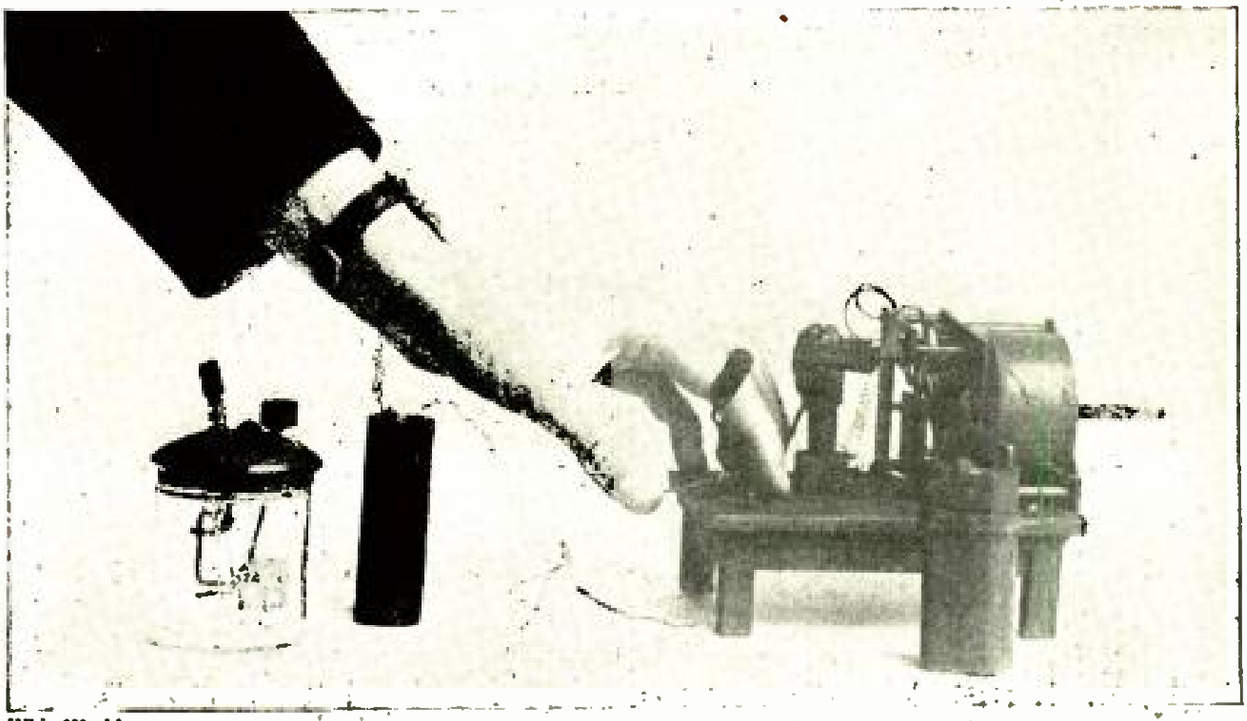
* "Opacity of an Ionized Gas," by John Q. Stewart, *Nature* (London), vol. 111, page 186 (February 10, 1923). There is a more complete report in the *Physical Review*, vol. 22, pages 324-332 (October, 1923).



International

ETHER WAVES TO CURE YOUR TOOTHACHE

This apparatus, developed by Dr. E. C. Cummings of the Harvard Dental School, produces ultra-violet light in the patient's mouth so that this form of ether waves, waves still shorter than those of light, can be applied directly to diseased tissue.



Wide World

THE ADAM OF RADIO SETS

This apparatus, recently found in London, is the original set used by David Hughes, the inventor of the first detector, in his radio experiments made in 1879. The transmitter is at the right and the receiver, made of knitting needles, corks and other odds and ends, is shown at the left. It is still in working order.

of Washington University, St. Louis, has found a direct indication that the sun is surrounded by electrons.* He has shown, from theoretical considerations as well as from experiment, that a cloud of free electrons will affect light that passes through it in such a way as to alter the wavelength of a part of the light. This is what scientists call the "scattering" effect. And it appears that the light from near the edge of the sun's disk, which light would traverse a great thickness of the supposed electron atmosphere, shows just this scattering effect that it ought to show if the atmosphere of electrons is really there.

To the radio public these new discoveries have not only the interest that any discovery about the sun must have for all of us who live by its light and warmth; they have, also, a direct importance to radio.

There remains no doubt at all that the electric properties of the sun, especially the electrons and other charged particles that are shot out from it, are factors of the greatest importance in radio transmission on earth. When we have succeeded in learning more accurately just what the sun is doing, just what is the space charge of electrons around it, just how many electrons are projected with sufficient velocities to reach the "plate" of the solar vacuum tube, that is, the earth; then we shall have gone a long way toward solving the mysteries of fading, of the effect of the Heaviside Layer, of the absorption of long-distance radio waves, and many others.

Like life itself, many of the phenomena of radio are regulated by things that happen on the sun nearly a hundred million miles away. Solar astronomy is one of the important branches of radio science.

* "Absorption Measurements of the Change of Wavelength Accompanying the Scattering of X Rays," by A. H. Compton. *Philosophical Magazine* (London), vol. 46, pages 897-911 (November, 1923).

A Discovery of Value to Radio in 1827

THE March, 1924, issue of that invaluable publication, the *Radio Service Bulletin*, issued by the United States Department of Commerce,* contains an interesting list of some of the great inventions and achievements that have marked important turning points in the development of radio. One might call them the "fifteen decisive battles of radio," except that there are many more than fifteen and that most of them were not so much "battles" as long sieges, the successful result coming only after years of laborious endeavor.

The first date cited by the compiler of this list is nearly a hundred years ago. In 1827, he writes, Savary discovered that a steel needle could be magnetized by an electric discharge. It was four years later, in 1831, that the Irish genius, Michael Faraday, the man who began as a bottle washer and ended as the greatest scientist of his time, discovered the principles of electromagnetism. It is from

* Every radio fan should be a subscriber to this publication. It costs only 25 cents a year, remitted to the Superintendent of Documents, Washington, D. C.

this latter event that most writers have dated the beginnings of radio.

But still earlier than this, earlier even than the experiments of Savary, were the recently rediscovered observations of Biot published in 1819, observations that were described last month in this Department. This work of Biot's the list in the *Bulletin* omits from mention among the other pioneers.

Continuing from Faraday, the list in the *Bulletin* notes the high points of radio history; the first production of oscillating currents by Professor Henry in 1840, Lindsay's first "wireless" signalling (by water conduction) in 1845, the announcement of the ether-wave theory by Maxwell in 1867, the original detector or first "coherer" invented by Hughes in 1879, Dolbear's first real radio in 1882, and, entering the modern period. the experiments of Hertz in 1886, of Marconi in 1897 to 1900 and of Fessenden in 1901.

A Simple Way to Map Electric Lines of Force

SEEING is believing, and the best way to believe in the reality of the fields of electromagnetic force that are supposed to surrouud coils and other conductors is to devise some way to *see* them. So thinks the well-known radio amateur, Mr. John Reinartz, and he has provided the way to do it.*

His apparatus is the familiar neon spark-indicator used for testing the behavior of automobile spark plugs. This is merely a small glass tube containing two electrodes sealed through the glass, the tube being filled with neon gas. Whenever this tube is placed in a high-frequency field of sufficient strength the neon gas inside it glows with a reddish light.

* "How Antennas Work," by John L. Reinartz, 1QP. *QST* (Hartford, Connecticut), vol. 7, No. 8, pages 16-19 (March, 1924).

From a photograph made for POPULAR RADIO by Hoppé, London

A LOUDSPEAKER THAT OPERATES ON A NEW PRINCIPLE

Mr. S. G. Brown, F. R. S., of London, is the inventor of the "frenophone," a loud-speaker which may be used in connection with a crystal set. The necessary amplification of the sound comes from the friction of a small vertical rod against a rotating glass disk. Both rod and disk are visible in the phonograph. The principle of the frenophone was described in POPULAR RADIO *for January, 1924, on page 94.*

CONDUCTED BY RICHARD LORD

A limited number of questions of general scientific interest will be answered each month in this department. Readers are invited to send in questions that have puzzled them—but the selection of questions for answer cannot be guaranteed nor can questions outside the radio field be answered by mail.

How does the temperature of the filament in a vacuum tube affect its operation?

IT determines the number of electrons that are set free from second to second by the filament and which serve as the carriers of the current in the tube from the filament to the plate. There are always a great many loose electrons inside all metals, including the metal wire of the filament. When the wire is cold these electrons stay inside it but when it gets hot they jostle each other around so much that some of them are forced out of the wire altogether and thus provide the electrons for the working of the tube. The hotter the wire the more electrons are forced out.

Is liquid air used in filling vacuum tubes? And how is it made?

Liquid air is not used as a material for filling vacuum tubes, but it has been used in laboratories in experiments on making a nearly perfect vacuuin (See POPULAR RADIO for October, 1922, page 92). It is used merely as a cooling agent to condense vapors that you do not want to get into the tube. With liquid air it is possible to obtain a temperature of 250 or 300 degrees below zero Fahrenheit. Liquid air is made by cooling ordinary air intensely This is accomplished by a succession of alternate compressions and expansions. each expansion making the air a little colder.

What is the difference between synthetic and natural crystals?

NATURAL crystals are those that are found ready formed in the rocks. Naural galena, for example, is a crystal of sulphide of lead, formed in the course of geologic ages in the mineral vein and now dug out by the miners. It is a common ore of lead and also of silver, since it frequently contains that metal as an impurity. Pyrite, another mineral sometimes used as a natural radio crystal, is a natural sulphide of iron formerly much used as a source of sulphuric acid. Synthetic crystals, on the other hand, are artificial mixtures of compounds made in the laboratory. They have many different chemical and physical compositions depending on the formula used in making them.

What are the harmonics of a broadcasting wave? I am told that some stations send out many harmonics and that that makes their waves hard to receive.

HARMONICS are the higher frequencies, representing exact multiples of the fundamental frequency. For example, suppose a station is sending on a wavelength of 600 meters, which is a frequency of 500 kilocycles. This is then the fundamental wave (or frequency). But if the antenna arrangements are bad, or for many other reasons, the wave actually sent out may contain also a frequency of *twice* 500 kilocycles, or 1,000 kilocycles, which corresponds to 300 meters. This is the "first harmonic." Similarly there might be also a frequency of 3 times 500 kilocycles, or 1,500 kilocycles, corresponding to 200 meters. This would be the second harmonic. There would be a third at 2,000 kilocycles or 150 meters, a fourth at 2,500 kilocycles or 125 meters, and so on. Of course, all broadcasting stations try to keep their sending wave as "pure" as possible, that is to avoid producing these harmonics.

How can you calculate the amount of heat produced in a wire by an electric current?

THE heating effect increases with the square of the current that is flowing and in direct proportion to the resistance of the wire. If you measure the current in amperes and the resistance in ohms you can calculate the amount of heat produced by the following rule:

Take the square of the current, multiply this by the resistance, then multiply the product by the fraction .2389. This will give you the number of calories of heat being produced a second—one calorie being the amount of heat required to heat one gram of water one degree Centigrade. This is a very small quantity of heat. The burning of one grain of coal will produce about 500 times this much.

How do they make the thin sheets of mica that are used in condensers?

THESE sheets are made by nature, not by man. Mica is a natural mineral containing somewhat variable percentages of four chemical elements: potassium, aluminum, silicon and oxygen. Chemists call it a silicate of aluminum and potassium. When mica crystallizes in the rocks the atoms in it arrange themselves so they will split apart much more easily in some directions than in others. This makes it easy to split off the thin sheets used in condensers. The original use of these mica sheets was in making the little windows that used to be put in the doors of coal stoves so that one could see the fire without opening the door.

What is the difference between the Centigrade thermometer used in scientific work and the ordinary thermometer?

ALL thermometer scales are purely arbitrary. When the Fahrenheit scale (commonly used in the United States) was first designed, its zero point was set at what was then believed to be the lowest temperature ever experienced on earth and its 100 degree mark at the highest. The scientific or Centigrade scale has its zero at the melting point of ice and its 100 degree mark at the boiling point of water. Zero Centigrade is the same as 32 degrees Fahrenheit. To convert a Centigrade temperature into a Fahrenheit one multiply by 9/5 and add 32. To convert Fahrenheit into Centigrade subtract 32 and multiply the remainder by 5/9.

Are the electric sparks produced when you stroke a cat's fur the same as other kinds of electricity or different?

THEY are the same. They are, in fact, a manifestation of frictional or static electricity, the same as is produced when you rub a glass or rubber rod on cloth. The friction detaches some electrons from one of the objects that are being rubbed together. These electrons accumulate on the other object, either the cloth or the rod, and produce a charge on it. When you get enough charge a small spark occurs, as it does on the cat's back.

I am told that I can test my headphones with a copper penny. How is this done?

WHAT you refer to, probably, is a way of making a small electric battery with a penny and another coin, preferably a nickel. Connect one terminal of the headphone to the penny, the other terminal to the nickel. Then touch both coins to a piece of blotting paper wetted thoroughly with a little weak vinegar. There will be a faint click in the phones when the coins touch the paper. But this is not a very dependable test for the quality of a telephone. It is better to test all the characteristics of a telephone by the standard electrical methods. If you lack the experience to do this, better buy a standard make of telephone having known characteristics.

What are isotopes?

THIS is a name for certain chemical elements which are really different though they seem very much alike. For example, there are at least five different varieties of lead. All of them look alike and have exactly the same chemical properties. You cannot tell them apart by any chemical method. Yet they differ in one important particular; their atoms have different weights. These five different varieties are called the isotopes of lead. The atom of one isotope weighs 206 units, another weighs 208 units, and so on. This idea of isotopes is very important in modern theories of the structure of atoms. See Sir Joseph Thomson's article in POPULAR RADIO for September, 1923.

Why is iron magnetic and other metals not magnetic?

THIS is really a good deal of a mystery; the theory of magnetism not being very well understood. Most scientists believe that iron is magnetic because the iron atoms are themselves little magnets, each one having its own north and south poles just as a bar magnet has. In unmagnetized iron the atoms are arranged irregularly, so that the magnetic effects of the atoms cancel each other. When you magnetize the iron what you do, really, is to turn the atoms around so that all the north poles point in the same direction and reinforce each other. Metals other than iron do not possess, scientists suppose, these little atomic magnets so they cannot be magnetized.

"STATIONS I HAVE HEARD"

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

SET IS GOOD AS WELL AS SIMPLE

A FAN in Canada can hear at least a dozen good stations in various parts of the United States by putting together three of the common instruments which can be purchased in any radio store and using one peanut tube.

Cyril A. Hark, 2517 Mauce Street, Montreal, has made a good double-circuit tuner of the regenerative type by using a vario-coupler, variometer and 23-plate condenser. His results were obtained with an antenna only 50 feet long and a 20-foot lead-in.

His list includes KDKA, Pittsburgh, Pa.; WEAF, New York City; WOC, Davenport, Ia.; WTAM, Cleveland, O.; WBZ, Springfield, Mass., and WDAP, Chicago, Ill.

* * *

THIS IS A CHALLENGE

"I CHALLENGE anyone to duplicate my reception on two tubes," is the way the gauntlet is thrown down by John Keiran of 32 Alleyne Street, West Roxbury, Mass. "I have received three English stations during the transatlantic tests, 2LO, 2ZY and 5IT, and have even picked up WNP, the station of the MacMillan arctic expedition, some 700 miles from the North Pole.

"I am using a one-tube regenerative set, with one stage of audio-frequency amplification. I attribute my success to my antenna, which is 100 feet in length and 30 feet above the ground. On a poor antenna, my set will not cover 300 miles. I have received over 100 stations with it in four months."

* * *

THEY DO IT WITH A MIXING BOWL IN SAN FRANCISCO

USING three tubes with six volts on the filament and eighteen on the plate of the detector in the four-circuit tuner, F. N. Bellish of San Francisco hears the local station, KPO, ten feet away from his Baldwin loudspeaker unit in a mixing bowl and both antenna and ground leads disconnected.

ALL WAVES VISIT LAKE HOPATCONG

LAKE HOPATCONG is good for fishing but better for radio listening, according to Edwin Carman of 514 West 168th Street, New York City. He took his Green circuit, which was described in POPULAR RADIO, to the camp for an outing, and learned something about the geography of the United States by checking his stations on a map.

With three tubes he picked up KHJ, Los Angeles, Calif.; WOAW, Omaha, Nebr.; KDZE, Seattle, Wash.; WSAI, Cincinnati, O.; WJAR, Providence, R. I.; 6KW, Cuba; WTAS, Elgin, Ill.; CFAC, Calgary, Canada; WCBD, Zion City, Ill., and WFAA, Dallas, Texas.

"Half of these stations were heard on an old-fashioned phonograph horn to which my phones were clamped," he states. "I have made one change in the circuit by tapping my coil at the following turns, 15, 35, 65, 85 and 105."

* * *

TWO DOZEN IN A WEEK

"I BUILT the Haynes DX receiver one week ago and have so far received twenty-four stations," writes Linden E. Crone of 667 South Seventh East Street, Salt Lake City, Utah.

"I am using a repaired WD-11 tube. My antenna is 90 feet long and 30 feet high."

Among his record stations are CHCB, Toronto, Canada; KDKA, Pittsburgh, Pa.; WBAP, Fort Worth, Tex.; KPO, San Francisco, Calif., and KFEC, Portland, Ore.

* * *

WHAT AN UMBRELLA CAN DO

THE distance between San Francisco, Calif., and Calgary, Canada, was spanned with one tube in the triple honeycomb-coil circuit described in the September issue, using the umbrella antenna which appeared in the same number.

"The music was distinct and clear," writes Matt. A. Gracin, the man who did it.

ONE TUBE CATCHES 92 STATIONS

NINETY-TWO stations have been logged by Harold B. Taylor of Atlanta, Ga., using three spider-web coils in a regenerative double circuit and one dry-cell tube. His antenna is a single wire 164 feet long and 40 feet high.

Among those he hears are KOG, Los Angeles, Cal.; KFDL, Denver, Colo.; WHA, Madison, Wis.; WLW, Cincinnati, O.; WCX, Detroit, Mich.; WOAN, Lawrenceburg, Tenn.; WAAP, Wichita, Kan.; WQAA, Parkersburg, Penn.; WEAY, Houston, Tex.; WOAF, Tyler, Tex.; WAAY Youngstown, O.; WAAC, New Orleans, La.; WNAV, Knoxville, Tenn.; WIAG, Birmingham, Ala.; 9CAO, Rockport, Mo.; WPA, Fort Worth, Tex.; WIAO, Milwaukee, Wis.; WHAB, Galveston, Tex., and so many more that his letter looks like several pages taken from a call book.

* * *

750 MILES WITH A CRYSTAL

DUDLEY JOHNSON of Oak Bay, Victoria, B. C., Canada, has heard San Francisco on his crystal set, a distance of 750 miles. The station was KPO, and it came in clear and loud.

THIS SET SPANNED THE UNITED STATES

This four-circuit tuner spanned the distance between Canada and Texas during the first five minutes it was operated. G. A. Foster, who built it from instructions published in POPULAR RADIO, *lives in Keewaydin Camp, Timagami, Ont., Canada.*

"I owe you this letter," he writes, "for I made my set from the description in the July issue of POPULAR RADIO last summer; besides KPO I have been hearing the nearer stations constantly."

* * *

A FIRST NIGHT PERFORMANCE ON THE REAL DX SET

WITH the Real DX Regenerative Receiver described on page 281 of the April issue of POPULAR RADIO, J. V. Trammel of Swenson, Texas, heard stations in Omaha, Nebraska, 750 miles distant, Memphis, Tenn., 900 miles distant, and Los Angeles, Cal., 1,100 miles distant, on the first night that his set was in operation.

* * *

SIMPLE SET SURPRISES HIM

WITH only a coil, a crystal, and a pair of phones, Frank Kosmata of Cicero, Ill., made the set described in the June number of POPULAR RADIO and connected it to a 50-foot antenna with results which startled him. He heard nine stations in Chicago, Ill.

* * *

PATIENCE MAKES CIRCUIT WORK

"AT first I was unable to make the four-circuit tuner work," writes C. A. Campbell of Watertown, N. Y., "but after a few minor changes, the results exceeded my expectations."

"I am using an antenna of only 40 feet, with a lead-in of about the same length. By connecting the single-turn wire of the primary to the top tap on the bank-wound coil and by using a 200-ohm potentiometer across my "A" battery with the negative "B" on the arm, I have been able to reach nearly every broadcasting station of importance in the eastern part of the country. Stations WBZ, WHAS, WGR, WDAP and WSAI can easily be worked on a loudspeaker in summer weather."

HE IS LISTENING TO KFI

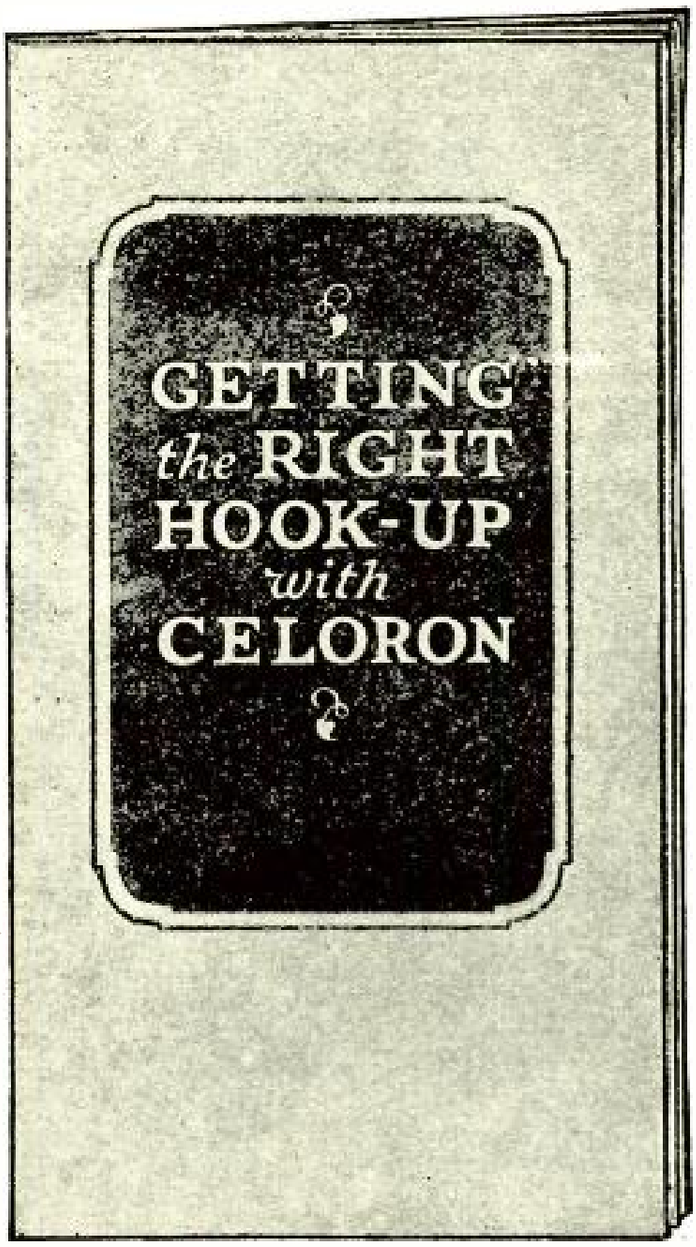
"I WANT to say," writes R. L. Walker of San Francisco, Calif., "that the hook-up in POPULAR RADIO for June, page 429, is surely a dandy. I can hear it all over the room with one tube and with one step of audio-frequency amplification I can not keep the head phones on. I am listening now to KFI, Los Angeles, over 500 miles away."

* * *

ONE TUBE AND AN OLD STAND-BY

THE popular old circuit employing two variometers and a variocoupler covers nineteen states with one tube for Laurel Carpenter of Bowling Green, O. He also uses two variable condensers which enable him to tune closer and to cut out much interference.

His list includes PWX, Havana, Cuba; WBZ, Springfield, Mass.; WJZ, Newark, N. J.; WEAF, New York City; KDKA, Pittsburgh, Pa.; WJAX, Cleveland, O.; WHAS, Louisville, KY.; WWJ, Detroit, Mich.; WDAP, Chicago, Ill.; WHB, Kansas City, Kans.; WFAA, Dallas, Tex.; WIAO, Milwaukee, Wis.; WMC, Memphis, Tenn.; WBT, Charlotte, N. C.; WLK, Indianapolis, Ind., and WCK, St. Louis, Mo. His list totals 65.



The right hook-up for you

WHAT'S the first thing to do in building a radio set? What hook-up is particularly efficient for getting local stations—for getting DX? What do the different radio symbols and terms mean?

We have prepared for free distribution a booklet that answers these questions and others connected with the building and operation of a set. It is called "Getting the Right Hook-up with Celoron." It contains diagrams of ten highly efficient receivers, ranging from a crystal to a super-heterodyne.

This booklet has been carefully designed for the set-builder. In it are hints and suggestions about selecting a panel and parts, and tips on tuning and on getting clear reception.

The edition of this booklet is limited. So mail the coupon today. It won't cost you a cent. But you must act at once.

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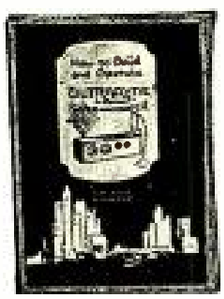

Send for 32-page illustrated book giving latest authentic instructions on drilling, wiring, assembling and tuning 6 and 8 tube Ultradyne receivers.

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The Ultradyne employs the "Modulation System," a basic development by R. E. Lacault, A.M.I.R.E., radio engineer of this company and formerly Radio Research Engineer with the French Signal Corps Research Laboratories.

The "Modulation System" places the Ultradyne years ahead of all present methods of radio reception. This new principle increases the sensitiveness over that of any known receiver. Weakest signals are made to operate the loud speaker.

Results secured by Ultradyne owners are amazing and exceed even those obtained with any other receiver under the same conditions. For range, signal audibility and faithful performance, the Ultradyne commands your first consideration.

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New improved long wave radio frequency transformers. Type "E" may be successfully employed in any circuit where long wave radio frequency transformers are essential.

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The *Needlephone* requires no batteries. Simply connect it to your set as you would a head set or a loud speaker and place the phonograph needle on the reed in the center of the *Needlephone*. It operates any make of phonograph (except Edisons not provided with Victor attachments).

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The Rhamstine* *Needlephone* is different—it is new—it is revolutionary. It gives you more perfect reproduction than any loud speaker. We want you to prove this to your own satisfaction, so we'll send it on a positive, money-back guaranty, you to be the judge. Send the coupon today.

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With 6 ft. cord

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Send me the *Needlephone*. I'll pay the postman $10 upon its arrival. It is distinctly understood I may return it if I desire, within 5 days and receive a refund in full.

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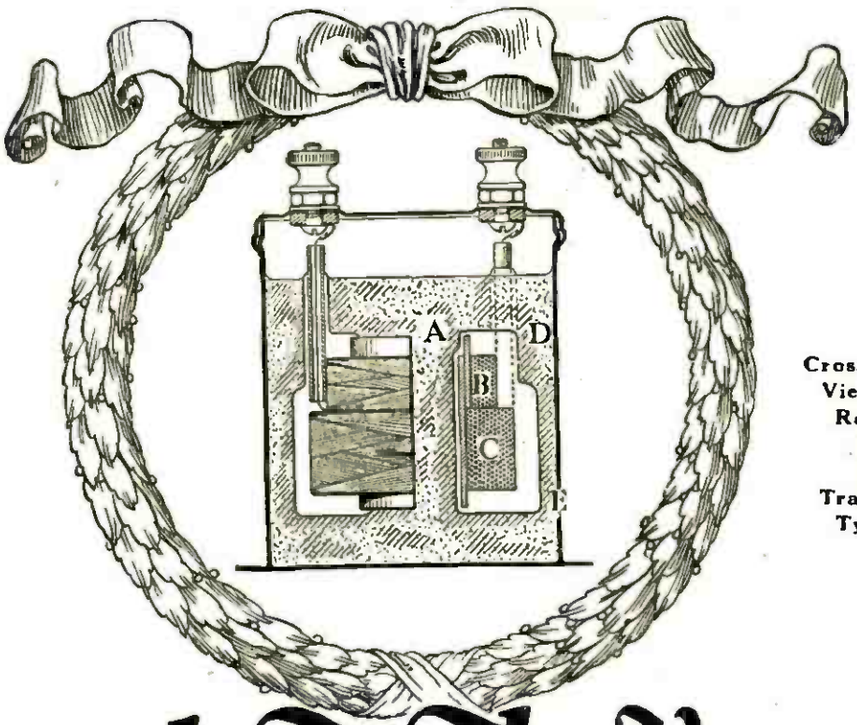

Cross Section View of the Receptrad Long Wave Transformer Type 1716

Laurels To The Victor!

The design of a perfected intermediate frequency amplifying transformer for use in Super-Heterodyne or long wave length amplification is a task calling for unusual engineering skill. In the type 1716 developed by RECEPTRAD engineers, it will be seen that unusual skill has been displayed in solving this most important unit in Supercircuits.

The special core A, is of comunited iron and forms a closed field. The primary B, is so wound with respect to the secondary C, that it affords the maximum step-up in signal voltage. Both are "Herring Bone Winding," a patented type used only by RECEPTRAD. The field is further shielded by a magnetic path D, and is metallically isolated from external fields by the case E.

The RECEPTRAD transformer is a victory for the steel core type but a greater victory for Receptrad because its efficiency exceeds by far any similar intermediate frequency coupler.

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Used in the Intermediate Frequency Amplifier. Covers frequencies from 5,000 to 25,000 meters. Self shielding Steel core guarantees power and stability.

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Covers wave lengths between 200 and 750 meters.

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Special Construction, Herring Bone winding; Sharply tuned.

TRANSFORMERS, TYPE ATX AND AT3, high efficiency, clear toned for First and Second step audio. **$5.75**

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SEND for our booklet "Amplification without Distortion" which explains amplification and the importance of using the right amplifying apparatus.

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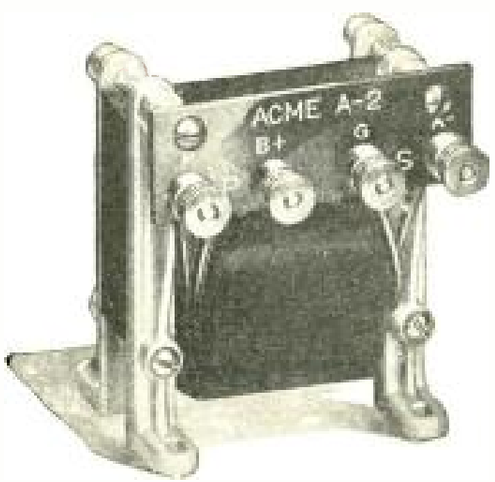

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VINCENT LOPEZ praises and endorses the rich, clear, natural quality of MUSIC MASTER reproduction. His Hotel Pennsylvania Orchestra is heard over the radio by untold thousands.

He has enjoyed radio music—mellowed and clarified as it passes through MUSIC MASTER'S amplifying bell of selected wood. His trained ear noted instantly the faithfulness of each re-creation.

MUSIC MASTER is an enduring musical instrument. Hear it and see it at your dealer's or have him send one to be tried and proved with your own set.

Dealers Everywhere

Music Master Corporation

(Formerly General Radio Corporation)

Makers and Distributors of High-Grade Radio Apparatus

S. W. Cor. 10th and Cherry Streets

Chicago **PHILADELPHIA** *Pittsburgh*

May I say a few words regarding the merits of the Music Master, which to my way of thinking is superlative in its field. For clearness of tone it exceeds any loud speaker which has been brought to my attention, and being directly interested in radio work I consider your product a big achievement and a valuable asset to the radio world.

Please accept my heartiest congratulations.

Sincerely yours,

Vincent Lopez

Exclusive O Keh artist

Music Master RADIO REPRODUCER

14-inch Model, for the Home **$30**

21-inch Model, for Concerts and Dancing **$35**

Connect in place of headphones. No batteries required. No adjustments.

BATTLE OF TRAFALGAR

ON October 21, 1805, Nelson's great naval victory of Trafalgar definitely ended Napoleon s scheme for the invasion of the British Isles. Although in a light breeze the English fleet maneuvered successfully in response to the signals from Nelson's flagship "Victory".

Modern fleets are not dependent upon the uncertainties and limited range of visual signals. Radio which gives us unlimited entertainment through broadcasting also is the modern agency which controls the movements of vessels in battle.

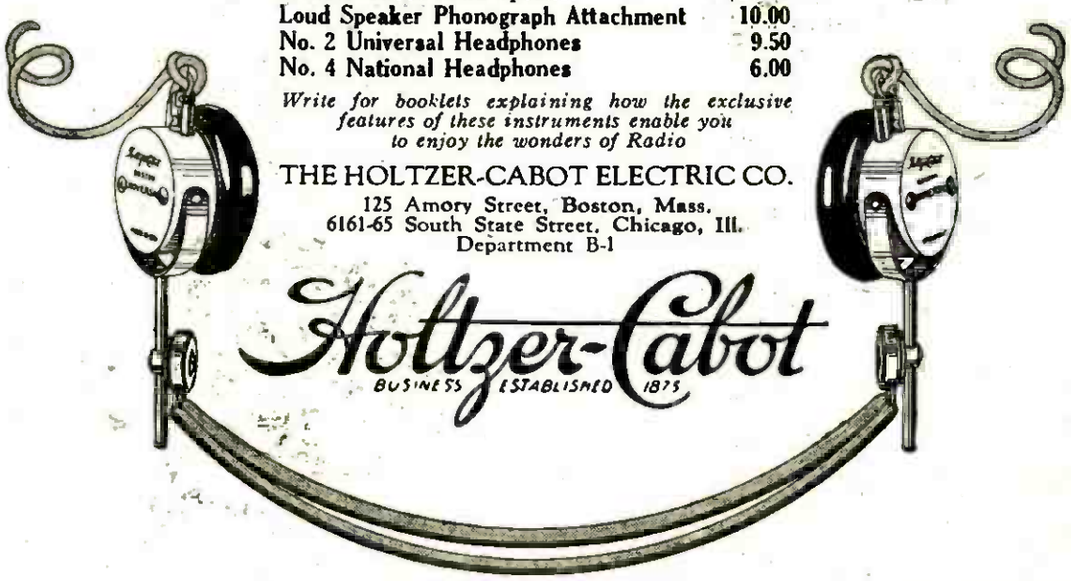
Holzer-Cabot Radio apparatus has added greatly to the development of Radio. Holtzer-Cabot Headsets, Loud Speakers and Phonograph Attachments contain the perfection of design and care in manufacture to enable perfect reception of Radio.

Holtzer-Cabot Loud Speaker	**$25.00**
Loud Speaker Phonograph Attachment	**10.00**
No. 2 Universal Headphones	**9.50**
No. 4 National Headphones	**6.00**

Write for booklets explaining how the exclusive features of these instruments enable you to enjoy the wonders of Radio

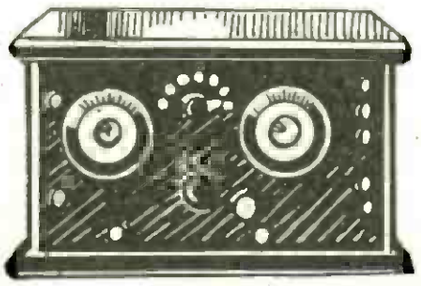
THE HOLTZER-CABOT ELECTRIC CO.

125 Amory Street, Boston, Mass.
6161-65 South State Street, Chicago, Ill.
Department B-1



"Tune in" on Success

Learn at Home To be a Radio Expert



The amazing expansion of Radio has opened thousands of wonderful new opportunities. Big salaries, easy and fascinating work, short hours and an excellent future are offered to ambitious men who enter the Radio field now.

Free 1000 Mile Radio Outfit

This set, when erected, has a range of over 1,000 miles. The cabinet is elegantly finished in a beautiful, lustrous mahogany. You can sell it at a handsome profit if you care to, after you have completed my course. Remember, you do not pay a single penny for it.

Membership Is Valuable!

Upon completion of my course, you receive a membership in the Radio Association of America. This designates that you are a thoroughly trained Radio man. It gives you prestige and a standing in your community not otherwise possible.

Thousands of Big Pay Opportunities

My course enables you to construct, install, operate, repair and sell Radio equipment. As my representative, you can, using either your full time or spare time, take orders from your friends and neighbors. You can easily earn from $35.00 to $125.00 a week installing Radio sets in your locality. It is being done every day by my students. What others have done, you can do.

On this very day there is someone in your neighborhood who is buying a Radio Set from someone else and is having Radio work done by others. On this very day there are big pay Radio positions that are going begging. This will be repeated tomorrow and for a long time to come. Time is precious. Begin at once to get the training that will fit you to cash in on this great chance. At least investigate. Mail the coupon to get the interesting bulletin "Radio Facts."

PROOF

Dear Mr. Mohaupt:
Your lessons are very easily digestible. To say that I enjoy them would be putting it very mildly—indeed, I crave them.
And, about the job at the Operadio Corporation; yes, I got it, thanks to you. I am learning to be an inspector at present, but I'll not stop there.
Please send me additional lessons as soon as possible.
GEO. A. GRAESSLE.

A. G. MOHAUPT, Radio Engineer

RADIO ASSOCIATION of AMERICA

4513 Ravenswood Ave., Dept. 56 Chicago, Ill.

Radio Experts Earn $3,000 to $10,000 a Year

New Radio Stations are being erected every day. Thousands of corporations are putting in private stations. Every large vessel requires its Radio Staff. From everywhere comes the urgent call for Radio Trained Men. There is almost no limit to the pay. Will you step forward and grasp this brilliant money-making chance or are you going to let days drift by and let others take in the cash?

"Learn by Doing" Method

My course is not "high-brow." It is written in plain, everyday language that can be understood by any man. You need have no previous training or experience. I give you a receiving set so that I can take you thru the various steps of Radio work in a practical way. You will be delightfully astonished in having made clear to you the wonderful forces of Radio that appear so mysterious to the untrained person.

FREE

I have ready for you a copy of "Radio Facts" which tells you of the latest opportunities that exist in the great field of Radio. I want you to note my "Money Back" guarantee that protects you absolutely. I also want to tell you about the big free 1,000 mile Radio Tube Set that I give away free with my course. I urge you to act at once. Fill in your name and address on the coupon and mail it to me immediately

MAIL COUPON

A. G. Mohaupt, Radio Engr., Radio Assn. of America,
4513 Ravenswood Ave., Dept. 56, Chicago, Ill.

Please send me details of your Home Study Course—also your Free "Radio Facts" and information on how I can get a FREE 1,000 mile Radio Set.

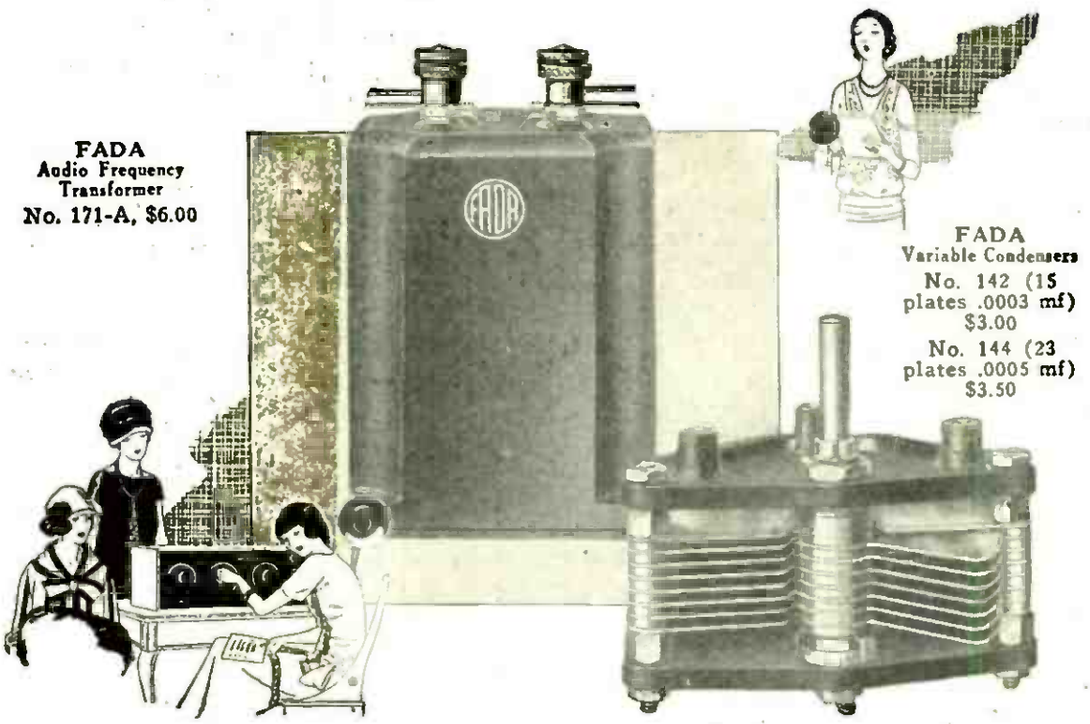
NAME.....

ADDRESS.....

CITY.....STATE.....

FADA

Announces a New Audio Frequency Transformer and New Variable Condensers



FADA
Audio Frequency Transformer
No. 171-A, $6.00

FADA
Variable Condensers
No. 142 (15 plates .0003 mf) $3.00
No. 144 (23 plates .0005 mf) $3.50

IN KEEPING with its established policy of producing only the finest of radio apparatus, F. A. D. Andrea, Inc., announces a new Audio Frequency Transformer suitable for all circuits and particularly adapted to the audio stages of Neutrodyne receivers.

A high average amplification over all audio frequencies is the outstanding accomplishment of this new FADA transformer. The highest note of voice or violin and the lowest note of organ or cello are reproduced with absolute tonal fidelity.

The new FADA audio transformer is a masterpiece of radio workmanship. Encased in bakelite with nickeled binding posts, it looks twice its worth. Try FADA Audio Transformers in your receiver and know what uniform and distortionless amplification really means.

—and now New Variable Condensers

The name FADA on a condenser means just one thing—condenser satisfaction. The new FADA condenser is made in two capacities 15 plate, capacity .0003 micro-farads and 23 plate, .0005 micro-farads and each the exact capacity at which it is rated. Radio frequency losses are reduced to a minimum by special rotor wiping contact brushes. A true "low-loss" condenser with an efficiency exceeding that of condensers selling at much higher prices.

Dealers are now ready to supply FADA transformers and condensers.

F. A. D. ANDREA, Inc., 1581 Jerome Avenue, New York

F. A. D. ANDREA, INC. LICENSED BY INDEPENDENT RADIO MANUFACTURERS, INC. NEUTRODYNE

Final *s-c-o-r-e*

Dad may wait for the evening edition. Or grandpa for his morning paper. But when a "croocial" series is on, millions of boys, hearts thumping, eyes glistening, follow each inning, play by play, cheering as the radio brings good news, groaning when defeat threatens. As long as boys and baseball thrive in summer, so will radio.

1924 radio business is conservatively estimated at 350 million dollars. And any radio dealer can testify that the biggest and best customers of this tremendous industry are boys. Boys are the source of probably eight out of every ten sales—buying for themselves, getting dad to buy for them, or infecting their elders with radio interest and enthusiasm.

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

is radio guide and authority for 500,000 boys averaging 15½ to 16 years old—leading spirits in families of very high average prosperity. Its stories and articles stimulate the radio wants of this vast army of readers. Then they eagerly read the radio advertisements.

Not only do they read the advertisements—they buy the advertised radio goods. This fact has proved itself so conclusively to radio advertisers that THE AMERICAN BOY carries, this year, more than double the radio advertising it carried in the same months last year.

Copy reaching us by June 15th will appear in August.

THE SPRAGUE PUBLISHING COMPANY

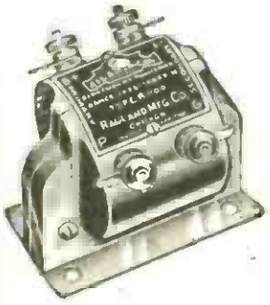
(Member A.B.C.)

548 Lafayette Boulevard **Detroit, Michigan**

"More Applause, Please"

Express your appreciation of the programs and repay the artists for their efforts. Applaud with postals! This will encourage the best talent to go on the air more often — and add to your enjoyment of radio.

You'll want to send "Applause Cards" to them all!



The new All-American Long Wave Radio Frequency Transformer, 4,000 to 20,000 meters. Unsurpassed for Super-Heterodyne, Ultradyne and all straight r. f. and reflex circuits. $6.

DELIGHTED and thrilled by the added distance and the increased clarity and loudness of your reception, the first night you use All-American Transformers to amplify, you'll feel like writing complimentary postals to all the stations. And do it!

Hundreds of thousands of set-owners already know from experience how proper amplification tremendously improves the pleasure of radio. That is why All-Americans are the most popular and most widely used of all transformers.

If your reception is below par, make it "above par" with All-American Amplifying Transformers. All the better dealers sell and recommend them as the best.

Special Offer: Latest diagram-circular on Power Amplification and Book of Tested Hook-ups mailed for 4c. in stamps.

RAULAND MFG. CO., 2658 Coyne St. CHICAGO

Pioneers in the Industry

All-American Power Amplifying Transformers give amazing roundness, richness, depth and clarity of tone, as well as greater volume, when used in "push-pull" circuits. Input and Output. Each $6.

Standard on the better sets ***A type for every circuit***

ALL-AMERICAN

AMPLIFYING TRANSFORMERS

Largest Selling Transformers in the World

Timmons Talkers

Eventually All Loud Speakers Will be in Cabinets

THIS is a development that is bound to come just as phonograph horns were put into cabinets. There is no sacrifice of tone because of being in a cabinet. As a matter of fact, tones from Timmons Talkers being "reflected" are pure, true and absolutely without distortion. Because of this Timmons Talkers make an especial appeal to musicians.

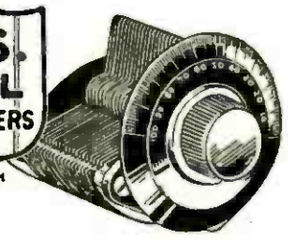
This "reflecting" of tones is accomplished by using two horns—one facing the other—and is similar in principle to the strings and sounding board of your piano.

We'll be glad to send you a cut-away view showing all the details of Timmons Talkers, including "Reflected Tone." Our folder, "Volume Without Noise," will be sent at the same time.

J. S. TIMMONS

339 E. Tulpehocken St., Germantown, Phila., Pa.

U.S. TOOL CONDENSERS
TRADE MARK



Up to the

Progress of Radio

Material and workmanship equal to the most exacting requirements of the latest circuits.

For Use Superheterodyne, Superdyne, Inverse Duplex, Four Circuit Tuner
Vernier Cap. .00057 Mfd. (24 Plate)
or Plain Cap. .00055 Mfd. (23 Plate)

Condensers of recommended capacity for all known circuits are also carried in stock by leading radio retailers.

End Plates of CELORON

Be Sure of Quality, Buy U. S. Tool Condensers

100% Guaranteed!

Write for Booklet

U. S. TOOL CO., Inc.

116 Mechanic St. Newark, N. J.

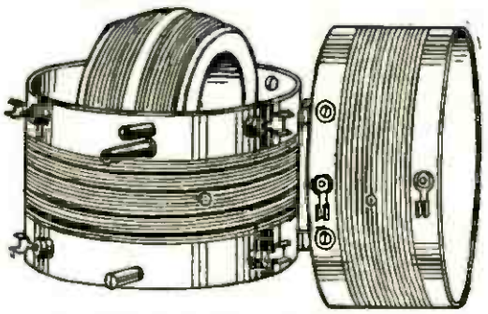
100% EFFICIENCY

guaranteed in using the

EASTERN COUPLER

for the

Superdyne Circuit



Most improved design and finest workmanship.
Wound with double silk wire on Genuine Bakelite Tubing.
Picture hook-up and material list free with each coupler.

PRICE, $6.00

Mail orders filled. Dealers communicate.

EASTERN COIL CORPORATION

22 Warren St., Dept. F. R., New York, N.Y.

CRESCENT LAVITE RESISTANCES

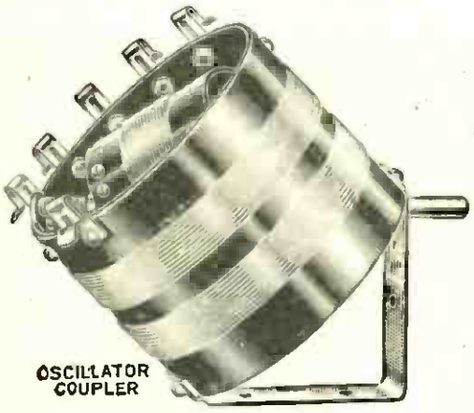
12,000
48,000
50,000
100,000
Ohms.

LIST $1.50

Special Sizes to Order

Used in the New Cockaday Circuit. Dealers write for discount.
CRESCENT RADIO SUPPLY CO. 1-3-5 Liberty St., Jamaica, N. Y.

SUPER HETERODYNE PARTS

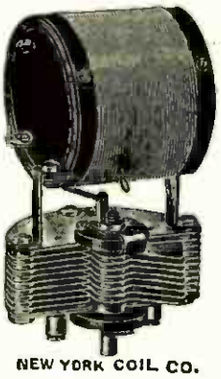


NEW YORK COIL, 3,000 Meter R K TYPE, INTERMEDIATE FREQUENCY TRANS-FORMERS are marvels of efficiency. Scientific positioning of primary and secondary, together with their extreme low height—1¼"—allows shorter grid and plate, wire connections than found in any other manufactured.

Price $4.00

OSCILLATOR COUPLER, Large XX Bakelite Black Tubing, Size 3¾ x 3", using low resistance double silk wire. Rotor, 180 degree type, 6 Fahnestock terminals, metal parts all nickeled. Will improve any heterodyne set. Price $4.00.

NEW YORK Condenser Tuned Radio Frequency Trans-Formers are designed to operate in *popular present-day circuits*. Electrical losses, such as distributed capacity have been reduced to the minimum.



The transformer is rigidly secured to our universally known New York Variable Condenser of 17 plates, which will tune sharply all wave lengths from 250 to 575 meters. ***Price, including Condenser, $4.50.***

NEW YORK COIL CO., 338 Pearl Street, New York

Pacific Coast—MARSHANK SALES CO., 1240 S. Main St., Los Angeles, Cal.

$8.00

14" - - - $12.50

The fact that the Fibertone is used by more Loud Speaker Manufacturers than any other one horn is a significant endorsement to those who want the best reproduction for the least investment. The base is designed to fit the phone from any head set. Use your own unit which you know is good.

If your dealer cannot supply you, write to us direct.

FIBER PRODUCTS COMPANY
34 Orange St. Bloomfield, N. J.

FIBERTONE

RADIO HORN

CARTER PORTABLE JACK

$1.50

Just the thing for summer. Keep the set in the house and extend the loud speaker out on the porch. Also for camping—touring and summer cottage use. Takes any standard Plug. Can be connected to set by wires to binding posts, or jack.

Any dealer can supply

Carter Radio Co.
1807 REPUBLIC BUILDING
CHICAGO

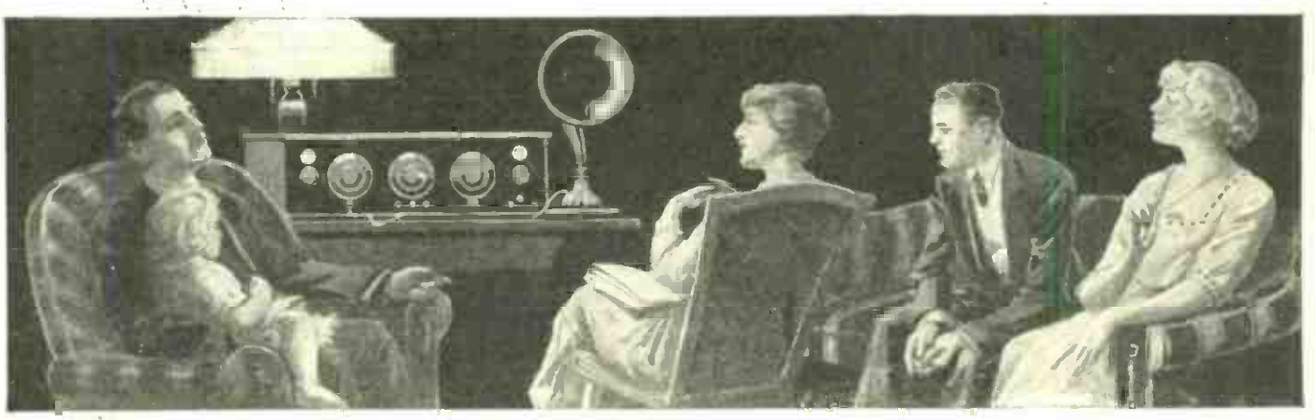
VACUUM TUBES REPAIRED

WD-11, WD12, UV-201A, UV-199, And others for **$2.50**

Quick service. All tubes repaired by us guaranteed to work as good as new.
Send your dead tubes. All you pay is $2.50 plus Postage to Postman.

THOMAS BROWN CO.
511-519 Orange St. Newark, N. J.

For the Fullest Measure



# of Undistorted Volume

TO obtain the fullest measure of undistorted volume, your receiver must deliver to the diaphragm of your loudspeaker or ear phones audio frequencies which will produce the maximum volume and purest qualities of tone.

This depends directly upon the efficiency of your audio amplifying transformers.

The GENERAL RADIO CO. type 231-A is distinctly a quality transformer — of high electrical and mechanical efficiency.

Features contributing to its superior performance are:

Low loss steel used in its core construction.

Layer winding properly insulated and impregnated.

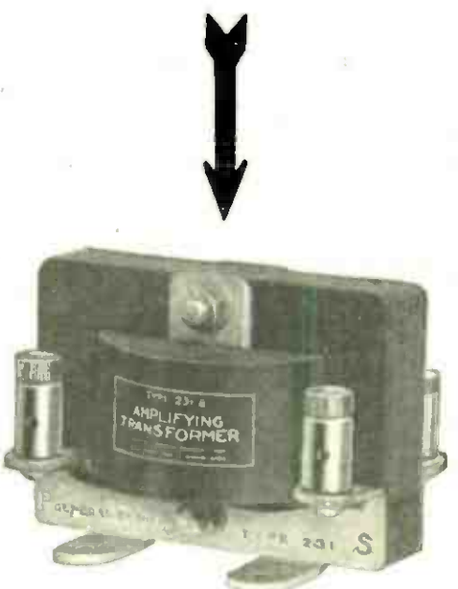
Air gaps in core to avoid distortion.

Unbreakable feet with convenient mounting holes.

Heavy leads with soldered connections.

High and flat amplification curve Which indicates that amplification is nearly uniform throughout its entire audio range, making it best for all stages.

Turns ratio 3.7 to 1 **Impedance ratio 10 to 1**



TYPE 231-A
Amplifying Transformer
"Best for All Stages"
PRICE $5.00

Sold by Good Radio Dealers EVERYWHERE

"Products of Proven Merit"

GENERAL RADIO COMPANY
Manufacturers of
Electrical and Radio Laboratory Apparatus
Massachusetts Ave. and Windsor St.
CAMBRIDGE, MASS.

GENERAL RADIO Co

The Crosley Two Tube Marvel

THOUSANDS of homes have been made happy by this little Crosley Model 51. In twenty-four days from its first appearance it was selling at the rate of 1,000 per day and hundreds of letters expressing appreciation of its excellent performance assured us that it was a favorite.

One of its two tubes is the noted Armstrong regenerative detector with the hook-up made popular in the Crosley Type V. Added to this is one tube of Audio Frequency Amplification giving Loud Speaker volume on local stations at all times and on different stations under fair receiving conditions. Otherwise head phones should be used for distant reception.

This Crosley two tube marvel has been a surprise to the Radio World and has proven the biggest seller on the market to-day. Have you bought yours? If not see your dealer to-day.

Other Crosley Models

Practically every Radio Dealer can furnish you Crosley Radio sets including not only the Model 51 but the Type V, a single tube receiver at $16.00, the Model VI at $24.00; the Super VI at $29.00; the Model X-J at $55.00; the Super X-J at $65.00 and the Trirdyn at $65.00, etc. The Crosley line is so complete that every home can find just the receiver to suit their desires or their limitations.

Send for Complete Crosley Catalog

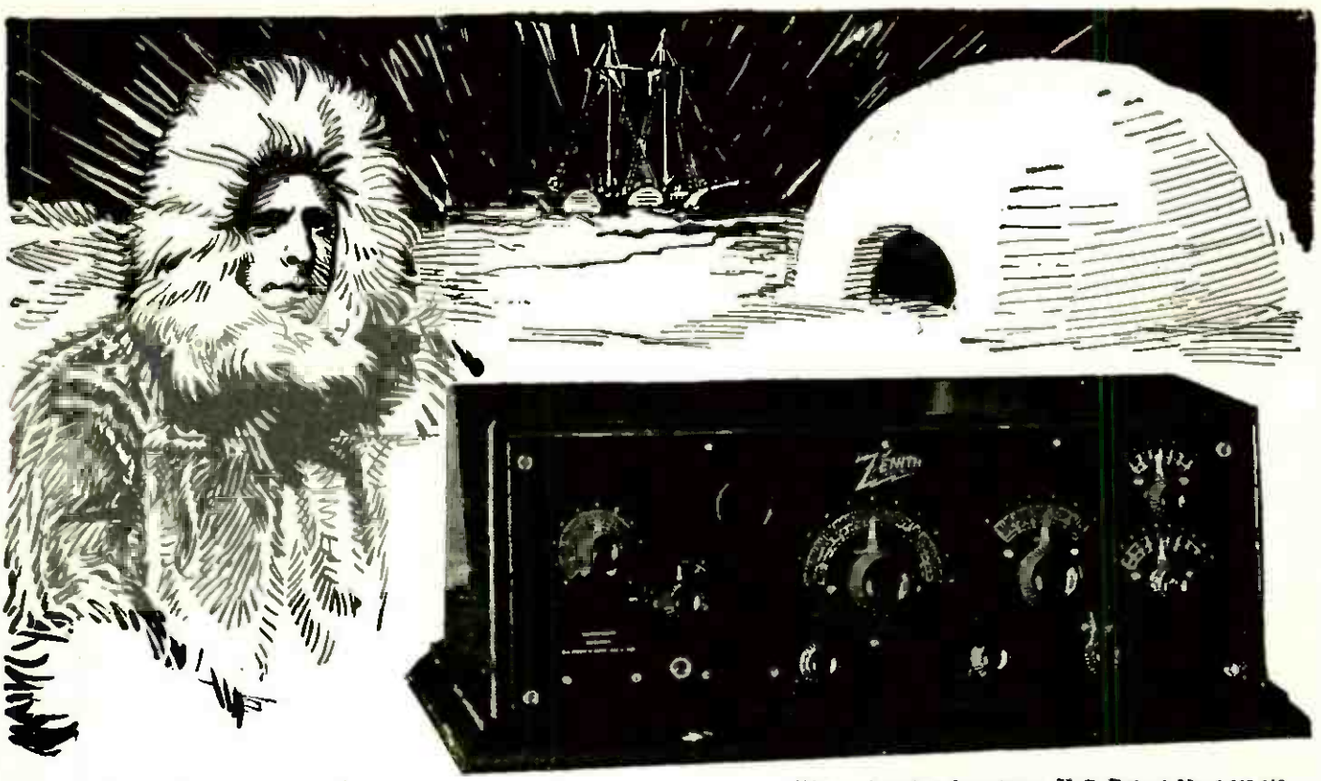
Crosley produces more Radio Receiver Sets than any other manufacturer in the world.

CROSLEY
Better-Cost Less
Radio Products

Crosley regenerator receivers are licensed under Armstrong U. S. Patent No. 1,113,149.

The Crosley Radio Corporation

Powel Crosley, Jr., President
Formerly
The Precision Equipment Company and Crosley Manufacturing Company
616 Alfred Street **Cincinnati, Ohio**



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

MacMillan Listens to Honolulu and New Zealand "Tunes In" California using

ZENITH

TRADE MARK

Long-Distance Radio

From a little ice-bound schooner—eleven degrees from the North Pole—comes this message:

"Am very thankful that Arctic Exploring Ship Bowdoin is equipped with complete Zenith radio apparatus. Here at top of world, in darkness of great Arctic night, we have already listened to stations practically all over the United States, from Europe, and even from far away Honolulu. Zenith has united the ends of the earth.—MacMillan."

Again, from far-off New Zealand comes a report of radio reception even more startling:

"It may interest you to know that the writer last evening landed KGO, Oakland, California, between 6:45 and 7:30 P. M. Heard his call four or five times distinctly, and jazz music. As San Francisco is ***6,300 miles from New Plymouth,*** and only one tube was used, we think this is a very fair performance."

—(signed) H. Charles Collier.

The sets used by Captain MacMillan and Mr. Collier are earlier models—since improved by the addition of ***a third stage of audio frequency.*** These new models represent an achievement not duplicated in any other set on the market. Write today for full particulars and name of nearest dealer.

Zenith Radio Corporation

McCORMICK BUILDING, CHICAGO, ILLINOIS

Model 3R The new Zenith 3R "Long-Distance" Receiver-Amplifier combines a specially designed distortionless three-stage amplifier with the new and different Zenith three-circuit regenerative tuner.

Fine vernier adjustments—in connection with the unique Zenith aperiodic or non-resonant "selector" primary circuit—make possible extreme selectivity.

2,000 to 3,000 Miles With Any Loud-Speaker

With the new Zenith 3R satisfactory reception over distances of 2,000 to 3,000 miles, and over, is often accomplisned in full volume, using ***any ordinary loud-speaker.*** The Model 3R is compact, graceful in line, and built in a highly finished mahogany cabinet - - - - - $160

Model 4R The new Zenith 4R "Long-Distance" Receiver-Amplifier comprises a complete three-circuit regenerative receiver of the feed-back type. It employs the new Zenith regenerative circuit in combination with an ***audion detector*** and ***three-stage*** audio-frequency amplifier, all in one cabinet.

The Zenith 4R may be connected directly to any loud-speaker ***without*** the use of other amplification for full phonograph volume, and reception may be satisfactorily accomplished over distances of more than 2,000 miles $85

ZENITH RADIO CORPORATION,
Dept. 1-E 328 South Michigan Avenue, Chicago, Illinois

Gentlemen:
Please send me illustrated literature on Zenith Radio.

Name .....

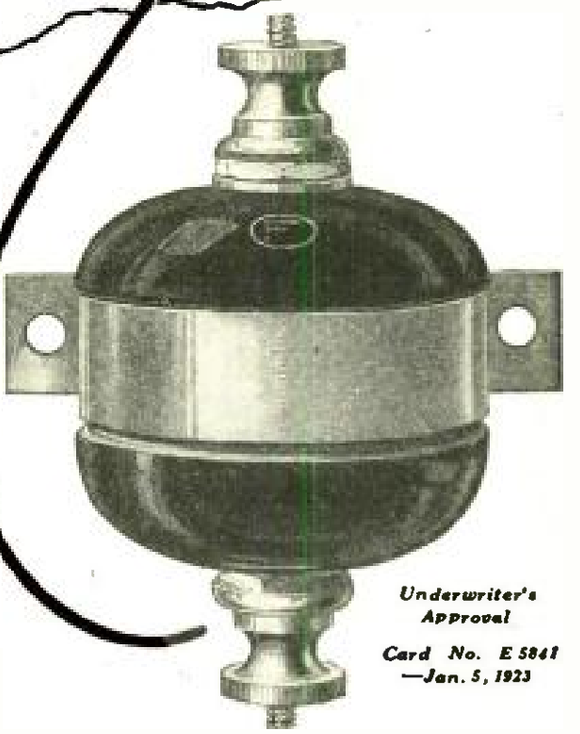
Address .....

UNDERWRITERS' REQUIREMENTS

"Each lead-in wire shall be provided with an approved protective device properly connected and located (inside or outside the building) as near as practical to the point where the wire enters the building.

. . . . . The protective device shall be an APPROVED LIGHTNING ARRESTER which will operate at a potential of 500 volts or less."

-here it is!



Underwriter's Approval Card No. E 5841 —Jan. 5, 1923

No. 248

not only *approved* by the Underwriters, but by thousands of radio enthusiasts, who are using it and who pronounce it *real protection*

"Little Joe" *Lightning Arrester*

The illustration shows "Little Joe"—a compact little unit but a giant in performance of the work for which it was designed. ... a heavy porcelain body beautifully glazed in a brown tone. So designed that it will interfere in no way with the radio receiving set. And it can either be suspended upon the aerial or fastened to wall with the heavy brass clamp which is furnished with each "Little Joe."

The Lightning Arrester Season Is Now On

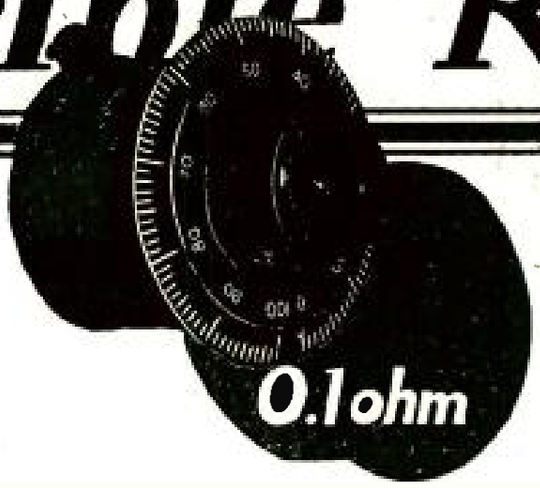
Endangering thunder storms are upon us. Insurance inspectors are critical in their examination of home outfits. All radio users should have lightning arresters to conform with the above rulings.

"Little Joe" is your one best bet. Supplied through your Dealer.

E. H. FREEMAN ELECTRIC CO., Trenton, N. J.

Manufacturers of "Circle F" Wiring Devices

Triple Range



Low Loss

The True Measure of Efficiency

0.1 ohm is the resistance of the

CONNECTICUT

D-10

Triple Range Variable Condenser

at a capacity of 330 micro-microfarads on a wave length of 215 meters.

This is a statement that means something.

Those who know that the losses of a condenser are in direct proportion to its resistance—

Those who have learned that measurements taken at radio frequency are much more valuable than those taken at audio frequency—

Those who can see the importance of judging the efficiency of a condenser for amateur and broadcast work on results obtained at a frequency in the immediate vicinity of that at which it is to be used—

Will see in the above the real reason why this condenser should be used by all who wish to obtain the greatest degree of signal strength and sensitivity from their receiving equipment.

Three Condensers in One

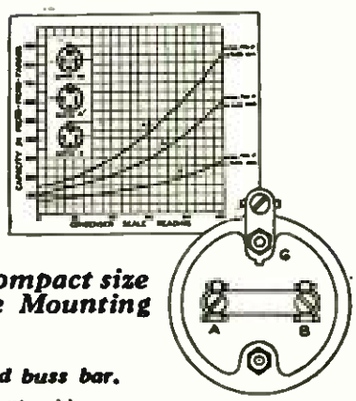
These three ranges of capacity enable it to take the place of the ordinary eleven, twenty-three and forty-three plate instruments.

The chart tells the story—

The range indicated by Curve B—from .000075 to .000275 mfd.—approximately that of an eleven plate condenser, is secured by wiring into the circuit from posts G and B.

The range indicated by Curve A—from .0001 to .0006 mfd.—approximately that of a twenty-three plate condenser, is secured by wiring into the circuit from posts G and A.

The range indicated by Curve AB—from .00015 to .00085—approximately that of a forty-three plate condenser is secured by bussing A and B and wiring into the circuit from G and B.



FEATURES: Vernier Scale—Complete Shielding—Compact size And all the convenience that goes with One-hole Mounting

PRICE $4.50

Complete with dial, index stud, spacing washers and buss bar.

Send for Bulletin A-104 describing this unique instrument, with information and diagrams illustrating its special applications.

CONNECTICUT TELEPHONE & ELECTRIC COMPANY
MERIDEN RADIO DIVISION CONNECTICUT

The New Melco Supreme Kit!

THE Melco Supreme Kit is ready for you! Follow the detailed blue prints and book of instructions and you can build at much less than regular cost the popular Melco Supreme. Melco is accepted as the greatest and most consistent long distance receiver available. It is supersensitive — has extreme selectivity — is exceptionally clear and tunes with the greatest of ease! Own a Melco Supreme — build it with the Melco Supreme Kit!

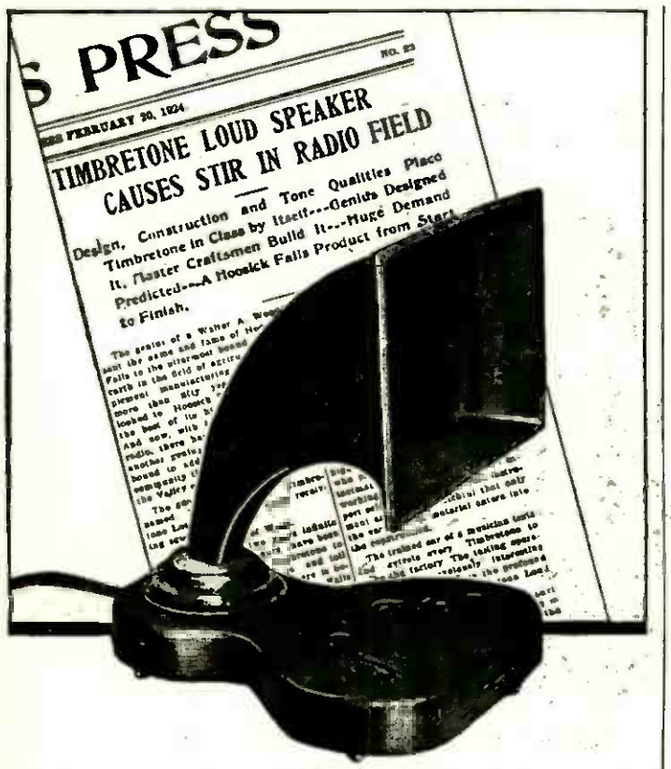
Write for Complete Literature on Parts and Sets

Kit Contains:

1—Telos Variometer
1—Telos Vario-Transformer, 1st stage
1—Telos Vario-Transformer, 2nd stage
3—4" Amsco "Vernigrip" Bakelite Dials
2—Amsco Compensating Condensers
1—By-pass .5 mfd. Condenser
1—Grid Leak and Holder
1—Antenna Series Condenser
1—.005 mfd. Condenser
1—.00025 mfd. Condenser
1—100 Ohm Tube Protective Resistance
Blue Prints and Book of Instructions

Every instrument laboratory tested
and unqualifiedly guaranteed

AMSCO PRODUCTS, INC.
Broome and Lafayette Sts., New York, N. Y.



(Made in Hoosick Falls, N. Y., by the Timbretone Mfg. Co.)

THE immediate response to our advertisement of last month prompts us to make a last minute change in this copy.

Orders received from all parts of the country have simply swamped us and we ask your indulgence in the shipping of your order in its turn.

We hope this condition will not arise again and find us wanting.

Those who have heard TIMBRETONE are unstinting in their praise. There is a treat in store for those who have not. Go to your dealer and ask him to order one for you. If either he or you are dissatisfied return it to us and your money will be refunded. If no dealer is available write us direct.

It is all wood—the older it grows the better it gets.

Retails at $20.00

How to Get the Best Results from Your Radio Set

First of all, remember that *good panels* are absolutely necessary — because the greater the volume and surface resistivity of the panels, the less surface-leakage and power-loss in your set.

Also remember that to get the best results you should use a new, *sharp* drill with *slight* pressure.

There is no longer any incentive to buy inferior panels, for the best panels made—

ELECTRASOTE
REG. U.S PAT OFF
TRADE MARK

RADIO PANELS

can be bought at any good Radio Dealer's Store

At 25 to 50% Less

than any other standard panel

Electrasote is one of the "Sote" products of world-wide fame introduced by THE PANTASOTE CO., INC.

All Standard Sizes

JOBBERS AND DEALERS: Write for our interesting proposition.

M. M. FLERON & SON, INC.

Exclusive Sales Agents for Electrasote Radio Panels

Trenton, New Jersey

Announcing:—

A New Magnavox
M4
requiring no battery

THE supreme achievement of Magnavox engineers represented in a Reproducer of truly *exquisite* tone quality.

The superb tone quality of M4 results from the perfection of the Magnavox semi-dynamic operating principle incorporating; *first*, a new magnetically balanced armature; *second*, an improved type of diaphragm supported by hollow rubber gaskets; and *third*, an extremely high resistance winding which makes M4 unusually sensitive.

Price $25.00

Beautifully finished in dark enamel with gold high lighting.

Equipped with flexible cord and Weston plug ready to connect as simply as a head set.

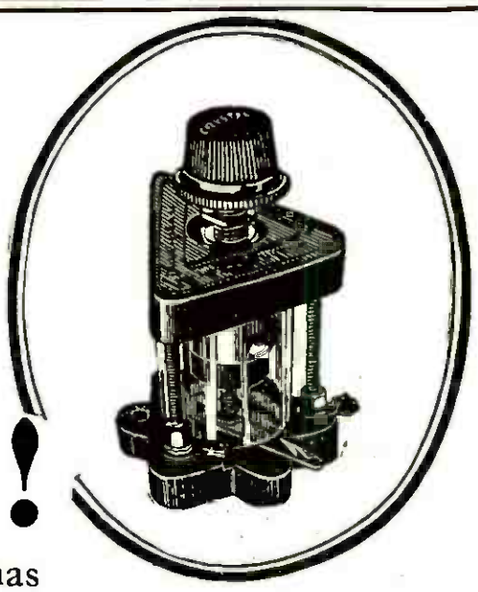
Magnavox M4 and other Magnavox Radio Products can be had of good dealers everywhere

THE MAGNAVOX CO., OAKLAND, CALIF.
New York Office: 351 West 31st Street
Canadian Distributors: Perkins Electric Limited, Toronto, Montreal, Winnipeg

MAGNAVOX
The Reproducer Supreme

6R

Reflex Problem SOLVED!



AT last the experimenter who has searched for the ideal crystal can depend upon a perfect detector. The New Freshman Double-Adjustable Crystal Detector has met every requirement of the ideal unit. It affords uninterrupted, noiseless, distortionless reception, yielding extraordinary volume with entire absence of squeals and howls often introduced by vacuum tube detectors.

Note These Exclusive Features:

1. Turns the crystal without disturbing the contact pressure.
2. Non-metallic housing prevents short-circuiting noises during adjustment!
3. Mounts neatly on the panel with only small knob showing!
4. Contact cannot be jarred from sensitive spot!
5. Adjustable at panel, also at base, with tension adjustment additional!
6. Super-Crystal withstands high voltages!
7. Loop-end contact permits complete coverage of crystal with gliding movement!
8. Rigid construction!

Hundreds of enthusiastic users of the new Freshman Detector are proclaiming it by far the best detector ever offered. Manufacturers of Reflex receivers, tuned radio frequency, "Supers," and similar circuits are specifying Freshman's for their crystal detectors. More for your money than in any detector ever offered!

What one Editor said of the Freshman Crystal

"The new Freshman 'double-adjustable' crystal detector 'stayed put,' even when the set was deliberately shaken, stood up to 130 volts on the plate circuit without noise or distortion," *wrote editor of New York Evening World's Radio Magazine in an article of March 19th, 1924. And in a review he continued:* "This detector meets every requirement of the reflex circuit.

"It is enclosed and provided with two adjustments, one varying the position of the crystal, and the other regulating the brush contact adjustment.

"The crystal is a pure natural ore and is embedded in an insulated housing, thus eliminating short circuits and consequent loud noises resulting from the cat whisker touching the metal housing.

"The Freshman detector can be panel mounted with only a small knob showing. All around it is the best crystal detector unit found for reflex work."

FRESHMAN

Double-Adjustable Crystal Detector

For base or panel use, complete with super crystal

$1.50

Freshman Super Crystal With Non-Metallic Housing 50c

No more searching for the sensitive spot—merely turn the knob as you would a dial!

FREE—Write for building plan of New York Times Reflex. Gives panel layout, list of parts required, etc. Operates loud speaker on two tubes. Ask for circular C-102.

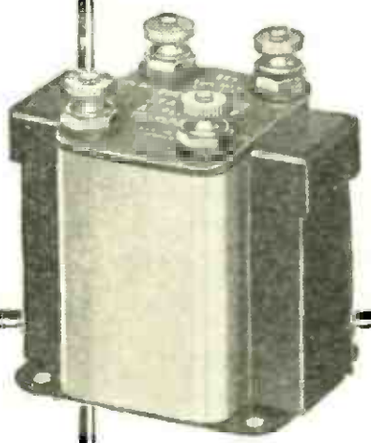
Chas. Freshman Co. Inc.
Radio Condenser Products
106 Seventh Avenue, New York City

Other Freshman products include variable grid leaks, fixed mica condensers, variable condensers, Antenellas, resistances, by-pass condensers, etc. At your dealer's, or, send purchase price and you will be supplied postpaid.

THE PERFECT REPRODUCER

3½-1 = Ratio
$4.00

6-1 = Ratio
$4.50



SUPER TRANSFORMER
(AUDIO FREQUENCY)

Did you ever realize that the small reproducer which rides the record is the most vital part of your phonograph? The most elaborate phonograph made with a poor reproducer would be worthless as a musical instrument.

The reproducer of your radio set is your amplifying transformer.

The Thordarson Super Transformer was designed and built with one primal aim,—perfect reproduction. It is the result of the combined efforts of Thordarson engineers and nationally known tone experts and musicians.

Thordarson amplification provides the finishing touch of refinement for your receiver—"that breath of life," you have so long sought.

THORDARSON THREE STAGE AMPLIFICATION USED BY KENNEDY AND ZENITH

For a year both of these manufacturers have used the Thordarson Super Transformer exclusively in both their two stage and three stage amplifiers. That's irrefutable proof of Thordarson excellence. These transformers are so well constructed electrically, and so completely shielded, that they can be placed side by side, even in a three stage amplifier, and still be free from distortion and howling.

Even Amplification Over the Entire Musical Range

THORDARSON
ELECTRIC MFG. CO.
CHICAGO, ILLINOIS

Eagle Neutrodyne Balanced! RADIO RECEIVER

Licensed by Independent Radio Manufacturers, Inc., under Hazeltine Patent No. 1,450,080, dated March 27th, 1923, and other patents pending.

EVERYWHERE the EAGLE leads! Fine balance of tube capacities—perfect as the balance of the experienced structural iron worker. Quality, the sum total of infinite skill and years of experience. Until others can successfully duplicate the exceptional skill in balancing and testing of each receiver, there can be no real rival of the EAGLE. A product of "quality" rather than quantity production. Stations located instantly by turning dials *always* to the same points.

Easy to operate as a phonograph

Unreservedly guaranteed.

Write for Literature

WE SOAR ABOVE
EAGLE RADIO COMPANY
NEWARK NEW JERSEY

18 Boyden Place

Atlas
TRADE MARK

RADIO-REPRODUCTION LOUD SPEAKER

"The Musician of the Air"

Presidential Conventions

The Republican Convention, Cleveland, June 10
The Democratic Convention, New York, June 24

Complete $25

Atlas Unit with phonograph coupling..... **$13.50**

A Message to the Public!

THE very next best thing to being actually present at these two events, of national and international importance, is to hear their ATLAS Re-PRODUCTION. Bring these momentous proceedings and orations right into your home in all their original naturalness for the entertainment and instruction of your family and friends. Get *all* of these speeches, every word clearly inflected, in the full, undistorted tones of the speaker. Just as realistic as though you were actually there. Buy your *Atlas* NOW!

Booklet "B" Upon Request

Multiple Electric Products Co. Inc.

Makers of Mono—TIME-LAG FUSES—Multiple

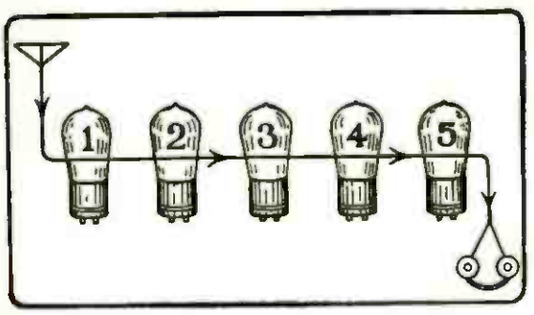
2 ORANGE STREET :: NEWARK, N. J.

District Offices in

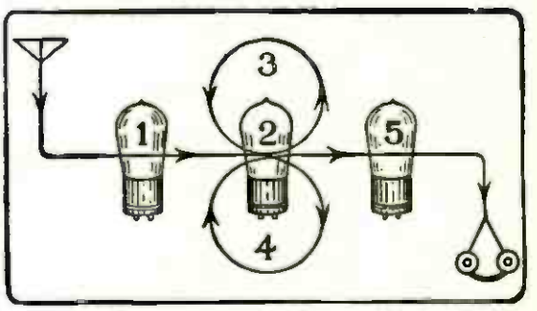
BOSTON, MASS. PHILADELPHIA, PA. BALTIMORE, MD.
PITTSBURGH, PA. DETROIT, MICH. CHICAGO, ILL. ST. LOUIS, MO.
DENVER, COLO. SAN FRANCISCO, CAL.

Sole Canadian Distributors, Marconi Wireless Telegraph Co. of Canada Ltd., Montreal, Canada

Why Use Five Tubes
To Do the Work of Three?



Three tubes, duo-reflexed as shown at the right, are fully equal to five tubes in conventional sequence.



The most important advance in coupling methods of late years is Erla Selectoformer, materially improving range, selectivity and volume. $5

Erla Push-Pull transformers handle output of five-watt power tubes, using as high as 350 volts on the plate, without distortion. Pair $10

Exclusive, double, tilting springs of Erla Sockets give clean, wiping contact essential to low amperage tubes. List 65c and 75c

FIVE stages of amplification with only three tubes—this is the secret of the amazing coast-to-coast loud speaker range of the Erla three-tube Duo-Reflex circuit, surpassing all but the most elaborate hook-ups in volume.

Erla Duo-Reflex action (patent applied for) enables vacuum tubes to do triple duty, as simultaneous amplifiers of received radio, reflexed radio and reflexed audio currents, multiplying efficiency while reducing cost.

Indispensable to the practical application of this principle, and the foundation of its success, are Erla synchronizing transformers.

Accurately superimposing (1) received and reflexed radio, and (2) rectified radio and reflexed audio currents, in their coincident passage through amplifying tubes, they eliminate all trace of distortion. Only those who have actually heard Erla performance can realize the vast improvement in tone quality resulting.

Other Duo-Reflex advantages, for example, the fool-proof tuning control, giving an accurate log of stations together with freedom from radiation, have equally scientific origin.

Erla Selectoformer, tested capacity condensers, and fixed crystal rectifier spell outstanding advancement in their respective fields.

For complete Erla circuits, ask your dealer for Bulletin No. 20; or write, giving his name.

Electrical Research Laboratories
Dept. R 2500 Cottage Grove Ave., Chicago

ERLA

Unduplicated sensitiveness, range and volume, from 200 to 700 meters, are assured through employment of Erla reflex transformers. List $5

Even three stages fail to impair the distortionless performance of Erla audio transformers, an achievement unduplicated. List $5

Any panel is improved 100% by Erla bezels, finished in bright nickel or dull enamel, with telescoping rim to fit ⅛" to ¼" thick material. 20c

STATEMENT OF THE OWNERSHIP, MANAGEMENT CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, OF POPULAR RADIO
Published monthly at New York, N. Y., for April 1, 1924.

STATE OF NEW YORK } ss.
COUNTY OF NEW YORK }

Before me, a Notary in and for the State and county aforesaid, personally appeared Douglas H. Cooke, who, having been duly sworn according to law, deposes and says that he is the Business Manager of POPULAR RADIO, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, POPULAR RADIO, Inc., 627 West 43rd Street, New York; Editor, Kendall Banning, 627 West 43rd Street, New York; Managing Editor, Katrine A. Campbell, 627 West 43rd Street, New York; Business Manager, Douglas H. Cooke, 627 West 43rd Street, New York. 2. That the owner is: POPULAR RADIO, Inc., whose stockholders are: New Fiction Publishing Corporation, 627 West 43rd Street, New York City, whose stockholders are: Douglas H. Cooke, 627 West 43rd Street, New York City; George d'Utassy, 465 East 57th Street, New York City, Vernal W. Bates, 46 George Street, New Haven, Conn.; Wiley Blair, 4607 Ross Avenue, Dallas, Texas; Harold B. Emerson, 9 East 40th Street, New York City; William Green, 627 West 43rd Street, New York City; *Harris Corporation, 34 Pine Street, New York City; Le Roy Sargent, St. Petersburg, Fla.; Abel I. Smith, 120 Broadway, New York City; Louis H. Strouse, Samuel Falk and Frank C. Fisher, Trustees in bankruptcy of Metropolitan Finance Corporation, 9 East 40th Street, New York City. *Harris Corporation with the following as Trustees in dissolution of Harvey Fisk & Sons (1921) now dissolved: John J. Donovan, 30 Church Street, New York City; Harvey Fisk, 34 Pine Street, New York City; Wilfred Jessup, Connersville, Ind.; Henry W. Peacock, Jr., 34 Pine Street, New York City; Joseph M. Shellabarger, 30 Church Street, New York City. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) DOUGLAS H. COOKE, Business Manager.

Sworn to and subscribed before me this 8th day of April 1924.

SEAL] JOSEPH T. COONEY, *Notary Public.*

My commission expires March 30th, 1926.

Earn $5.00 to $20.00 a Day in RADIO

You can! Hundreds of ambitious men are already earning thousands of dollars in this wonderful new industry—many working only in their spare time. Mail coupon below for Free Book which describes fully the amazing money making opportunities in Radio and tells how YOU can earn from $5,000 to over $10,000 a year!

THE astounding growth of Radio has created thousands of big money opportunities. Millions of dollars were spent during the past year on Radio—and thousands of young men are needed right now to meet the ever increasing demand of work. Never before have there existed so many and such remarkable opportunities for making money in this wonderful new field.

Men are needed to build, sell and install Radio sets—to design, test, repair—as radio engineers and executives—as operators at land stations and on ships traveling the world over—as operators at the hundreds of broadcasting stations. And these are just a few of the wonderful opportunities.

Easy to Learn Radio at Home in Spare Time

No matter if you know *nothing* about Radio now, you can quickly become a radio expert, by our marvelous new method of practical instruction—instruction which includes all the material for building the latest up-to-date radio apparatus.

Scores of young men who have taken our course are already earning from $75 to $200 a week. Merle Wetzel of Chicago Heights, Ill., advanced from lineman to Radio Engineer, increasing his salary 100% *even while taking our course!* Emmett Welch, right after finishing his training started earning $300 a month and expenses. Another graduate is now an operator of a broadcasting station PWX of Havana, Cuba, and earns $250 a month. Still another graduate, only 16 years old is averaging $70 a week in a radio store.

Wonderful Opportunities

Hardly a week goes by without our receiving urgent calls for our graduates. "We need the services of a competent Radio Engineer"—"We want men with executive ability in addition to radio knowledge to become our local managers"—"We require the services of several resident demonstrators"—these are just a few small indications of the great variety of opportunities open to our graduates.

Take advantage of our practical training and the unusual conditions in Radio to step into a big paying position in this wonderful new field. Radio offers you more money than you probably ever dreamed possible—fascinating easy work—a chance to travel and see the world if you care to or to take any one of the many radio positions all around you at home. And Radio offers you a glorious future!

Send for FREE BOOK

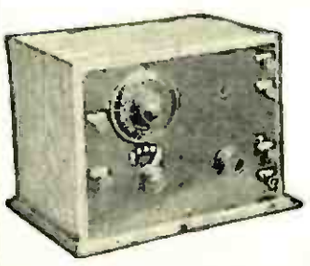
Learn more about this tremendous new field and its remarkable opportunities. Learn how you can quickly become a radio expert and make big money in Radio. Find out what remarkable successes our graduates have had—even a few weeks after their training finished.

We have just prepared a new 32-page booklet which gives a thorough outline of the field of Radio—and describes our amazing practical training in detail. This Free Book, "Rich Rewards in Radio," will be sent to you without the slightest obligation. Mail coupon for it *now*!

National Radio Institute

Dept. 32FA Washington, D. C.

1000 Mile Radio Set FREE



In order to complete your practical instruction at home, learning by actual experience, this splendid regenerative receiving set is now included in addition to material for building the latest up-to-date receiving sets without the slightest additional cost.

Fresco Reg. License Armstrong U. S. Patent No. 1113149

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Radio Firms Secure practical Radio Experts among our graduates. Write us today.

$25 for $10

THE FAMOUS

THE ACOUSTICAL AMPLIFIER
BEL-CANTO
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LOUD SPEAKER

Price $10

Delivered Free to your Door

Guarantee

Money back anytime within ten days if dissatisfied. We further guarantee to the publication carrying this advertisement that each and every speaker will be sold on the above terms and the instrument will be exactly as offered in this issue.

You cannot buy the BEL-CANTO through any dealer—only direct from us, the manufacturers. We save you these three profits—Distributor, Jobber and Dealer

7 Points of BEL-CANTO Superiority

1. Fiber Horn, Crystalline finish.
2. Our own adjustable unit.
3. Heavy metal base, eliminating top heaviness.
4. All other metal parts heavy cast Aluminum highly polished.
5. Height 22", Bell 10".
6. Guaranteed one year against mechanical defects of any kind.
7. No extra battery required, just plug in on the phone circuit.

Call at our factory, send us your check, money order, or pay the postman $10.00. Prepaid to any part of U. S. and Possessions.

SENT FREE RADIO LOGGING CHART—GET ONE

BEL-CANTO MFG. CO.

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417-419-421 E. 34th St., New York City
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NOTHING IS WORTH WHILE UNLESS IT IS "RELIABLE"

Tune In On
The Station You Want
With Dependable Results

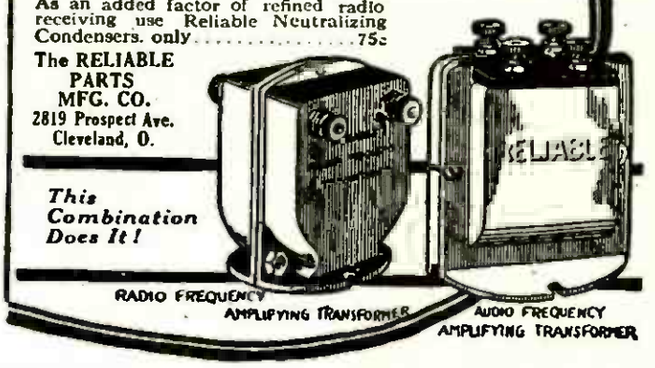
Are you master of your radio set or do you simply trust to luck in getting distant stations?
You can get both distance and volume with

RELIABLE AUDIO and RADIO FREQUENCY TRANSFORMERS

Three stages of Audio Transformers to select from.
2 to 1 and 4 to 1 ratios at.....$4.45
6 to 1 ratio at.....4.95
Radio types from 150 to 750 meter ranges.....2.75
As an added factor of refined radio receiving use Reliable Neutralizing Condensers. only.....75c

The RELIABLE PARTS MFG. CO.
2819 Prospect Ave.
Cleveland, O.

This Combination Does It!



"Madera" Clearspeaker Stands Lots of Punishment

No. 804 here illustrated is ideal for vacationists. Stands only 12 inches high with a broad secure base.

"Madera" Artificial Wood is twice as dense as natural wood—stands moisture, heat, and hard knocks.

Yet, its acoustic properties are marvelous—resembling a rare old violin. It is also largely neutral to the discordant vibrations of summer static.

Price by parcel post prepaid anywhere in the U. S. only . . . **$15.00**

When you order, give name and address of your favorite radio dealer.

AMERICAN ART MACHE CO.
351 W. Austin Ave., Chicago, Ill.

Charge Your Battery For A Nickel

The Gold Seal Homcharger charges Radio and Auto Batteries at home overnight for a nickel. Your dealer has it. Write for FREE booklet and list of broadcasting stations.

The Automatic Electrical Devices Co.
132 West Third St., Cincinnati, Ohio

Add Miles and Smiles with Branston Standard Radio Parts.

Branston Kit No. R-99

$36.50

In the Summertime—You Need the Best Receiver You Can Build

Branston Honeycomb Coils and Geared Back and Front Panel Mountings. Best for Selective Tuning.

All sizes; mounted or unmounted. Note sturdy, substantial, permanent construction and beautiful finish. Genuine Bakelite used throughout. Licensed under De Forest patents.

Send 2c stamp for New Honeycomb Coil Hookups.

Compiled by experts and includes five good Honeycomb Coil "Hookups" and complete catalog of famous Branston Radio Apparatus.

Build a Super Heterodyne Receiver that will bring in whatever you want in the Summertime, when adverse atmospheric conditions demand the best instrument you can get. (And remember, when next Winter's big radio programs come in, you will have the best possible receiver to get them.)

Branston Kit No. R-99 contains 1 Oscillator Coupler, complete with mounting brackets, bank wound inductance and adjustable coupling coil with locking device; 3 Intermediate Radio Frequency Transformers. Very sharply tuned and completely shielded; 1 Special Transfer Coupler for first or last stage of Intermediate Frequency; and 1 Specially designed Antenna Coupler so that either loop or antenna can be used. This apparatus has been specially designed for Super Heterodyne, Ultradyne, and similar circuits. It has been rigorously tested and proved better than any heretofore obtainable.

"Super Heterodyne Construction"

Our Book (one dollar) explains operation of Super Heterodyne receivers, gives circuit diagram and full size panel layout. It contains complete directions for building a Super Heterodyne Receiver that will be extremely selective, free from interference, and in fact, better than any other radio-receiving method. The amateur, with this book, can easily build a superior receiving instrument.

CHAS. A. BRANSTON, Inc.

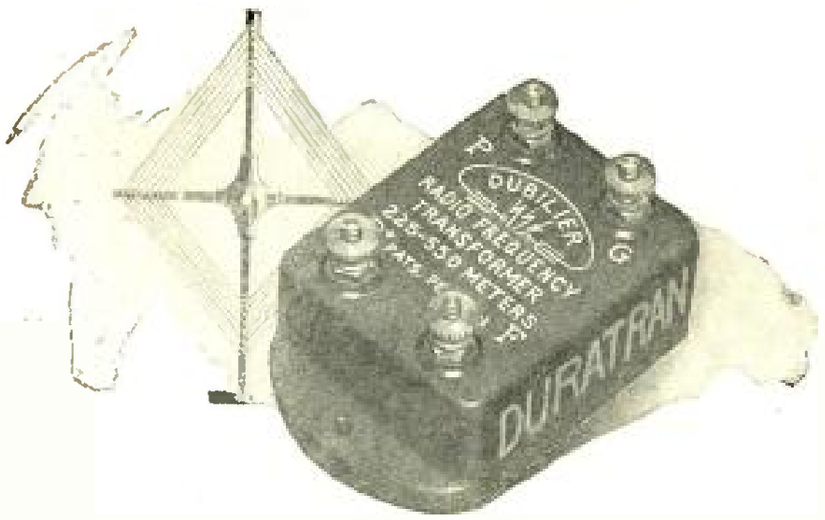
811 Main Street :: :: :: Buffalo, N. Y.

In Canada — Chas. A. Branston, Ltd., Toronto
Branch Office: London, Eng.

Manufacturers of Branston Violet Ray High Frequency Generators

BRANSTON RADIO

Reg. U. S. Pat. Office



—for unrivaled summer reception
The Dubilier Duratran and a Loop

Less static is picked up with the indoor loop, especially the directional loop, than with an antenna.

Combine the indoor loop with the Dubilier Duratran radio-frequency transformer, and you make DX summer reception perfect.

The Duratran amplifies powerfully and uniformly over the entire band of broadcasting wave lengths. The Duratran dampens the longer static waves and amplifies the waves sent from the broadcasting station. Broadcast music and speech predominate over static.

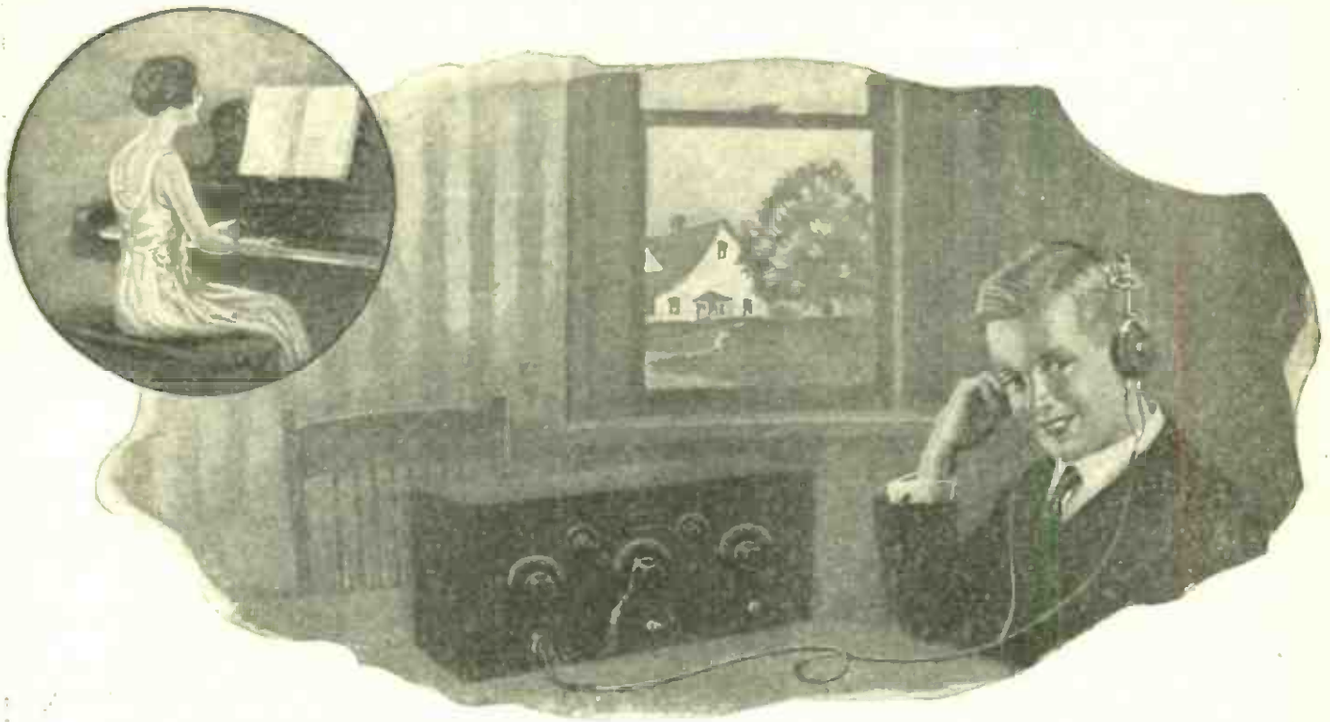
The indoor-loop and one or two stages of Duratran radio-frequency amplification—the combination can't be beaten for summer reception.

Free Blueprints of R. F. Hook-ups

Ask your dealer for free blueprints of Duratran hook-ups. If he has none write for them to us and give us his name.

Dubilier Condenser and Radio Corporation

40-50 West 4th St., New York



You hear each note
as if you were right there

NO MATTER how fine a receiving set you have —it is no better than the headphones you use. Connect a pair of Murdocks to your receiver —and tune-in on local or distant stations. It's the real thing. Voices and music come in mellow and true — clearly and with wonderful volume. Just as if you were in the same room.

Murdock Radio Phones represent the highest acoustical efficiency. Particular attention is given to the proper seating and clamping of the diaphragms. This prevents distortion. The sensitive diaphragms translate radio signals into the natural sounds of voice and music.

Their extremely light weight enables the user to wear Murdocks for hours without discomfort. The head-band is of new design, flat and yielding, and will not bind the head. Ear caps are especially designed to exclude outside noises. There are no screws on the head-band or adjusting rods.

Built, not assembled

Murdocks are made in a single unit, of superior moulded insulation. Each part is fitted by one process into its proper place. They are moulded together — assuring firmness, strength and durability. And they can't get out of adjustment

Murdock Radio Phones are the result of 20 years of research and effort to make a high grade head 'phone that sells at a moderate price. Over 1,000,000 Murdocks are in use today. Quantity production has enabled us to standardize our quality and price — so that when you buy a Murdock you are sure of getting the best possible 'phone value. Buy a Murdock today and test it out. They are fully guaranteed.

Murdock 'Phones and Plugs at your nearest dealer

WM. J. MURDOCK COMPANY 374 Washington Avenue, Chelsea, Mass.

Branch Offices: **Chicago and San Francisco**

MURDOCK
RADIO PHONES
Standard since 1904

—MAIL COUPON FOR FREE BOOKLET—

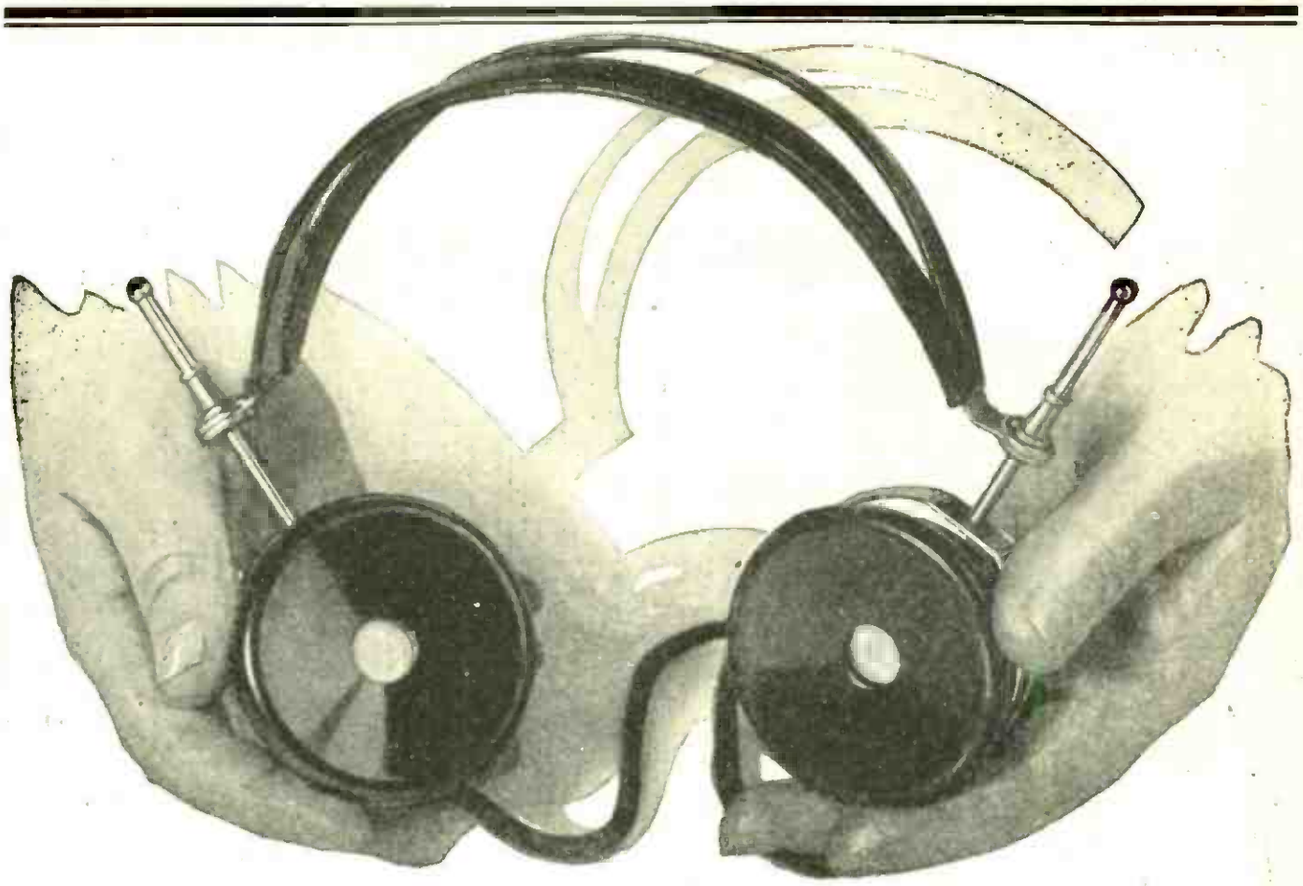
Wm. J. Murdock Co.
374 Washington Ave., Chelsea, Mass.

Gentlemen: Please send me, without obligation, your free booklet, "The Ears of Radio," which explains the importance of radio 'phones to efficient radio reception.

Name .....

Street .....

City ..... *State* .....



The Phones with the New Idea

N & K Head Sets mark a new era in radio reproduction—an era of *clearness* and *naturalness*. Designed especially for the reception of *musical tones*, they record the entire range of the human voice and of musical instruments with extreme clearness and freedom from distortion. This is due to mechanical design different from that of any head set produced in America. The *extremely careful quality of workmanship* used is almost impossible to obtain in this country.

Sold on a comparison basis

If, when you use N & K Phones on your own radio set, you do not find that they reproduce all the tones more clearly and naturally than any set you ever used before, and if they do not fit more comfortably, the store where you bought them will refund your money, promptly and cheerfully. We protect dealers and replace any returned phones.

N & K Head Set, Model D, 4000 ohms, has extra large diaphragms and ear caps, insuring better reproduction, better comfort and the exclusion of outside sounds. Sanitary, leather-covered head bands. Six feet of stout cord. Retail price $8.50. Write for "*The Phones the Fans Are Talking About*," interesting new descriptive folder.

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Dept. P6. 15 William St., NEW YORK
Exclusive Distributors for U. S., Canada and Mexico

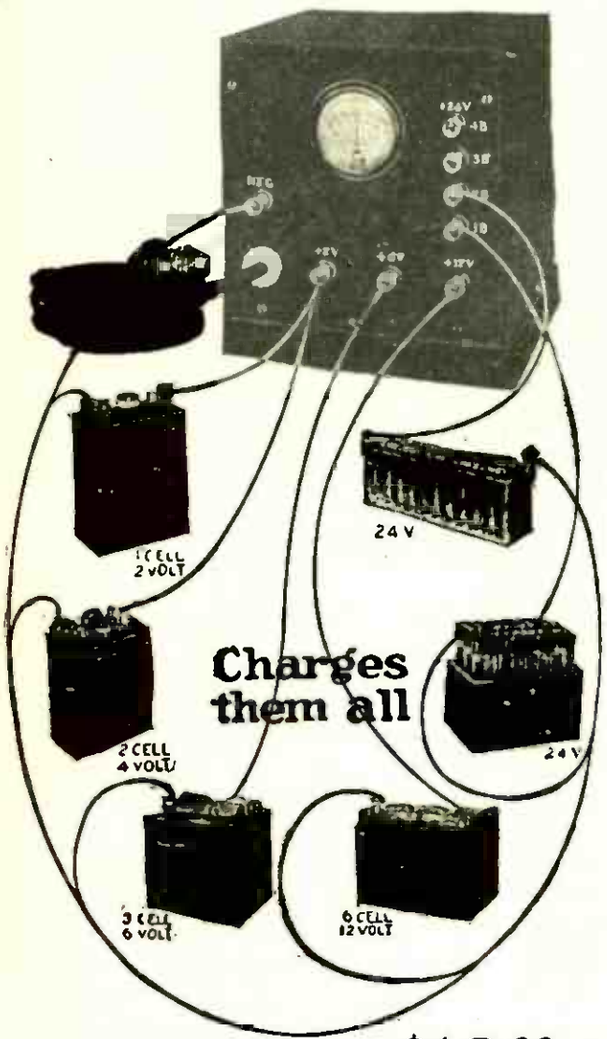
N & K

Imported
PHONES

DEALERS: N & K Phones provide the high spot in the radio stocks of dealers all over America. Backed by advertising and strong sales co-operation, they are proving attractive profit-makers. Packed in cartons of ten, with display material.

N&K KING OF THE AIR TRADE MARK

ULTRA HANDY CHARGER



ULTRA MODEL $18.00

Note

"Handy Charger" Features

No bulbs to break.
No acids to spill.
No fast-wearing parts.
No auxiliaries necessary.
No sticking contacts.
No wood used—Fireproof.

Beautifully finished Case — automatic in operation. Costs less than 1 cent per hour to run. Ask your dealer. Illustrated descriptive folder on request. Write us.

INTERSTATE ELECTRIC CO.
of St. Louis, Mo. 4015 Laclede Ave.

FRESHMAN NOISELESS TESTED MICA CONDENSER
MFG. BY CHAS. FRESHMAN CO. Inc. NEW YORK CITY
PATENTS PENDING

ACCURATELY RATED CONDENSERS *for* CRITICAL CIRCUITS

Through the accuracy and dependability of Freshman Noiseless Tested Mica Condensers, hookups and circuits have been perfected which have completely revolutionized the art of radio reception.

The Freshman is so designed that constant equal pressure is exerted on the condenser plates over the entire area. They are the only condensers that have this construction and therefore the only ones that avoid noises, due to variable pressure on the plates.

All capacities—from 35c up.

Ask your dealer for prices on all capacities of Freshman Fixed Condensers. He has them in stock.

"To Receive The Long Distance Smile, —get Freshmans!"

Write for circular M-1, giving complete information and prices on our entire line.

Chas. Freshman Co. Inc.
Radio Condenser Products
106 Seventh Avenue, New York

NA-ALD

De Luxe Dials

The artistic qualities of Na-ald De Luxe dials distinguish these dials as truly beautiful. They add to the appearance of any set in which they are used.

Na-ald Dials have a high gloss finish. They are moulded of genuine Bakelite and have patented construction. Dials are matched and made in 2", 3", and 3¾" sizes.

Alden Manufacturing Company
Largest makers of Radio sockets and dials in the world
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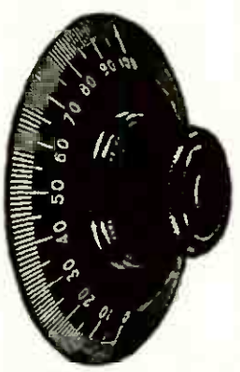

No. 3003—4
3 Inch
35c, 3 for $1.00

SOLDER WITH INSULATION
At Least 1,000 Miles More Distance

is the usual reward if you can solder without impairing the insulation of your set.

If you are building a radio-frequency amplifier you should read our free booklet:

"HOW TO SOLDER RADIO SETS"
Write for it
THE VALLEY FORGE CHEMICAL CO., Valley Forge, Pa.

Radio HARTMAN Products

HARTMAN ELECTRIC CO.
MANSFIELD, OHIO.

Your Choice! —for Only 35 Cents in Stamps!

Hundreds of reliable hook-ups and circuit diagrams—practical hints and handy knacks—money-saving tips and pointers on how to make and improve your own sets. Take your pick of all this authoritative information on radio!

PERHAPS you haven't realized what a tremendous amount of information is available in the back issues of POPULAR RADIO. Since the first number was published, May, 1922, literally hundreds of requests have come to us for these valuable back issues of POPULAR RADIO which contain so many practical hints and worth-while suggestions.

There are still a few copies left of many of these back issues. *While they last* you can take your pick of them at only 35 cents each, to cover cost and mailing. Here's your opportunity to complete your files of POPULAR RADIO and to add to your store of information on just the subjects which interest you.

Glance over this partial list of contents of each issue. Then tell us which ones you want, enclosing stamps, check or money order to cover your requirements. Our stock is getting very low, so don't delay taking advantage of this offer!

May, 1922

—Harnessing waves to wire.
—How to tune a Regenerating Receiver.
—Symbols that help in reading diagrams.
—How to make soldered connections.
—How Radio waves are sent and received.

June, 1922

—Wireless that we can see.
—Can we talk to the dead by Radio?
—How electricity is generated.
—Tones that do and don't broadcast.
—How to make a simple tube Receiving Set.

July, 1922

—Steinmetz on ether waves.
—How to learn the code.
—How to make a two-circuit Receiving Set.
—How high frequency currents are generated.
—Pointers for preventing interference.
—How to make a loose-coupler coil.

August, 1922

—How machines are controlled by Radio.
—How Radio circuits are coupled and tuned.
—What "call letters" mean.
—How to make a variable condenser.

September, 1922

—How to build the Armstrong Circuit Receiver.
—A resonance wave coil for reducing static.
—How to make a rotary plate condenser.
—The simplest receiving antenna.

October, 1922

—How to make a spider-web tuner.
—How to make your own grid condenser.
—Don'ts for Radio fans.
—How to use a Regenerative Set as a transmitter.
—How to restore worn-out crystals.

November, 1922

—Sir Oliver Lodge on ether waves.
—How to add a Vacuum Tube to your crystal set.
—The most popular transmitting aerial.
—How to make a novel variocoupler.

December, 1922 (Out of stock.)

January, 1923 (Out of stock.)

(A Reprint of Mr. Cockaday's article describing the DX Regenerative Receiver may be had for 25 cents.)

February, 1923 (Out of stock.)

March, 1923 (Out of stock.)

April, 1923 (Out of stock.)

May, 1923 (Out of stock.)

(A full description, however, of Mr. Cockaday's original 4-Circuit Tuner will be found in POPULAR RADIO'S handbook, "How to Build Your Radio Receiver," advertised on pages 70 and 80.)

June, 1923

—How the microphone transmitter works.
—How to build a good single tube receiver.
—How to make a crystal detector stand.

July, 1923

—The ratio in size between your antenna and your coil.
—Useful facts about ear-phones.
—How to make a dry-cell tube Regenerative Set.
—How to keep up your storage battery.

August, 1923 (Out of stock.)

(A full description, however, of the Tuned Radio Frequency Receiver will be found in POPULAR RADIO'S handbook, "How to Build Your Radio Receiver," advertised on pages 70 and 80.)

September, 1923

—How to get a radio license.
—How weak signals are regenerated.
—How to make a battery charging rectifier.
—How to build the Haynes DX receiver.

October, 1923

—Practical hints for Coil Calculations.
—How to make a Two-stage Audio-frequency Amplifier.
—Ten good rules for Broadcast Listeners.
—How to make a simple Honeycomb Receiver.

November, 1923

—The 100 Best Hook-ups (Part 1).
—Receiving without Antennas.
—How to build the New Regenerative Super-heterodyne Receiver (Part 1).
—How to build a combination Short and Long-wave Receiver.

December, 1923

—How to Select your Radio Parts.
—The 100 Best Hook-Ups (Part 2).
—How to Read a Diagram (Part 1).
—How to Build an efficient Crystal Receiver.
—How to Build the Super-heterodyne Receiver (Part 2).

January, 1924 (Out of stock.)

February, 1924

—How to add "Push and Pull" amplification to the original 3 tube Cockaday 4-Circuit tuner.
—The original 4-Circuit Tuner as a Portable Set with Loop.
—The 100 Best Hook-ups (Part 4).
—How to build a 3-tube Reflex. Receiver (Part 1).

March, 1924

—Hoffman Transformer Measurement Chart.
—The 100 Best Hook-ups (Part 5).
—How to Build an Amateur Transmitter.
—A 3-tube Reflex Receiver (Part 2).

April, 1924

—How to Build a Simplified Neutrodyne Receiver.
—The 100 Best Hook-ups (Part 6).
—How NOT to Tune the Single Circuit Receiver.
—A Novel Substitute for "B" Batteries.

May, 1924

—A Compact Radio Kit for a Spring Hike.
—How to Get the Maximum Radio-frequency Amplification.
—Getting Static's Autograph
—100 Best Hook-ups (Part 6).
—A measurement Chart for Use in Designing a Rheostat.
—Where Interference Comes In.
—How to Make an Audio-frequency Amplifier that Does Not Distort.

POPULAR RADIO, INC.

627 West 43d Street **Dept. 68** **New York City**

Build It Right!

Blueprints, accurate and so simplified that knowledge of radio symbols is unnecessary. Your choice of two receivers and an amplifier.

IN constructing any radio apparatus you will find POPULAR RADIO BLUEPRINTS time saving, money saving and labor saving—three outstanding features that will appeal to you.

EACH set consists of three prints; (A) Panel Pattern; (B) Instrument Layout; (C) Wiring Diagram.

Panel Pattern.

This blueprint is the exact size of the actual set. So accurate that you need merely lay it on your panel and drill as indicated. You can readily appreciate the convenience of this Blueprint. No scaling to do, no danger of ruining the panel through faulty calculation.

Instrument Layout.

Again you have an actual size print of each instrument and binding post and its exact location both on the panel and within the cabinet. Even the cabinet structure is clearly shown.

Wiring Diagram.

The unusual feature of this Blueprint is that it is a **full size picture diagram** of the finished set. Each instrument or other part appears exact size and the wires are so clearly traced from one contact to another that you can connect all terminals accurately without even knowing how to read a hook-up diagram.

Blueprints Ready.

At the present time three sets of Blueprints are available and have been priced at the very low figure of $1.10 per set, postpaid. Each set consists of three Blueprints and we cannot break a set to supply single prints.

"Improved" Cockaday 4-Circuit Tuner was described in the January, 1924, issue of POPULAR RADIO. It is a simplified regenerative set that can be built with about $95.00 worth of parts. It provides for automatic tuning, practically unlimited distance range, maximum volume of sound, excellent reproduction and no interference.

Set of three constructional Blueprints $1.10.

The Non-Regenerative (Simplified Neutrodyne) Tuned-Radio-Frequency Receiver, described in the April, 1924, issue of POPULAR RADIO, can be built with parts costing about $70.00. This circuit has remarkable sensitivity and is notable for its ease of control, distance range and clarity of reception.

Set of three constructional Blueprints, $1.10.

In the May, 1924, issue of POPULAR RADIO, is a complete description of an **Audio-Frequency Amplifier.** This is a newly developed type of amplifier that is entirely unmarred by distortion. The parts will cost about $45.00.

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For convenience use the coupon below in ordering sets of Blueprints. If you desire any of the descriptive articles mentioned above, refer to page 76 in the advertising section of this issue.

POPULAR RADIO, INC.

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627 West 43rd St., New York City Date.....

Enclosed is my remittance of $....., for which kindly send me Blueprint Set (s) consisting of Panel Pattern, Instrument Layout and Wiring Diagram as checked below:

- ☐ **"Improved" Cockaday 4-Circuit Tuner.**
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Any one set of three Blueprints for $1.10; any two sets for $2.20; all three sets for $3.30

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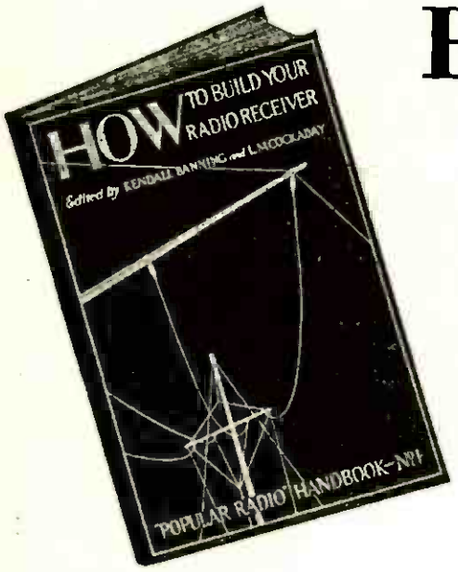

Copies will be given away to all who request them before present limited supply is exhausted.

POPULAR RADIO'S HANDBOOK is too valuable to give away. Its tremendous popularity has convinced us of this. So as soon as the Second Edition is gone no more will be offered on the present terms.

A beginner with no previous technical training or knowledge will find this book invaluable. Clear, concise diagrams and instructions, easily understood, accompany every set described. And there is a wide selection from which to choose.

"How to Build Your Radio Receiver" gives complete specifications for the construction of *seven* separate and distinct receiving sets—covering the most remarkable range and variety of circuits, from the most modern simple crystal set to the famous Super-heterodyne.

All working details are given—the list of parts required and their approximate cost; complete hook-ups and circuit diagrams and *how to read them;* illustrations making all points clear, and simple instructions on how to assemble, mount, wire and operate each set.

100 PAGES
Size 7¾ x 11¼ inches

Edited by
Kendall Banning and
L. M. Cockaday

—How to build a Crystal Set.
—How to build the Haynes Single Tube Receiver.
—How to build a Two-Stage Audio-Frequency Amplifier.
—How to build the Original Cockaday 4-Circuit Tuner.
—How to build a 5-Tube Tuned Radio-Frequency Receiver.
—How to build the 5-Tube "Improved" Cockaday 4-Circuit Tuner.
—How to build the Regenerative Super-heterodyne Receiver.
—How to add "Push and Pull" Amplification to the Original Cockaday 4-Circuit Tuner.
—How to read a Diagram.
—How to put up an Outdoor Receiving Antenna.
—List of U. S. Broadcasting Stations of 50-watt Power and up.
—Ten good Rules for Broadcast Listeners.
—Practical Pointers for Getting Best Results.

Ready Reference Guide

In this new book edited by Mr. Banning and Mr. Cockaday, you will also find scores of valuable suggestions about aerials, how to select your parts, how to install your set, tips on tuning and how to learn the code.

In all, a book you will not want to be without—one that will be worth many dollars to you. Yet, if you act at once, it will cost you not a penny. We will send you a copy of this valuable handbook absolutely free with a year's subscription to POPULAR RADIO.

The demand for the first edition encouraged us to print a much larger second edition. But it is evident that we were too conservative. Soon the second edition will be exhausted and when it is gone we positively cannot fill any more orders for a free copy with your annual subscription.

So if you would avoid disappointment, fill out the Coupon printed on the opposite page for your convenience and mail it at once. It will bring by return post this big 100 page cloth bound volume of practical information that you require. Our unconditional money back guarantee protects you fully, so act quickly.

THE universal verdict acclaims "How to Build Your Radio Receiver" as the outstanding radio contribution of the year. The purpose of the editors was to provide a dependable working guide for the construction and operation of receiving sets that would enable beginner or expert alike to build a set that would exceed expectations in the final results. Their choice included seven representative circuits that in laboratory tests had proved most nearly ideal from the viewpoint of selectivity, tone, volume, distance, simplicity of construction, ease in tuning, reliability and general all-around satisfaction. That the editors have achieved their aim is evident from the large number of letters received by us daily.

You will find sets employing both crystal and vacuum tube detection, with regenerative amplification, audio-frequency amplification, "push and pull" power amplification, radio-frequency, *compensated* radio-frequency and *intermediate* wave radio-frequency amplification.

You have your choice of crystal, one-tube, three-tube, five-tube, six-tube or eight-tube sets—as broad a selection as could be desired, all clearly illustrated, diagrammed and described in the simplest possible terms.

And best of all, if you act quickly, this remarkable handbook will come to you FREE with your year's subscription to POPULAR RADIO at the mere price of the magazine alone—only $3.00.

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If you are not *more than satisfied* with this great bargain, simply notify us within 10 days and your money will be refunded without question. Just fill out the handy coupon below. A FREE copy of "How to Build Your Radio Receiver" will be sent you, postage prepaid, at once. Your yearly subscription to POPULAR RADIO will also be entered at once.

POPULAR RADIO, Inc.

627 West 43d Street :: New York City

What Readers Say

"'How to Build Your Radio Receiver,' is one of the most complete books of its kind I have ever seen. I wish that all the books that come to my notice were as worthy of commendation as this one."

ROBERT S. WOOD, Radio Editor,
New York Evening World.

"Mr. Banning and Mr. Cockaday have compiled a book which deserves to rank high in the estimation of amateur set builders. The typography is excellent, the diagrams clear and easily read, and the whole manner of presentation far superior to anything that has thus far been attempted by a radio publisher."

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"To say I am surprised and delighted puts it too mildly. I knew that any book that POPULAR RADIO put out would be good; but I had no idea that I would receive such a big and truly valuable book as 'How to Build Your Radio Receiver.' A whole year of POPULAR RADIO, with this wonderful book free, is the biggest $3 value I've ever had."

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"In one evening I built a set following the easy instructions in your book, and my friends are all jealous of me now."

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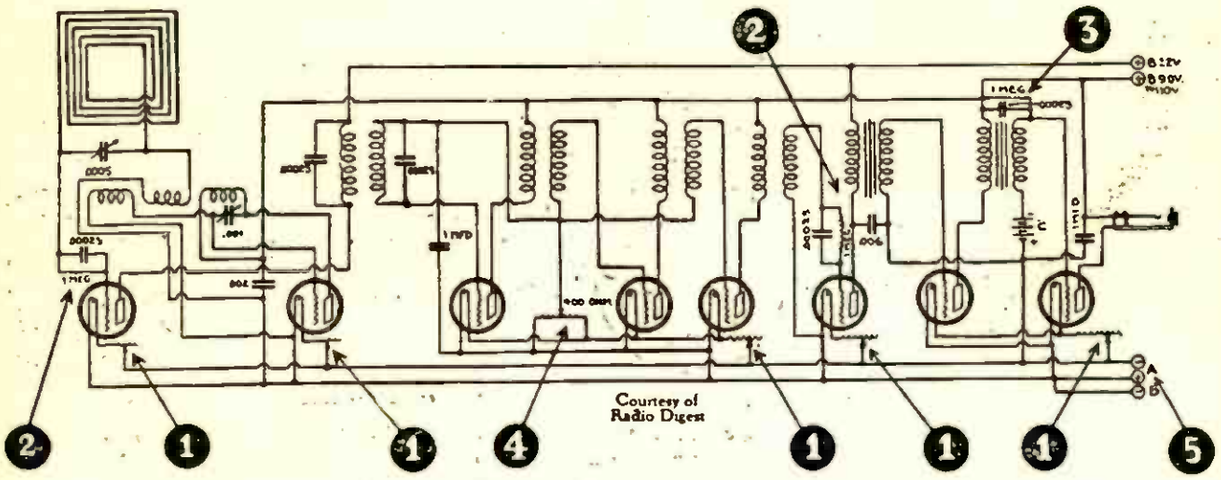

For the Super-heterodyne

Bradleystat

PERFECT FILAMENT CONTROL

For all tubes. Provides a stepless, noiseless range of control that simplifies tuning and oscillator control. Holds the record for long range tuning.

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THE PERFECT GRID LEAK

Provides a stepless range of grid leak control from ¼ to 10 megohms. Furnished with or without grid condenser rated at 0.00025 m-f.

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THE PERFECT RESISTOR

Made in three ranges:—10,000 to 100,000 ohms; 25,000 to 250,000 ohms; 50,000 to 500,000 ohms. Ideal for use as fixed or adjustable resistors.

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THE PERFECT POTENTIOMETER

Made in 200-ohm and 400-ohm ratings for all circuits. Gives a smooth, stepless range of potential control, so essential for super-heterodyne circuits.

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PERFECT BATTERY SWITCH

A compact, enclosed battery switch which requires only one hole in panel to mount it. Nickel-plated and well built. Should be installed in every set to protect tubes against accidental burning. Saves time, tubes, and batteries.

THIS remarkable radio receiver, when properly constructed, is a marvelous hook-up for selective tuning and long range. It is gaining in popularity, everywhere, and is destined, no doubt, to become one of the leading types of receivers among discriminating radio enthusiasts.

The surest way to build a successful super-heterodyne receiver is to use only the finest parts. Among the important items are the adjustable grid leaks, potentiometers, special resistors, filament rheostats, and battery switches. In fact, there are no parts more important than the grid leaks and condensers.

For these parts, standardize on Allen-Bradley radio products listed on this page. They represent the experience of rheostat designers with more than twenty years of training in this important field. Attempts have been made, from time to time, to imitate Allen-Bradley radio products, but without avail. They stand supreme in their field, and with a record of successful performance that places them in the front rank of high-grade radio products.

Mail this Coupon for Radio Bulletins

If you will drop this coupon in the mail, with your name and address, we will send you a complete set of folders describing Allen-Bradley radio products in detail. Be sure to get this information before you lay out your super-heterodyne receiver.

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Manufacturers of graphite disc rheostats for over 20 years

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Please send me, by return mail, a complete set of your radio folders on Allen-Bradley radio products. RUSH.

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Approved by Over 200 Experts
New Crosley Engineering Achievement

A THREE tube set with five tube efficiency—the greatest selectivity with the minimum effort—positive calibration to any wave length between 200 and 600 meters.

It was only after a year of constant experimenting, that our engineering department perfected this exceptional receiver. Thorough tests proved to us that it would out-perform any receiver ever before produced. We shipped out 200 of these sets to experts in every part of the United States. Their criticisms are one and the same—"tried out your new Trirdyn Receiver Saturday night and logged 13 stations, among them Cuba, New York and Omaha, between 9 and 10 o'clock. The set was very selective. During the time this test was on, local station KSD was operating and we went through them without any difficulty or interference whatever."

This new Crosley triumph is called the Trirdyn because of its original combination of the three "R's"—Radio frequency amplification, Regeneration and Reflex. The first tube incorporates non-oscillating, non-radiating tuned radio frequency amplification; the second tube, a regenerative detector reflexed back on the first tube for one stage of audio frequency amplification. Then it has a third tube which acts as a straight audio frequency amplifier. It uses the ultra selective aperiodic antenna circuit and external selector coil, which adds to its wonderful selectivity.

The Crosley Trirdyn in range, volume and selectivity is the equal of any five tube receiver on the market. Any type of tubes can be used and either indoor or outdoor antenna.

The opinions of many experts have convinced us that the Trirdyn is the best receiver ever offered the public regardless of price.

Practically every radio dealer can furnish you Crosley Radio Sets

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

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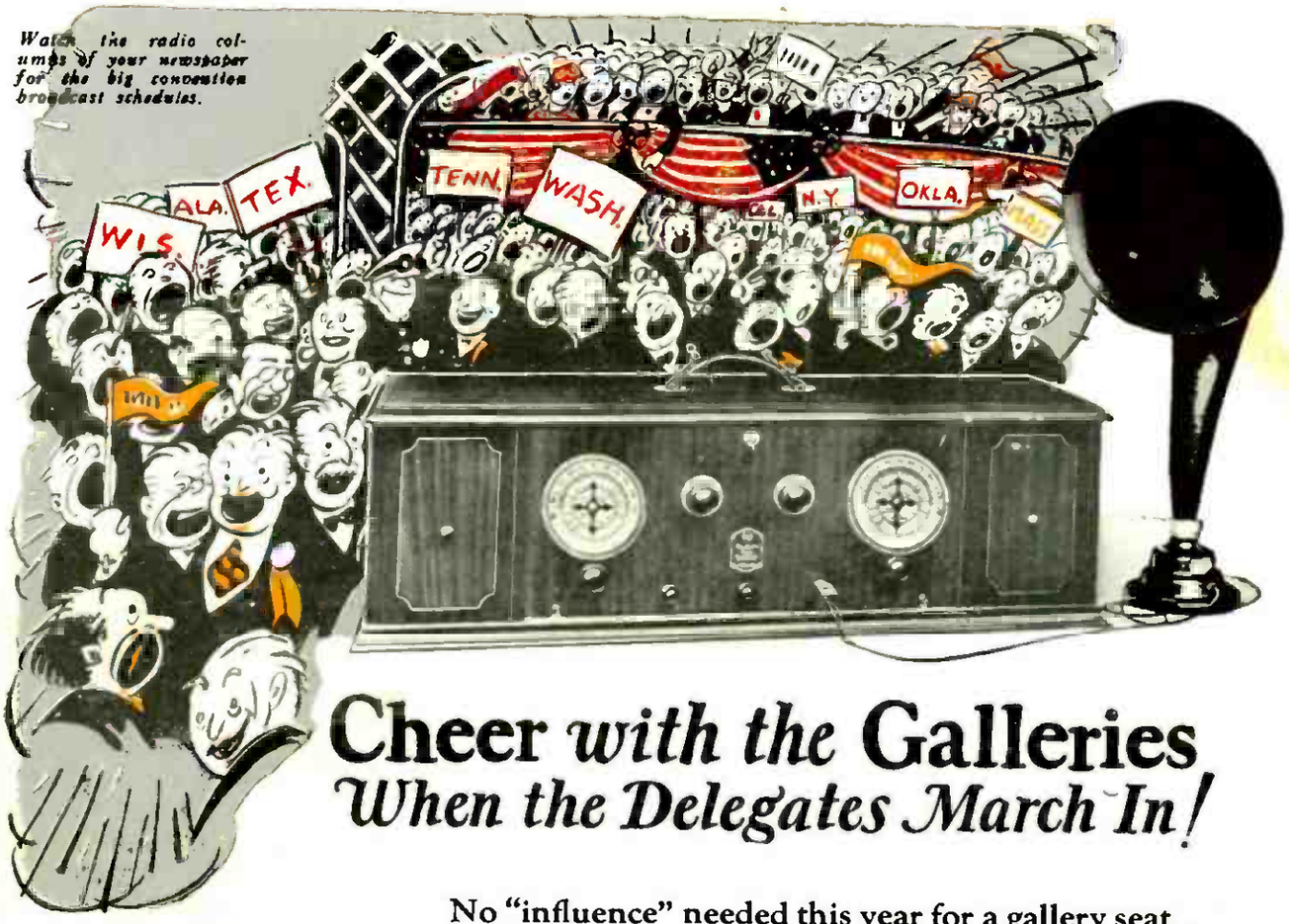

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When the Delegates March In!

No "influence" needed this year for a gallery seat at the big political conventions! Get it all with a Radiola Super-Heterodyne.

When the delegates march in—their banners streaming; when the bands play and the galleries cheer—be there with the "Super-Het." Hear the pros and cons as they fight their way to a "platform" for you. Hear the speeches for the "favorite sons." The sudden stillness when the voice of a great speaker rings out. The stamp and whistle and shrill of competitive cheering. Hear the actual nomination of a president.

It used to be all for the delegates' wives and the "big" folks of politics. Now it's for everybody. Listen in. Get it all! With the *newest* Radiola.

Radiola Super-Heterodyne

It needs NO ANTENNA—no ground—no connections of any kind. Has a handle to lift it by. Tunes in with just two knobs that you turn to marked spots on the dials. Tunes out powerful near stations to get the far ones. A wonderful new achievement in the perfection of its tone—its sensitivity—and its supreme selectivity!

Complete with six Radiotrons UV-199 and Radiola Loudspeaker; everything except batteries . . $286

• • •

External, rotating loop, easily assembled, larger than self contained loop in Radiola Super-Heterodyne, for extreme reception range.
Loop AG 814 . . . . . $12.00

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There are many Radiolas at many prices. Send for the free booklet that describes them all.

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