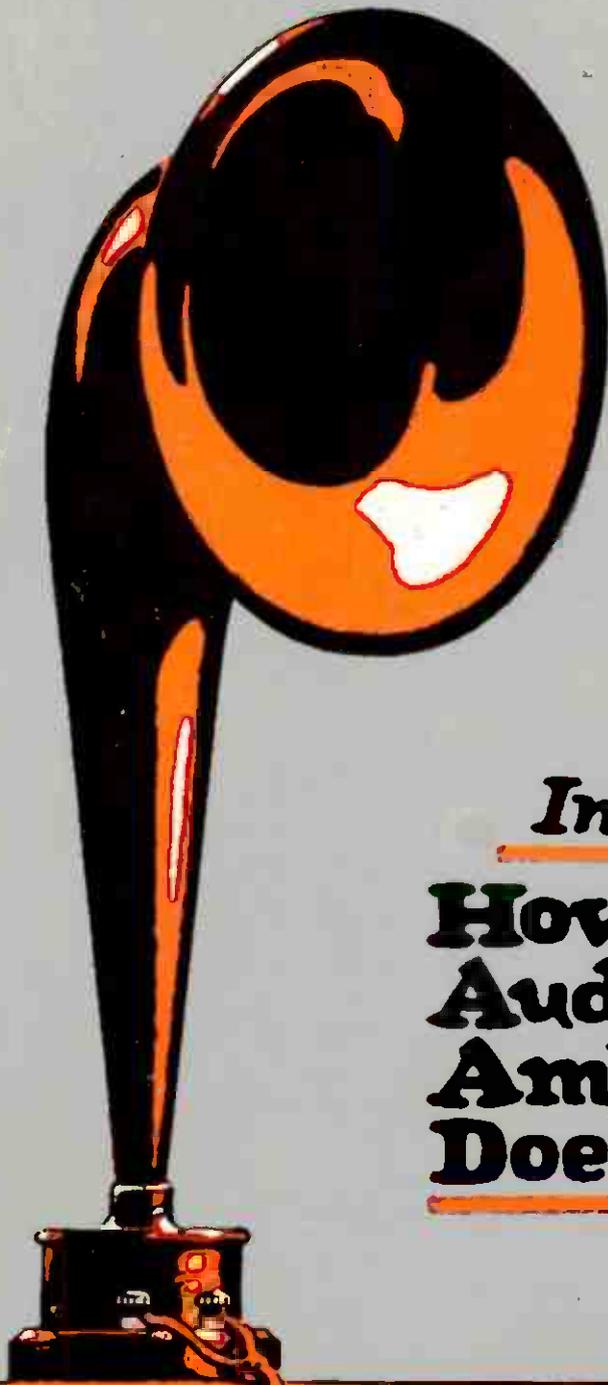


Popular Radio

Edited by **KENDALL BANNING**

MAY 1924

25¢



In this Number

**How to Make an
Audio-frequency
Amplifier that
Does Not Distort**



\$35 for a two tube Radiola



This symbol of quality is your protection.



Radiola III

At \$35

Radiola III. Two Radiotrons WD-11. Head telephones. In brief, everything except the dry batteries and the antenna.

You Can Add

Radiola Loudspeaker . . . \$36.50
Radiola Balanced Amplifier (push-pull) together long distances with a loudspeaker. Including two Radiotrons WD-11, \$30

Or Buy Complete

RADIOLA III-A, the amplifier combined with Radiola III in one cabinet; with four Radiotrons WD-11, head telephones and Radiola Loudspeaker, \$100

A NEW two-tube RADIOLA—designed and built by world-famed engineers in the great RCA laboratories—priced at less than you could build it for at home! A real RADIOLA—including the tubes and headphones. A new model. Improved in sensitivity and selectivity. Getting distance on the headphones, and near stations on a loudspeaker. Receiving clearly—reproducing truthfully. Its thirty-five dollar price means at last that every home, everywhere, can tune in on the fun with a small receiver built for big performance.

There are many Radiolas at many prices. Send for free booklet that describes them all.

Radio Corporation of America

233 Broadway
New York

Sales Offices:
10 So. La Salle St.
Chicago, Ill.

433 California St.
San Francisco, Cal.

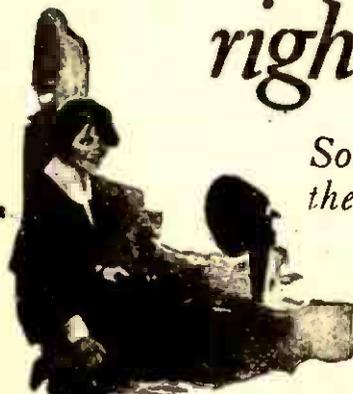
RADIO CORPORATION OF AMERICA
Dept. 45 (Address office nearest you).
Please send me your free Radio Booklet.

Name _____
Street Address _____
City _____ R. F. D. _____
State _____

Radiola

REG. U.S. PAT. OFF.

Better Radio— right through the summer!



Some three million more listeners than there were last year—and they'll all have a season of real enjoyment!

ALL through the country fans are headed straight for the most amusing and enlightening season that radio ever offered. Daily treats! Daily helps! Daily marvels!

Three Main Developments

contribute to the tremendous step-ahead of this summer's radio regime. Better programs—stronger broadcasting—clearer reception.

Better Programs

Selected more keenly—and chosen according to the tastes of the vast audience whose opinions are molding the quality and tone of the programs. An outstanding feature will be the coming presidential campaign. All important messages of all the parties will be broadcasted. More churches are planning to send their services to vacationists. Sports will be vividly and adequately reported. All round programs—packed with vital interest—art—news—home hints—business—fun—good music!

Better Sending and Receiving

Sending over diversified wave lengths to permit greater selectivity. More powerful sending stations—interconnections of important stations for simultaneous broadcasting of messages of national import—rebroadcasting from high power stations through sub-stations located at distant points. All these make for more satisfactory reception. And the vast improvements in sets and circuits, in tubes and loudspeakers assure clearer and truer reception. Surely this will be a season of jollity and interest. Tune in—and get the good things that crowd the air!



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

- 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

Brandes

The name to know in Radio

© C. Brandes, Inc., 1924

Please refer to POPULAR RADIO when answering advertisements.

POPULAR RADIO

EDITED by KENDALL BANNING



CONTENTS for MAY, 1924

(Cover design by Frank B. Masters)

VOLUME V	NUMBER 5
Radio-operated Code Machines in a Newspaper Office.....	FRONTISPIECE
What is Radio Doing to Our Newspapers?..... <i>Marlen E. Pew</i>	Page 423
Melting Metals by Radio..... <i>E. F. Northrup</i>	430
A Compact Radio Kit for a Spring Hike..... <i>H. W. Sinclair</i>	438
How to Get the Maximum Radio-frequency Amplification..... <i>George Lewis</i>	442
How Radio Locates Ships at Sea..... <i>S. R. Winters</i>	449
Getting Static's Autograph..... <i>Austin Bailey</i>	450
How to Test Telephone Receivers..... <i>J. T. MacGregor-Morris</i>	454
What Can We Do With 3,000,000 Volts?..... <i>Thomas Elway</i>	456
100 Best Hook-ups..... <i>Technical Editor</i>	463
Installation No. 6	
How Radio Saved a Sailing Ship..... <i>Armstrong Perry</i>	468
A Measurement Chart for Use in Designing a Rheostat..... <i>Raoul J. Hoffmann</i>	470
Article No. 8	
Where Interference Comes From.....	473
How to Make an Audio-frequency Amplifier That Does Not Distort..... <i>Laurence M. Cockaday</i>	476
Will Radio Create a New Kind of Dramatic Writing? An Interview with—..... <i>Edward C. Carpenter</i>	486
Underground Radio Telegraph..... <i>S. R. Winters</i>	490
DEPARTMENTS	
Broadcasts..... <i>David Lay</i>	493
What Readers Ask..... <i>Laurence M. Cockaday</i>	498
Facts You Hunt For..... <i>Richard Lord</i>	504
Hints for Amateurs..... <i>Albert G. Craig</i>	506
In the World's Laboratories..... <i>E. E. Free</i>	508
Listening In..... <i>Kendall Banning</i>	516
"Stations I Have Heard".....	521
With the Inventors..... <i>Thomas Elway</i>	523

VOLUME V

MAY, 1924

NUMBER 5

Published monthly by Popular Radio, Inc., 627 West 43rd St., New York, N. Y., telephone number Chickering 1906; Douglas H. Cooke, President; Kendall Banning, Treasurer. Price, 25 cents a copy; subscription, \$3.00 a year in the U. S., Canada and all countries within the domestic postal zone; elsewhere, \$3.50 a year, payable in advance. The International News Company, Ltd., No. 5 Bream's Bldg., London, E. C. 4, sole distributors in England. Entered as second class matter April 7, 1922, at the Post Office at New York, N. Y., under the act of March 3, 1879. Copyright, 1924, and title registered as a trade-mark by Popular Radio, Inc. Copyright in Great Britain by Popular Radio, Inc., 6 Henrietta St., Covent Garden, W. C., London, England. Printed in U. S. A.

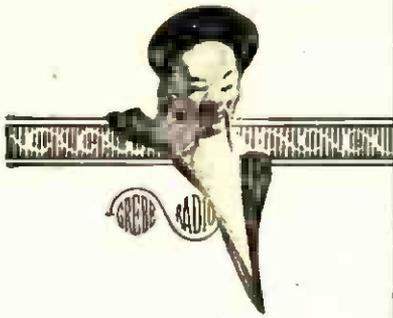
E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

For advertising rates address

E. R. Crowe & Company, Inc.

New York: 25 Vanderbilt Ave.

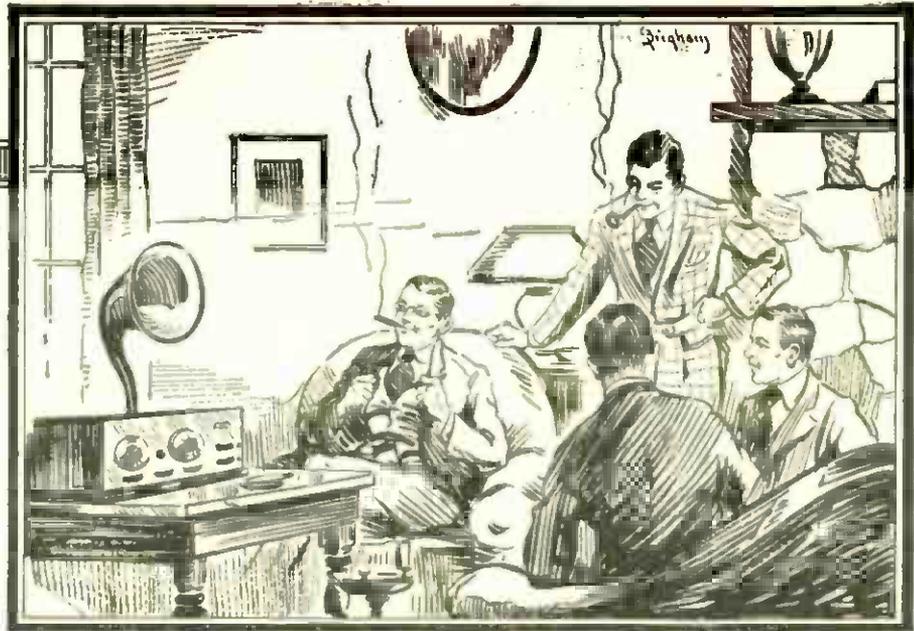
Chicago: 225 North Michigan Ave.



"The gods cannot help one who loses opportunities."
—Mencius

If you are wise you will lose none of the opportunities for entertainment that a Grebe Broadcast Receiver will bring.

Doctor Hux



Trustworthy Performance

WHETHER the evening's feature be the broadcasting of the World's Heavyweight Championship or a Sunday Night Concert, you will anticipate it with keen pleasure and confidence when you tune in with your



Type CR-12. A 4-tube Receiver combining Regeneration and Tuned R.F. **\$175⁰⁰**
(Accessories extra)

GREBE Broadcast Receiver

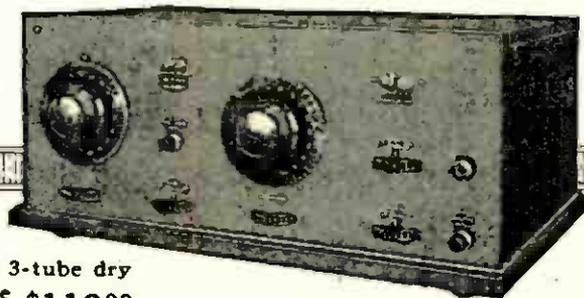
Made in two easily operated types, in which every detail of craftsmanship is an assurance of trustworthy performance.

Each Instrument is the result of more than ten years of radio manufacturing experience.

Ask your Dealer or write us for literature

A. H. GREBE & CO., Inc.
Van Wyck Blvd., Richmond Hill, N.Y.

Western Branch: 451 East 3rd Street, Los Angeles, Cal.



Type CR-14. A 3-tube dry cell Regenerative Receiver **\$110⁰⁰**
(Accessories extra)

Licensed Under
Armstrong U.S.
Pat. No. 1,113,149

Please refer to POPULAR RADIO when answering advertisements.

PAGES WITH THE EDITOR

WITH this number POPULAR RADIO celebrates its Second Anniversary—with a bigger and (we believe) better magazine than has ever been issued before.

Two years ago this month, POPULAR RADIO started out as a modest little publication of only 72 pages. This present number that you have in your hands now contains 220 pages—a growth of over 300 percent!

Two years ago the well-known amateur, William Andrew Mackay (2AQB) called personally at our office and paid in cash the first subscription to be entered in our books. Today that list has grown to 34,000—the largest subscription list of any radio magazine in the country.

DURING the last six months of 1923 (according to the figures of the Audit Bureau of Circulation) the total net sales of this magazine showed the extraordinary gain of 92 percent—an increase that (so far as we know) marks POPULAR RADIO as “the fastest growing radio magazine in the world.”

WHY POPULAR RADIO is leading all other magazines in circulation gains may be explained in two ways.

First; because it is giving the radio amateurs and broadcast listeners the practical, helpful and interesting articles that they most want to read;

Second; because it includes among its contributors the foremost scientists, inventors, writers and radio experts of the world.

HERE, for example, is a partial list of some of the world-famous authorities who contribute to POPULAR RADIO—a list of such extraordinary distinction as to prompt one reader to refer to POPULAR RADIO, not only as “the leading magazine in the radio field, but one of the most distinguished class magazines of our time.”

Sir Oliver Lodge (British), Dr. Lee De Forest, Dr. Elihu Thomson, Dr. Irving Langmuir, Senator Guglielmo Marconi (Italian), John Hays Hammond, Jr., Nikola Tesla (Serbian), Hudson Maxim, Prof. J. H. Morecroft, Prof. James A. Fleming (British), Dr. Charles P. Steinmetz, Dr. Ernest Fox Nichols, M. Edouard Belin (French), Laurence M. Cockaday, Major-General George O. Squier, John V. L. Hogan, Sir Joseph J. Thomson (British), Paul Godley, Hiram Percy Maxim, Raymond Francis Yates, Jesse Lynch Williams, Will Irwin, Waldemar Kaempffert, Ellis Parker Butler, William G. Shepherd, Gerald Stanley Lee, Fred C. Kelly, Gelett Burgess, Dr. Austin Bailey, Powel Crossley, Jr., Prof. Gordon D. Robinson, Lt. Commander Fitzhugh Green, George Creel, Homer Croy, Howard Brubaker, Harry Houdini, Commander S. C. Hooper, Dr. G. W. Pickard, Prof. Reginald A. Fessenden, Henry

D. Hubbard, Harold P. Donle, J. C. Gorman, Dr. Clayton H. Sharp, James H. Collins, Dr. Hereward Carrington, Leroy Scott, Mrs. Christine Frederick, Armstrong Perry, Dr. E. E. Slosson, Forrest Crissey, Percy Mackaye, Morris S. Strock, E. L. Hall, Dr. Emil Wiechert (German), Capt. H. J. Round (British), Dr. Louis Cohen, Gen. Gustave Ferrié (French), Prof. A. M. Low (British), Marlen E. Pew, Orson Lowell, Robert C. Benchley, George H. Doran, Watson Davis, Dr. Henry Smith Williams, Major General J. G. Harbord, Robert G. Skerrett, William J. Burns, Clare Briggs, Hon. John J. Tigert, T. Commerford Martin, Edward R. Hewitt, Don Herold, Dr. Edwin G. Northrop, Dr. Willis R. Whitney, Dr. E. E. Free, Capt. Leon Deloy (French), C. Francis Jenkins, Commandant René Mesny (French).

WITHIN the past seven months POPULAR RADIO has gained 300 percent in advertising—the greatest increase ever achieved by a magazine within an equal period. Now, advertisers give increasing patronage to a particular magazine for just one reason—because that magazine pays advertisers best.

AND this gain of 300 percent is of particular significance because, within this very period, POPULAR RADIO has excluded from its pages a large volume of advertising which it believed to be contrary to the best interest of the radio fan and of the radio industry for the leading radio magazine to continue to carry—general, or non-radio, advertising, cut-rate advertising, and the advertising by fly-by-night concerns.

OUR experiment of reversing the old, standard left-to-right presentation of radio circuit diagrams is meeting with a good deal more than the casual attention of the radio fans. Promptly following the announcement (in our March issue) of our intention to test out the scheme in our April number, the Editor began to receive letters for and against the change; so far he has received five letters in favor of the new right-to-left arrangement to one in favor of the old left-to-right arrangement. Write the Editor and tell which you think is better! (On page 476 of this issue you will find a right-to-left circuit diagram.)

THE first letter to reach the Editor came from the engineering concern of Willis L. Adams of Niagara Falls, N. Y.; it expresses disapproval of the proposed change as follows:

“We cannot see any reason why a radio diagram should read from the right instead of from the left. English speaking people as well as most others read from the left to the right and we cannot see any reason why we should become Orientals and learn to read from the right to the left. The fact that a radio set is

(Continued on page 6)

Dubilier Duratran

reduced from \$5⁰⁰ to

INCREASED production facilities have lowered the manufacturing costs of the Dubilier Duratran Radio-Frequency Transformer.

And the public receives the benefit in a big price reduction.

No Missing Wavelengths With the Duratran

Think what this means.

The Dubilier Duratran is designed to bring in all the broadcasting stations—not just one or two. And it does this with an amplification factor of over twenty for all broadcasting wavelengths.

Every Duratran is carefully tested for stability, amplification and wavelength range before it leaves the factory.

**Dubilier Condenser and
Radio Corporation**
40-50 West Fourth Street, New York

\$4

Write for Free Blueprints of R. F. Hook-ups

Ask your dealer for free blueprints of Duratran radio-frequency hook-ups. If he has none, write to us for them and give us his name.



DUBILIER DEVICES

PAGES WITH THE EDITOR

(Continued from page 4)

reversed while the wiring is being done does not complicate matters at all, as the mind subconsciously reverses the diagram."

* * *

BUT the next few letters that came in were all in favor of the proposed change. Here are quotations from the first three of them:

"I have long been of the opinion that the reverse order to that in which radio diagrams are given would be more logical—so much so that I usually make such a diagram for any particular hook-up that I wish to keep."

—WILLIAM J. MYATT, Philadelphia, Pa.

* * *

"I AM inclined to believe that the change will be welcomed by the bulk of your readers. Personally, a reversed diagram looks funny to me because I've looked at so many with the input at the left, but in actual practice I find little difficulty reversing the plan in my mind; this is undoubtedly due to the fact that my mind has been trained to reverse it. A reversed plan would not be as confusing to me as the old-style plan is to a person constructing his first set; therefore, I am in favor of your idea."

—CHARLES G. KITTNER, Clifton, N. J.

* * *

IN one of the important French radio magazines for January, *La T. S. F. Moderne*, there



"POPULAR RADIO AHEAD OF THE RADIO INDUSTRY"

DURING its first two years of existence POPULAR RADIO has made the wonderful strides necessary to keep it abreast—ahead of—the progress of the industry. The editors and managers are to be congratulated, and basing expectation on past performances, there is no reason to expect but that POPULAR RADIO will still be well in the lead on its next birthday."

—PAUL F. GODLEY.

is a complimentary article by A. Marie on how to build the Cockaday one-tube receiver.

"You will be astonished by the selectivity of this apparatus as well as by its great sensitivity," the author writes. "The results that you will obtain will repay you, I am sure, for the trouble of reading this article and of building the Cockaday apparatus. In particular, although we were using an antenna placed only 400 meters from Station PTT, which is less than the wavelength of this station, we have been able to receive London distinctly."

* * *

STEADILY the circuits developed by and published in POPULAR RADIO are spreading over the world.

* * *

ONE of the most interesting of the "human documents" that have found the way to the Editor's desk during the past month comes from Guatemala in Central America—a tiny republic that is so remote that few of the inhabitants have ever heard of radio and where "no radio apparatus is for sale."

* * *

THIS particular document comes in the form of a letter from M. Turton, who, despite his isolation from the radio world, has all the earmarks of the dyed-in-the-wool fan, with all of the real fan's ingenuity and enterprise. He recently wrote to station KFKX in Hastings, Nebraska; his letter tells his story:

* * *

"I NEVER saw or heard a radio receiving set until November 15, 1923. On that date I had the good luck to get hold of the October number of POPULAR RADIO. I read a few pages in it and became so interested in it that I decided to build a triple-honeycomb-coil set as described in that issue.* The article explained how to make the coils but not how to make the variable condensers. This was a poser, but not for long; I looked through the advertising columns which showed pictures of condensers, these were sufficient to go by. I built a 43-plate and a 13-plate condenser.

* * *

"THE next item was where I was going to get a vacuum tube. Then I thought of the ships that come into Barries, which is the Guatemalan port. Here I was able to buy a UV-201 tube. I put up an antenna 25 feet high at one end and 18 feet at the other end, and 50 feet in length. Then I was ready to go to work—but I am sorry to say that I could not hear anything at all. I played with the thing a week and after making some alterations I listened in on December 20th. Great was my surprise to hear a piano playing! The announcement I could not get well at first, because I did not know how to tune in, but last night I was able to recognize the announcers' voices of station WLW in Cincinnati, Ohio, and KFKX in Nebraska."

* "How to Make a Simple Honeycomb Receiver," by S. Gordon Taylor.

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



Get ready now for summer radio

A GREAT radio summer is at hand. To enjoy summer radio at its best, equip your receiver with the best batteries you can get. Put in new Eveready Radio "B" Batteries and see what wonderful, long-lived service they will give.

Made especially for radio use, Eveready "B" Batteries will operate the loud speaker at maximum volume for long or short periods, depending on how rapidly the current is taken out of them. Packed full of pep and punch and go, Eveready "B" Batteries pour out their power the moment you turn on the tubes.

Eveready "B" No. 767 is the standard amplifier "B" Battery, and gives 45 powerful, dependable, zippy volts. Five sturdy Fahnestock Clips make this big "B" Battery available for detector tube use as well—varying the voltage from 16½ to 22½ as required.

Insist on Eveready "B" Batteries, remembering that they are the product of thirty years of experience and know-how in battery making. For maximum battery economy and service buy Eveready Radio Batteries—they last longer.

Manufactured and guaranteed by

NATIONAL CARBON COMPANY, INC.

Headquarters for Radio Battery Information

New York

San Francisco

Canadian National Carbon Co., Limited

Factory and Offices: Toronto, Ontario



No. 767
"B" Battery
45 volts

Storage
"A"
Battery



No. 766
"B" Battery
22½ volts



No. 7111
Dry Cell
"A"
Battery



No. 764
"B" Battery

No. 771
"C" Battery



EVEREADY Radio Batteries

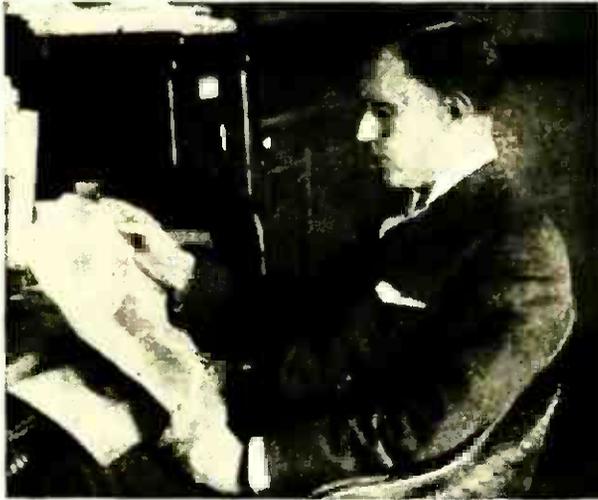
—they last longer

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 Co., Inc., 128 Thompson Avenue, Long Island City, N. Y.

Please refer to POPULAR RADIO when answering advertisements.

PAGES WITH THE EDITOR

(Continued from page 6)



A JOURNALIST'S VIEWS ON THE EFFECT OF RADIO ON JOURNALISM

MARLEN PEW, the author of "What Is Radio Doing to Our Newspapers?" on page 423 of this issue, writes from the point of view of the thoroughly experienced and essentially practical-minded journalist. Beginning as a reporter on the *Cleveland (Ohio) Press* back in 1897, he has had extensive training in the newspaper world; during the World War he came prominently into the public eye as the head of the News Bureau of the War Department, and later as the general manager of the *International News Service*. He is now editor and publisher of *The Editor and Publisher*.

WHEN POPULAR RADIO announced its policy of refusing advertising from fly-by-night manufacturers and dealers of radio apparatus, it did so with the purpose not only of maintaining the integrity of its advertising pages but also with the purpose of protecting both its readers and its advertisers from irresponsible business concerns. This policy is costing this magazine several pages of advertising a month. We knew that it would.

As evidence of the sincerity with which this policy is maintained, we are publishing here some correspondence that tells a dramatic little story that is well worth recording. The episode begins with the following letter written on the stationery of a radio club:

"We are a strong group of radio fans very much interested in the manufacture of vacuum tubes. We own and operate a small factory where we have conducted some valuable experiments resulting in a tube which we believe the equal if not the superior of the RCA 201-A. We are aware, however, that owing to patent difficulties, we cannot for the present appear under our own name, nor can we give the actual location of the factory as we may be forced to move our equipment at a moment's notice in order to avoid an injunction. We are, however, ready to start an advertising

campaign on this tube and have appropriated for this purpose about \$2,000 to cover one year's advertising, believing that at the end of that time the patent situation will have clarified so that we can come out in the open. We would appreciate your writing us, not only as to rates, but as to whether we can depend upon you to hold our actual address and location in confidence and permit us to use a mailing address only, which will be on Fifth Avenue in New York City. Upon receipt of a favorable reply, we will send our representative to discuss the matter with you."

THE second chapter opens with a personal call at the office of POPULAR RADIO. The result of that call is recorded in the following letter from the same source:

"OUR representative left with you a sample of the tubes which we are now manufacturing. We shall be interested in a report of the same at your early convenience. We wish to confirm conversation with him in regard to our stamping these tubes and to assure you that we will positively never stamp our tubes 'Radiotron' or any name remotely resembling it. Furthermore, our advertisement will carry an absolute guarantee covered by a deposit in cash, preferably with your management, to insure refund on any tubes purchased from us, which do not give absolute satisfaction. Again we wish to emphasize the fact that all we would ask of you is to consider the location of our factory and the names of the officers of the company in strict confidence. We wish to state, furthermore, very frankly, that we are aware of the facts that our tubes infringe on certain patents and that they infringe in exactly the same way as do all makes of independent tubes now on the market. In fact a notice of infringement has been received at our present mailing address, but we have paid no attention to it.

"We are prepared to move our factory over night at a moment's notice. In fact, all our machinery is not permanently attached to the floor, but is mounted on platforms which can be moved in short order. Two months ago, we were tipped off to the effect that an operative of the RCA had obtained access to our plant, and we were obliged to move the same in the night to our present location. It is our intention to operate under quite a different name from that of the factory. Furthermore, in common with most independent manufacturers of tubes, we do not intend to register our firm name in the County Clerk's office at present. In placing these facts frankly and freely before you, we shall look confidently for equal frankness on your part, and the acceptance of our advertisement, or, failing that, good reasons why you cannot do this."

(Continued on page 10)

For Those Who Demand the Best



The Thompson MAGNAPHONE

Reg. U.S. Pat. Office

Supreme
in Tone and
Volume

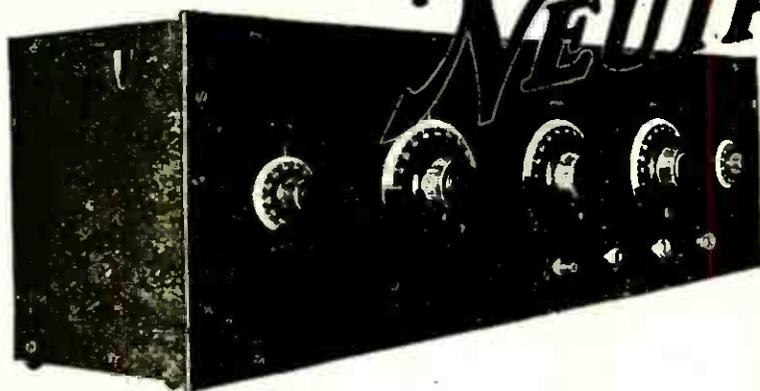
Radio At Its Best

A radio reproducer specially designed — and proved by the experience of hundreds of users — to bring out the best that any receiving set can afford, the THOMPSON MAGNAPHONE is free from the shortcomings that limit the possibilities of loud speakers of the ordinary or "telephone receiver" type. It enables you to enjoy radio at its best — it multiplies the "pleasure possibilities" of any radio receiver.

Price \$35.00

At Dealers Everywhere

The Thompson



NEUTRODYNE RADIO

Licensed under Hazeltine patent No. 1,450,080 and pending application Ser. No. 433,729. Other patents pending.

Price \$150.00

Without Tubes or Batteries

The range, the selectivity, the clearness of reproduction, the simplicity of operation, for which the neutrodyne stands in the world of radio, are exemplified in highest degree in this THOMPSON NEUTRODYNE—the product of 14 years of high-quality radio manufacturing experience. Carefully balanced, thoroughly tested, correct in design, refined in every construction detail, the THOMPSON NEUTRODYNE reveals radio at its best — whether in the hands of the experienced radio enthusiast or in those of the newest beginner. Your dealer can give you a demonstration — ask him.

R. E. THOMPSON MANUFACTURING CO.

Sales Office: 150 Nassau St., New York

Factory: Jersey City, N. J.

PAGES WITH THE EDITOR

(Continued from page 8)

As a matter of mere business routine this offer of a \$2,000 contract was rejected by our advertising manager, who wrote: "I am sorry to have to advise that our policy will not permit of our handling your advertising."

* * *

THE concluding chapter comes in the form of a letter written on the stationery of the West Englewood, N. J., Radio Club, signed by its secretary, Mr. James W. McConnell. Here it is:

* * *

"You have been very frank, and we are, therefore, going to be very frank with you. We thank you, therefore, for refusing this advertisement. It is exactly what we had expected from a publication of the standing such as yours. This may seem strange to you, but we mean every word. Furthermore, we wish to thank you for the article on Page 4 of your magazine for February, wherein your editor lays down his policy. We were particularly impressed by the statement of your intention to protect your advertisers as well as your readers against the unfair competition of fly-by-nights.

* * *

"Just by way of test we purposely submitted to you a most tempting advertisement covering \$2,000 for the year and drew an exact picture of a fly-by-night, to see whether you would rise to the bait. Thank heaven you did not, and we want to commend you for it! Henceforth 'the magazine with the silver cover' is going to be the one we shall buy and whose advertisers we shall endeavor to patronize."

* * *

THUS it is again demonstrated that inclusion in the advertising pages of POPULAR RADIO insures about the same standard of merit as the mark "Sterling" on silver!

* * *

"Our little girl, Ellen, aged six," writes Mr. W. G. Beasley, a reader, of Carthage, Missouri, "saw a lake steamer for the first time and was particularly concerned with the large, funnel-like ventilators. 'Look,' she exclaimed, 'at all the ship's loudspeakers!'"

* * *

THE launching of a new book is always a matter of some concern to the publishers—especially if the book happens to be the first one. That is why the Editor awaited with special interest the first comments concerning the new volume, *How to Build Your Radio Receiver*, which is No. 1 of the proposed series of POPULAR RADIO handbooks.

* * *

THE first letters of comment reached us promptly following the mailing of the books. For the benefit of those readers who have not yet obtained the volume (which for a limited period is being presented free of charge with every \$3.00 a year subscription to POPULAR RADIO), we are printing here the estimates of

it that came in the first three letters to reach the Editor's desk:

"You have certainly 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. It requires no great prophetic gift to foretell the splendid reception by the radio public of this volume."
—WALDEMAR KAEMPFERT, *author and scientist.*

* * *

"*How to Build Your Radio Receiver* is one of the most complete books of its kind that I have ever seen. I feel, after running through it, that you have struck a note that will be very popular with the beginner. I wish that all the books that come to me were as worthy of commendation and space as this one."

—ROBERT S. WOOD, *Radio Editor,*
"New York Evening World."

* * *

"WHEN I renewed my subscription to POPULAR RADIO last month I knew I would get my money's worth in the magazine, but I little realized what a fine book I was to receive until my copy of *How to Build Your Radio Receiver* arrived. It proves to me again that POPULAR RADIO never does things by halves!"

—ARTHUR R. LEACH, *Groton, N. Y.*

* * *

THAT POPULAR RADIO is being used more and more as a text-book in our schools and colleges is evidenced by the rapidly increasing number of subscriptions that are coming in from the educational authorities throughout the country. Educational authorities usually have pitifully small appropriations, and their purchases are necessarily made with great discretion; it is particularly gratifying, therefore, to record a recent bulk order of forty-four subscriptions from the Board of Education of New York.

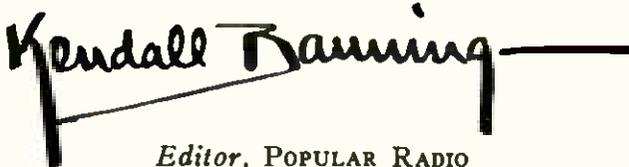
* * *

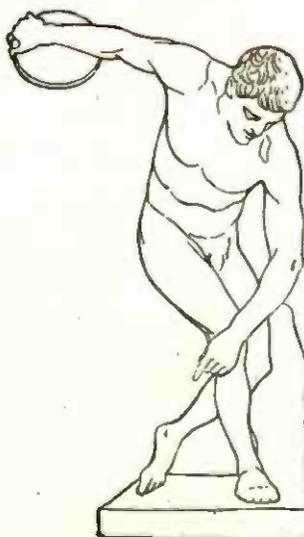
YOUR courageous stand (in Pages with the Editor) for the protection of your readers should make you in truth the POPULAR RADIO magazine. Would that some other radio magazines had some of your courage!

—F. H. GEER, *Columbus, Nebraska.*

* * *

WITH the next issue POPULAR RADIO begins a series of articles that will be of particular value to the radio fan during the summer months—articles that tell him how to use his set in camp, on his motor car, on his boat and on hikes, as well as how to overcome many of the difficulties in getting good reception during the hot weather period.


Kendall Banning
Editor, POPULAR RADIO



The new All-American Long Wave Radio Frequency Transformer.



The MASTERPIECE of Amplification

Again All-American steps to the fore, this time with a long wave radio frequency transformer that has already taken two continents by storm.

Placed on the market only after every conceivable test had been given in an endeavor to find even a single flaw, it has proved itself "the masterpiece" of all transformers suitable for Super Heterodyne, Ultradyn and all straight radio frequency and reflex circuits.

It is for wave lengths 4,000 to 20,000 meters (75 to 15 K.C.). Among its advantages are: windings of extremely low capacitance, properly treated and impregnated; a handsome nickel-plated

shell of the same shape and size as All-American Audio Frequency Transformers—to insure ease of assembly and neatness; and the fact it is shielded to prevent inter-stage coupling or reaction.

Yet the price—in conformity with the All-American policy of building only the best but building in great quantity to moderate the cost—is but \$6.

A notable addition to the All-American family of audio and radio frequency and power amplifying transformers—the most popular, most widely used transformers in the world!

All the better dealers sell the All-American.

RAULAND MFG. CO. 2650 Coyne St., CHICAGO



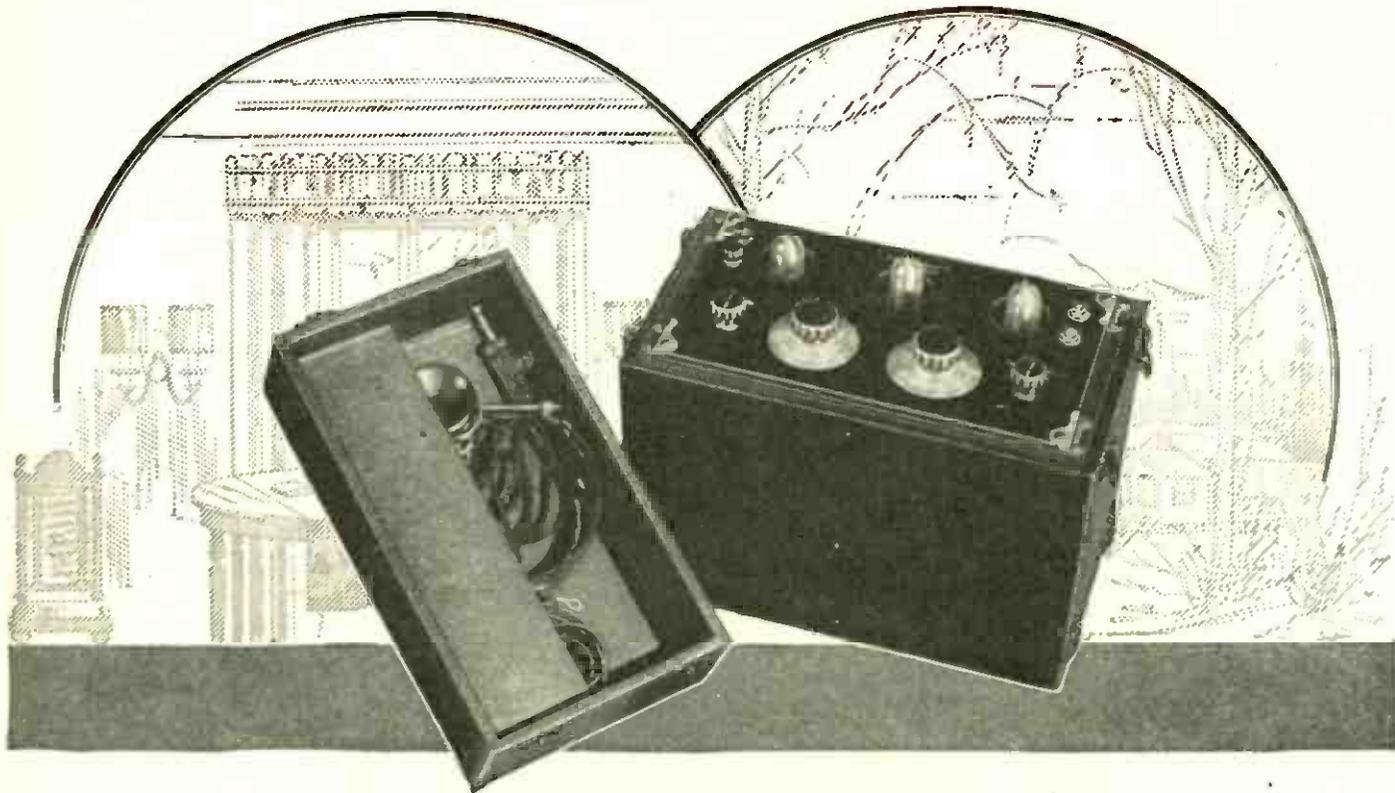
ALL-AMERICAN

AMPLIFYING TRANSFORMERS

Largest Selling Transformers in the World

SPECIAL OFFER!

Diagram-circular on power amplification and All-American Book of 22 Tested Hook-ups sent for 4c in stamps.



For City Homes and Summer Cottages



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 furniture 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 station as it is in your own living room.

New! The famous Kennedy built as a home radio receiver, that is instantly convertible into a portable unit, no larger than a traveling bag.

Model III is essentially the same as the latest Kennedy Receivers but is housed in a three-compartment case specially designed for portability. It has the same purity of tone—the same naturalness and vividness of reproduction—the same ease of tuning. By turning one single dial, the best broadcasting entertainment is literally at your finger-tips.

The circuit used is an exclusive development of Kennedy Engineers—fundamentally sound and correct. It does not radiate or throw out the squeals and whistles that are the cause of present active agitation against radiating receivers.

Price, without accessories, \$101.50. (\$104.00 west of Rockies.) With Kennedy 3000-ohm phones and plug, \$111.50. (\$114.00 west of Rockies.)

Ask any Kennedy dealer to demonstrate this new Model III—he will gladly install it in your home so you can judge its remarkable performance.

All Kennedy Receivers are licensed under Armstrong U. S. Patent No. 1,113,140.

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS

K E N N E D Y



Please refer to POPULAR RADIO when answering advertisements.



Keystone View Co.

POPULAR RADIO Gets a Birthday Letter from Dr. Lee De Forest

I am sure no one connected with the radio art or industry can fail to recognize the debt we all owe to Popular Radio during the first two years of its existence. No agency has done more to popularize and dignify the new art, to arouse widespread interest in its merits, and abiding faith in its future than has this magazine.

I am gratified to join with its host of friends and well-wishers on the occasion of its second birthday, in predicting for Popular Radio new usefulness and enlarged success.

Very sincerely,

Lee De Forest



Morris Rosenfeld

Radio-operated Code Machines in a Modern News Room Are Capable of Transmitting and Receiving 800 Words a Minute

One New York daily at present sends at the rate of 48,000 words an hour to a Chicago daily by means of the Finch high-speed relay apparatus; the transmission of news pictures by radio is already an accomplished fact and will eventually become common practice. The eight code machines shown above, at present operated by wire by the Associated Press, are part of the battery of 110 that are in present use by that news agency for disseminating news to the press.

Popular Radio

VOLUME V

MAY, 1924

NUMBER 5



What Is Radio Doing to Our Newspapers?

Not since the introduction of the telegraph has any invention so profoundly affected—actually and potentially—the methods of collecting and disseminating news, or given the world such an entirely new conception of reporting. What these significant changes portend is told here by one of the best known and most successful of American newspaper men—

MARLEN E. PEW

THE insatiable appetite of the American people for news demands a practical application of radio in the wide and rich field of daily journalism. News distribution is a natural broadcasting process.

Radio in its present development is essentially a broadcasting device. The next great step in the amazing progress of domestic radio communication will be, in my belief, in the direction of news service, with ultimate revolutionary and highly beneficent effects.

However trite, it is necessary to say that news, as the basis of public opinion, is the foundation rock of popular government and, therefore, the controlling

social force. Only those who have catered to the public through newspapers can estimate—and then only feebly—the craving of the average American for news concerning current events. The hands of our hundred millions eagerly reach out once, twice or thrice every day of every year for a news ration. The free flow of plain and garnished fact rushes ever on and on with the irresistibility of a Niagara; as definitely a part of every man's life as the clock, meals and bedtime.

Successful publishers are those who have in some measure caught the spirit of the people to learn quickly the truth concerning important events. The

American press is today the best organized, freest and most enterprising engine of publicity in the world.

The huge dailies of the cities have grown so fat and complete with news, features and advertising as to be burdensome to read.

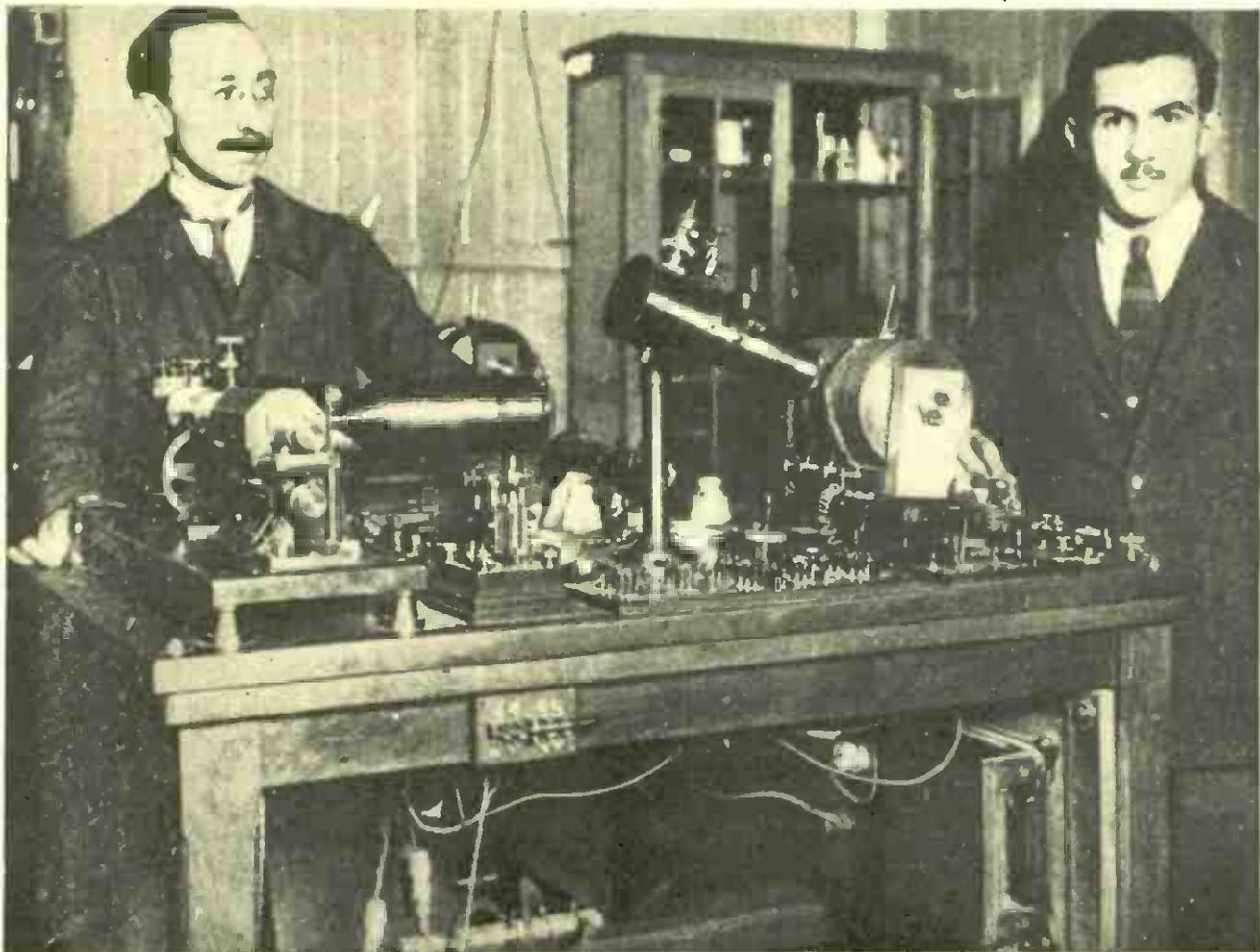
The modern newspaper is geared to such rapid collection of the news, printing and distribution of papers that the result of the Kentucky Derby, the death of a President, the price of corn at Chicago, the capture of a Chinese bandit, may be known across the country within from three minutes to an hour after the event has actually occurred. If no newspaper edition has yet been shot from guns to gain speed in delivery it is because the bright young men of the circulation department have overlooked

it. Tomorrow it will be done at Chicago and next week it will be "old stuff" at Kalamazoo.

The point is that when radio tackles the news job in earnest it will have a problem worthy of its powers; a huge commercial undertaking brimming with wealth and of high social usefulness.

Overseas radio has for several years rendered good service to the press, in competition with cables, but nothing important has been gained that would not have been obtained by additional cable lines. As automatic radio transmission and reception increases volume and lowers rates, foreign news over all seas should become almost as fast and cheap as is news by land-line Morse in this country at the present time.

In the near future attempts will be



International

THE "BELINOGRAPH" AT WORK IN THE NEWSPAPER FIELD

By this apparatus, the invention of M. Edouard Belin of France, news pictures can be sent by wire or by radio. The device is in use in Europe for the transmission of facsimiles of bankers' money orders, the signature being reproduced with sufficient accuracy for all financial purposes.

made to serve large numbers of newspapers with so-called "telegraph news" by means of radio-propelled, high-speed equipment, such as is now used in connection with the Morse wires. During the past three years, highly important developments have been made in this direction, the relay problem having been solved to a nicety.

An eight-hour-day Morse wire, carrying an average of 12,000 to 15,000 words, at an average cost of \$13 a mile a year, let alone the heavy cost of hand sending, relaying and receiving, will be supplanted in the near future by a radio circuit equipped with relatively inexpensive automatic machinery which will be capable of transmitting over distances of a few hundred miles radius. Automatically, receivers on printing machines will receive 200 or 300 words a minute, or 100,000 to 140,000 news words during the period of press activity in the average evening newspaper office.

As the writer is the "father" of this application of radio-propelled, automatic news-printing equipment, and as the innovation (for business reasons) has not been announced to the public, a technical consideration of the matter is inappropriate in this article. But the fact should be noted that the news agencies are alive to the incalculable economies in cost, speed and wordage, of such automatic radio telegraphy.

No newspaper can publish 100,000 words of telegraph news a day without being a burden to readers. It would mean twelve and one-half solid pages of the average paper devoted to interests other than local news, features, advertising and pictures. The average city newspaper does not publish more than six or eight solid pages of local and telegraph news altogether.

But a heavy volume of received news is desirable in that it gives editors a wide range of selection. Speedy delivery is of tremendous importance. With high-speed radio delivery the press

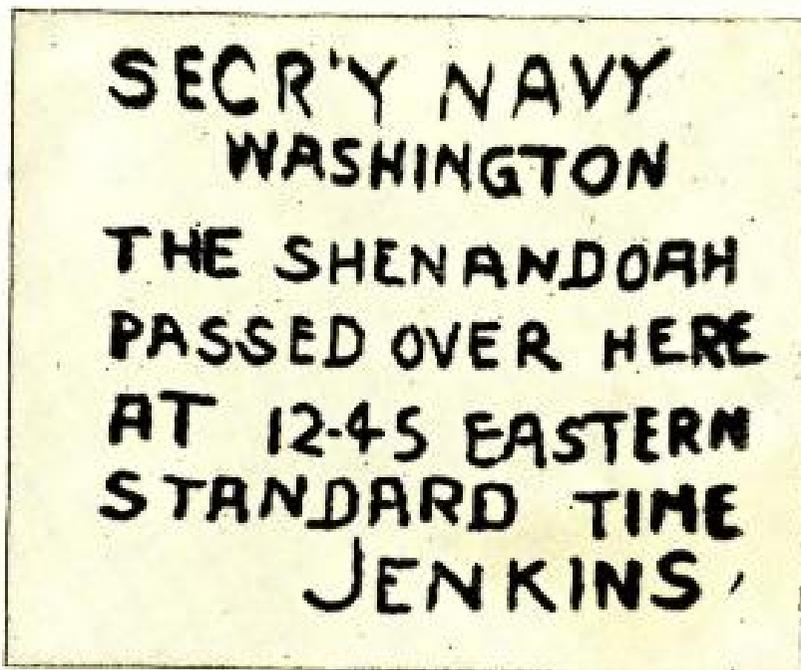


International

RADIO IS MAKING POSSIBLE "A NEW KIND OF REPORTING"

When President Coolidge gave an after-dinner talk in New York on February 12th, the occasion was "covered" by a reporter who gave a word-picture of the happenings to the microphone—and then permitted the listening fans to hear the speeches for themselves.

services will be able, for instance, to lay down in the office of every subscribing newspaper, within a half hour, a six-thousand-word President's message which was delivered to the reporters at the White House at the moment the President departed to read the address before Congress. Each editor would be able to make his own selections of excerpts instead of giving this important function into the hands of the press association editor.



THE FORERUNNER OF THE RADIO NEWSPAPER

This written message was transmitted by radio, just as you see it here, by the apparatus invented by Mr. C. Francis Jenkins of Washington, D. C. Whole newspaper pages may be sent and received in this way including both type matter and illustrations.

It is possible, too, that rapid and cheap distribution of such news matter can be accomplished through the methods for the radio transmission of photographs recently devised by Jenkins in the United States* and by Belin in France. The entire text of a President's message, in typewritten script or in printed copy, could be photographed and the photograph broadcast by radio to subscribing papers. Photographs and texts have been broadcast thus by the Jenkins apparatus and are now being handled commercially (though by land-wire not by radio) by the telegraph service of the French Government.

A logical extension of this process will be the radio transmission of entire newspapers or parts of them. A news or feature page may be made up at a central office and photographed. The photograph may be sent by radio to receiving stations in the suburbs or in other cities. At these receiving stations an automatic apparatus will convert this radio photograph into type or plates from which the newspaper can be printed at once.

It would be quite possible, for example,

*See "The New Radio Movies" by Watson Davis in *POPULAR RADIO* for December, 1923.

to edit and set-up a newspaper in New York, transmit it photographically to a dozen cities all over the country and issue the identical paper (or certain identical sheets of a paper) simultaneously in all these cities, with no greater delay than now occurs between the completion and issuance of a single edition.

But it is more particularly the matter of direct news service to the reading public, and the question of what effect this may have upon newspapers, that both the radio men and the publishers are discussing today.

The huge newspaper publishing business is at present in the attitude of resisting this innovation. The several important press associations or services are insisting, with considerable success, that newspapers subscribing to their services shall make no use of their news on local radio broadcasting outfits, even if owned or operated in conjunction with such newspapers. The large independent radio broadcasters have been forced to collect their own news, if they desired to transmit news facts to their audiences. Press associations will not sell news to them.

The fifty-odd newspapers of the country that have established radio broadcasting services have used them mainly as free amusements, the cost being charged to good will and reputation for enterprise, items not to be neglected in the field of successful newspaper operation. Such news as the editors of these papers can collect, independent of press services, which in most instances is local news, may be available for radio broadcasting, but this is usually not the most important news. Even the *local* news of Associated Press members is controlled by that association, according to the by-laws.

For instance, in the case of the death of a President, the flash news would come to the newspaper from its press service wire. This news would be the

property of the press association. The newspaper would have license only to publish it in its columns and would be expressly forbidden to broadcast it on the office radio equipment.

Rather than disapproving of this rule, many newspaper editors consider it a means of conserving the power of the paper to sell on the streets. If the average reader is acquainted with a news fact the purchasing motive, it is argued, is lost or, at least, impaired.

I think it is the experience of editors who actually have broadcast news that radio service has not seriously impaired the circulation of the newspapers, but the logic of the matter certainly implies that it might do so.

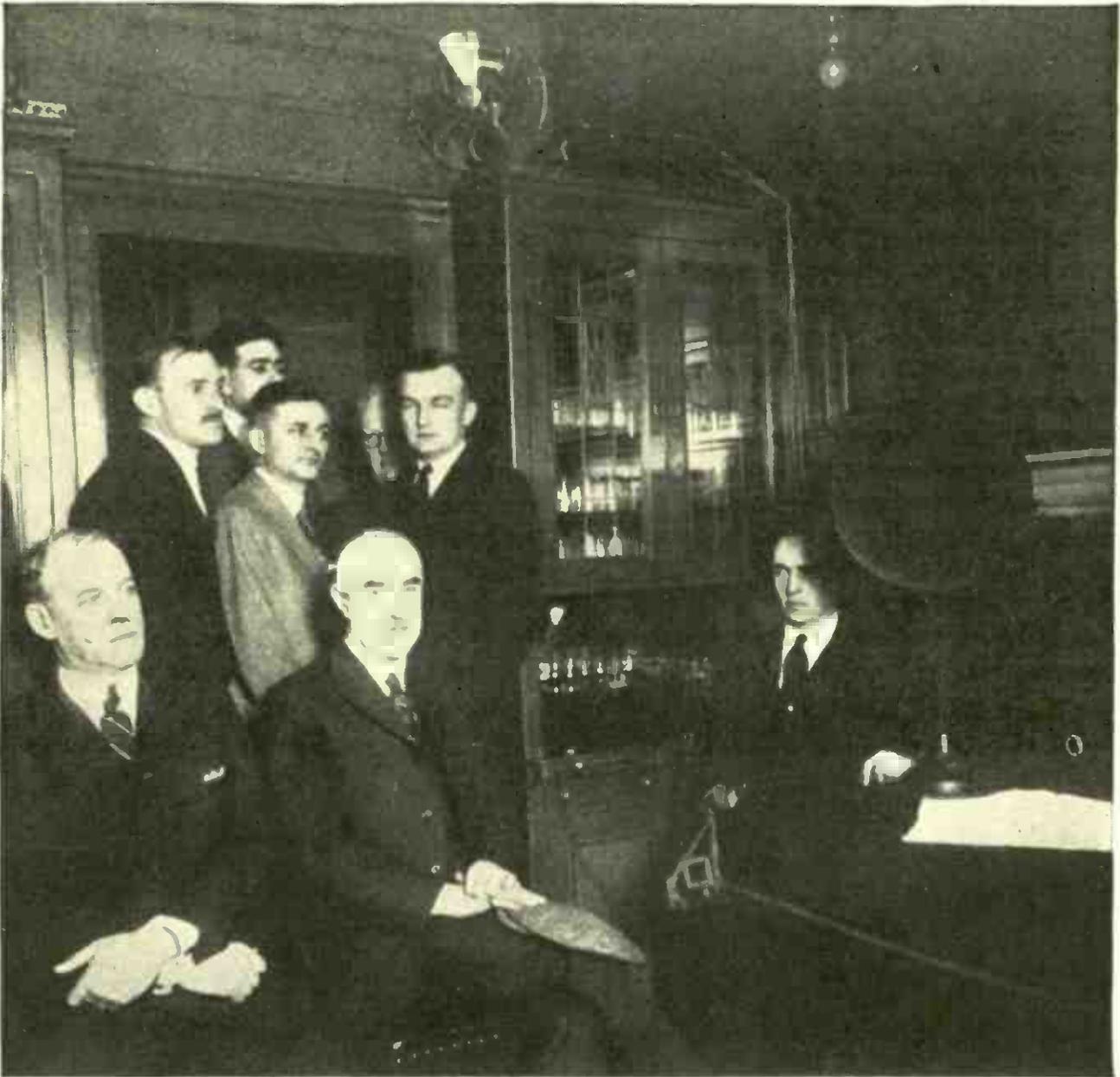
Yet the news reporting by some of the leading broadcasting stations deserves high praise.



International

RADIO COMES TO THE AID OF THE WIRE NEWS SERVICE

When all the land lines, telephone and telegraph alike, were put out of commission by the snowstorm of last February, radio took over the news service in Chicago and in many other cities and pinch-hit during the emergency. This picture was made in the offices of the International News Service in Chicago.



International

GETTING THE NEWS OF THE DAY BY RADIO ON MOVING RAILWAY TRAINS

When a group of officials of the United States Chamber of Commerce recently made a tour of the west, their private car was equipped with a receiver which enabled them to receive the news bulletins and other broadcast entertainment while speeding over the rails.

I recall particularly the report of a banquet a year ago in honor of the venerable French statesman Clemenceau. I had intended to be present at this banquet, but being detained at home, with my family about me, I listened to a radio report from our loudspeaker.

As I should not have been seated near to the Tiger's place at the table if I had attended the banquet, I am certain that I heard his address more distinctly at my home. Every word, every heavily drawn breath, the applause, in

fact the whole spirit of the occasion was faithfully reported to me. It was by all means the finest news report I had ever received, opening my eyes to a new form of reporting, impossible to newspapers.

The station was announced and a clever observer, with a pleasant voice, began a description, all in the present tense, of the banquet room and the arrival of distinguished persons, making a more colorful news report than could have been written, to which was added

the interest gained from instant contact with the facts as they occurred.

No feature was overlooked. The decorations, appearance of prominent men as they took their places at table, a satisfactory account of the dresses and ornamentation of the distinguished women; all this helped prepare the minds of the radio auditors for the real purpose of the meeting.

When Clemenceau left the hall, surrounded by a police squad, the announcer told this. He told, also, how the guests took leave and what was heard in the way of comment on the speech. Finally he closed the entertainment with a brief story of how the radio transmitter had been concealed in a bank of roses set directly before the Tiger's plate, of the fact that the speaker was averse to speaking into the radio and throughout the evening had been unconscious of the fact that perhaps a hundred thousand persons outside of the hall had been listening to his words; even to those deep sighs and to the gurgle of the water as he drank to clear his throat.

That sort of news reporting cannot be done by newspapers and surely it has its place in the scheme of American life.

For various reasons, aside from the chief reason of vastly increased cost of radio news service over newspaper news service, it is inconceivable that the future will see the newspaper supplanted by the radio. To my mind such dreams of radio promoters are as hollow as is the feeling of publishers that radio is to be feared and guarded against.

What may reasonably be expected from radio telephony in local broadcasting is a news service harmoniously

supplementing and benefiting the printed sheet.

In this regard imagination travels rapidly: In the first place there must be a financial motive for newspaper publishers to accept radio as a means of public service. This must be more potent than the mere prestige attending it.

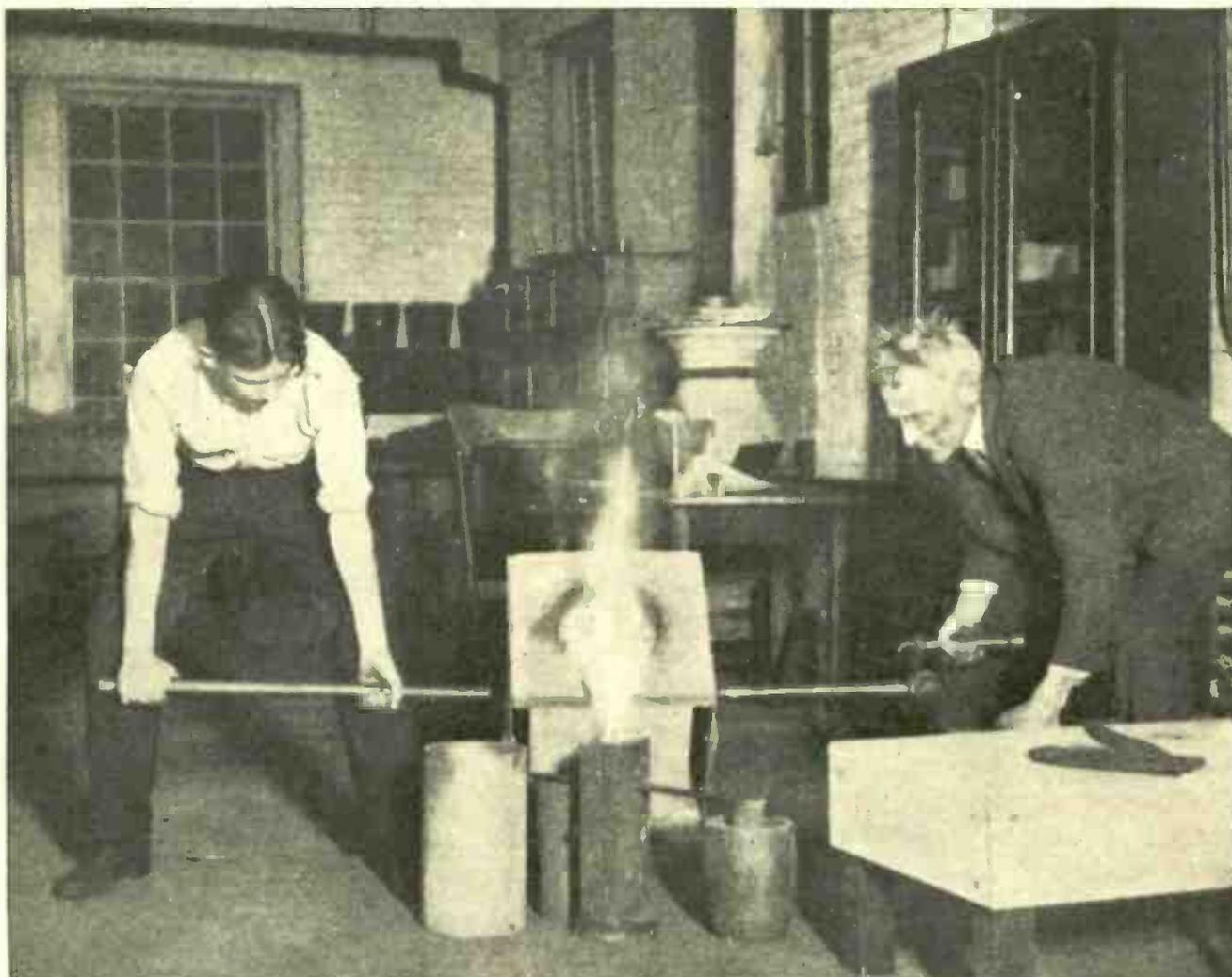
Inventious, now rapidly on the way, of methods of sending radio currents through controlled channels, may make it possible to "string" subscribers on a radio circuit even as on telephone, electric light or illuminating gas circuits. This may solve the financial problem. Perhaps the commercial scheme behind newspaper radio telephony will involve the placement of inexpensive receiving apparatus in the homes of subscribers, these being tuned to a central sending station. The key which would unlock this service to the subscribing family would be issued for a financial consideration.

It is easily possible that instead of being a financial burden radio service may become highly profitable as an auxiliary to the printed sheet. It is reasonable to believe, therefore, that if newspaper publishers do not accept local radio as a part of their public responsibility, outside interests will organize it and make it competitive to the newspapers.

Such radio service certainly would involve both news service and entertainment. The day will come, I dare say, when a newspaper in St. Louis, will subscribe for the service of the New York Metropolitan Opera and will give it to subscribers as regularly as the "Mutt and Jeff" comic strips are now furnished on the printed sheet.

Will Radio Help the Deaf to Hear?

So many conflicting answers have been made to this question that POPULAR RADIO has undertaken an investigation on its own account and is at present conducting a series of laboratory experiments in cooperation with doctors and scientists. The results will shortly be published in this magazine.



Ajax Electrothermic Corporation

"HOT FROM THE RADIO FURNACE"

Dr. Northrup and an assistant are here shown pouring out the metal fused by the power of radio waves.

Melting Metals by Radio

There are many metals that you dare not melt in an ordinary furnace if you want to keep them pure because the dust and gases of the furnace enter the metal and spoil it. Radio offers a solution of this important industrial problem in Dr. Northrup's remarkable "radio furnace," by means of which no fire or dirt touches the molten metal at all—nothing but radio waves.

By E. F. NORTHRUP, Ph.D.

A GOOD many years ago the brilliant Henry Augustus Rowland, America's most original physicist, taught at Johns Hopkins University to a small group of students, of which I was one, the fundamental principles of electromagnetic radiation. These principles, as mathematically stated by Maxwell and experimentally verified

by Hertz, were wonderfully presented.

The subject of ether waves was an abstruse one for the "young idea" to grasp. But we were eager and well I remember how our minds were gradually pried open and how our enthusiasm grew and our ambition rose high.

In those days it was only at centers of higher education that "pure science"

could live. There were few commercial laboratories of research and none of them would have dreamed of working upon a subject like wireless waves—a subject that had no money in it!

But the attitude of the commercial mind has changed since then, not a little because of the chosen few who sat at the feet of the great Rowland and who went forth—some to distant places—and carried with them the torches he had lighted.

It was in 1896, about two years after I had listened to Rowland's lectures, that I found myself a Professor of Physics at Austin, Texas. It was in this state that some very early American experiments were made with electric waves, with electric tuning and with the actual wireless transmission

to a considerable distance of electric signals.

G. W. Pierce, now a professor at Harvard University and an authority on radio, and Dr. Fritz Reichmann, then a student in the University of Texas, were my enthusiastic co-workers in the many experiments made on Texas soil.*

This was a long time ago but the principles then developed and used are exactly the same as are now used for melting steel, brass, silver and even glass, as well as many other highly refractory materials. They are the same principles that we employ in the Ajax-Northrup high-frequency induction furnace, not only for melting hun-

*The antiquarian can find many of these experiments described in the volumes of the *Electrical World* for 1897 and 1898.

A Maker of Modern Miracles

In his laboratory at Princeton University and later at Trenton, N. J., Dr. E. F. Northrup, distinguished American physicist and one of the first men on this continent to transmit messages by radio, has a small, dark-colored tube into which he can insert a steel bar and have the metal flow out in a few moments as fiery liquid steel!

In another small crucible he can attain the temperature of melted tungsten, the most refractory of metals.

Gold, platinum, iridium, molybdenum, yield at once to the tremendous heat of this simple little apparatus. What does it?

Radio!

This is the new radio furnace in which the most intense of electric heats is applied to metals and other substances without any contact with wires or other carriers of electricity. The heating is done entirely by electromagnetic waves—the same waves that are used in radio—which fall on the substance itself and heat it, without contaminating it with carbon vapors as does the electric arc.

In this authoritative article Dr. Northrup describes how this marvelous apparatus works.

dreds of pounds of metal but for producing throughout a considerable space inside the furnace a higher temperature, in a space free of carbon gases and often in a vacuum, than was ever obtained before.

It is because these principles are the same, that radio fans are taking an interest in this new method of electric heating—a method that may be called, with perfect scientific accuracy, "heating by radio."

Indeed much of the actual apparatus used for this radio heating is likely to prove valuable to the radio expert in sending his dots and dashes, or maybe his voice, half way around the world.

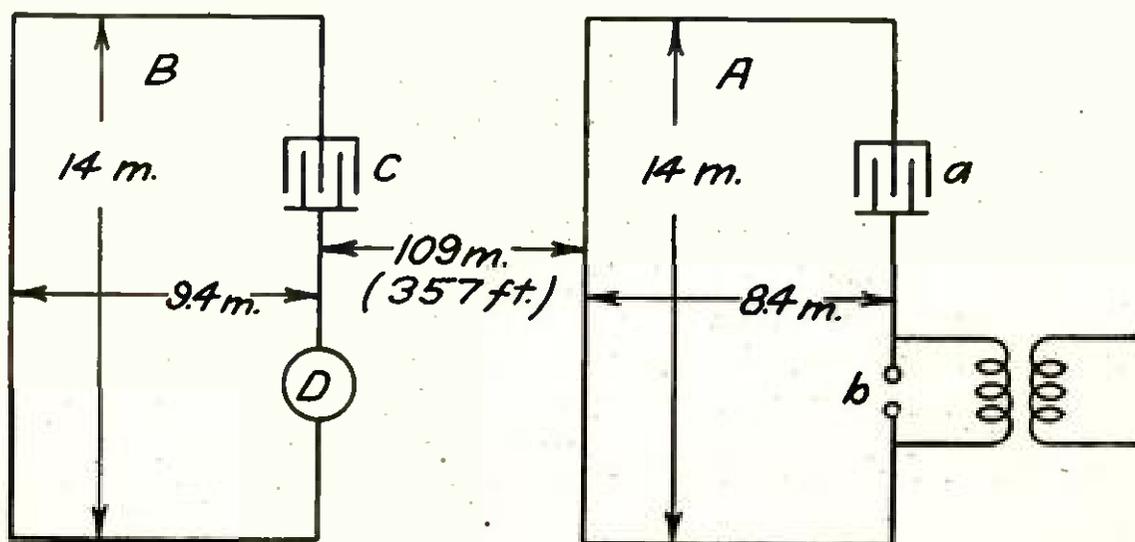
The apparatus that we used in those early experiments in Texas consisted of two rectangular loops of bell-wire, as shown in the accompanying diagram. One of the loops contained a condenser and a spark-gap; the other contained a detector especially devised for the purpose and which consisted of a small silver disk suspended on a quartz fiber inside a coil of a few turns of wire.

No amount of direct current passed through the coil of this instrument would deflect the silver disk when the current was steady. Even a large current of commercial frequency would

make only a very small deflection. But when the minutest current of radio frequency passed through the coil large deflections were obtained. The two loops were placed 109 meters (357.6 feet) apart, their planes facing each other, as shown in Figure 1.

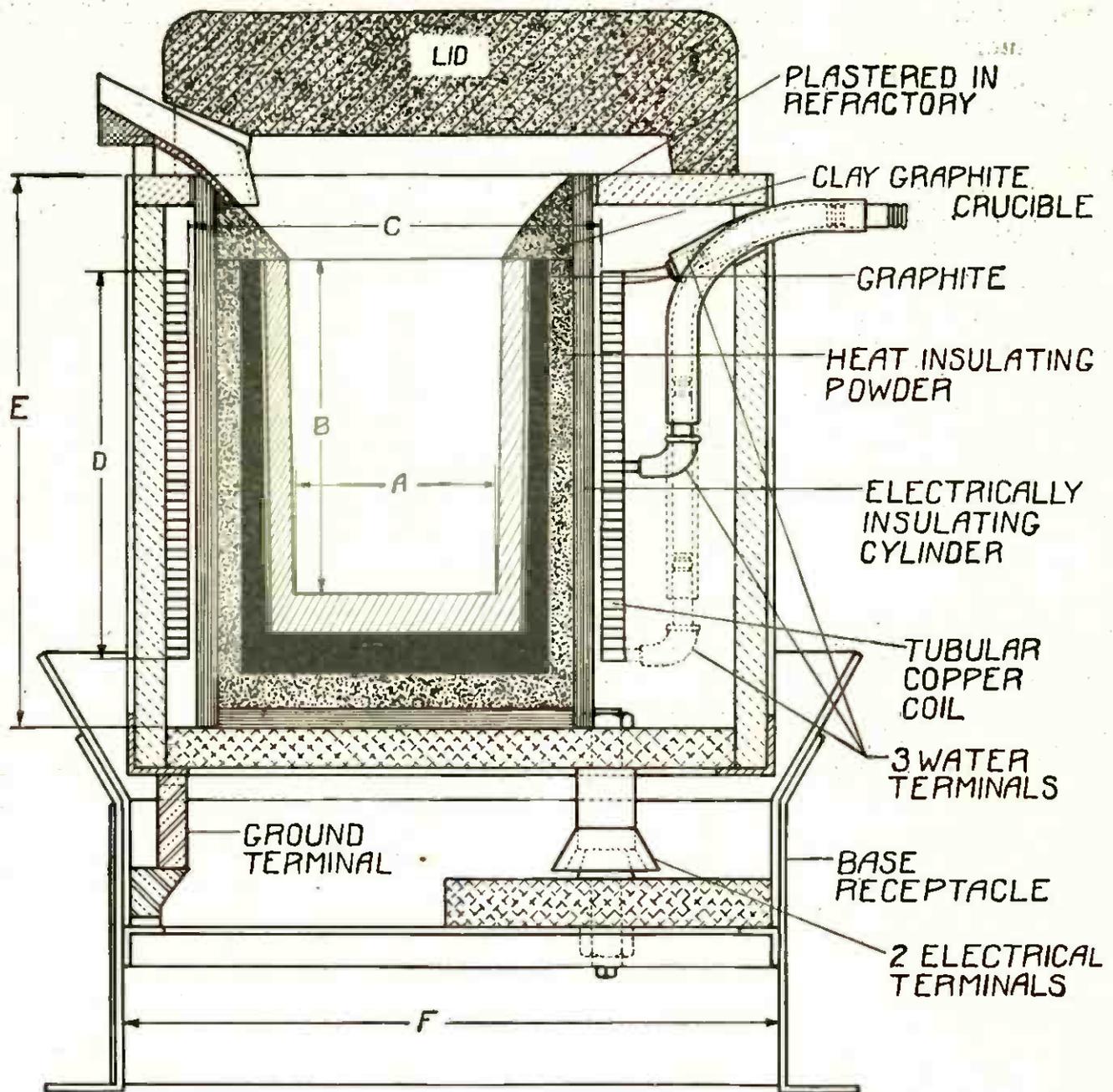
We soon learned that to get deflections of large value it was necessary to tune the receiving circuit accurately to the transmitting one. This we did by varying the capacity of the condenser. As accurate tuning was approached the deflections of the detector became decidedly larger. In Figure 2 is shown one of the sharp resonance curves that we succeeded in obtaining at that time, one of the first radio resonance curves, I suppose, that was ever obtained.

The experiment thus described is only one of a large number of similar nature that we made using the oscillating-current galvanometer as our detector. For example, we constructed two similar Hertzian oscillators. One that acted as a transmitter was placed in one room of a building, while the other, acting as a receiver, was placed in a distant room of the same building. In the receiving oscillator the "detector" took the place of the spark-gap in the transmitter. The Texans were much amazed to see us



THE HOOK-UP FOR THE RADIO EXPERIMENTS OF 1896

FIGURE 1: These two Hertzian loops were used by Dr. Northrup for the transmission and reception of what were probably the first radio signals ever produced on the American continent.



THE DESIGN OF THE RADIO FURNACE

The metal to be melted is placed in the space AB. An oscillating current in the water-cooled copper coil D supplies the radio waves that melt the metal.

thus transmitting signals from one part of a building to another through solid brick walls and without wires.

On December 25, 1897, I wrote:
 "The experiments (which were those described above) are merely of scientific interest. . . . They give, in a manner, by numerical relation, confirmation of the much-talked-of electrical harmony."

How dimly the experimenters of that period, including the writer and his associates, visioned the future of radio

*In the *Electrical World*.

communication!

Wireless waves produced with high-frequency current now ceaselessly cross and criss-cross each other without any mutual interference. They fill the ether about the earth. They are ever present in the seclusion of our homes. They go forth into every corner of our globe, and they make the whole world think the same thoughts and learn the same news at the same instant.

However, the inductive effect of high-frequency current surging in one circuit, whether loop or antenna, upon

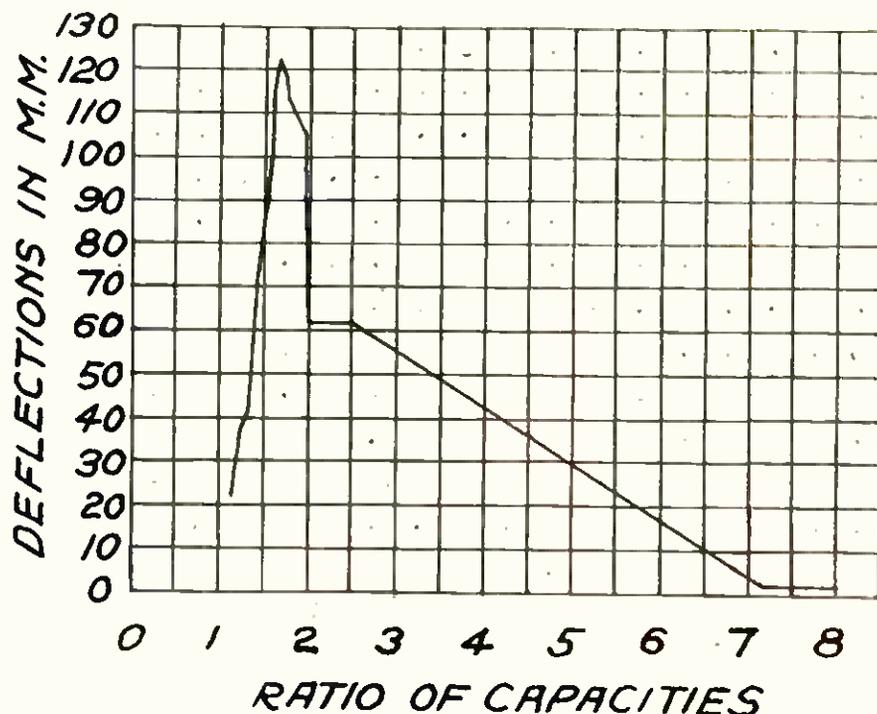
another circuit is not confined in its usefulness to the instant communication of intelligence. If one stops to consider the almost infinitesimal fraction of the energy radiated from a sending antenna which is intercepted by the receiving antenna, it seems fanciful to suppose that high-frequency oscillations could be used to set up, by induction, currents that will melt 500-pound charges of metal or raise substances to the blinding white temperature that will fuse tungsten. Yet such is the fact.

But in order to accomplish these results we must arrange our circuits very differently in one respect than when we wish to transmit intelligence.

For sending a signal to a great distance we are not concerned with the wasted power that radiates off into space and never reaches our receiving set. Indeed, of the total power supplied to the sending antenna the fraction that reaches the receiving antenna is inconceivably small. If turned into heat it would not perceptibly raise the temperature of a short wire the size of

the finest hair. But small as this received energy is, the amplifier magnifies it so that all the signals are clearly received and easily interpreted. This is what we are interested in in radio—the clear reception of signals. The power efficiency of the system is of little consequence. In fact, if we look upon the sending and receiving stations of a radio transmission as an electrical system for transmitting power from one place to another it is the most inefficient electrical transmitter of power that has ever been put into useful service.

If, on the other hand, we wish to transmit power without wires from a sender to a receiver for the purpose of heating the receiver we must make this transmission of power take place with little waste or the method will be without value. We are able to do this only by meeting one essential condition. This condition is that the receiving circuit be placed very close to the sending circuit. In transmitting signals the coupling is very loose and must be so, for the distance between primary and



THE PHENOMENA OF "TUNING" WERE FIRST INVESTIGATED BY MEANS OF GRAPHS LIKE THIS

FIGURE 2: Dr. Northrup describes in this article how resonance curves like that shown above (which was one of the first) were obtained in 1896 and how the phenomena of tuning were investigated by this means.



Ajax Electrothermic Corporation

THE RADIO FURNACE AND THE RADIO FIREMAN—THE INVENTOR
Each of these radio furnaces in Dr. Northrup's laboratory is a separate unit. The mercury arc, the condensers, the transformers and other accessories for each furnace are contained in the cabinets to the rear.

secondary may of necessity be half the circumference of the globe. But for the efficiency in power transmission which we must have for useful heating the coupling between primary and secondary must be very close, and no necessity prevents us from making it close.

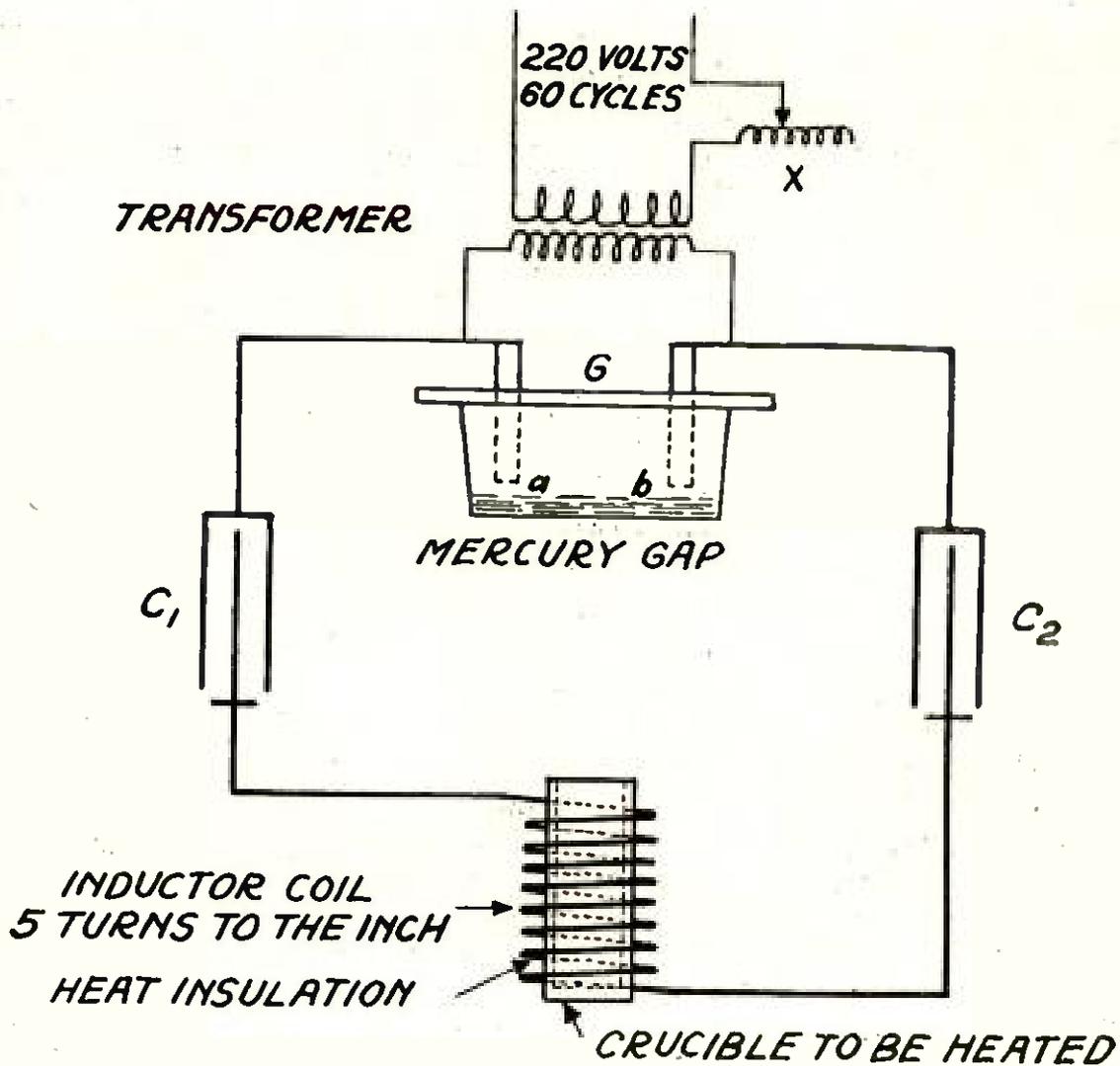
The constructions that I shall describe very briefly for heating with high-frequency current conform to this necessary condition of close coupling. Heating by radio has become a practical success and many hundreds of kilowatts are so employed in many parts of the world.

Naturally if much power is to be received to become changed into heat, much power must be supplied. It becomes necessary, therefore, to build very powerful oscillators which will yield from ten kilowatts to sixty kilo-

watts of power, and at least sixty or seventy percent of this power must become changed into heat at a localized place—the furnace.

These oscillators are being manufactured for operation on single-phase, two-phase, and three-phase circuits. The brief description which follows applies to an oscillator for operation on a single-phase circuit. Such an oscillator will absorb from 20 kilowatts to 30 kilowatts from the supply main and will give by wireless radiation (over the distance of an inch or two) 14 kilowatts to 21 kilowatts to the material being heated. An oscillator for this purpose makes use of no unfamiliar circuits or unfamiliar principles. Figure 3 shows diagrammatically the arrangement of the circuits employed.

The transformer has its secondary



THE HOOK-UP FOR THE RADIO FURNACE

FIGURE 3: An oscillating current produced by the special mercury arc *G*, is regulated by the condensers *C*₁ and *C*₂ and is fed through the inductor coil which surrounds the metal to be heated.

which develops 6,600 volts connected across the double discharge gap *G*. The reactance *X*, placed in series with the primary of this transformer, limits the flow of current to a suitable amperage. In practice the transformer is so constructed that this reactance is an internal reactance inside the transformer itself.

The condensers *C*₁ and *C*₂ become charged to opposite polarity as the voltage supplied by the secondary of the transformer increases. Finally when the potential becomes high enough the double gap breaks down at points "a" and "b" and the condensers discharge themselves through the coil *C*. This discharge of the condensers is oscillatory. The electricity swings back

and forth in the circuit shown in heavy lines exactly in the manner of a pendulum whose bob swings in a viscous fluid. Gross matter, however, moves slowly while electricity moves fast, and in one second the electricity will make from ten thousand to fifty thousand complete oscillations.

If the high-frequency currents set up were discharged into a sending antenna they would give rise to waves radiating out into space of wavelengths varying from 30,000 meters to 6,000 meters. The waves, however, are not allowed to radiate into space but fall upon the mass inside the crucible and generate large currents in it which heat it. The mass in the crucible may be considered as an absorber of the radiant

energy which in a radio system spreads out through space.

The crucible itself may have a wall of conducting material, such as graphite, or the mass inside it may be a conducting material, such as broken pieces of the metal to be melted, the wall of the crucible being non-conducting. As we are able to make this or the crucible (which acts, of course, as the secondary) but little smaller in diameter than the inside diameter of the coil, a very considerable proportion of the energy radiated from the coil gets caught and changed into heat. The rest of the energy is returned to the condensers and keeps the electricity oscillating until it has made several swings each of diminishing amplitude.

It is necessary in order to reach a high temperature to prevent the heat generated in the crucible and the mass within it from escaping. This is done by filling in the small space between the crucible and the coil with a heat insulator that will stand a high temperature, such as powdered magnesia.

Experience has shown that the coil itself is best made by winding edge-wise a single layer of hollow, flattened copper tubing. Through this flattened tubing a small stream of water is kept flowing. This water keeps the coil cool and its resistance low. When a furnace is made in this way one may melt platinum in a crucible and the molten metal may be less than one inch away from the inside of the inductor coil without the coil heating sufficiently to feel hot to the hand.

The discharge gap used in this apparatus consists of an approximately oval iron box with a flat bottom. The box is partly filled with mercury, and the discharge occurs between the mercury and the ends of two amalgamated, hollow, water-cooled copper electrodes. The electrodes pass in through glass insulators in the manner of an ordinary spark plug. By turning a wheel, the electrodes can be raised

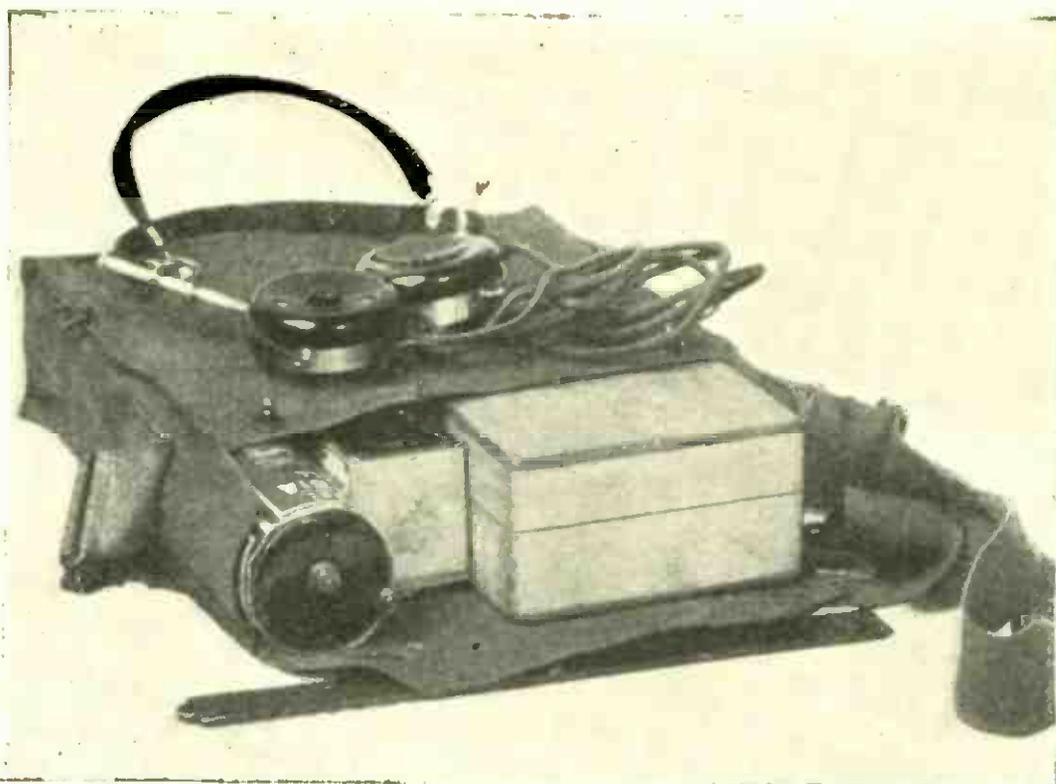
and lowered, thus varying the length of the discharge gap and the power delivered to the furnace by a considerable proportion of its maximum.

This gap functions in a remarkably steady and satisfactory manner. This is largely due to an extraordinary property possessed by mercury. It is able to quench an arc instantaneously whenever a series of oscillations have become considerably reduced in amplitude. This quenching action of mercury is improved when alcohol vapor or, better still, when hydrogen gas, fills the discharge gap-box. This quenching or disruption of the arc is entirely automatic. When the arc is cut off the condensers at once begin to re-charge; the gap again breaks down, and there is thus produced a regular repetition of wave-trains.

As the gap chamber is tightly closed very little noise issues from it. A gap of this construction when operated single phase will readily handle 25 kilowatts.

If we were to remove the crucible from the coil of one of these furnaces and then straighten out the coil and connect one end of it to the earth, the generated waves of electromagnetic energy would be radiated out into space just as from an antenna. A minute portion of these waves could then be intercepted at a great distance by a receiving antenna and we would have a wireless system for transmitting intelligence instead of the device we have described for producing elevated temperatures and melting the most refractory substances.

Common basic principles can often be traced among contrivances which at first sight appear to have nothing in common. In this case we see the principles familiar to the radio engineer, pressed into service for use of the metallurgist and chemist, for the melter of glass, of non-ferrous metals, of the precious metals, of steel alloys, and for the many users of high and controllable temperatures obtained by electric heat.



THE ENTIRE RECEIVER FITS INTO AN OLD ARMY GAS MASK PACK
This pack also carries the complete accessories—tubes, telephones, batteries and antenna equipment.

A Compact Radio Kit for a Spring Hike

Attach a short length of antenna wire to a limb of a tree or a fence, spread out the set on the ground, connect up the telephones and batteries—and listen in!

By H. W. SINCLAIR

WITH the tiny radio receiver (briefly described here), scarcely larger than a man's hand, it is no longer necessary for the tourist hiker to be without his favorite sport of "listening in" on the radio concert world while he is out in the woods.

By merely disconnecting the phones and batteries the entire set may be put into a canvas carrying case ten inches square. An army gas mask equipment serves admirably. To use this portable receiver it will only be necessary to string up a temporary antenna and tune in on the radio world.

It is a far cry from the old-fashioned receiver with its multiplicity of knobs and dials to this single-control outfit which is no larger than a cigar box; the outside dimensions of the box being five by nine inches, and two and three quarters inches deep.

The new design is the result of experimentation by the writer*, who for some months has been seeking to arrange a receiver which could be used by Boy Scout Troops while engaged in hiking programs incident to their scout training.

* Mr. Sinclair is a Boy Scout Executive of Middletown, Ohio.

It is evident that in the production of this instrument, a radio set which is at once readily portable, efficient and inexpensive has been achieved.

As may be seen in the illustrations, dry cells are used for power to light the filament of the WD-11, or UV-199 detector tube, and these batteries, together with the miniature "B" battery shown, slips into the side compartment of the gas mask bag which is used as a carrying case.

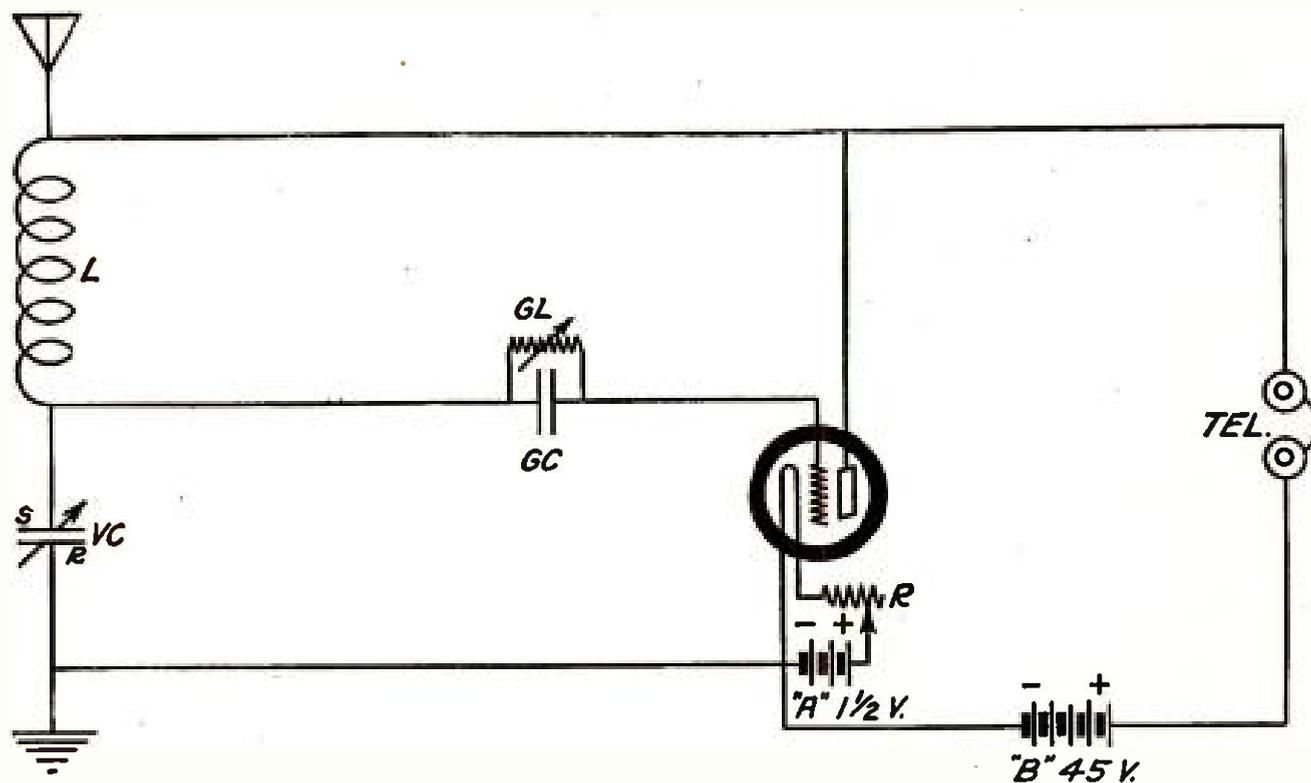
Another unique feature is the extremely small space taken up behind the panel. This is accomplished by the use of a late design in variable condensers which is very shallow. The model used in constructing this set being of a capacity equal to the conventional twenty-three plate size, yet it only requires three quarters of an inch clearance as against the five or six inches usually allotted. It is recommended that either a Miami, a Dubilier Variadon or a Connecticut variable con-

denser be used here, on account of the small space they occupy.

A multiple telephone connector is supplied which allows four pairs of headphones to be plugged in series with the plate circuit, making the instrument available for a number of listeners at one time.

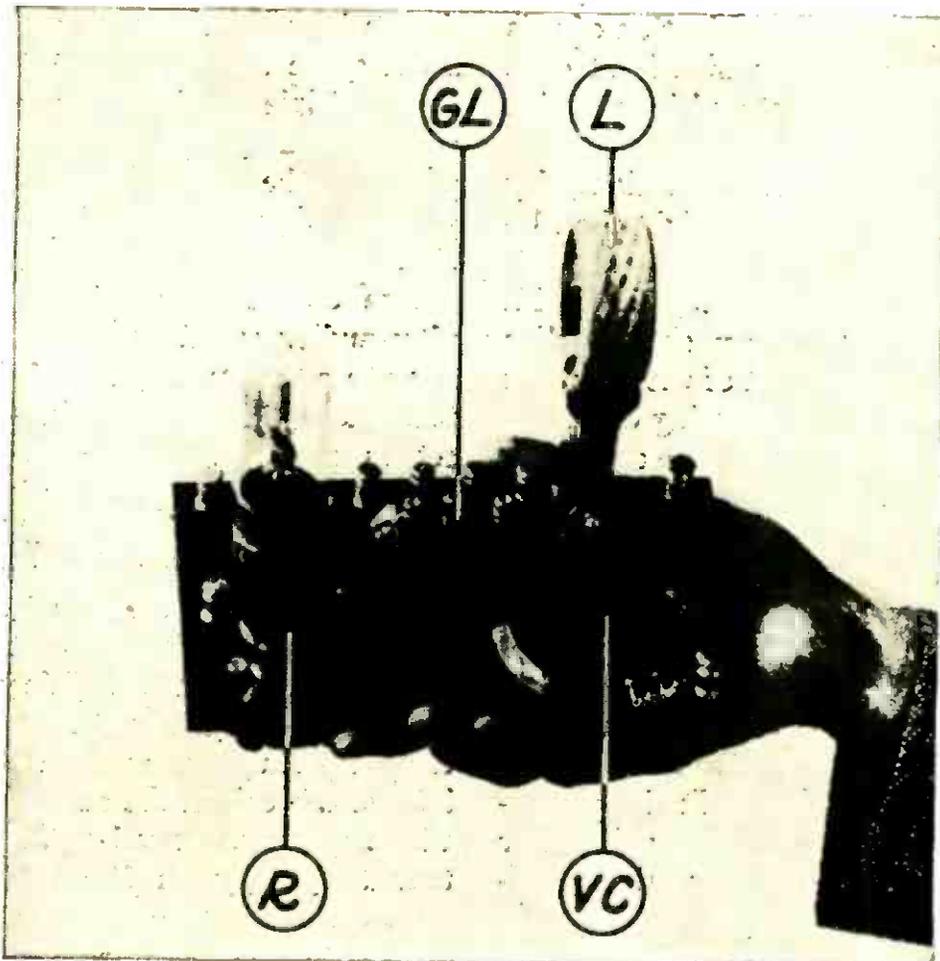
The circuit used resembles both the ultra-audion and the Colpitts circuit, having the most desirable qualities of both these famous hook-ups. In operation the set is remarkably selective and sharp tuning, little body capacity being noticeable in adjusting. A variable grid-leak aids somewhat in adjusting regeneration and in clearing the tone of signals.

Perhaps one of the most interesting features to which the little set may be adapted is its wavelength range in reception. By simply changing the size of the honeycomb coil in the antenna circuit the whole range of wavelengths from amateur telegraphy on 175 to 200 meters,

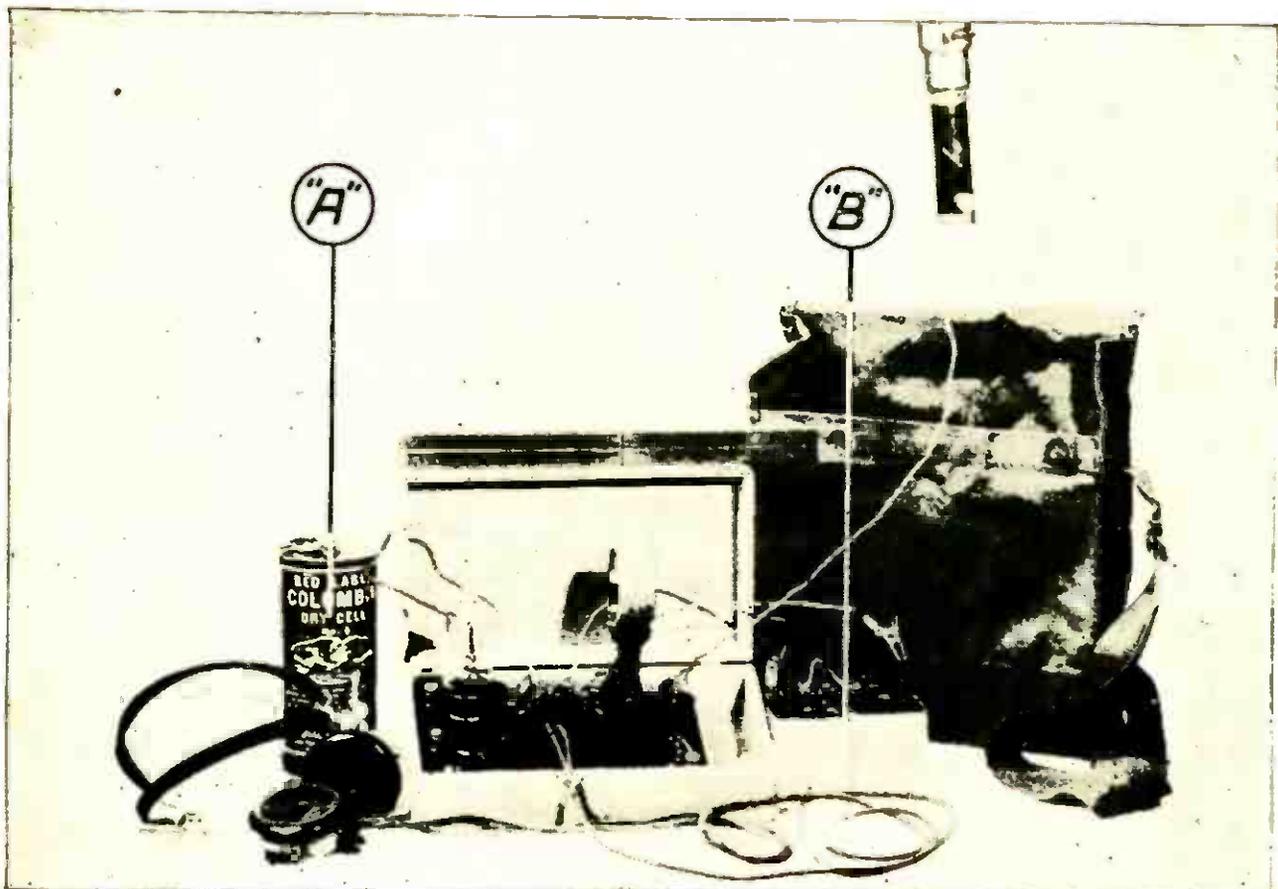


HERE IS THE CIRCUIT YOU MUST FOLLOW

Connect up the coil *L* (size L-50) and the condenser *VC* (.0005 mfd.) and an ordinary mica grid condenser *GC* (.00025 mfd.) and a variable grid-leak *GL*. The tube may be either a WD-11 or a UV-199 or a C-299. The latter two tubes will require three dry batteries, however, and the first tube requires only one, which cuts down the weight of the pack; the batteries marked on the diagram are for the first-mentioned tube. The resistance *R* should be about 6 ohms for the WD-11 and 30 ohms if the other tubes are used. Compare the designations on this diagram with those on the two pictures on the following page.



The upper picture shows the receiving unit taken out of its cabinet; the lower picture shows the receiver set up for listening in. It is connected to a lamp socket.



radiophone broadcasting on 300 to 500 meters, up to the long-range stations on commercial and navy wavelengths can be picked up at will.

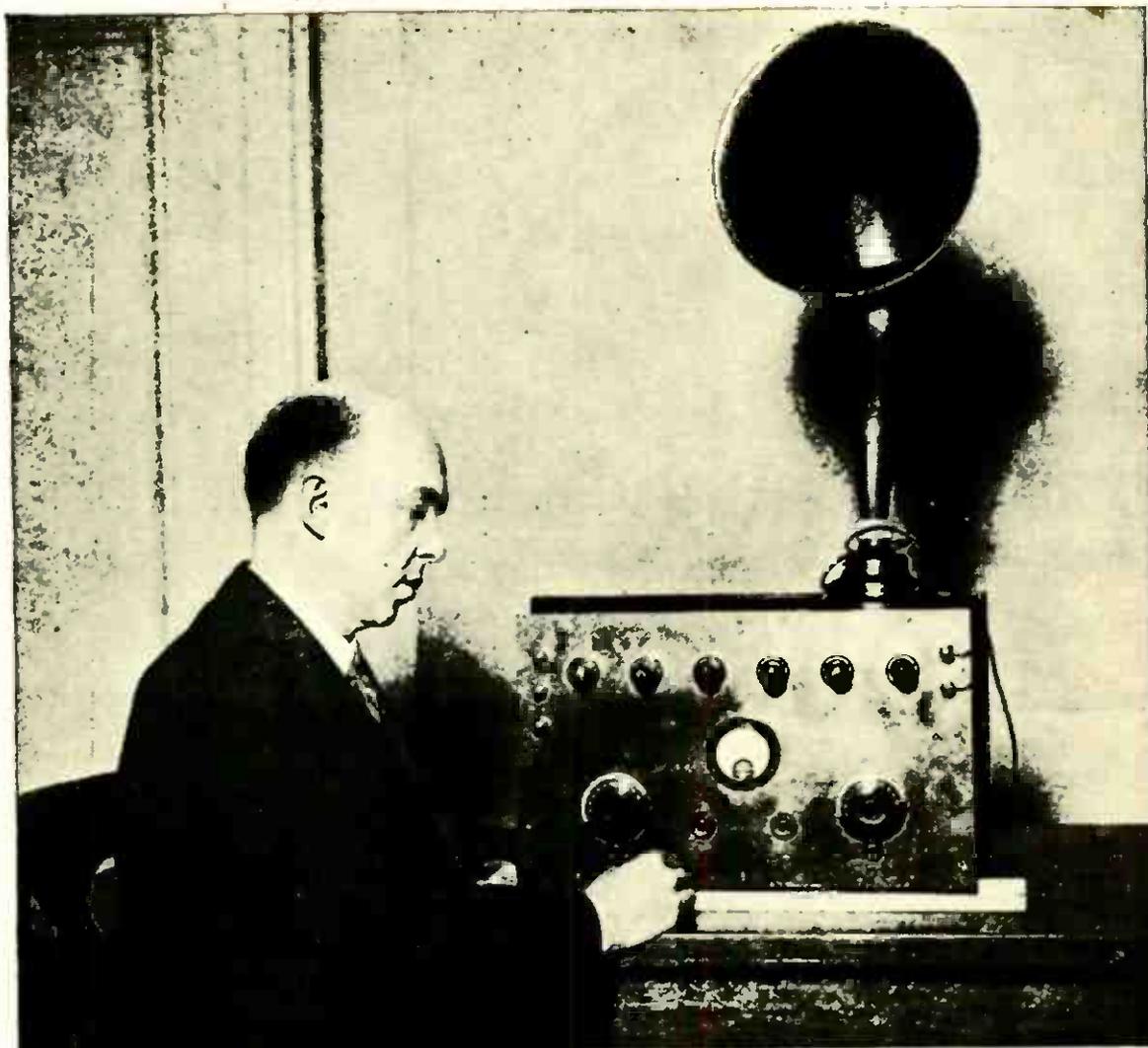
Phenomenal success has been had with reception on a one-hundred-foot antenna located in Southwestern Ohio, the following stations being logged, clear and distinct, with one dry-cell tube: New York, 600 miles; Schenectady, 450 miles; Buffalo, 300 miles; Detroit and Chicago, 350 miles; Davenport, 550 miles; Dallas, 900 miles; and Havana, 1,150 miles.

Good results have been obtained up to 500 miles range using a lamp-socket antenna plug.

The apparatus is so simple in operation,

the only tuning control being the variable condenser in the antenna circuit, that even the uninitiated novice can pick up music without any previous knowledge of radio or of the operation of sets. This feature makes it doubly valuable for use on outing parties, where any member of the crowd can hook in a concert without waiting for the owner of the set to perform any dial-juggling stunts.

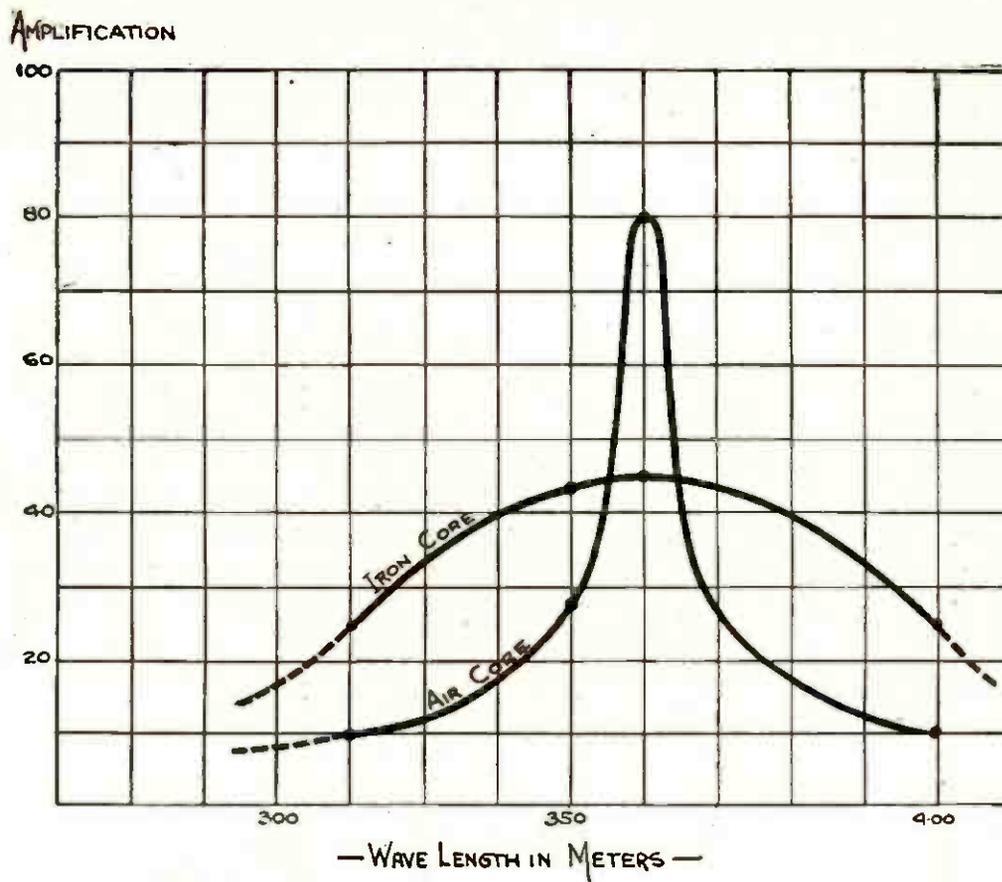
The set, however, is *not* recommended for city use, as it re-radiates strongly. For use in the open spaces, where there are no neighbors to interfere with and where a portable set is required, it is ideal.



Wide World

THE INVENTOR OF THE REGENERATIVE CIRCUIT EXPERIMENTS WITH A NEW SUPER-HETERODYNE

E. H. Armstrong (above) and Harry Houck have just made public their latest work on an important improvement for the super-heterodyne. It is the use of a "second harmonic" oscillator. The set is of extraordinary sensitivity.



A COMPARISON OF SELECTIVITY FROM IRON-CORE AND AIR-CORE TRANSFORMERS

FIGURE 1: These two resonance curves show the relative selectivity obtained with an air-core transformer and an iron-core transformer for radio-frequency amplification. Notice how much greater amplification is obtained on 360 meters with the air-core transformer. On wavelengths other than this, however, the iron-core transformer gives the greater amplification.

HOW TO GET THE MAXIMUM Radio-frequency Amplification

Various types of radio-frequency amplification are now much in the eye of the radio public and many advantages are claimed for each. But there are also disadvantages of each. This article tells of both.

By GEORGE LEWIS

RADIO-FREQUENCY amplification has been used for a number of years in the design of radio receivers for commercial communication purposes wherein the wavelengths range from 600 to 25,000. At the longer wavelengths, corresponding to those used in transatlantic communication, little difficulty is experienced in obtaining satisfactory results.

The advent of radio broadcasting at wavelengths between 360 and 400 meters, however, introduced so many new problems in transformer design, that the manufacturers of radio-broadcasting receivers seemed to favor the use of a detector and several stages of audio-frequency amplification. The operation of the vacuum tube as a radio-frequency amplifier offers far greater application

than any other service at the present time. And while it is true that the vacuum tube may be utilized effectively as an audio-frequency amplifier and as a detector in receiving circuits, yet signals cannot possibly be received unless the strength is sufficient to operate the detector.

In the early days of radio, communication over a certain distance was looked upon as a problem of transmitter power, as it was considered that a certain energy would be required to operate a detector and unless the transmitting station was capable of delivering this energy at the receiving point, communication could not be established. Today the problem has been altered from *transmitter power* to *receiver sensitivity*—a much less expensive proposition, brought into effect by radio-frequency amplification.

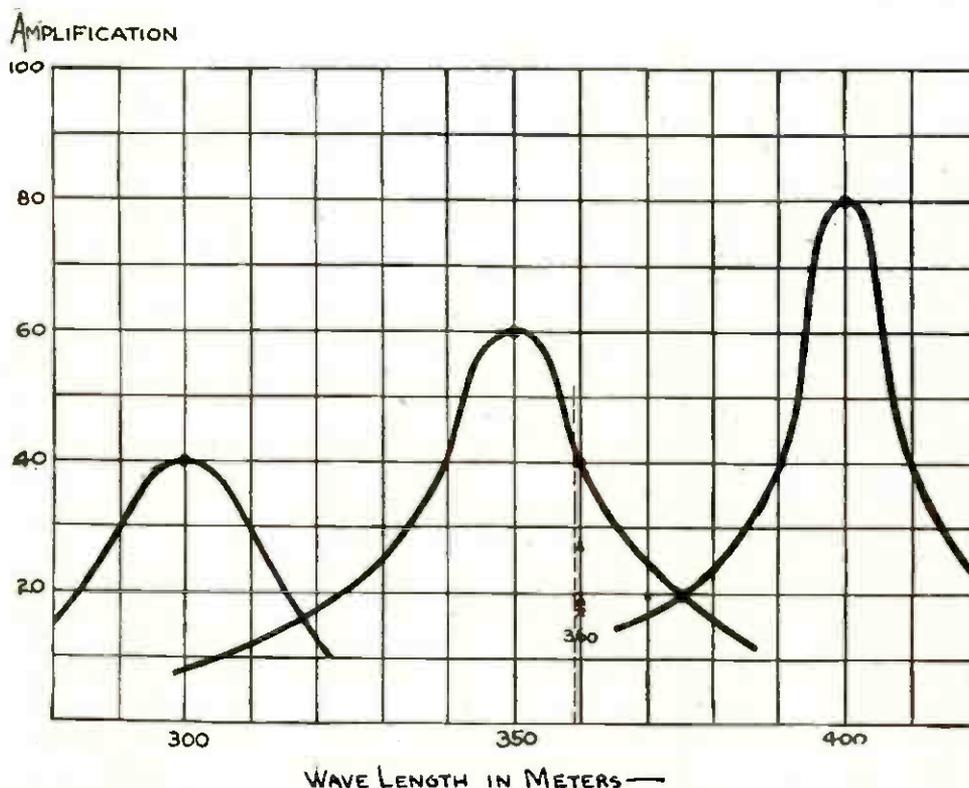
In other words, the more modern receiving equipment brings about the

same effect as moving the transmitter up toward the receiver.

It is an accepted fact that the output of a detector does not vary in direct proportion to the input voltage applied to the grid, but as the grid potential is lowered a certain "cut-off grid voltage" is reached below which no response is registered in the plate circuit and the electron tube ceases to function as a detector.

This means, that signals from radio stations located at a distance so far from the receiver as to prevent potentials greater than the "cut-off grid voltage" to be applied to the detector tube of the receiver, cannot be recorded, even though a number of stages of audio-frequency amplification are employed.

At applied potentials greater than this "cut-off grid voltage" value the output or response in the plate circuit of the detector increases more rapidly than the



A RESONANCE CURVE FOR A RADIO-FREQUENCY TRANSFORMER

FIGURE 2: In this case the transformer has a winding tapped in three places. The highest amplification is obtained on 400 meters. The next highest peak would be at approximately 350 meters and the lowest tap would give a peak at 300 meters. At wavelengths between these taps, however, the amplification would drop off quite severely.

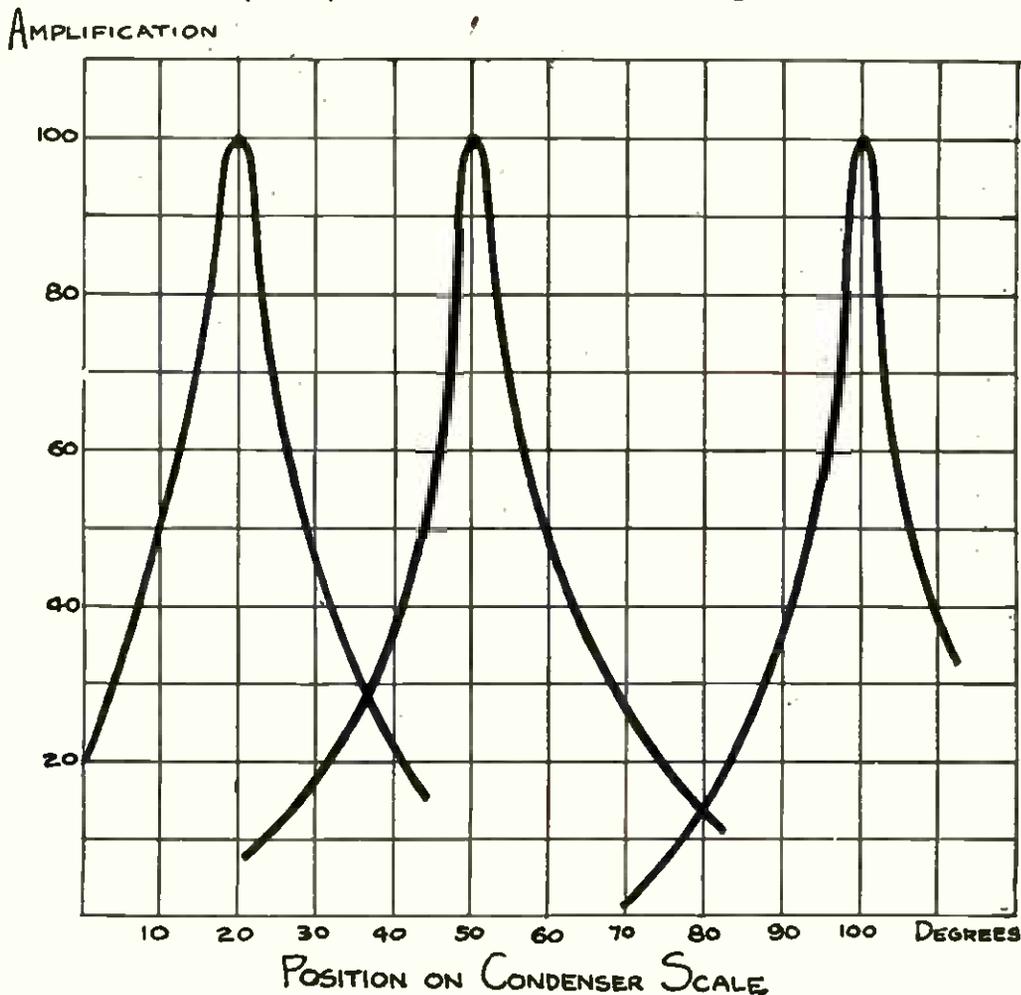
square of the input potential. Therefore, any arrangement that tends to increase the potential delivered to the detector will not only greatly increase the volume of detected signals, but make it possible to receive stations which would be inaudible otherwise, due to the inherent "cut-off" factor of the detector tube. This condition immediately recommends the use of radio-frequency amplification.

Radio-frequency amplification, in general, may be grouped in the following classes:

- 1; *inductive coupled*
 Air-core transformers (aperiodic)
 Air-core transformers (tuned)

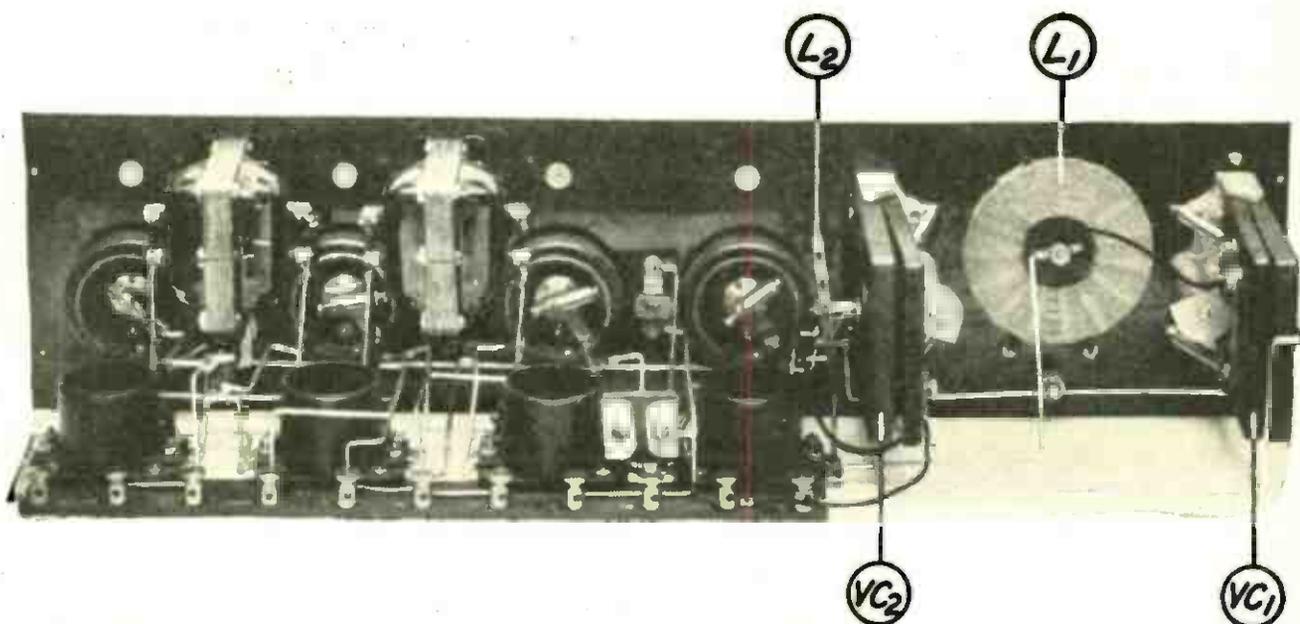
- Iron-core transformers (aperiodic)
 Iron-core transformers (tuned)
 2; *direct coupled*
 Tuned impedance
 Choke-coil arrangement
 Resistance coupled
 Electrostatically coupled

Practically all of the systems of radio-frequency amplification have been used from time to time with some degree of success, either in this country or in Europe. However, the particular construction of the American vacuum tube, together with the shortness of the waves utilized for broadcasting, has tended until recently to confine the practice in this country to inductive-coupled transformer arrangements.



A RESONANCE CURVE FOR A TUNED TRANSFORMER

FIGURE 3: This device would be used with a variable condenser. The condenser settings are shown along the bottom edge of the chart. These settings correspond to the wavelength ranges shown on the charts in Figures 2 and 3. Using this method of amplification, the resonance peak could be shifted along over the entire range with higher constant amplification at the various wavelengths. For instance, at a setting of 20 on the condenser, corresponding to a wavelength of about 300 meters, the amplification could be considered as 100. By simply varying the condenser throughout the entire scale, the peak can be shifted to cover all wavelengths (within a certain range) with equal efficiency. This is shown on the graph, by the two additional curves for a condenser setting of 50 and 100 respectively.



A RECEIVER EMPLOYING TUNED-RADIO-FREQUENCY AMPLIFICATION

FIGURE 4: The antenna circuit is tuned with a coil, L_1 used in connection with a variable condenser, VC_1 , of "book" type. The plate circuit of the radio-frequency tube is tuned by a similar coil and condenser, L_2 and VC_2 , respectively.

During the past year, however, a number of manufacturers have developed and marketed receivers in which the radio-frequency amplification was accomplished by a fixed ratio. Transformers of the direct-coupled type are composed of two inductive windings which, when operated in connection with the grid-to-plate capacity of the vacuum tube, bring about resonance of the desired frequency. This arrangement for transformation is limited by the extremely narrow wavelength band over which the transformer will efficiently operate. A fixed-ratio transformer with an air core is remarkably efficient in its operation. However, the sharp resonance curve confines all practical operations to wavelengths quite close to its resonance period.

This limitation is shown by the sharp-peaked resonance curve of Figure 1.

Here it is evident that the receiver operated with this transformer will receive radio concerts at a wavelength of 360 meters with a signal intensity or volume of 80. Other stations broadcasting on a wavelength of 400 meters will be received with a volume of 10.

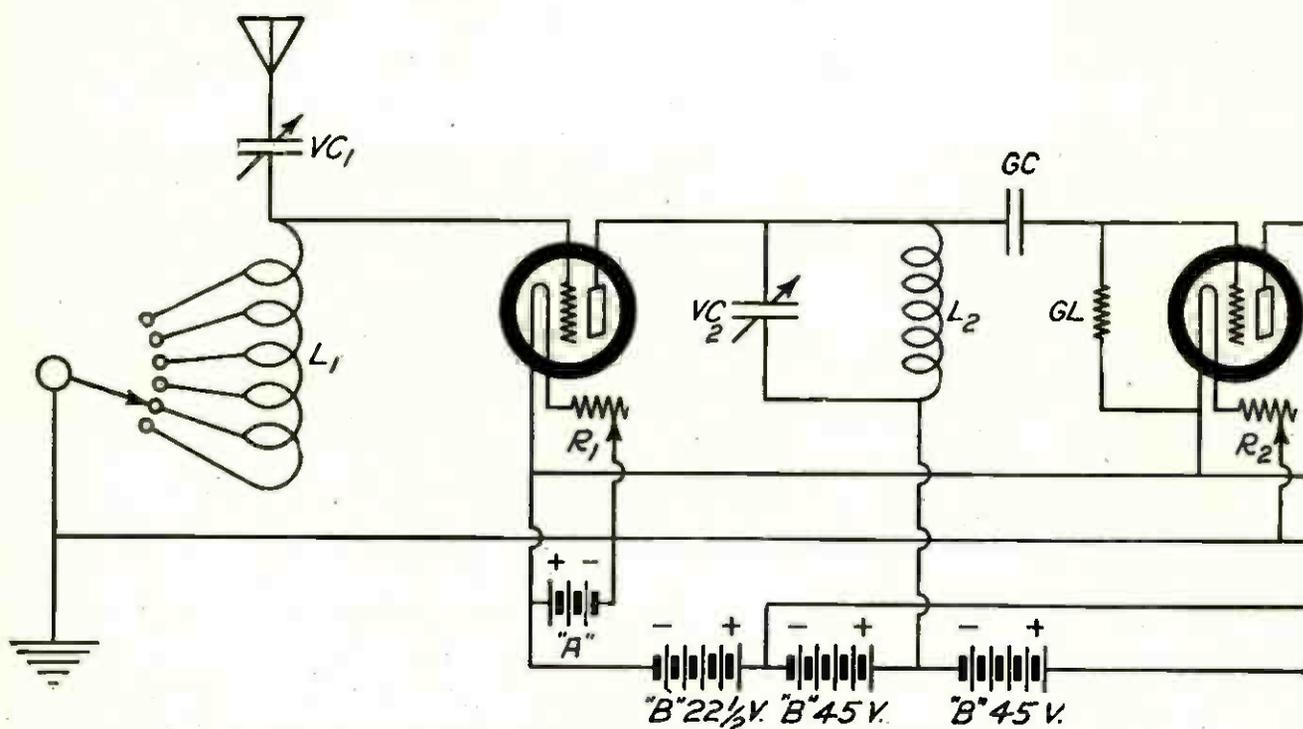
The air-core transformer has been utilized with a fair degree of success

when the windings are provided with a switching arrangement wherein the turn ratio and the resonance period can be set for several separate wave zones.

For instance, a transformer may be constructed with three taps so connected to the windings that a resonance is obtained at 300, 350 and 400 meters. An amplification curve for a transformer of this class is shown in Figure 2.

It will be noted that the highest amplification point is at 400 meters, and that all of the other resonance points are lower. This is due to the resistance introduced when the coils are tapped. The 400-meter position utilizes the whole coil. The other positions do not, but have "dead ends" or inactive sections, which absorb a part of the energy.

While the amplification obtained at 360 meters is only 40, as compared to the 80 listed for the transformer in Figure 1, this tapped transformer can be used more efficiently at all wavelengths between 275 and 425. It is readily appreciated that the strength of received signals is not uniform between the wavelengths here listed, but stations transmitting at wavelengths of 300, 350



HOW TO CONNECT UP THE INSTRUMENTS

FIGURE 5: This electrical wiring diagram shows the proper way to connect up the instruments in order to incorporate radio-frequency amplification in a set such as shown in Figure 4. Such a set will have the same resonant characteristics as given in the graph in Figure 3.

and 400 meters are received with a maximum signal strength, and those at 275, 320 and 370 meters are received with reduced volume.

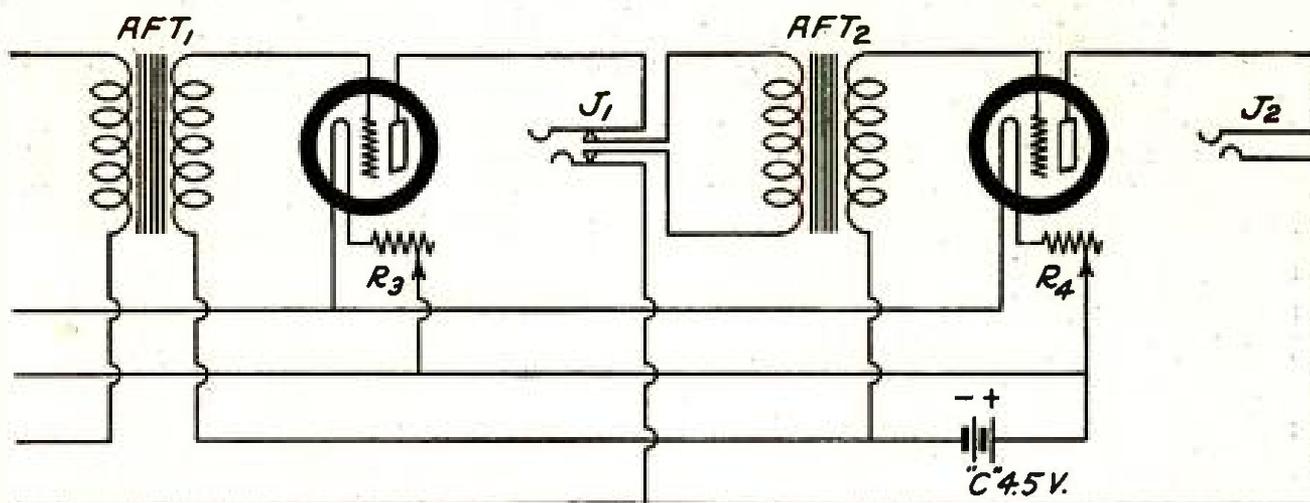
A great majority of the radio-frequency transformers in use at the present time, instead of using tapped windings so as to obtain tuning peaks or high-amplification points as described, introduce a magnetic core which tends to broaden the useful wavelength band. The construction of this transformer is exactly the same as the air-core transformer except for the introduction of the magnetic core. The influence of the magnetic circuit in broadening the resonance curve is shown by the low, broad curve of Figure 1, wherein the sharp resonance period of 360 meters is not obtained, as is the case when the core is removed. While the volume of the received signal is reduced to 45 in comparison with the 80 obtained when the core is removed, the signal volume at 300 and 400 meters is increased.

Receivers that embody transformers of the types described above have been operated with a certain degree of suc-

cess during past years where all of the radio broadcasting stations of this country were licensed to operate on wavelengths of 360 or 400 meters. Stations transmitting at wavelengths greater or lower than these values are what may be termed beyond the useful amplification wavelength zone of these transformers.

As a result of the vast amount of interference caused by the six hundred American broadcasting stations transmitting on two wavelengths, the Department of Commerce Radio Conference recommended that licenses be issued to permit stations to broadcast on various wavelengths between 200 and 600 meters. Since the recommendations of this conference have been put into effect an overwhelming number of complaints have been received where stations operating on the higher and lower wavelengths could not be received with the desired signal strength. The reasons for this are apparent when the above facts are considered.

The sharp resonance curve shown in Figure 1 represents the amplification



at various wavelengths on each side of the resonance point with a transformer composed of two coupled windings having a definite value of self inductance. As the windings are composed of a great number of closely associated turns, they bring about a high value of distributed capacity between the various turns of the windings. The effect of this combination can be represented by a condenser having the same value as the distributed capacity and connected between the terminals of the coil.

In the particular instance of the transformer of Figure 1, the inductance and capacity of the windings are purposely proportioned in the design of the transformer to be resonant at 360 meters, thereby enabling the radio concerts to be received with the greatest intensity at this broadcasting wave.

Windings designed to have an appreciable value of distributed capacity cannot be included in the class of efficient inductances as the condensers formed between the windings are notoriously inefficient, due to the poor dielectric properties of the insulation covering the wire. A more efficient design may be arranged by altering the construction of the inductance so as to reduce the internal or distributed capacity as far as possible and then bring about the

resonant condition at 360 meters by tuning the circuit by means of an efficient variable condenser. An arrangement of this class is termed "tuned-radio-frequency amplification," and represents the most efficient form of radio-frequency amplification available at the present time. Not only is the amplitude of the received signal increased from 80 to 100 by the introduction of an efficient inductance and condenser, but the wavelength range of the system can be greatly increased.

As an example, assume that the condenser and coils were selected so that resonance was obtained at 600 meters when the condenser was set at 100 degrees, corresponding to its full scale, or maximum capacity, position.

The resonance curve obtained at this setting is shown by the right-hand curve of Figure 3. This arrangement would bring about resonance at 400 meters when the condenser was set at 50 degrees, as shown by the middle curve of Figure 3. The 300-meter resonance curve is shown at 20 degrees. If resonant at 360 meters, the condenser would be adjusted to a position between 30 and 40 degrees where the 360-meter signals would be received with the same intensity as the three waves already shown. Here we have a

radio-frequency amplifier of practically uniform amplitude, that is, amplification with equal intensity at any wavelength over the range of the instrument. The simplicity of construction and the ease with which the tuned-radio-frequency amplifier is operated cannot be overestimated.

Figure 4 illustrates a receiver of this class wherein the inductance consists of a special form of basket-woven coil of an extremely efficient type used in combination with a tuning condenser.

Figure 5 shows the wiring diagram of a receiver which uses this type of tuned-radio-frequency amplification.

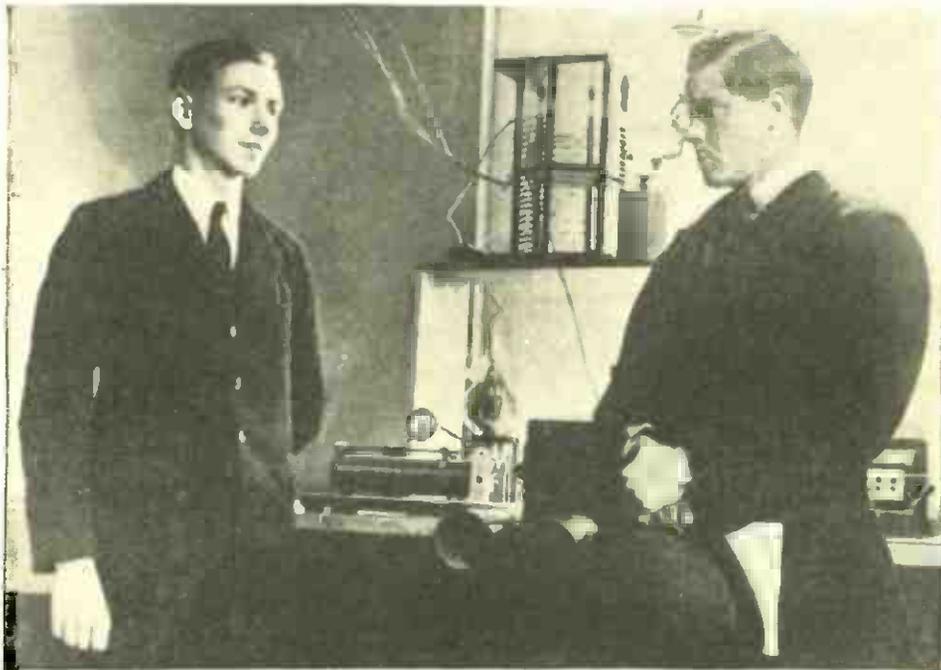
In this type of amplifier the condenser plays an important part. Experimenters and investigators have appreciated the technical advantages embodied in this principle of amplification. However, the popularity of this system has been retarded by the discouraging reports circulated by those constructing such an amplifier with condensers having high dielectric losses or strong external or stray electric fields.

The condenser having the high loss reduces the over-all efficiency of the device to that of the ordinary transformer and the stray field, prevents the proper wavelength adjustment.

It is claimed at times that there is little difference between radio-frequency amplification and audio or voice-frequency amplification except a slight increase in the range of the receiver.

In conclusion it may be stated that radio-frequency amplification will not materially increase the power or volume of strong signals, and that *all* magnification of power *must be accomplished* by audio-frequency amplification. However, the following inherent advantages found in radio-frequency amplification are most important in the design of an efficient radio receiver:

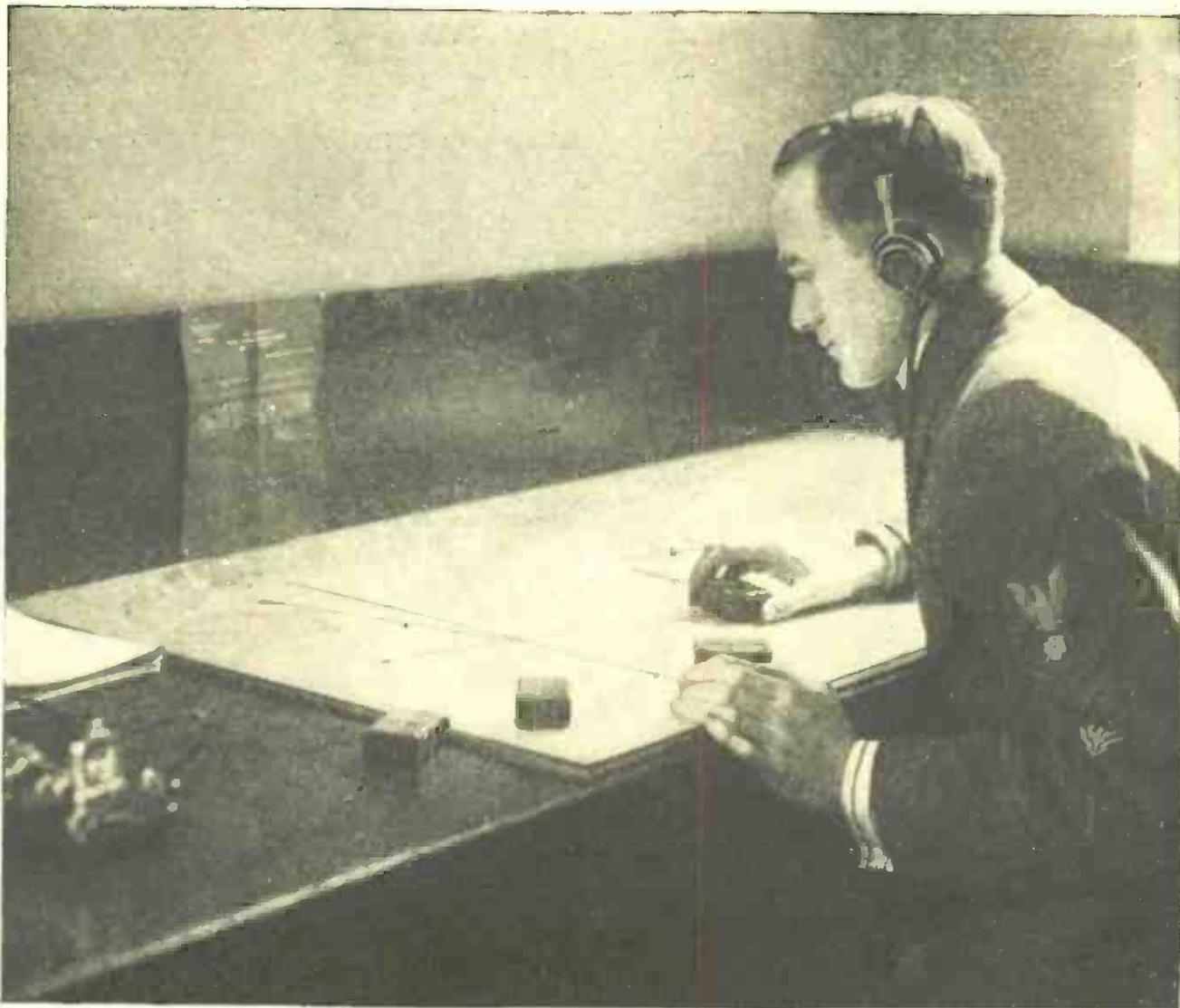
- 1—An increase in the receiving range of a receiver;
- 2—Amplification without distortion of signals;
- 3—Possibilities of employing loop or frame-type antennas;
- 4—Reduction of the possibilities of interference caused by re-radiation when used with regenerative receivers.



Kadel & Herbert

THE PRINCE OF WALES CONGRATULATES AN ENGLISH AMATEUR—

for his achievement in transmitting and receiving messages from the United States on a home-made set. The amateur is Cyril Goyder of the Mill High School.



S. R. Winters

How Radio Locates Ships at Sea

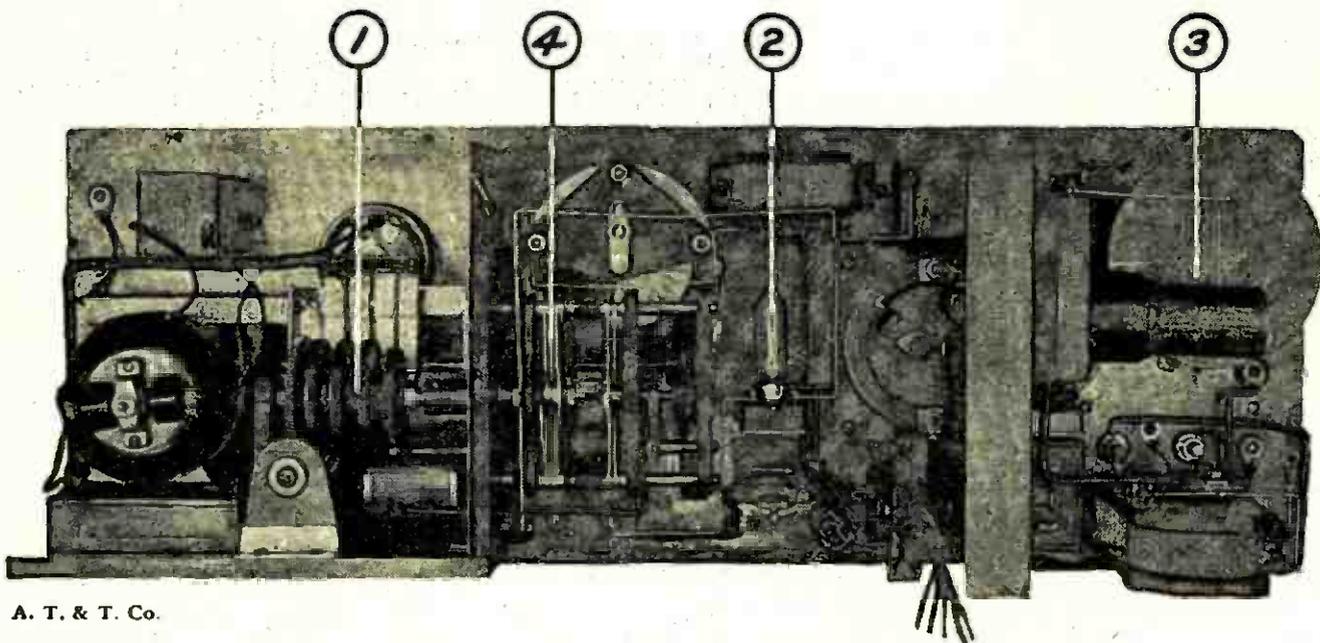
By S. R. WINTERS

THE picture at the top of this page explains how a radio operator ashore can determine the position of a ship at sea more accurately than the captain can do it for himself. The chart shown is at the central compass-control station ashore, connected by land wire with each of the radio stations that possess a direction finder. The strings on the chart pass through holes at the positions of these radio stations.

Suppose that the operator at one of these stations hears a ship's transmitter working. The ship may not be calling for bearings but the operator listens just the same. His radio compass shows him the exact direction of the ship from

his station. He sends this over a land wire to the compass-control station where the chart is. The man at the chart grasps the weight attached to the cord representing the compass station, pulls out the cord and puts it on a line which represents the ship's bearing from the compass station. Two or more other compass stations send similar reports and other strings are adjusted. Where the strings cross, there the ship is.

Not so long ago a British ship hit the New Jersey sand within a thousand feet of where a navy compass man had told the captain she would strike.



A. T. & T. Co.

BEHIND THE SCENES OF THE STATIC RECORDER

FIGURE 1: *The motor at the left drives the frequency selector 1 and the variable condenser 4. At the right of center is seen the local oscillator tube 2, and at the extreme right is the thermocouple 3, and associated circuits.*

Getting Static's Autograph

Here is a practical experimenter who goes out looking for static. Not content with listening to it, he has developed a scheme for automatically recording both its presence and its magnitude. This matter of automatically recording static may have a real idea behind it; we had better not, just offhand, award it the blue ribbon for useless occupations. Static is one of the things which is constantly "on the air" and which is a source of annoyance, not only to the B.C.L., but also to the amateur and the radio engineer. May it not be that the best method to pursue in attempting to circumvent it is to learn all we can of its variations in intensity from minute to minute throughout the various seasons, and from what direction it comes and what appear to be its causes? From continuous observations, certain deductions can probably be drawn regarding (for instance) the times of day and year when long-distance work can best be carried out, and the amount of power which would be required to get messages through with the degree of certainty required in rendering commercial service. The following account of automatic recording of static is written by Dr. Austin Bailey, of The American Telephone and Telegraph Company laboratories:

By AUSTIN BAILEY

THE origin of static and its wave form have considerable scientific importance. Some work along this line has been done by European experimenters. However, the thing of most immediate importance in radio-communication engineering is an accurate, quantitative method for the measurement of radio noise.

In our work on measuring radio noise, there have been developed several methods of determining the *noise level* in

the ether which involves the use of the human ear.

These methods, while very useful, require that someone take the readings, and in order to obtain any considerable amount of continuous data, the observations become decidedly tiresome. In addition to this there is the personal element which introduces considerable variation in the observations—depending upon the individual who is obtaining the data. For these reasons we have thought

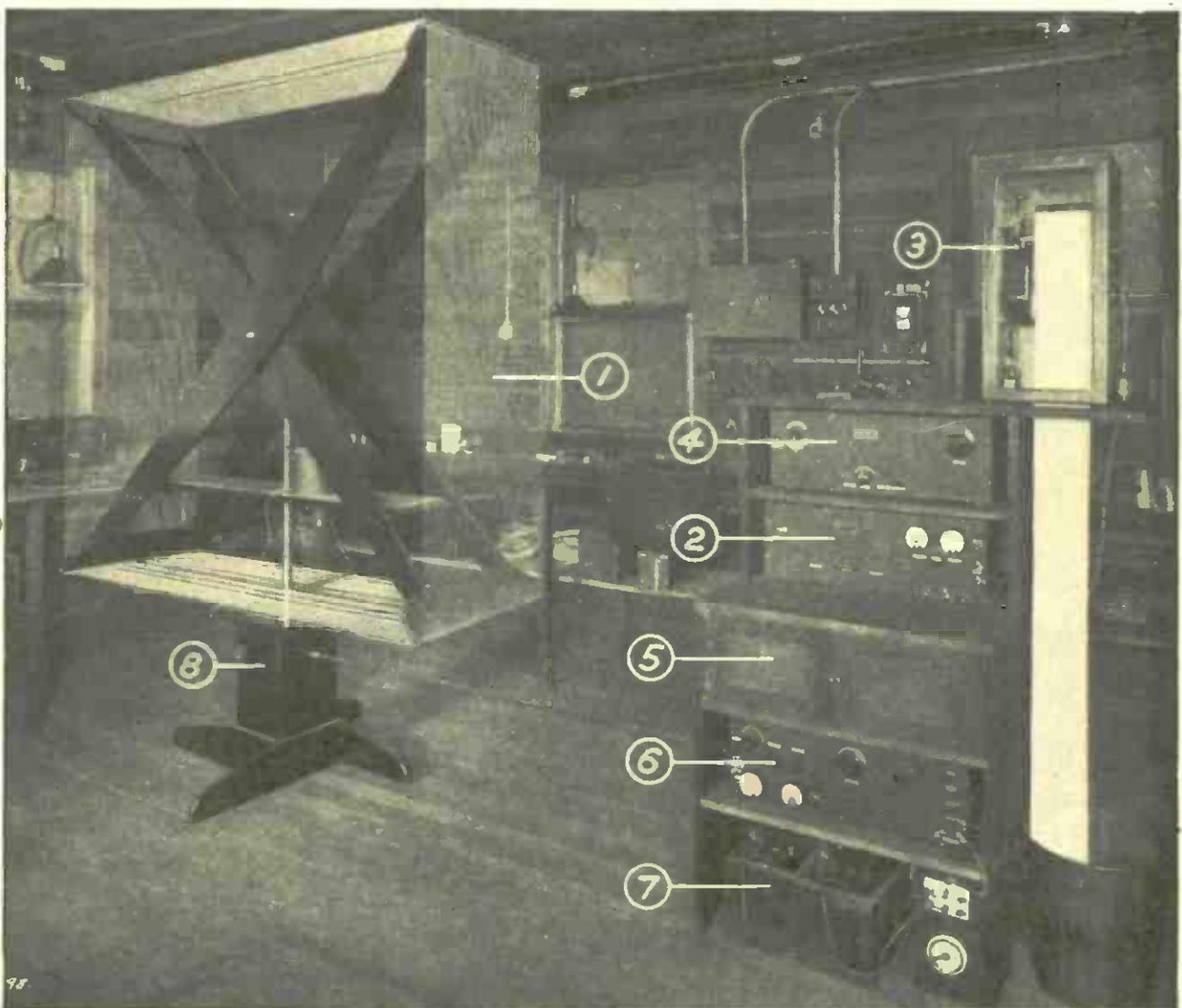
it worth while to develop an automatic means of taking and recording readings of the static noise level by means of some instrument which could run continuously twenty-four hours a day, every day in the year, and which would require only occasional attention.

The way in which this is done is really simple, although it does require some special apparatus.

The radio noise is picked up on a loop antenna and passed into a radio-frequency amplifier. The output of this amplifier passes through a transformer into the heating element of a thermocouple. The D. C. output of the thermocouple operates a recording galvan-

ometer of ordinary type, which gives a continuous record of the variations in the current which heats the thermocouple. A picture of this radio appliance is shown in Figure 2.

This is really quite simple, and it is only necessary to obtain a quantitative value which will correspond to a given deflection on the recorder. This is accomplished by introducing into the loop a comparison signal from a local oscillator of the same frequency as that of the radio noise, and by measuring the value of this input and recording the corresponding output. In this outfit the calibration is completely made without the attention of an operator. The auto-



A. T. & T. Co.

A VIEW OF THE STATIC STATION

FIGURE 2: The large loop 1, is supported by a base which also contains the resistance box 8. The rest of the apparatus is bunched together; 3 is the automatic recorder, 2 and 4 are the amplifiers, 5 is the "B" battery box, 6 is the instrument shown in Figure 1 and 7 is the storage battery.

matic calibration is shown on the right of the sample record for August 26, 1923 (Figure 3).

Starting at the right-hand side of the chart at 6 A.M. the observer sees a record of static until about 6:20 A.M. Suddenly the recording mechanism closes a circuit that starts a motor. The motor then operates a contactor switch which closes the filament circuit of the local-signal input oscillator, decreases the amplification of the outfit by a fixed amount, and connects the galvanometer so that for three minutes it records the value of the local signal which is put into the loop. At the end of this time the galvanometer is again connected in its normal position so that it records the output of the amplifier.

A variable air condenser is rotated slowly by the motor so that it changes the frequency of the oscillator, insuring that the local signal is exactly in tune with the loop. The record of this part of the calibration appears as a resonance curve on the chart under the heading "output."

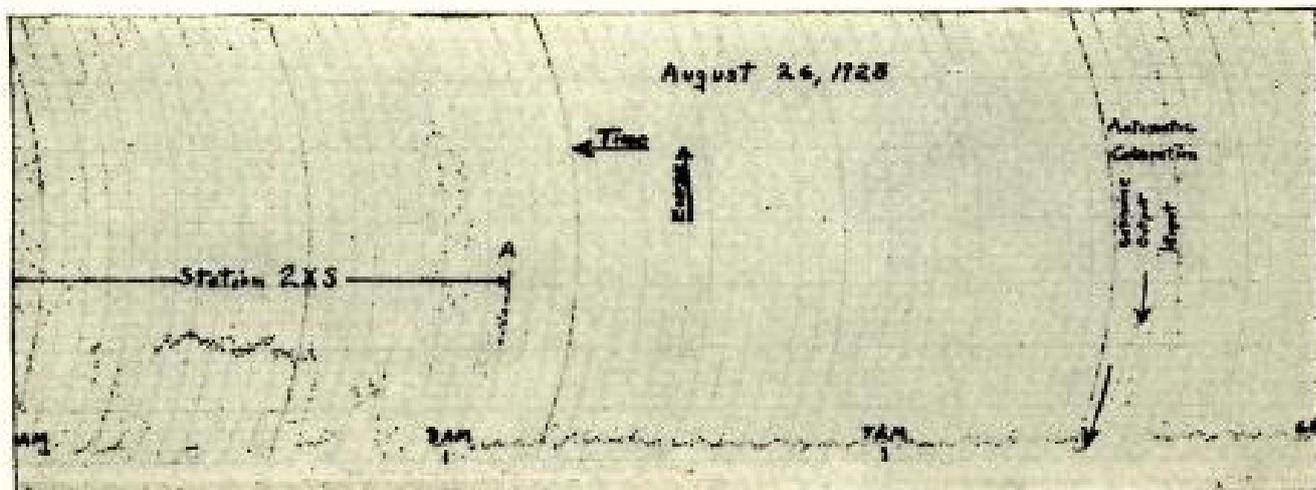
Following this resonance curve, the contactor switch closes a relay which "short circuits" the input of the amplifier, and for two minutes records only the zero correction on the galvanometer. This is shown on the record under the heading "set-noise." At the end of this

period, the set is restored to its original condition and the recording of static continues.

One of the interesting details which was observed almost immediately upon placing this outfit in operation was the abrupt change in the value of the static which occurs at sunrise.

Practically any operator will tell you that if you listen around the sunrise period you will notice this change, but one would never expect it to have so great a magnitude as the change shown on the sample chart given in Figure 4 for April 13, 1923. Here you will notice that just before sunrise there is an increase in the amount of radio noise or static. As the day breaks, this noise starts to diminish rapidly and reaches a minimum shortly after sunrise.

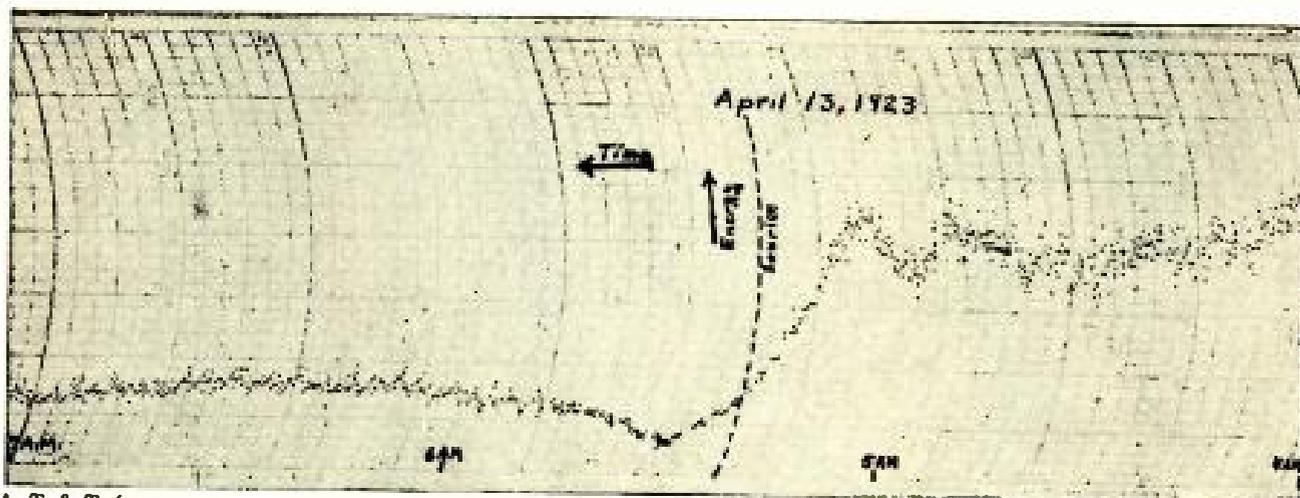
This change in static occurs every morning regularly at sunrise and does not depend upon weather conditions. With the receiving loop placed in the east and west direction this change is most pronounced and probably the reason for this is the fact that some rather sudden change in transmission occurs between dark and daylight. As the earth revolves on its axis, the sun is shining on one side while the other is in complete darkness. This gives rise to a shadow wall that separates day and night. For radio waves—and static comes under



A. T. & T. Co.

AN AUTOMATIC CHART RECORD OF STATIC

FIGURE 3: The small dotted curve is a record of the strength of static received by the automatic station for the early morning hours of August 26, 1923.



A. T. & T. Co.

NOTE THE SHARP DECREASE IN STATIC AFTER SUNRISE

FIGURE 4: This is the same kind of a chart as shown in Figure 3, except that the time period in this case covers the early hours of April 13, 1923. The changes in the strength of static before and after sunrise are well shown.

this heading—this shadow wall appears to act as a giant reflector or refractor.

Now, as practically all of the static received on the eastern coast of the United States originates in the southwest, one may see that as the shadow wall passes the station, it appears to reflect or refract the static waves from the southwest and acts as a shield and greatly reduces the static.

Often other sources of interference besides static are present; when they are strong enough and lie within the narrow band of frequency on which the loop receives, they will, of course, be shown on the record. Occasionally a transmitting station of considerable power will suddenly come on and will give quite a deflection. Such a place is shown at A on the chart in Figure 3 for August 26, 1923. Station 2XS located at Rocky Point, L. I., which transmitted telephone

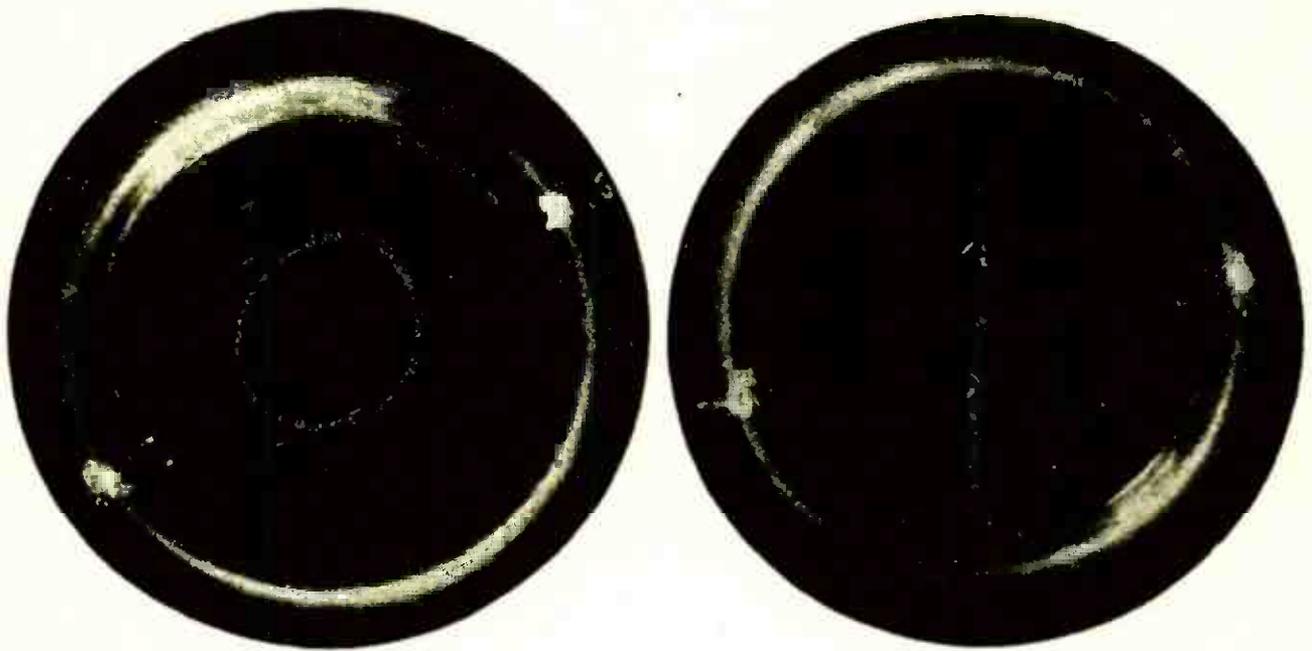
conversation to London last January and has since been used for testing purposes, "came on," and because it was so much stronger than the static, had the effect of completely masking it.

Of course, in using results obtained on a recorder, a great deal of care must be taken to interpret the records correctly, otherwise erroneous ideas will be obtained.

Static, which to so many is a constant source of annoyance, has become for a few persons a very interesting phenomenon and one which deserves a great deal of study regarding its magnitude, its causes and its origin. The records thus far taken tell very little about the real origin of static but they do give very interesting results regarding its magnitude and from what localities it seems to come.

How to Use Your Radio Set on Your Vacation

THE rapid strides that are being made in eliminating the old static bugaboo promise to give radio a far bigger vogue among the fans this summer than ever before. In the coming issue of POPULAR RADIO—for June—will appear the first of a series of articles that will describe in detail just how to use a radio receiver on your motor car and on your pleasure boat, and how to install it in your summer camp.



SAND TESTS ON TWO GOOD TELEPHONE DIAPHRAGMS

The diaphragm at the left is vibrating as a whole, causing the sand grains to collect in a uniform ring around the magnet poles. The one at the right is vibrating in two parts, with most of the sand collected on the line between them. So long as the sand makes a symmetrical pattern like either of these the receiver is behaving properly.

How to Test Telephone Receivers WITH GRAINS OF COMMON SAND

At a meeting of the Royal Society in London last year, Prof. MacGregor-Morris of East London College, exhibited an ingenious device for making the vibrations of a telephone diaphragm visible to the eye. The sand figures that show the vibrations appear in less than a second after the sand is sprinkled on the diaphragm, this being only a small fraction of the time needed for any other testing method.

By PROF. J. T. MacGREGOR-MORRIS, M.I.E.E.

ABOUT three years ago, during the course of an examination of the properties of the so-called "humming" or "howling" telephone, Professor E. Mallett and the author had occasion to determine the various modes in which a standard 60-ohm telephone-receiver diaphragm was vibrating.

It was thought that a convenient method of investigating the matter would be to use the well-known method invented over a hundred years ago by the Prussian physicist, Chaldni; it consists in sprinkling sand on a vibrating plate in order to determine the position

and form of the nodal lines.

With this object in view the ebonite cap of the telephone receiver was bored out so that a much larger portion of the metal diaphragm was exposed to view, but so that enough of the cap was left to enable the diaphragm to be gripped as firmly as ever. The receiver was clamped in a stand so that the plane of the diaphragm was horizontal and faced upward.

The receiver was then connected in circuit with an ordinary vacuum-tube oscillator, so that by varying the electrical capacity in the oscillator circuit

the receiver diaphragm could be forced to oscillate at any desired frequency from 500 cycles a second up to one which was well above the limit of human hearing.

If now, some fine dry sand be lightly sprinkled over the diaphragm, any characteristic mode of vibration, if present, will at once be rendered apparent by the figure in which the sand grains arrange themselves. On varying the frequency of the oscillating tube circuit certain sand figures spring into existence with almost surprising sharpness as soon as the frequency imposed by the oscillator corresponds exactly with the natural frequency of the diaphragm.

At least twelve different figures have been obtained in this way, each corresponding to a different manner of vibration of the diaphragm. Two of these figures are reproduced in the accompanying illustrations showing the sand arranged, respectively, in a line and in a circle.

This method of testing by means of an oscillator and sand figures enables a rapid check to be made of the correctness of adjustment of the working parts of a receiver. As evidence of this statement there is reproduced herewith a third figure showing a great lack of symmetry in the arrangement of the sand and, therefore, in the vibration of the diaphragm. This lack of symmetry is due, probably, to the distances of the pole pieces from the diaphragm being unequal.

As experience is gained with this method it is probable that the usual opening of the telephone ear-cap will prove to be sufficient to allow of a sand figure being obtained and judged for symmetry. If so, it will be possible to test receivers without enlarging the opening in the ebonite ring.

It will be clear that for the characteristic frequencies at which the diaphragm



AN IMPERFECT RECEIVER

The unsymmetrical arrangement of the sand shows that the receiver is not working correctly. Probably the poles of the magnet are improperly adjusted so that one is farther from the diaphragm than is the other.

tends to vibrate naturally, a definite amount of electric energy supplied to the receiver will result in a more powerful response of the receiver diaphragm to these particular notes than for frequencies far removed from them.

In music it is well known that the quality of a note produced by different musical instruments of the same pitch depends on the relative intensities of the various harmonics constituting that note. Bearing this in mind, we see that any undue emphasis upon one or more of the constituent harmonics of a note will distort the character of the note. A particular telephone diaphragm may easily alter the quality of a particular note so that the instrument which produced the note may be entirely unrecognizable.

There are many other causes of distortion of sounds by telephone receivers and their circuits, but this is one of the more important and is easily tested by sand figures in the simple way here described.

¶ "Will radio haul our trains?" See POPULAR RADIO for June.



From a photograph made for POPULAR RADIO

AN 80,000-VOLT CIGAR LIGHTER

This novel "use" for high-voltage electricity is devised by Mr. S. N. Baruch of New York. The current used is of high frequency as well as high voltage; that is why there is no danger to the experimenter.

WHAT CAN WE DO WITH 3,000,000 VOLTS?

The greatest scientific mystery of this decade is the relation between ether waves and matter. - What is the electron? How are radio waves produced and how do they affect electrons and atoms? - What is the ether? - One of the most promising ways of attacking these problems is by high-voltage electricity.

By THOMAS ELWAY

SCIENCE has found a new tool, a new weapon to assist the more complete conquest of the forces of nature. It is the availability of electric voltages measured in millions instead of in thousands—voltages hundreds of times greater than the scientists of even

twenty years ago would have dreamed of being able to control and to use.

Nor are these tremendous voltages mere scientific toys. Although the production in the laboratory of potentials up to 2,000,000 volts is less than two years old, it has resulted already in the

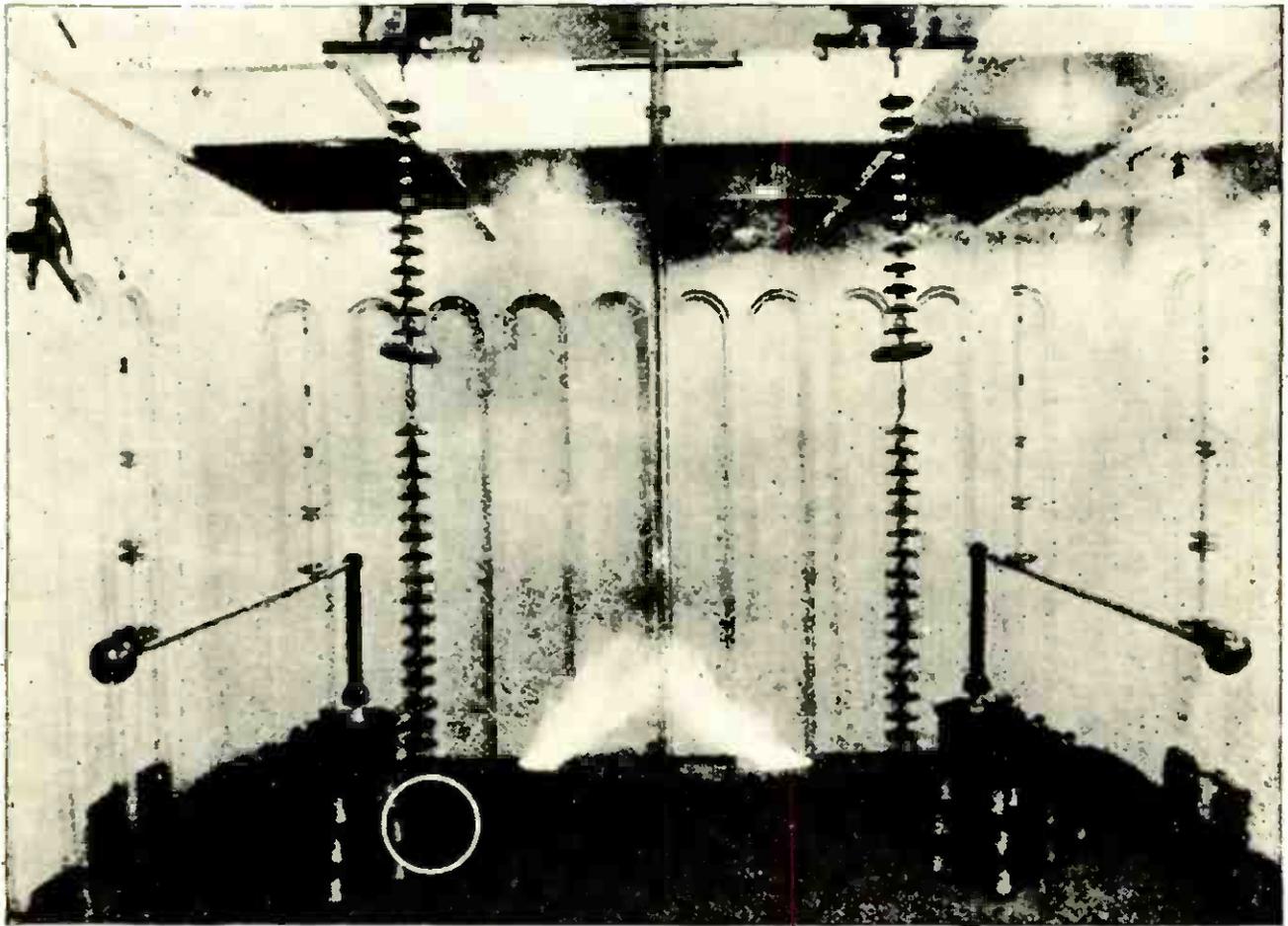
acquisition of experimental data of the greatest value to the design of electrical machinery and to other problems of electrical engineering, including the design of antenna systems for high-powered radio stations.

It is probable, scientists believe, that the application of these high voltages to the problems of physics will result within a year or two in still more fundamental advances. We may get clues to the real nature of matter and electricity; to the fundamental radio problem of what constitutes the disturbances in space that we call ether waves; perhaps even to that most interesting of all scientific problems, the problem of the nature of life!

What has been accomplished so far is scarcely more than the mere production of the high-voltage charges.

A potential of 1,000,000 volts was attained for the first time nearly ten years ago, but it was difficult to control with the apparatus then available and was little used. Within the past three years interest in high-voltage work has revived. A potential of 1,000,000 volts was generated again by two of the larger engineering laboratories, that of the General Electric Company and that of the Westinghouse Company. The latter company succeeded in building a single transformer capable of producing this potential. Simultaneously the Pittsfield laboratory of the General Electric Company passed the million-volt figure and produced discharges at the tremendous potential of 2,000,000 volts, some of them, perhaps, even more than this.

Out in California the Southern California Edison Company is finishing the



International

A MILLION-VOLT ARC TRIES THE QUALITY OF INSULATORS

In this experimental laboratory at Freiburg, Germany, new designs and materials for electric insulators are tested with a potential of 1,000,000 volts. The figure of the man (inside the white circle) indicates the size of the arc.

construction of a million-volt experimental laboratory at Pasadena and the California Institute of Technology, jointly with the great astronomical observatory at Mount Wilson, has assembled, to work in this laboratory, probably the most distinguished group of physicists and chemists ever gathered under the roofs of a single institution. Here in Pasadena there will begin this year the most comprehensive attack ever attempted on the problems of matter, of energy and of ether waves. Together with the million-volt weapon that they are preparing, the California scientists will have the best apparatus and the most highly trained assistants that science can suggest. No one can predict what they may not do. The news from Pasadena in the next two years may easily prove to be the most important news in the world.

The 2,000,000-volt potential that is already an accomplished fact, the 3,000,000 volts or more that we can have, probably, at any time that we can afford the money for the necessary apparatus, bring us close to the natural high-voltage discharges that we call lightning. We are surpassing Benjamin Franklin and the famous kite. We not only tap the lightning; we *make* it.

Just what the real voltage of lightning is, is still something of a mystery. The scientists of the General Electric Company, as a result of their experiments on the duplication of lightning effects on small scale laboratory models, estimate an average potential of some 50,000,000 volts for a good sized flash. An English investigator, Professor C. T. R. Wilson, believes in much higher figures, reaching even to 1,000,000,000 volts.

On the other hand, Professor Harris J. Ryan of Stanford University reaches much lower estimates. He has found by experiment that the length of a spark produced by a certain voltage increases tremendously with the high voltages. Although moderate voltages

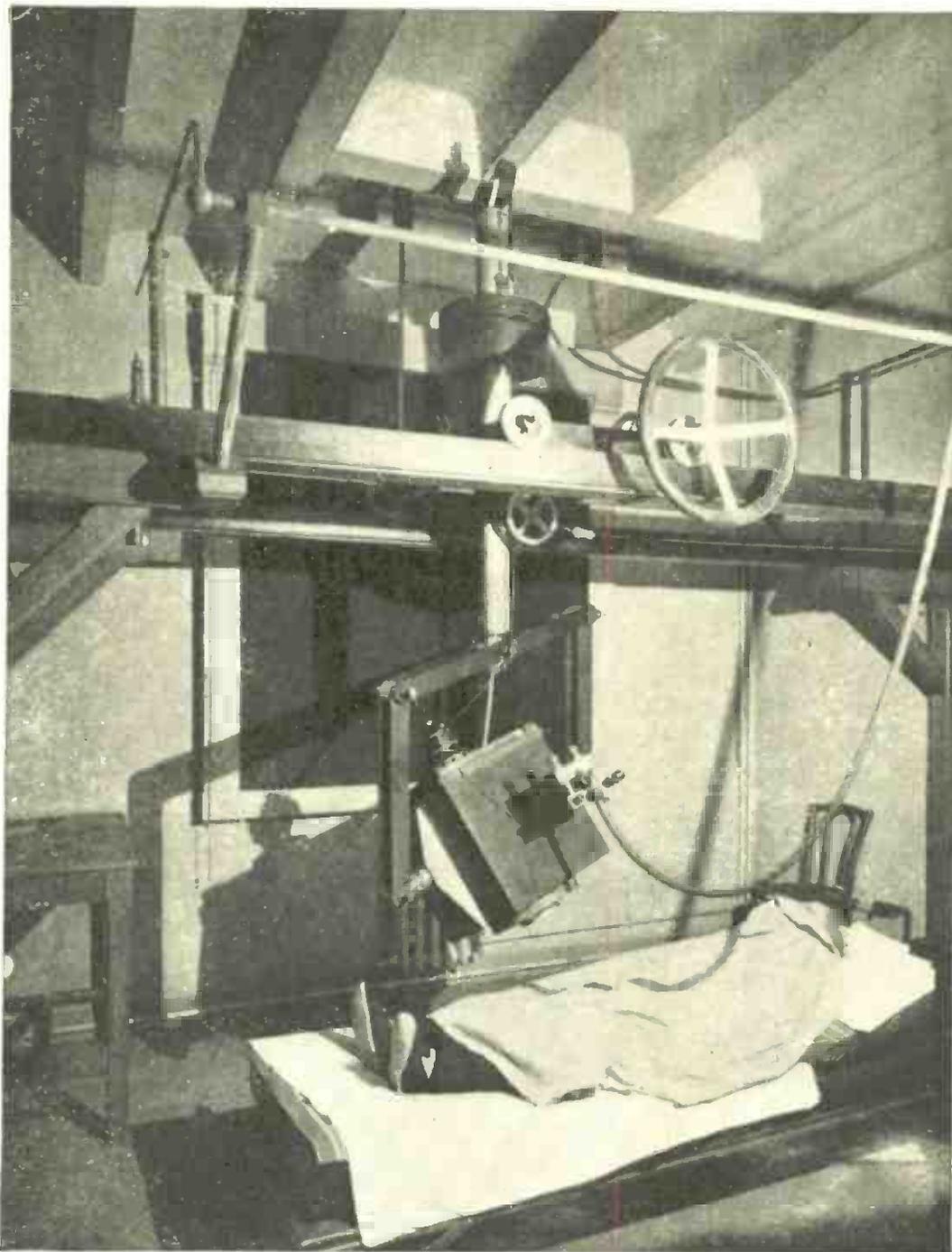
give sparks of only about one inch of length for each 10,000 volts, 3,000,000 volts would give, Professor Ryan thinks, a spark eighteen miles long. It seems to him, therefore, that natural lightning may be between 2,000,000 and 3,000,000 volts, quite within the range of the potentials now becoming available in the laboratory.

Whoever may prove to be right in this argument, whether lightning has the two or three million-volt value of Professor Ryan or the fifty million volts or more demanded by the other engineers, it is obvious that our laboratory resources begin to approach it. The late Dr. Steinmetz was able to blow up pieces of trees and to destroy toy villages with his artificial bolts. More important practically, it has been possible to use these available voltages to test insulators, to study the behavior of dielectric materials exposed to very high potentials, to study the electric surges in power lines induced by lightning flashes and to investigate many similar problems of power-line engineering.

It has been possible, too, to apply some of the facts learned to the problem of protecting large radio antenna systems from lightning bolts and from the induced surges caused by lightning. When the experiments are a little more complete it will probably be possible to generate artificial static and to study in this way the real nature and control of the radio disturbances caused by lightning and by other sources of atmospherics.

But the most fruitful field for high-voltage research is likely to be found, I believe, in the fundamental problems of physics. One of the striking things about physical science in the past thirty years is the way in which it has pushed its investigations of the behavior of matter into conditions of temperature, pressure and the like not naturally available on earth and never before attainable here.

Over a hundred years ago, for ex-



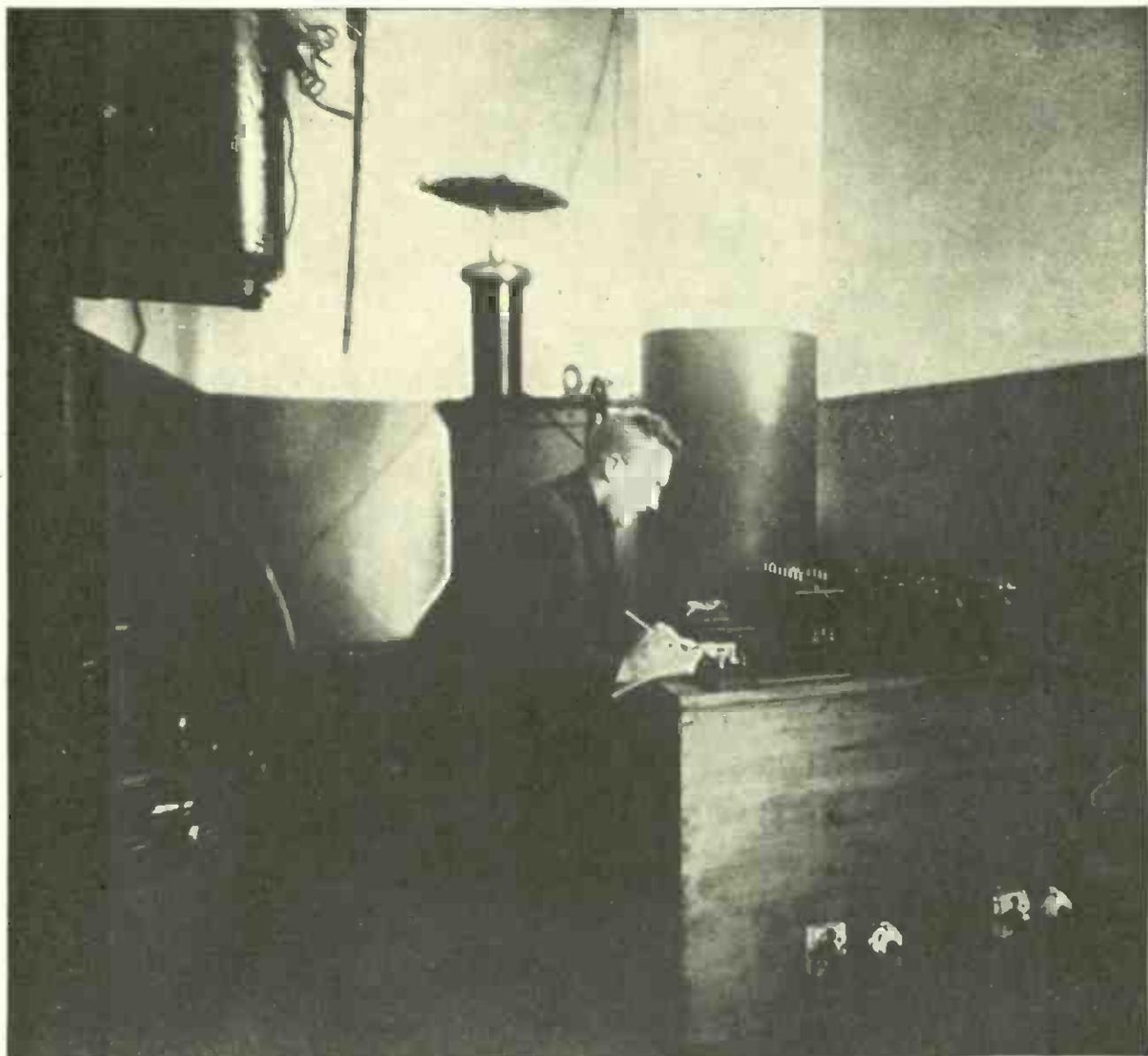
Boyer

HOW HIGH-VOLTAGE ELECTRICITY AIDS THE SICK

This apparatus, in the Institute of Radium in Paris, uses a potential of 100,000 to 250,000 volts to produce the extremely powerful X rays used in the treatment of cancer and other diseases.

ample, when the first thermometers were being constructed, it was believed that the highest temperature attainable was that of a charcoal fire and that the lowest degree of cold was that of a cold winter in the north of Europe. The zero point of the Fahrenheit scale was set at this lowest air temperature and it was thought that "below zero" temperatures were impossible.

But science has now made available to the laboratory worker temperatures tremendously beyond this range in both directions. Electric furnaces produce temperatures up to 5,500 or 6,000 degrees Fahrenheit, more than twice as hot as the hottest charcoal fire. And the development of liquid air, liquid hydrogen and liquid helium has given us low temperatures reaching to 455 de-



Habirshaw Electric Cable Co.

TESTING CABLES WITH HIGH-VOLTAGE CURRENTS

One of the main practical uses of very high voltages, at present, is in testing electric cables before they leave the factory. Possible faults in insulation can be discovered and corrected before the cable is laid.

degrees below zero, Fahrenheit, within three or four degrees of the theoretical absolute zero of temperature at which all heat is supposed to disappear.

An instance of the importance of such extreme temperatures to science is the discovery that at the lowest degrees of cold the electric resistance of metals becomes almost nothing. If we could cool off a copper wire to the temperature of liquid helium and keep it from warming up again, we could send millions of kilowatts of electric power through it without burning it out and with only an infinitesimal loss of the

electric energy. Of course, we cannot do this practically, at least not yet. But the facts about electric conductivity at very low temperatures have important bearings on the theories of electric conductivity in general and will result, we may be sure, in some kind of practical utility to electrical engineering.

The new high temperatures have been most useful also. Modern knowledge of alloys is largely due to high-temperature work, as is the knowledge that resulted in the discovery of ductile tungsten and the perfection of the tungsten filament for electric lamps and

for radio vacuum tubes. If modern science had not had available to it temperatures hotter than the charcoal fire of the ancient alchemists there would be no tungsten wire nowadays and no radio.

The significance of all this for the possible utility of high-potential electricity is that these high voltages will permit us still further to extend the range of conditions that we can realize in the laboratory and to which we can expose materials in order to study their properties and behavior. For example, the highest temperatures ever attained on earth have been reached quite recently by sending a high-voltage electric discharge suddenly through a tiny metal wire. The wire, of course, burns up. In doing so it is supposed to reach, for an instant, a temperature in the neighborhood of 50,000 degrees Fahrenheit.

This is a higher temperature, even, than that of the surface of the sun. It probably does some very serious things to the constitution of the atoms of matter. Two Chicago scientists have announced, indeed, that by exploding in this way some very thin wires of tungsten they think that they have succeeded in decomposing some of the atoms of tungsten and transmuting them into other kinds of atoms, notably into

atoms of helium. This experiment lacks confirmation by other workers but the result is by no means an impossible one. If the problem of artificial transmutation of the elements ever is solved, as we feel sure it soon will be, it is very likely to be accomplished in some such way as this, by the application of very high temperatures and very high voltages, in combination, to the atoms of matter.

It is believed, indeed, that exactly this sort of thing is going on all the time in the interior of the brighter stars. The temperature at the center of such stars probably exceeds a million degrees. The electric potentials may be equally tremendous. The ordinary earthly elements, astronomers believe, cannot exist under these conditions. Iron and gold and oxygen and all such elements will be decomposed into simpler ones. The spectroscope indicates that this is the case and it is probable that the scientists out at Pasadena will be proving it directly before long by duplicating here in an earthly laboratory the conditions which exist, we believe, off there millions of millions of miles away in the heart of a flaming star.

A distinguished scientist told me not long ago that there were, in his opinion,

Five Mysteries That High-voltage Electricity May Help to Solve—

1. What is the electron?
 2. What is magnetism?
 3. What is the origin of gravitation?
 4. What is ether—the supposed medium that carries the electromagnetic waves of light and of radio?
 5. What is it that enables living matter to keep alive and to reproduce itself?
-

five fundamental scientific mysteries:

First was the mystery of what the electron is.

Second was the mystery of magnetism.

Third was the problem of the origin of gravitation.

Fourth was the great mystery of the ether, the question as to what it is that carries the electro-magnetic waves of light and of radio.

Fifth was the mystery of life, of how living matter is able to keep alive and reproduce itself.

The solution of any one of these mysteries might be of incalculable benefit to mankind and it is not likely that we will solve any of them by studying electrons or magnets or anything else under the ordinary conditions that exist on the surface of the earth. We must place our atoms and electrons and our living cells under *unusual* conditions. We must see what happens to them when they are 100,000 degrees hot, or when they are charged to a potential of three or four million volts. It is stress that brings out the qualities of atoms, as of people. Cook them, freeze them, compress them, electrify them, and we will find out what they are.

It is in investigations like these that we will find, I believe, the greatest value

of our new 2,000,000-volt or 3,000,000-volt tool. It will help us to pry open the deep secrets of the universe.

But it may have some direct practical utility as well. There is already in service a 220,000-volt line for transmitting electric power. A 1,000,000-volt line is possible and may arrive before long. Mr. F. W. Peek, Jr., has calculated what such a line would have to be like. The towers would be 157 feet tall and the arms carrying the conductors would be nearly 50 feet from side to side. The conductors themselves would not be wires as in present transmission lines but would be hollow copper tubes $6\frac{1}{2}$ inches in diameter. They would hang on a string of porcelain insulators more than fifteen feet long.

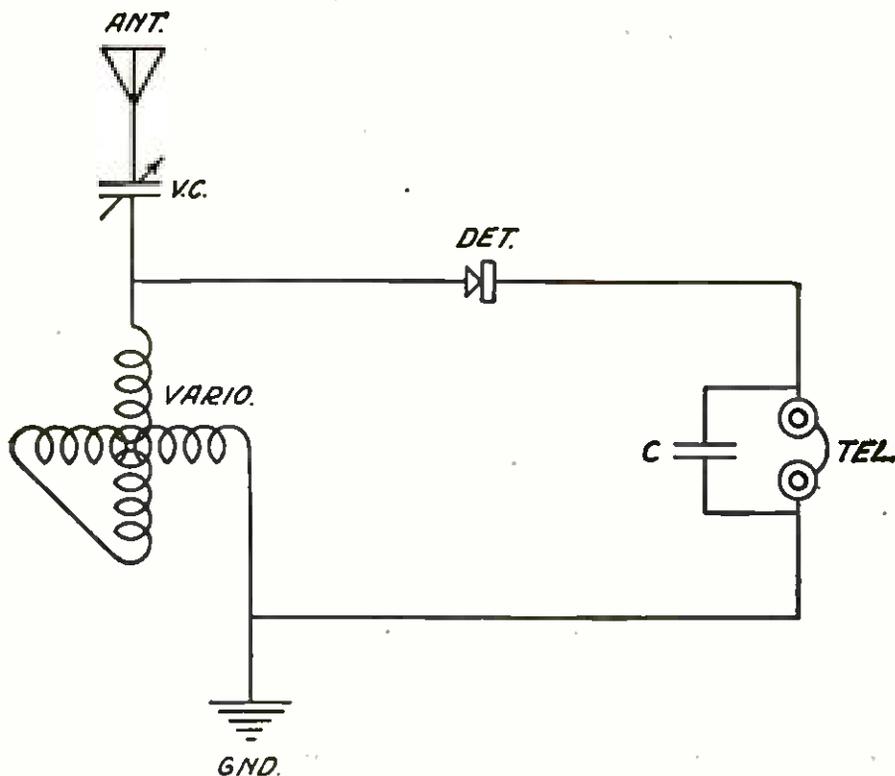
Such a line would carry 3,000,000 kilowatts a thousand miles with only 12 percent loss. No one is planning such a line now but it is only a few years since 200,000 volts was considered to be impossible and now it is a fact. A few years more and even a million volts may be a commonplace. And whether this happens or not, the use of these high voltages in laboratory work is very sure, I believe, to open to us some of the deepest secrets of Nature. Watch the news from Pasadena!



Kadel & Herbert

AN AMATEUR'S RECEIVER THAT SPANS THE CONTINENT

This set employs only one step of tuned radio-frequency amplification, but it enables its builder, Harold Herbert of New York, to listen in on California.



SINGLE-CIRCUIT CRYSTAL SET

Cost of parts: Not more than \$18.00.

Selectivity: Fair.

Operation: Simple. The antenna circuit is tuned by both the condenser and the variometer. The closed circuit is controlled by the variometer.

Construction: Very simple to make.*

Approximate range: 15 miles.

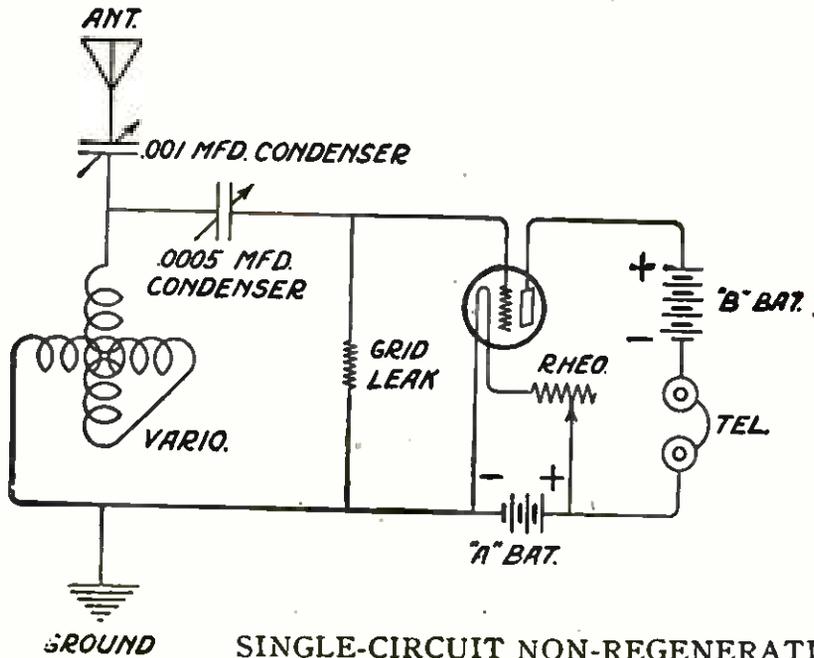
Outstanding feature: A good, inexpensive set for the city dweller who is content to listen to local programs with the headphones.

**(See POPULAR RADIO, December, 1922, page 292, for details of operation.)*

100 BEST HOOK-UPS

INSTALLMENT NO. 6

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 and amateur transmitting circuits, each thoroughly tested. The approximate ranges given here are averages based on actual records made with 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 previous issues of POPULAR RADIO.



SINGLE-CIRCUIT NON-REGENERATIVE SET

Cost of parts: Not more than \$22.00.

Selectivity: Only fair. (This modification is a little more selective than the one shown on page 50 of the January issue.)

Operation: Simple. The variometer and one of the variable condensers tune the antenna, and the variometer and the other

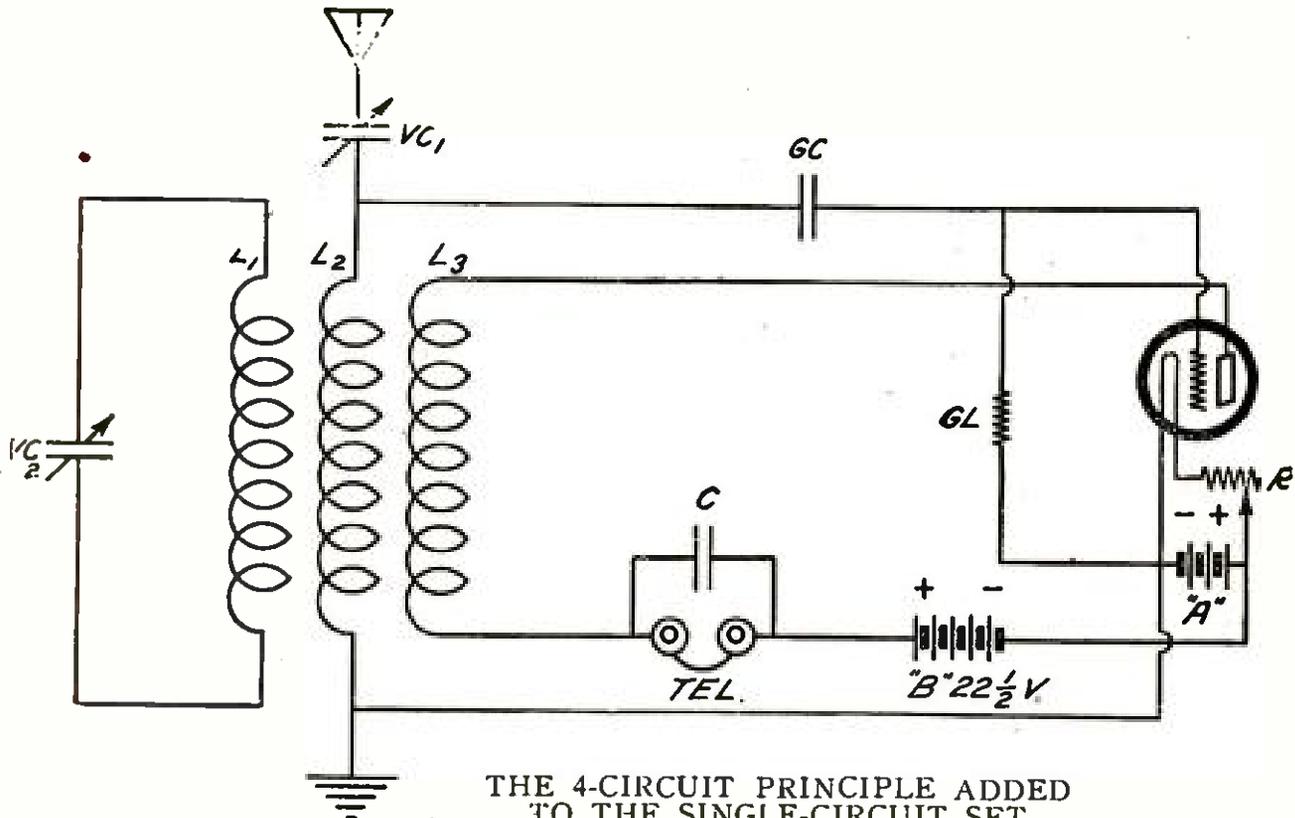
variable condenser control the grid-circuit tuning.

Construction: Not complicated.*

Approximate range: 100 miles.

Outstanding feature: A non-re-radiating, single-circuit receiver for reception of local signals.

*(See POPULAR RADIO, January, 1923, page 59, for constructional details.)



THE 4-CIRCUIT PRINCIPLE ADDED TO THE SINGLE-CIRCUIT SET

Cost of parts: Not more than \$25.00.

Selectivity: Fair.

Operation: The extra circuit, comprising the condenser VC2 and the coil L1, gives a much better control of regeneration than in the conventional circuit.

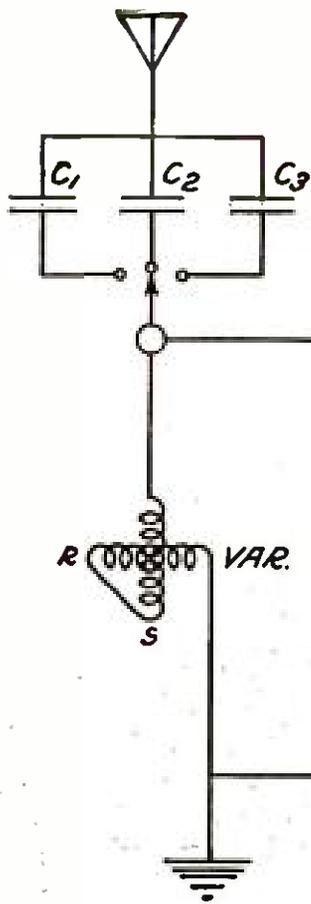
Construction: Just an ordinary acquaintance with tools and some ability in wiring up

the circuit is necessary.*

Approximate range: 500 miles.

Outstanding feature: The added circuit will give stability to the control of regeneration so that the circuit will not burst into oscillation and cause a violent disturbance in neighbors' receivers.

*(See POPULAR RADIO, October, 1923, page 325, for constructional details.)



A SIMPLIFIED REFLEX

Cost of parts: Not more than \$24.00.

Selectivity: Only fair.

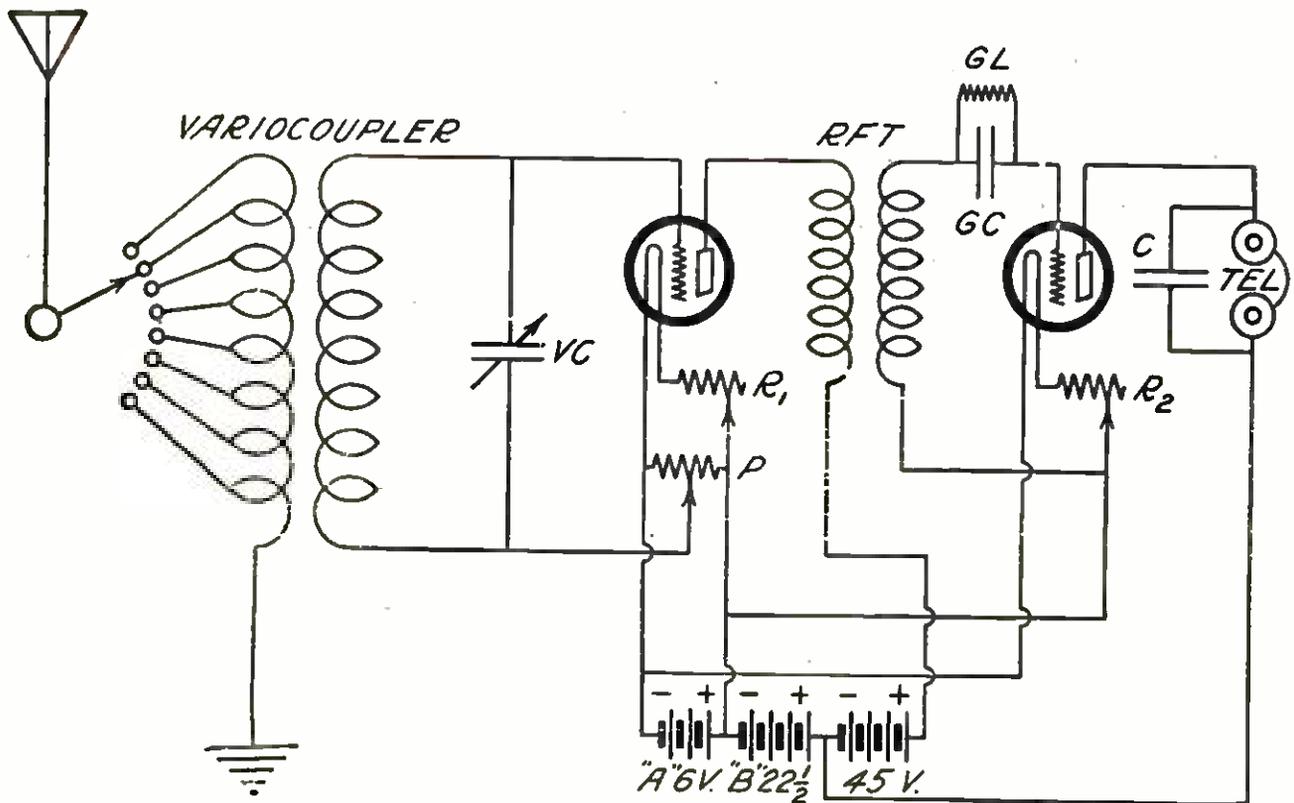
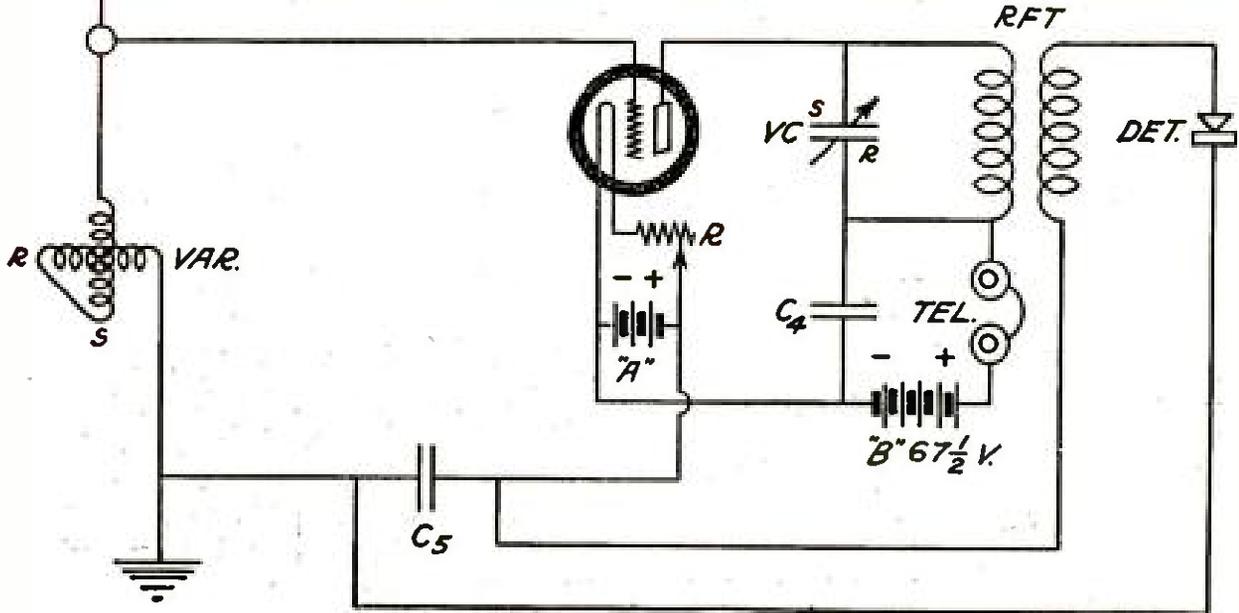
Operation: Extremely simple.

Construction: Easy.*

Approximate range: 800 miles.

Outstanding feature: No audio-frequency amplifying transformer is used.

*(See POPULAR RADIO, January, 1924, page 81, for constructional details.)



ONE STAGE OF RADIO-FREQUENCY AMPLIFICATION ADDED TO A STRAIGHT AUDION CIRCUIT

Cost of parts: Not more than \$28.00.

Selectivity: Good.

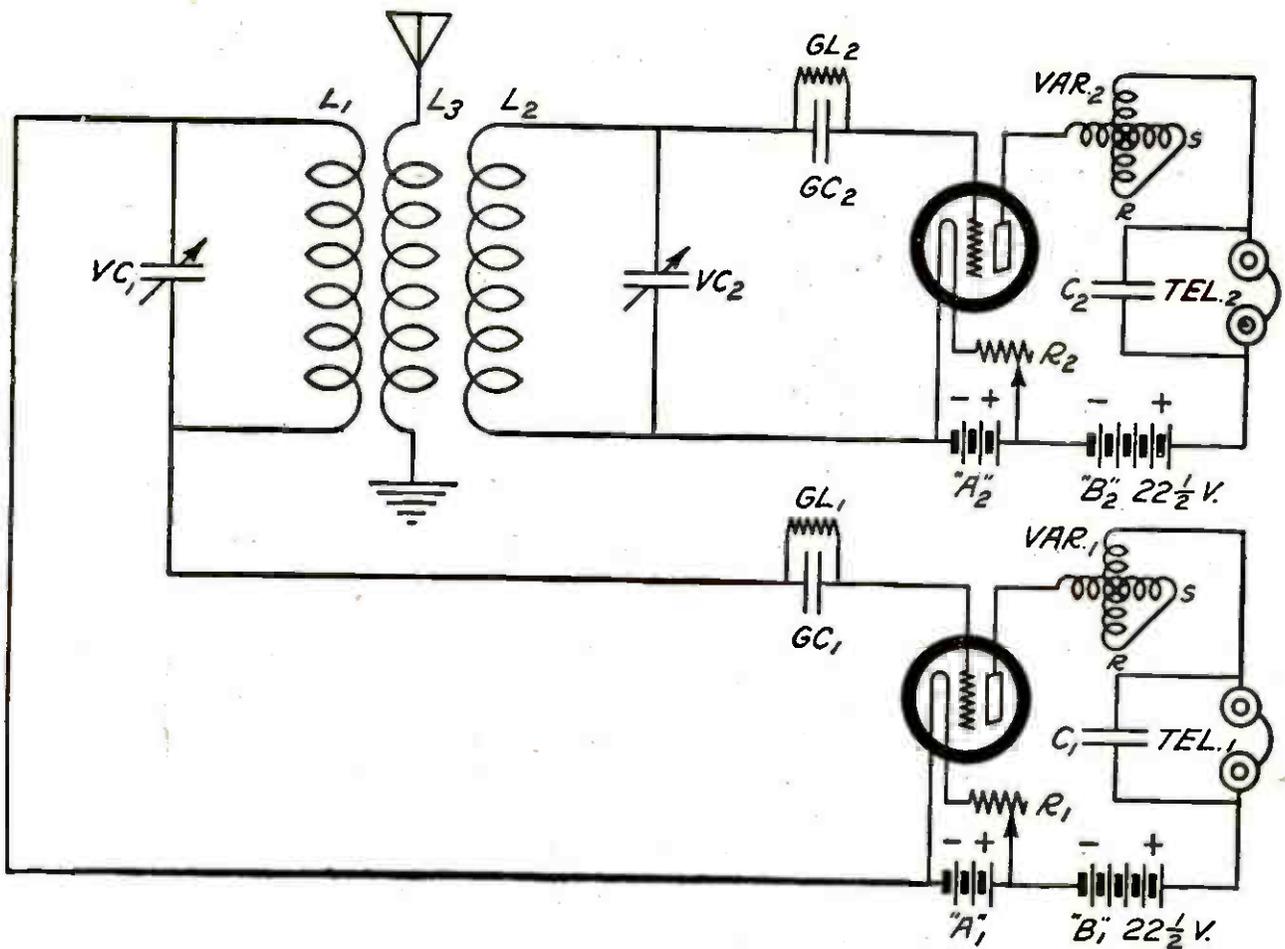
Operation: Not difficult.

Construction: Nothing especially complicated.*

Approximate range: 500 miles.

Outstanding feature: This is a good circuit for the man who already has a simple vacuum-tube circuit and wishes to make it more sensitive.

*(See POPULAR RADIO, June, 1923, page 471, for constructional details.)



A DUPLEX REGENERATIVE RECEIVER

Cost of parts: Not more than \$55.00.

Selectivity: Very good.

Operation: A few weeks' practice will suffice to enable efficient tuning of both parts of the set.

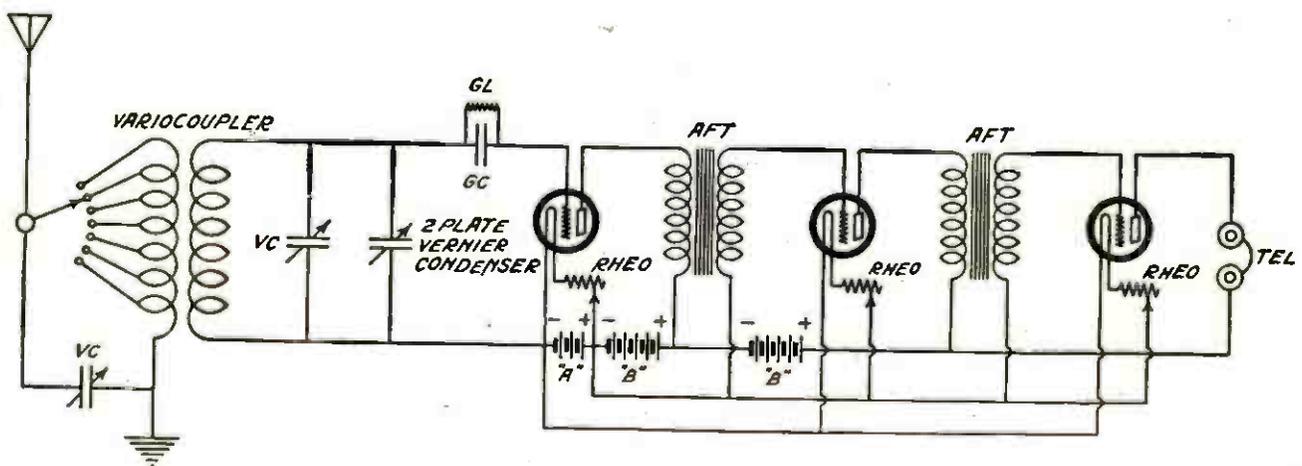
Construction: Just an ordinary acquaintance with tools and some ability in wiring up

the circuit is necessary.*

Approximate range: 500 miles.

Outstanding features: Sharp tuning, and the fact that the set will bring in two programs (on different wavelengths) at the same time on two pairs of telephones.

**(See POPULAR RADIO, January, 1924, page 96, for constructional details.)*



A SIMPLE AUDION CIRCUIT WITH TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than \$40.00.

Selectivity: Fairly good.

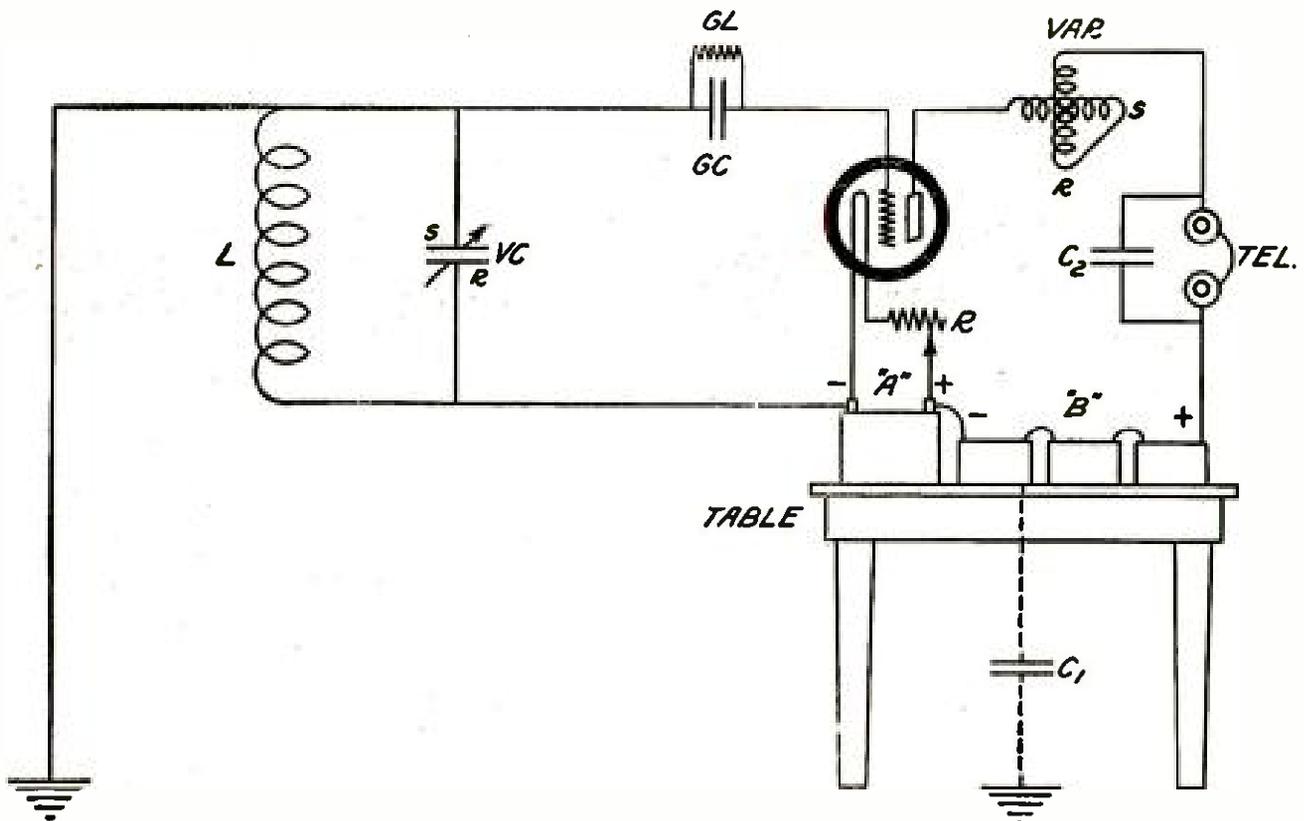
Operation: Easy to operate.

Construction: Simple.*

Approximate range: 300 miles.

Outstanding feature: The set will bring in any signals, with great clarity, as long as they are strong enough to operate the detector.

**(See POPULAR RADIO, March, 1923, pages 232-233, for constructional details.)*



A REGENERATIVE SET FOR RECEPTION WITH A GROUND ONLY

Cost of parts: Not more than \$23.00.

Selectivity: Excellent.

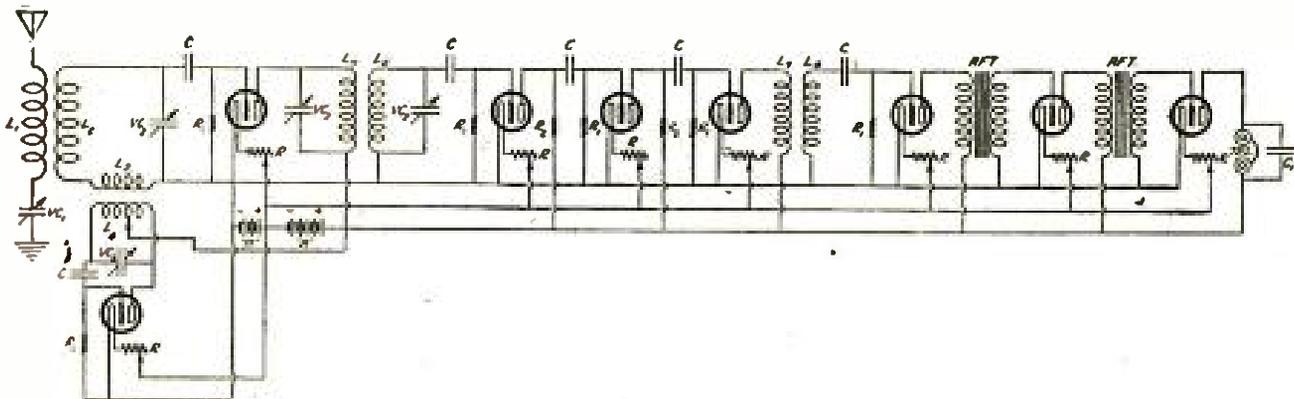
Operation: Easy to tune. There are only two controls, the variable condenser for wavelength, and the variometer for regeneration.

Construction: Very simple to make.*

Approximate range: 25 miles.

Outstanding feature: This is a good type of receiver for local reception where the conditions make impossible the erection of an outside antenna.

*(See POPULAR RADIO, November, 1923, page 372, for details.)



A RESISTANCE-COUPLED SUPER-HETERODYNE WITH TWO STAGES OF AUDIO-FREQUENCY AMPLIFICATION

Cost of parts: Not more than \$80.00.

Selectivity: Excellent.

Operation: Difficult.

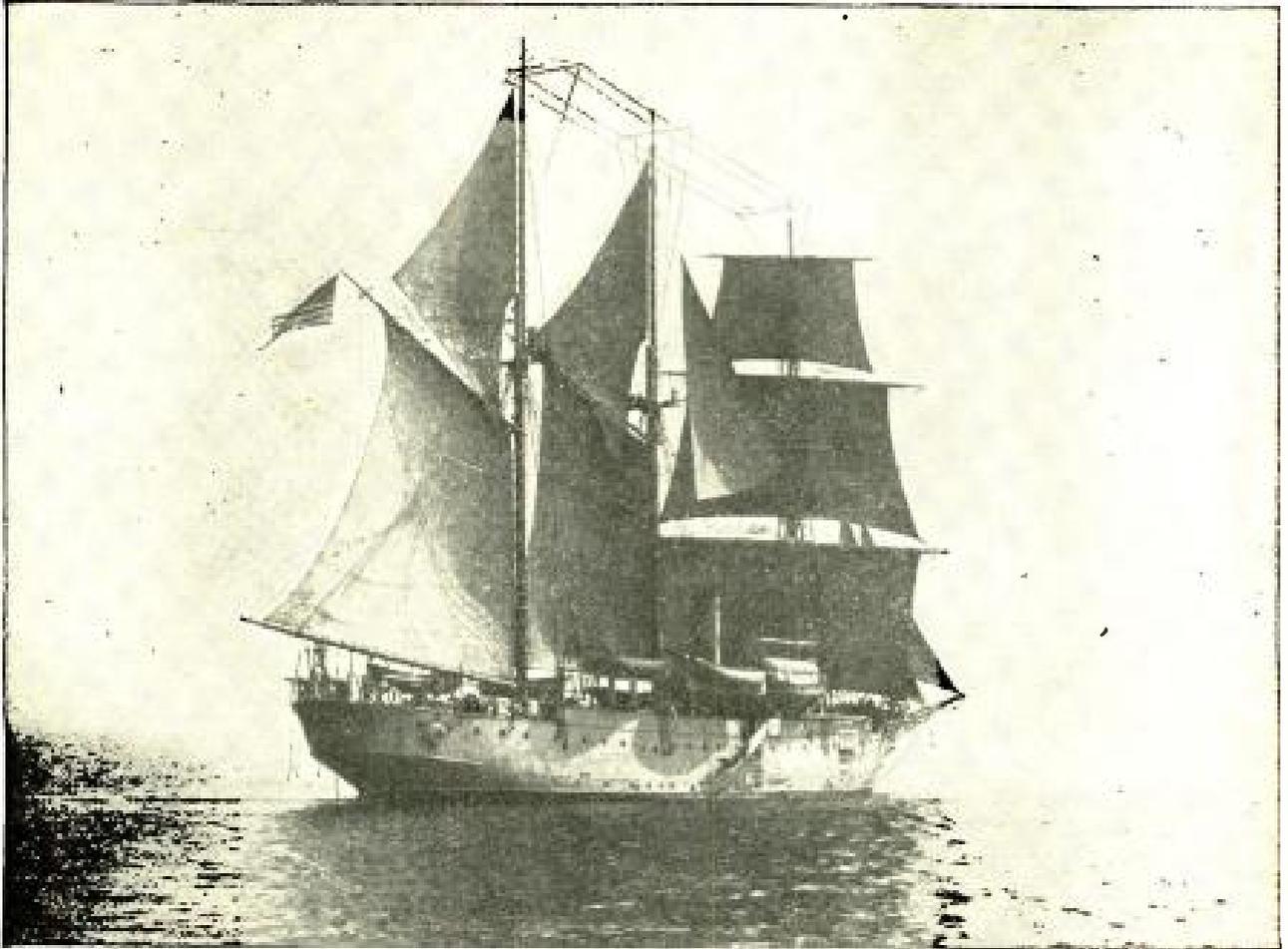
Construction: A very complicated circuit to

master.*

Approximate range: 3,000 miles.

Outstanding feature: This set combines sensitivity with great selectivity.

*(See POPULAR RADIO, June, 1923, pages 468-469, for constructional details.)



International

HER ANTENNA PROVED TO BE A LIFE-LINE

The NEWPORT, schoolship of the New York State Nautical Training School, kept in such close communication with the broadcast weather reports that she was just able to keep outside the fringe of a tropical hurricane.

How Radio Saved a Sailing Ship

A true adventure of the only large vessel of its kind that is equipped with receiving apparatus.

By ARMSTRONG PERRY

THE only sailing ship in the world equipped with radio is probably the *Newport*, the schoolship of the New York State Nautical Training School. And last summer when the *Newport* made her practice cruise across the Atlantic and back she was altogether a sailing ship, for her auxiliary steam plant was out of commission.

Nevertheless, Mr. Albert Bombe, who sailed with her as radio operator, kept his radio in commission with the help of storage batteries and other expedients.

Not many voyages in recent years have necessitated so much ingenuity in adapting radio to unusual conditions. And in few voyages, if any, has radio rendered so vital a practical service to the ship. On her return trip the *Newport* encountered the fringe of a tropical hurricane. She had no steam power with which to run away and it might have gone ill with her had she experienced the full force of the storm.

But Mr. Bombe's radio was able to pick up frequent bulletins of the storm's

progress and the captain was able to use this information in dodging the danger.

The use of radio on a sailing ship involves many unusual conditions. The wires cannot be protected from the wear and tear by men and gear, as they can on a steamship. Operator Bombe's first two days aboard were occupied entirely in repairing defective insulation and in removing short circuits where accidents due to these causes had damaged the wiring.

Then when he was ready to open up with his transmitter, he discovered that the officers were using the lead-in as a clothes line because it happened to run through their quarters. This interfered with both transmission and reception.

One day an engineer touched the lead-in while the transmitter was working and was severely burned. Another day a leaky spark-gap nearly burned up the whole set.

Besides being responsible for the radio work, Bombe issued a daily newspaper filled with items caught from the air. He also served as librarian and general consulting scientist. When the navigator observed, one day, an unusual deflection of the compass, Bombe showed him a passage in a Life of Columbus stating that the discoverer of America had noted a similar phenomenon when his ships were

in approximately the same position in the ocean.

The *Newport* touched at only one port in Europe, Teneriffe in the Canary Islands, then she started homeward. While nearing the American coast, Bombe picked up the hurricane warning.

The storm was headed up from the Bahamas. The captain knew that all he could do was to play a dodging game. For a week it was up to Operator Bombe to get news, somehow, of the progress of the storm and of weather conditions in other quarters. One error in copying latitude or longitude might mean shipwreck.

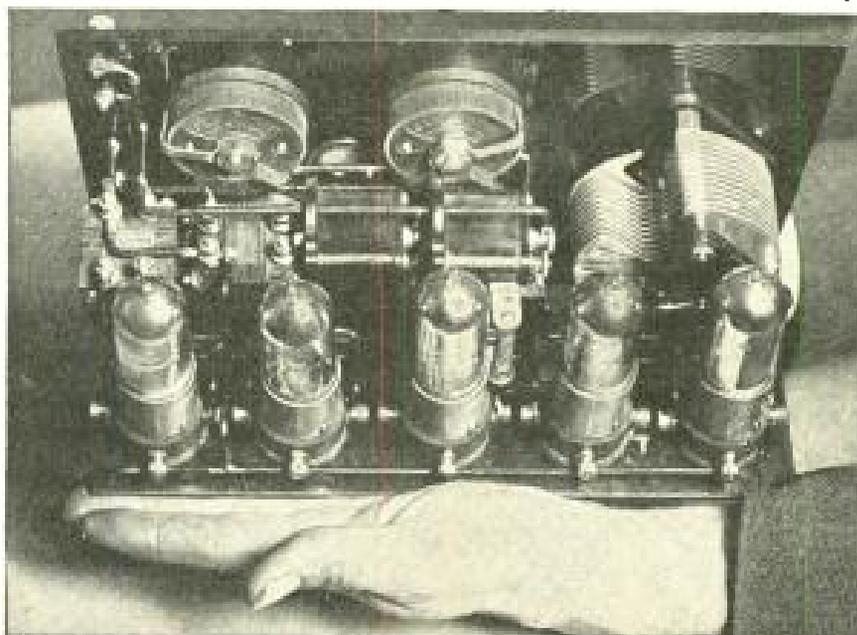
The static was terrific and Bombe had great difficulty in copying the warnings. Sometimes the ship had to run far off her course in order to escape an extension of the tempest. Sometimes she set all sails and trusted to speed and luck in crossing the path of a storm she could not avoid.

Good navigation and good fortune—plus radio—brought the schoolship home eventually, undamaged and with all hands in good health and spirits.

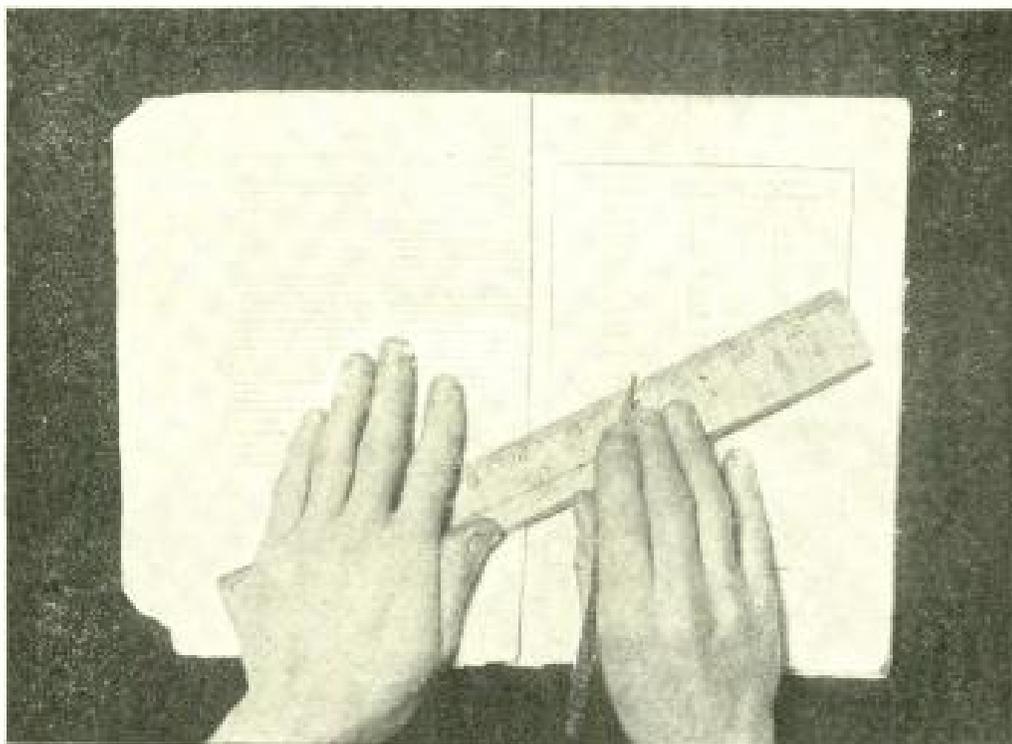
The ocean graveyard that received so many luckless sailing ships in the old days when there was no radio, had been cheated for once.

THE SMALLEST 5-TUBE SET IN THE WORLD?

Its maker, Sidney Kasindorf of New York, thinks that it is. It consists of two stages of radio frequency, detector and two stages of audio frequency, and operates a loudspeaker on a small loop antenna.



Kadel and Herbert



These are all the tools
you will need—

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

A MEASUREMENT CHART FOR USE IN DESIGNING A RHEOSTAT

ARTICLE NO. 8

The previous articles contain charts *For Determining the Constants of Radio Circuits and Calculating Capacities of Condensers in Series*, in February, 1923; *For Determining the Dimensions of Your Coil*, in March, 1923; *For Determining the Capacity of a Condenser*, in May, 1923; *For Determining the Capacity of Your Antenna*, in July, 1923, and *For Determining the Constants of a Loop Antenna*, in August, 1923; *For Use in Designing a Transformer*, in March, 1924; *For Determining the Maximum Capacity of a Variable Condenser*, in April, 1924.

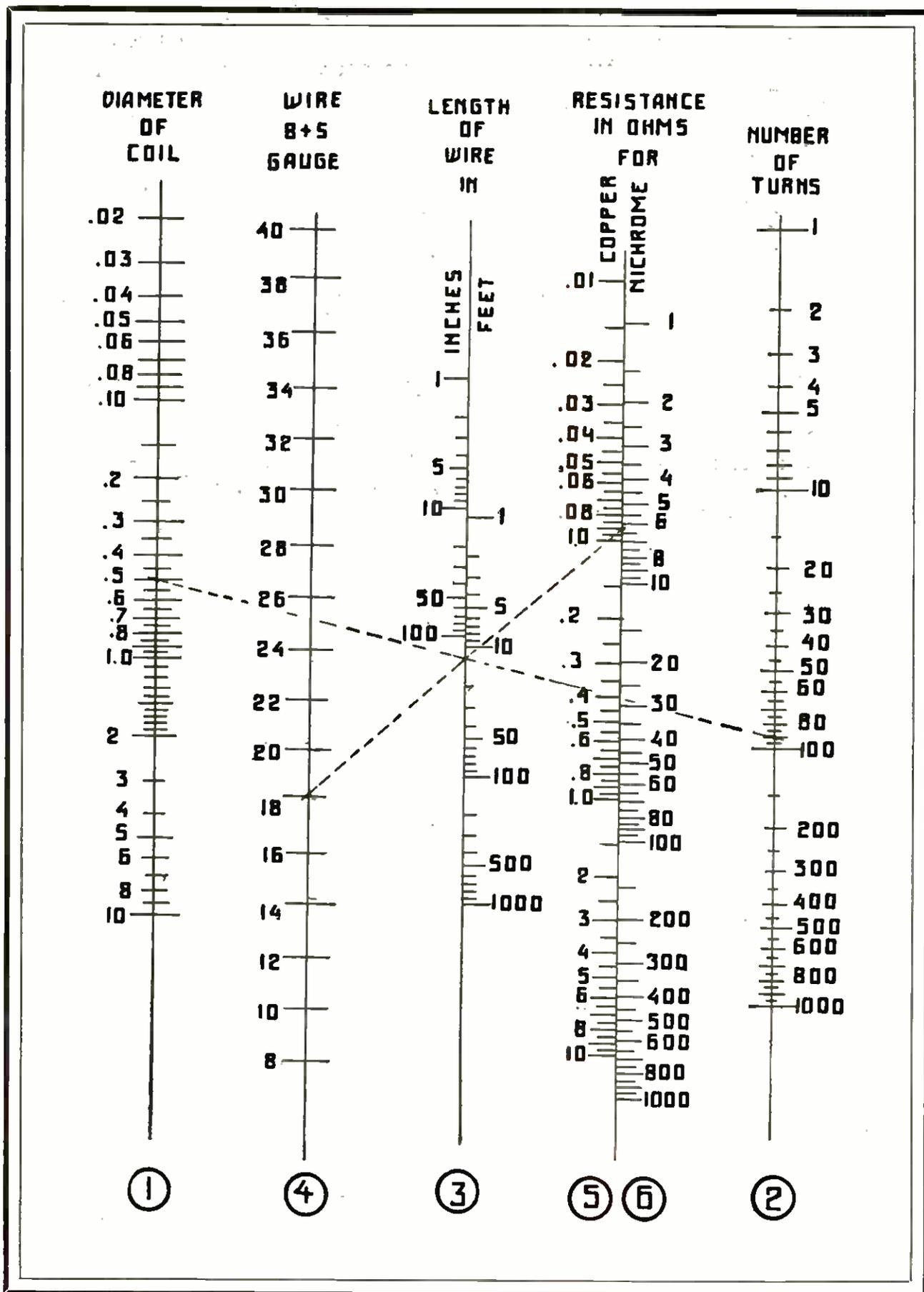
By RAOUL J. HOFFMAN, A.M.E.

MATERIALS used for transmission and distribution of electric energy are conductors, which have a certain resistance. This resistance is measured in ohms. The resistance of a wire is inversely proportional to the cross-section of the wire; that is, the thinner the wire, the higher is the resistance.

The standard thicknesses for wires, in electrical engineering, follows the B. &

S. wire gauge and most handbooks have reference tables for the resistance of a standard length of wire.

Copper has almost the lowest resistance of any of the conductive materials. Assuming the resistance for copper as a unit, we can find the resistance for various materials by multiplying the resistance of copper by the following figures, if the same length and thickness is taken.



HOW THE RESISTANCE CHART IS USED

You must first determine the diameter of the coil upon which you are to wind the resistance wire. Then you should decide what size of wire you want to use. The chart will give you the resistance of the wire and the number of turns you should wind on to get any specified resistance. The article tells you how to do it.

Silver	by	.94
Copper	"	1.00
Aluminum	"	1.7
German Silver.....	by about	20
Monel Metal	by	26
Mercury (quicksilver)	"	53
Nichrome Alloy	"	68

A rheostat is a device for controlling the resistance of a circuit. The rheostat plays a large role in most electrical circuits; especially in radio work. For standard material German silver or nichrome wire is used and wound into the shape of a coil.

The method of calculating the resistance of a rheostat is simplified by the use of the chart illustrated on the preceding page.

To find the resistance of a No. 18

wire, 12 feet long, connect 18 on scale No. 4 with 12 on scale No. 3 and read, for copper, on scale No. 5. The result is .09 ohms. For nichrome, on scale No. 6, the result would be 6.2 ohms.

To calculate the resistance of a coil rheostat half an inch in diameter, having 90 turns, made of No. 18 B. & S. nichrome wire, connect .5 on scale No. 1 with 90 on scale No. 2 intersecting the reference line on scale No. 3, giving a total length of 12 feet.

Then connect the intersecting point on scale No. 3 with 18 on scale No. 4 and read the resulting resistance of 6.2 ohms on scale No. 6.

This table will help you greatly in the design of special rheostats of various resistances.



Internat.onal

A RADIO FIRST-AID STATION ON SKIIS

In the winter sports regions of Germany, where accidents sometimes occur and the services of a doctor are required, a novel radio equipment has been devised for summoning aid. The apparatus consists (as shown above) of a miniature receiving and sending set that is attached to the person of the doctor.



Kadel & Herbert

INTERFERENCE FROM BRUSHES ON ELECTRIC TRAINS

The brushes on the elevated trains produce sparking which really is very troublesome. This sparking will make your loudspeaker respond with a ripping sound something like static each time a train starts up.

Where Interference Comes From

Radio amateurs who live in the suburbs of a city are troubled by a peculiar kind of interference in receiving. This trouble manifests itself in a loud, scratchy, humming sound which drowns out reception and lasts for periods ranging from two or three seconds to several minutes continuously, several times each evening. One of these amateurs, Sidney Kasindorf of the Bronx, New York, started out with a portable receiver with a directional loop antenna and tried to track the interference to its lair. The pictures shown here illustrate some of the causes for interference which are likely to bother receiving.



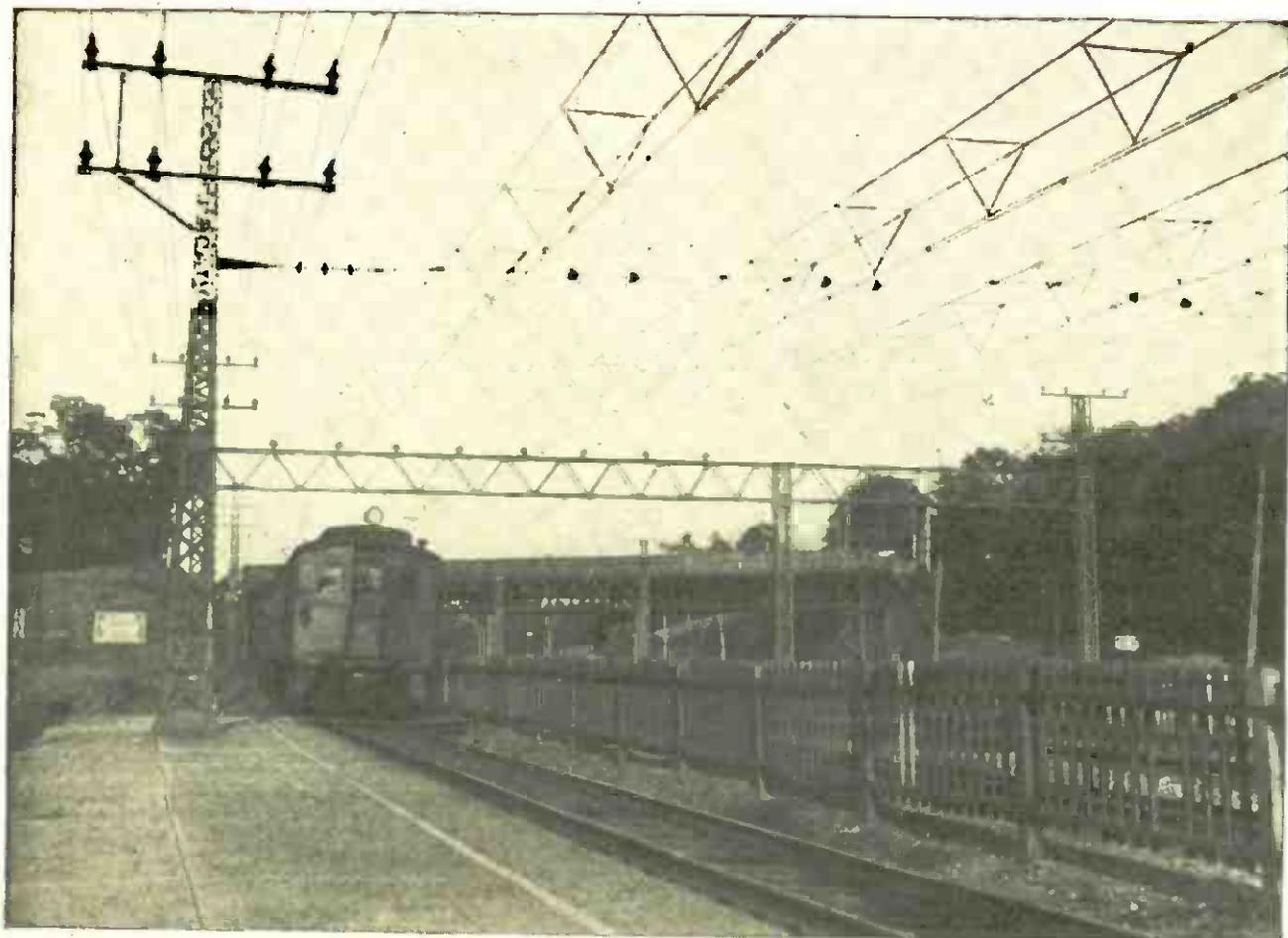
Kadel & Herbert

INTERFERENCE FROM MAIN POWER SWITCHES

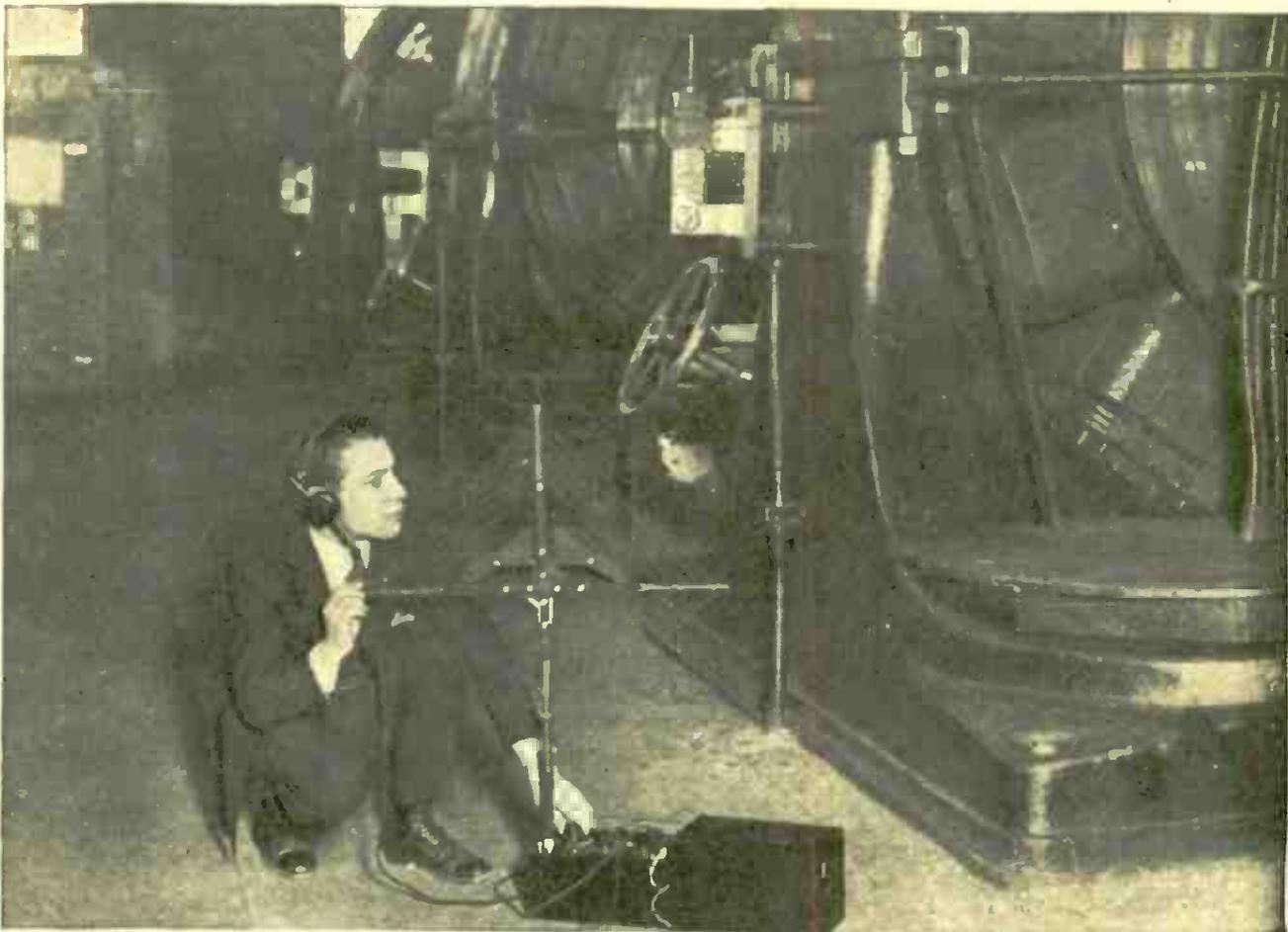
Opening or closing a giant switch at the power station will also cause a radio impulse which will be accompanied by a simultaneous "crack" issuing from the loudspeakers of the receiving sets situated within a block or so of the station.

INTERFERENCE FROM HIGH-TENSION LINES

The worst interference was found to emanate from the railroad high-tension lines. It is not definitely known whether this is caused by leakage on the lines or by an oil switch, opening and arcing, or whether it is caused by passing trains whose power is derived from the overhead trolley system. When all of the various causes have been tracked down the amateurs will attempt to have the unconsciously offending interests co-operate with them to eliminate the trouble.



Kadel & Herbert



Kadel & Herbert

INTERFERENCE FROM LARGE GENERATORS

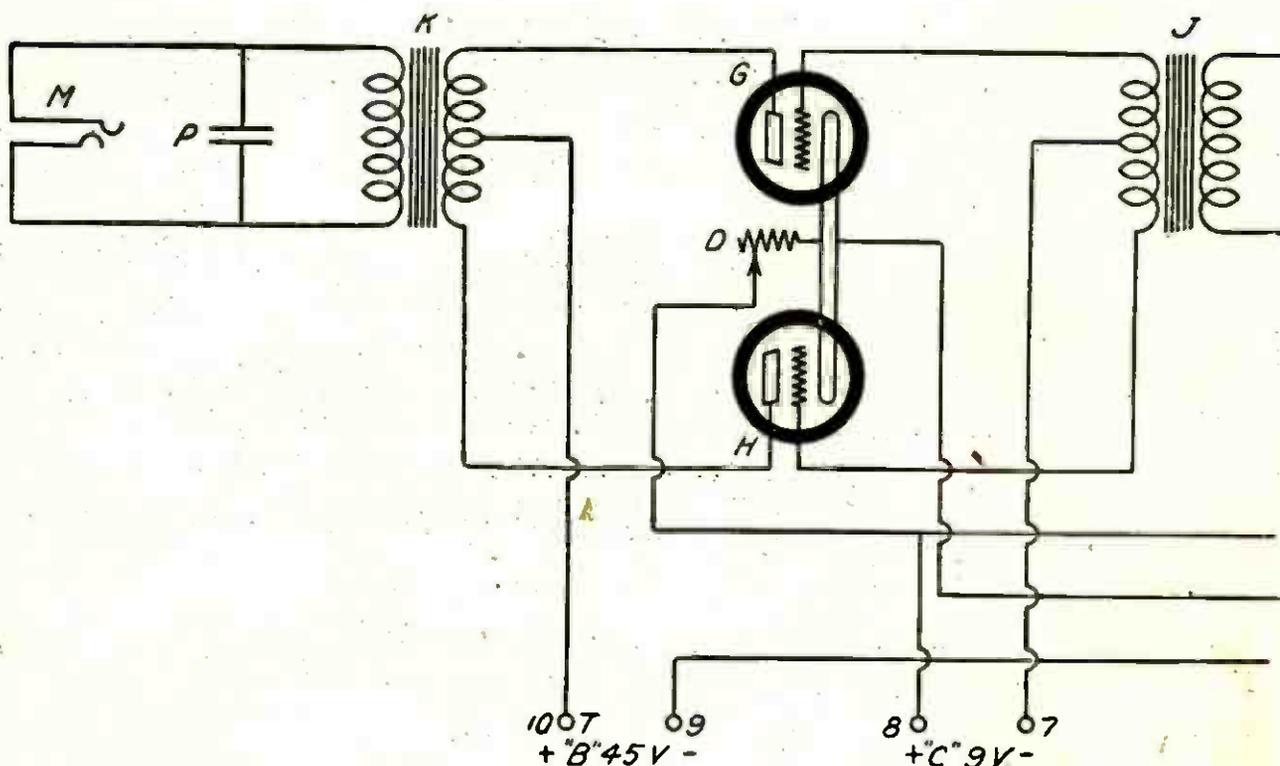
The sparking at the commutators on the large D.C. generators or the rotary converters in a power house or substation cause another kind of interference which will tend to spoil reception in the immediate vicinity of the power house.



Kadel & Herbert

INTERFERENCE FROM AUTOMOBILES

The ignition of automobiles sends out feeble impulses which can be heard in the telephones of an ultra-sensitive receiver in the form of a series of clicks. Of course, the wavelength of these impulses is extremely short and they would not affect an ordinary receiver.



THE ELECTRICAL WIRING DIAGRAM

FIGURE 1: This drawing shows the correct way to hook up the various instruments and parts in the circuit so that they will function properly. Notice that the diagram is drawn from the RIGHT to the LEFT, so that the wiring is shown exactly as it goes into the amplifier.

HOW TO MAKE AN AUDIO-FREQUENCY AMPLIFIER —THAT DOES NOT DISTORT

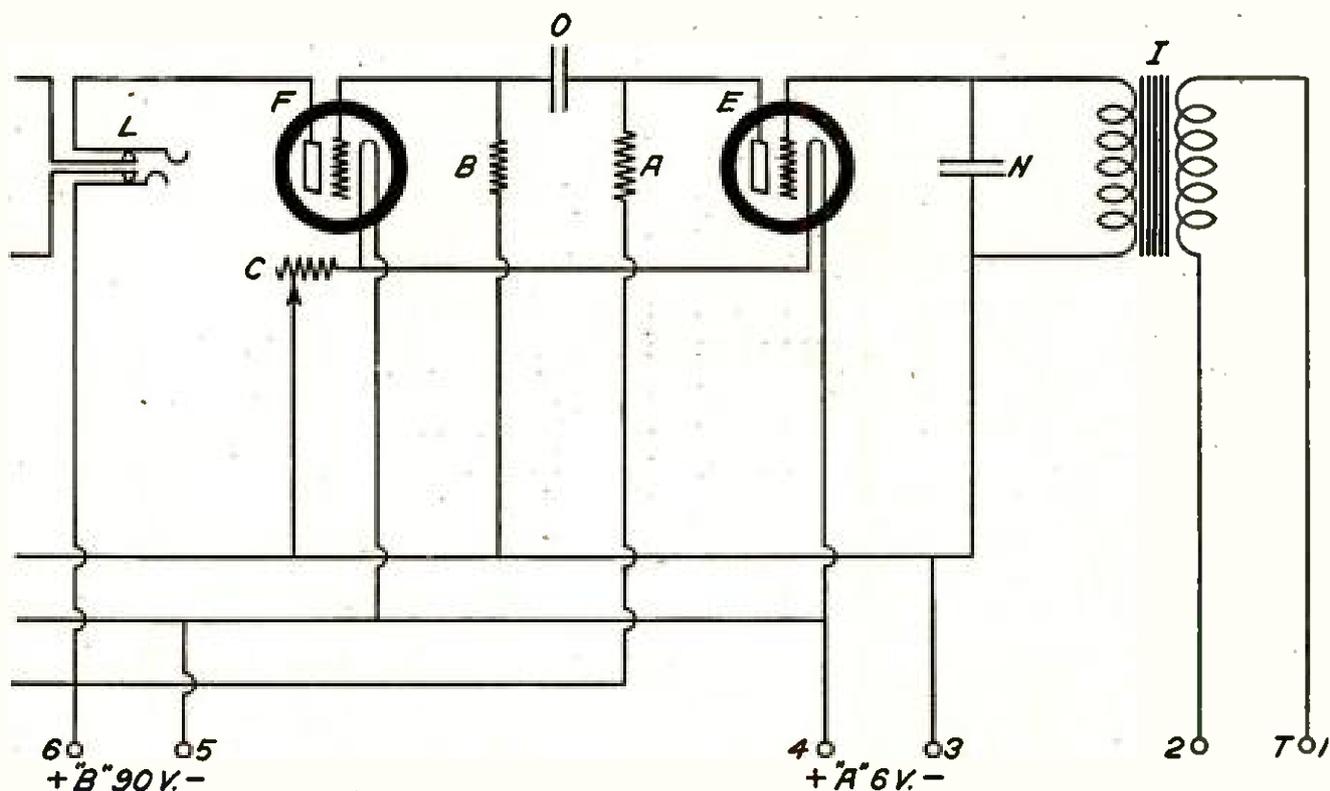
This article is of value to every user of a radio set—because it describes a newly developed type of amplifier that is entirely unmarred by distortion. It may be built by anyone who has only the ordinary proficiency with tools.

By LAURENCE M. COCKADAY, R. E.

COSTS OF PARTS: About \$45.00

HERE ARE THE ITEMS YOU WILL NEED—

- | | |
|---|--|
| A—Bradley-Ohm No. 25 (25,000 to 250,000 ohms); | O—Dubilier mica fixed condensers, .005 mfd plain (three used in parallel); |
| B—Bradley-leak, $\frac{1}{4}$ to 10 megohms; | P—Dubilier mica fixed condensers, .005 mfd plain (three used in parallel); |
| C and D—Amsco rheostats, 20 ohms; | Q—composition panel; |
| E, F, G and H—Naald standard vacuum-tube sockets, No. 400; | R—Quinby radio frames 7 by 8 inches; |
| I—Amertran transformer, 5 to 1 ratio; | S—cabinet; |
| J—Como "input" transformer; | T—EBY binding posts; |
| K—Como "output" transformer; | U—connection block; |
| L—Martin-Copeland jack, double-circuit; | V—Celatsite (insulated connecting wire); solder, screws, etc. |
| M—Martin-Copeland jack, single-circuit; | |
| N—Dubilier mica fixed condenser, .00025 mfd. with clip for transformer; | |



THERE is no doubt that radio reception, in its most popular form, the reception of radio broadcasting, depends to a great extent upon some form of loudspeaker for its popularity.

The loudspeaker that is used to reproduce the broadcast entertainment must be a good instrument; so that the programs will have real life, they should not give a thin, squeaky, dim or distorted reproduction. Most of the new loudspeakers now on the market are good.

There are, however, many other problems that must be considered in insuring good clear broadcast reception. First of all, there is the matter of the transmitting apparatus. The microphone that picks up the broadcasting in the studio must convert the sound waves of the voice and music without distortion. The modulation system of the transmitter must not introduce any noticeable distortion. These problems apply to the transmitting station, and most of the larger broadcasting stations now have modulation systems in which the broadcast material is transmitted with a good to excellent degree of clarity. There are other considerations, however, that apply directly to your own receiving apparatus!

In some of the more simple regenerative receivers there is a possibility of obnoxious distortion in the detector circuit itself.

In the single-circuit regenerative receivers this over-regeneration causes distortion not only in the owner's set, but in the other sets in the neighborhood that receive on the same wavelength.

For clear and enjoyable reproduction in a loudspeaker, then, there must be *no distortion in the detector circuit.*

And here we come to the amplifier!

The amplifier is the last piece of apparatus between the microphone at the transmitting station and the loudspeaker at the receiving station. We must have a good amplifier before we may be sure of the consistently good reception that is to make radio broadcasting really popular in the home.

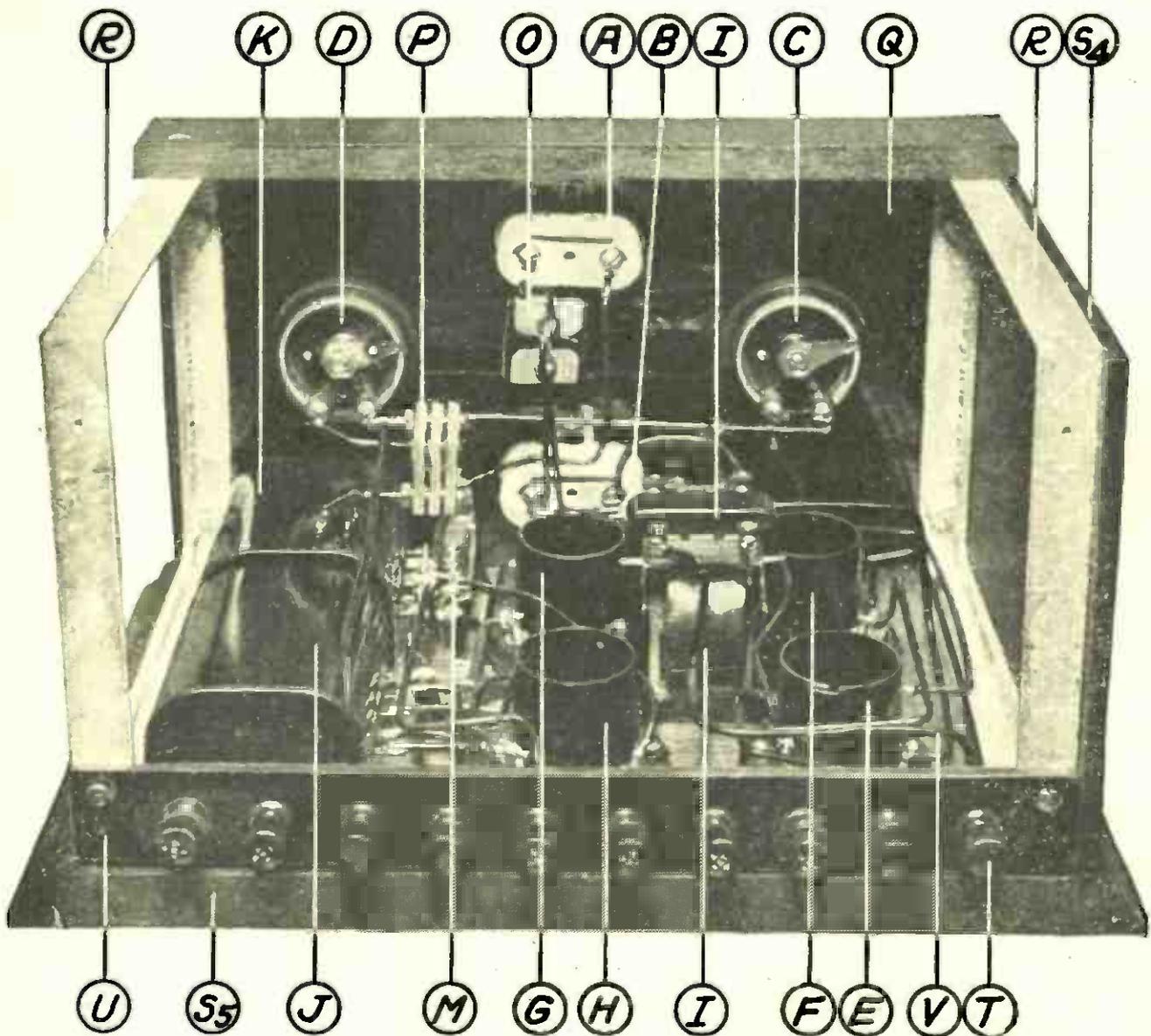
The amplifier that is commonly used is ordinarily built up of two stages of transformer-coupled amplification which amplify at an audible frequency. Now it is an almost impossible feat of engineering to get a two-stage transformer-coupled amplifier that will give maximum signal amplification and still retain the best quality of reproduction. Even if we design a

transformer that with a specified type of tube will give equal amplification over frequencies between 200 and 3,500 or 4,000 cycles, yet when we couple two such stages together with more voltage on the plate of the second stage we encounter trouble from a sort of feed-back, and some distortion that is due to the magnetic condition of the iron core upon which the transformer is wound. Therefore, we have to "dope" such an amplifier with resistances or capacities, or both, connected in different parts of the circuit, to eliminate this trouble at least in part. And even then, we do it only at

a considerable loss in over-all volume.

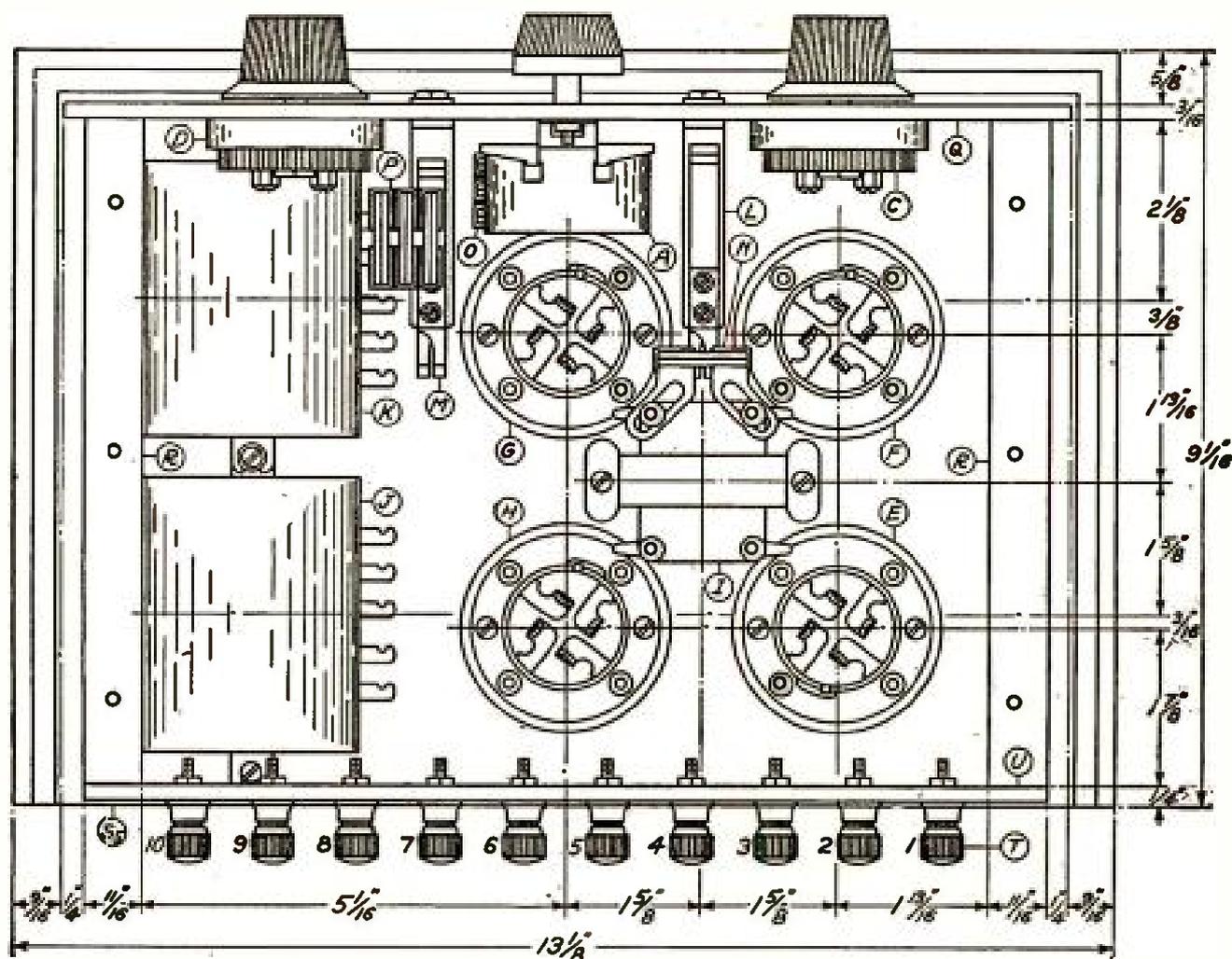
This does not mean, in a well-designed amplifier of this type, that it is impossible to get satisfactory results, but it does mean that in most of the home-built amplifiers the construction usually calls for two audio-frequency amplifying transformers (good, bad, or indifferent), two rheostats, two tubes and a couple of jacks wired up to "make a noise." And that is why some people who listen to one of these for the first time observe:

"Well if this is radio, give me a phonograph."



VIEW OF THE AMPLIFIER, FROM THE REAR

FIGURE 2: This photograph shows clearly, the arrangement of the parts mounted directly on the panel, as well as the parts mounted on the base of the amplifier. The parts are all designated by letters that reappear in the text, the diagrams and the list of parts.



THE WORKING DRAWING FOR CONSTRUCTING THE AMPLIFIER

FIGURE 3: Here are shown the exact positions for the instruments. The positions are given, center to center, for all instruments. Note that the binding posts are mounted on a composition strip, which is screwed to the aluminum frames.

The amplifier that is described in this article consists of three stages:

- First stage; transformer coupled
- Second stage; resistance coupled
- Third stage; push-and-pull, transformer coupled.

The transformer in the first stage operates from the plate current of the detector tube, which is small; therefore, the distortion due to core saturation is not present.

The second stage uses a higher plate voltage; therefore, instead of being coupled by a transformer it is coupled through a new variable resistance which can be set at the correct value for the tubes used. This type of amplification is practically distortionless.

For the third stage is used the push-and-pull method of connecting two tubes

in the circuit, with a split-winding input transformer and a split-winding output transformer so that the two tubes work in a manner, analogous to the steam engine; one tube (piston) pushes while the other tube (piston) pulls. In this system the output-transformer core is only energized by the signal variations and the normal plate currents of the two tubes cancel out and do not produce any core magnetization.

These three methods of coupling between stages used in combination produce a great volume of sound, still they retain the clarity and truthfulness of the original sound as spoken, sung, or played into the microphone.

This amplifier can be connected to *any* single-tube set and will be applicable to *any* multi-tube radio-frequency set. It

should be connected direct to the plate circuit of the detector.

The electrical wiring diagram is shown in Figure 1.

The Parts Used in Building the Amplifier.

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of the amplifier 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.

Q *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.*

If instruments other than the ones listed are used it will necessitate only the use of different



ASSEMBLING THE CABINET

FIGURE 4: *This picture shows how the wooden strips that form the cabinet are fastened to the frames with machine screws. They can be attached in a few minutes with no other tools than a screw-driver.*

spacing of the holes drilled in the panel for mounting them.

How to Construct the Amplifier

After procuring all the instruments and materials for building the amplifier the amateur should set about preparing the panel (shown in Figures 2, 3, 5, 6, 7 and 10).

First of all the panel should be cut to the correct size, 7 x 12 inches.

Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 5.

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

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

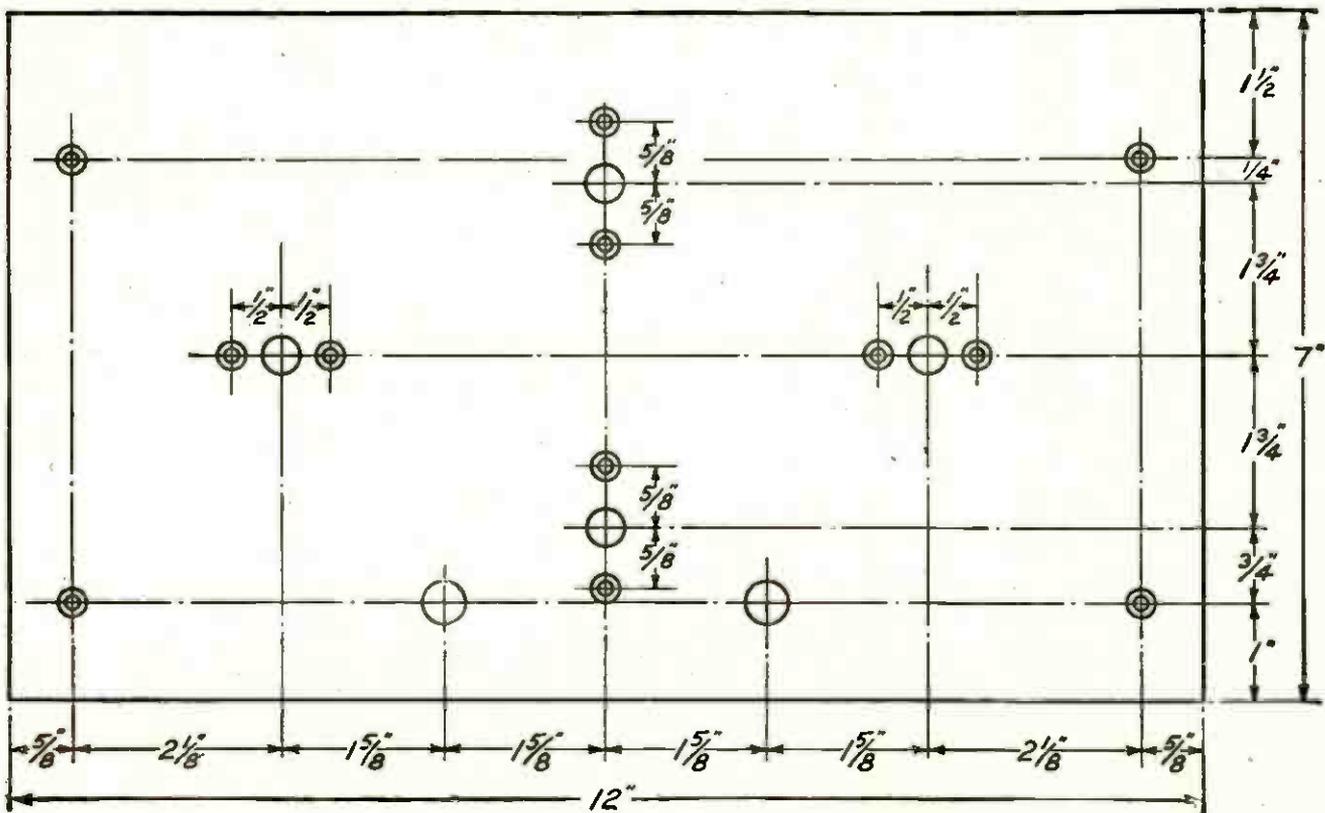
Next, the two rheostats, C and D, should be fastened to the panel Q, in their respective places by two screws each as shown in Figures 2, 3, 6, 7 and 10, and the small knobs and shafts affixed.

Then the coupling resistor A, should be mounted on the panel with the leak B, mounted below it. These two instruments are clearly shown in Figures 2, 3 and 10; they are mounted by unscrewing the shaft and knob, which is then inserted through the panel and then the rest of the instrument is screwed to the panel by two screws.

Now fasten the two jacks, L at the left (looking from the front) and M at the right-hand side. (See Figure 10.)

This completes the work on the panel itself.

The next job is to mount the panel on the two frames R. This is easily done with four machine screws inserted through the panel into the threaded holes provided in the frames. When this is done, attach the panel and the frames to the base in the same manner, with machine screws inserted up through the base into the four drilled and tapped holes that will be found in the bottom edge of the frames. The holes drilled in the base should be countersunk and a brass washer placed underneath the screw-head. This eliminates the possibility of the screws marring the surface of the table it is set upon. The brass washers prevent the wood from breaking out where it is weakened by countersinking.



THE DRILLING PLAN FOR THE PANEL

FIGURE 5: This drawing shows where to drill the holes for mounting the instruments. The correct spacings are given for the holes. The holes outlined with a double circle should be countersunk so that the heads of the screws will be flush with the surface of the panel.

Now mount the rest of the parts on the wooden base S itself. Refer to Figure 3 for this and mount the four tube sockets E, F, G and H with brass wood screws. Then fasten down the transformer I, with two wood screws, and the transformers J and K, with three wood screws between them. The two adjacent feet of these transformers are held with a single screw.

The fixed condensers N, O and P are not fastened mechanically but are supported by the wiring and may be left until that work is being done.

Next, cut the connection block U out of composition panel according to the size given in Figure 9. This should be drilled for the ten binding posts and for the two screws that are used to fasten it to the back edges of the two frames R.

After the block is completed, attach the ten binding posts and cut off the screws of the three left-hand posts close to the inside surface of the panel, looking from the rear.

This will prevent shorting of the wires that are attached to the inside end of the posts, against the metal frame of the transformer J.

After the block U has been attached to the frames, you are ready to start the wiring.

How to Wire the Amplifier

In the design of this amplifier, care has been taken that there should be little or no interaction between stages, as this would cause

an objectionable whistle. However, the builder of this amplifier may be sure that if the specified parts are used and put together as specified, the results will be as specified.

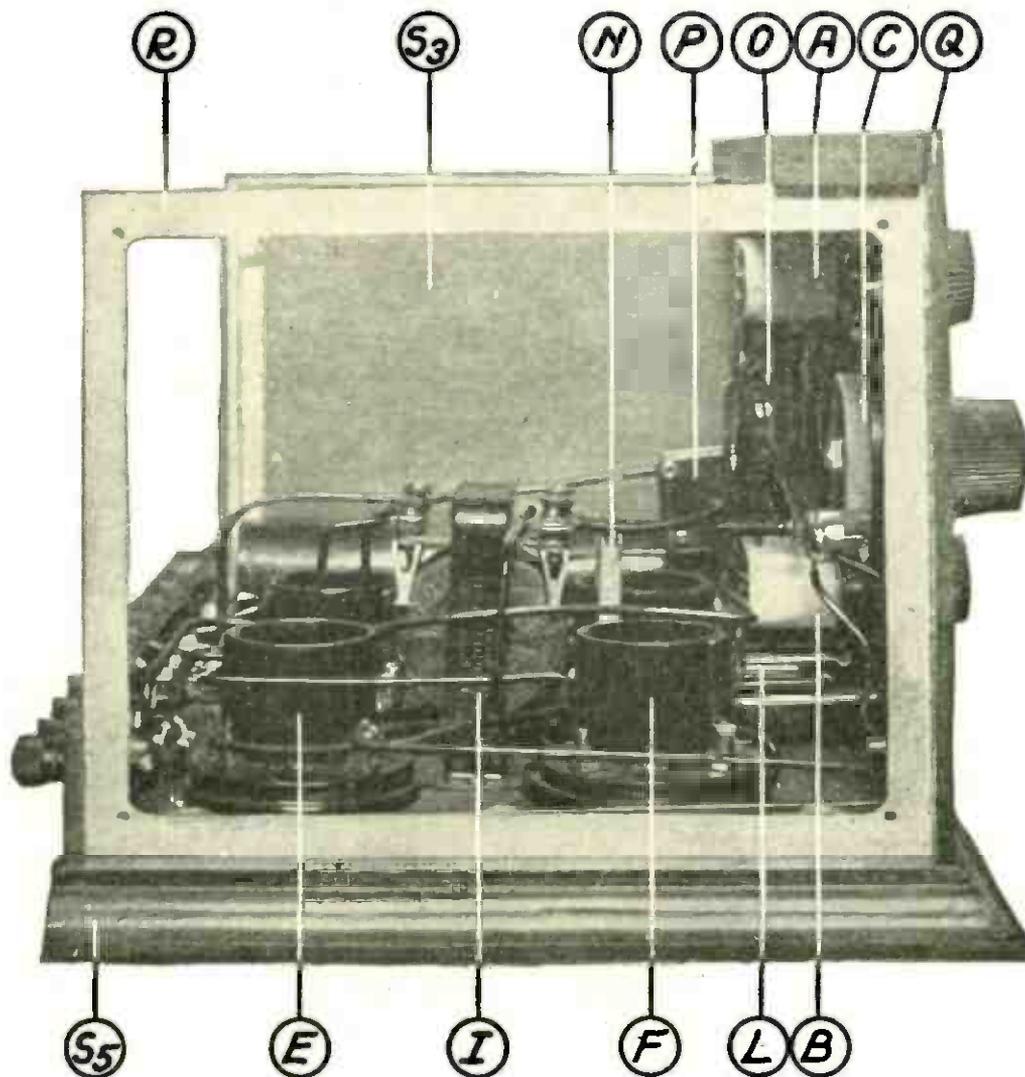
In wiring the set a type of bus-wire already covered with insulation was used and this saved a lot of labor. Just cut the wire to the correct length, bend it into shape, and scrape the ends and solder in place.

Carefully study out from the diagram in Figure 1, just what way would be the shortest way to run each wire, and do the least accessible wiring first.

Wire up the filament circuits first including the two rheostats, and the proper binding posts as shown by the numbers, 3 and 4 in Figure 1, and including the connections to one side of the grid-leak B, the positive "C" battery terminal No. 8 and the negative "B" battery post No. 5. Also finish the connections to the filament terminals on the sockets.

Next, connect up the input terminals P and B+ of the transformer I to the binding posts Nos. 1 and 2. Then finish the secondary circuit of this transformer including the condenser, N, the grid connection to the first tube socket E and the connection to the negative "A" binding post No. 3.

Now wire up the plate circuit of the first tube including the plate terminal of the first tube socket E, the resistor A, the condenser O, the remaining terminal of the grid-leak B, and the grid terminal of the second tube socket F.



VIEW OF THE AMPLIFIER, AS SEEN FROM THE LEFT

FIGURE 6: This picture shows how to mount the tube sockets and the transformer and gives a better idea of the way the frames are attached to both the wooden base and the panel.

Then connect up the plate circuit of the second tube including the jack L, the plate terminal of the second tube socket F, the connections to the primary terminals of the transformer J and the connection to the binding posts Nos. 6 and 9.

Wire up the grid circuits of the two last tubes, including the grid terminals of tube sockets G and H and the secondary terminals of the transformer J, and the binding post No. 7.

Next, connect the jack M to the output terminals of the transformer K and the condenser P. This is rather a difficult job, as there is not much room to work. Be sure that the wires do not short-circuit between the jack and the terminals of the transformer.

The last job in wiring is to connect up the plate circuits of the last two tubes. This work will include the plate terminals of the two tube sockets G and H, the primary terminals of the transformer K and the connection to the binding post No. 10.

When this is finished the wiring job is complete.

How to Set Up the Amplifier

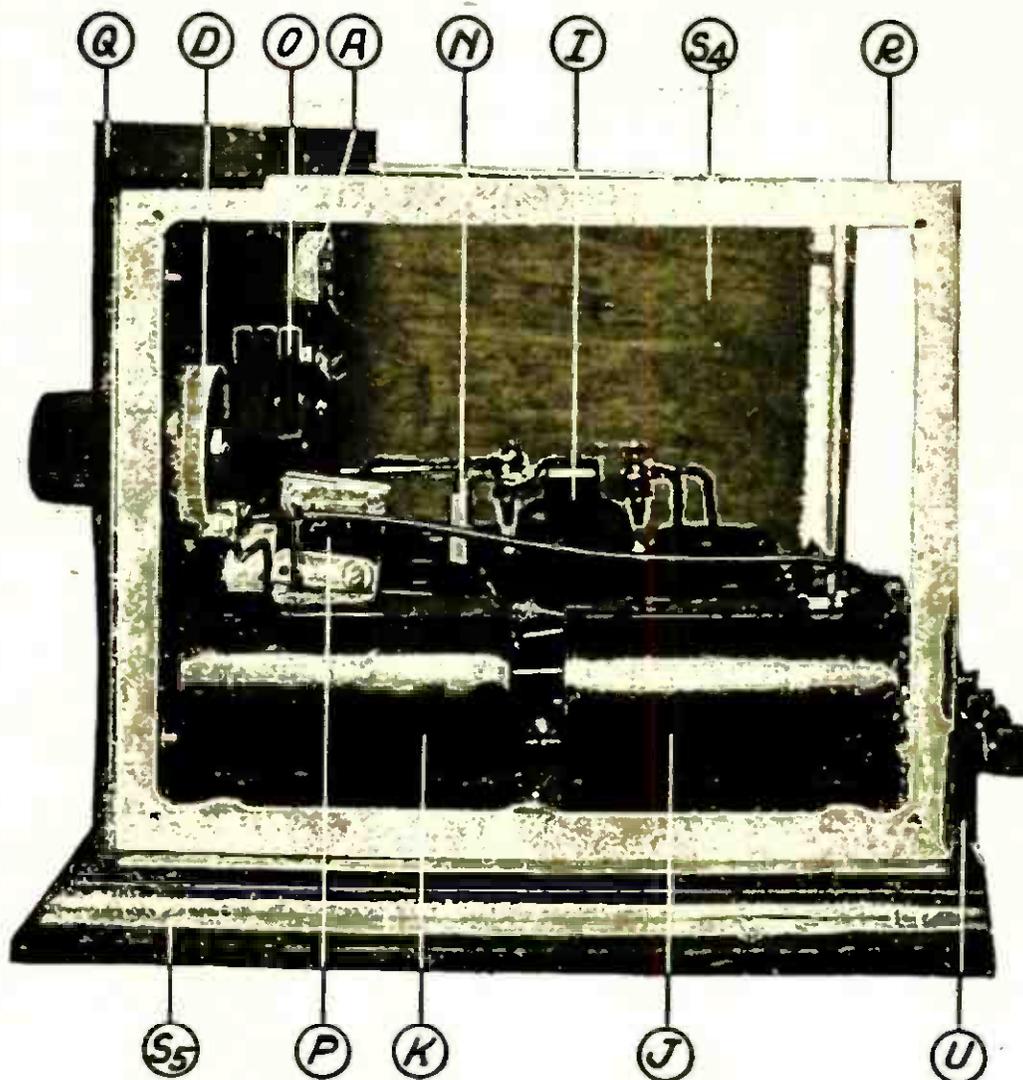
Place the amplifier on the table, after the sides, back and lid have been screwed on, alongside of the single-tube set (or other type of set) and connect up the receiving unit as usual, with a six-volt "A" battery and a 22½-volt "B" battery.

To add the amplifier to any single-tube receiver, connect two wires from the posts Nos. 1 and 2 on the amplifier, in place of the telephones that are ordinarily used on the receiving set. This places the primary of the transformer I in series with the plate circuit of the detector.

There should be no other audio-frequency amplification used except what is contained in the amplifier itself.

Next, run two leads from the "A" battery used on the detector, to the posts Nos. 3 and 4 on the amplifier. Be sure that you get the correct polarity. (See Figure 1.)

Now obtain three 45-volt sections of "B" battery, and connect two of them in series, 90 volts, between the posts Nos. 5 and 6. The



VIEW OF THE AMPLIFIER, AS SEEN FROM THE RIGHT

FIGURE 7: Here we see the two push-and-pull transformers, one of the rheostats, the mica fixed condensers and the edge of the binding-post connection block which is screwed to the frames.

positive terminal should be connected to post No. 6. (See Figure 1.)

Next, connect two Eveready "C" batteries, of $4\frac{1}{2}$ volts each, in series, giving 9 volts, between the posts Nos. 7 and 8. Post No. 8 is positive.

The last connection will be the third section of "B" battery, 45 volts, between the posts Nos. 9 and 10, with the positive connected to post No. 10.

The amplifier is now ready for use.

Operating Data

Tune in a signal on the detector, and then turn up the knobs of the grid-leak B and the resistor A on the amplifier with a clockwise motion until they are practically all in. Then insert the loudspeaker plug into the jack M.

Turn up both rheostats about four-fifths of the way—and you should immediately hear the signals issuing from the loudspeaker.

Then adjust the rheostats to best signal strength.

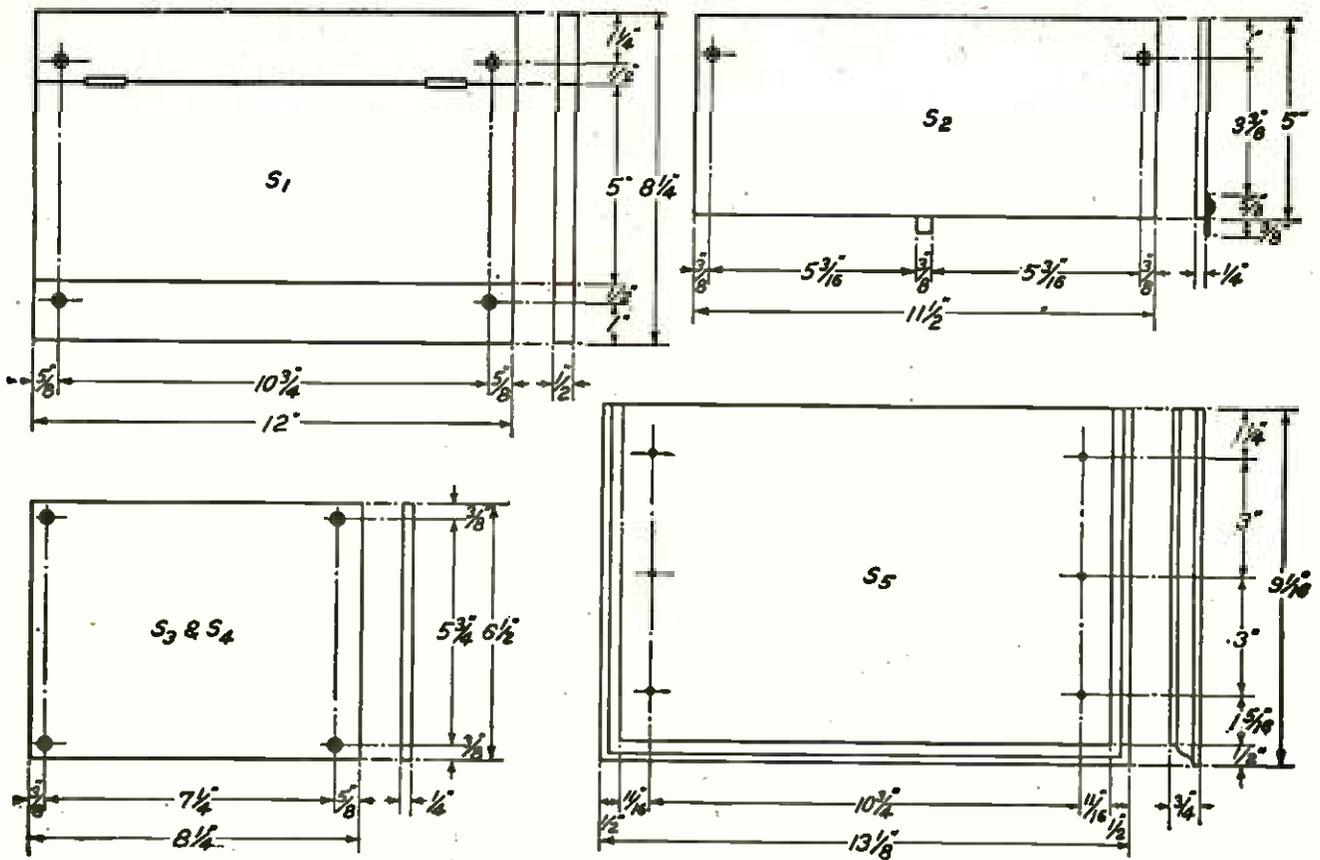
Next, adjust the resistor A to best position for loudest signals; this is done by rotating

counter-clockwise. If rotated too far, the signals will disappear.

Finally, adjust the grid-leak B for both loudness and clarity. The best way to get the most out of the amplifier would be to place a D.C. milliammeter with a scale reading from 0 to 20 milliamperes in series with the negative lead from the "B" battery; the lead running to post No. 5.

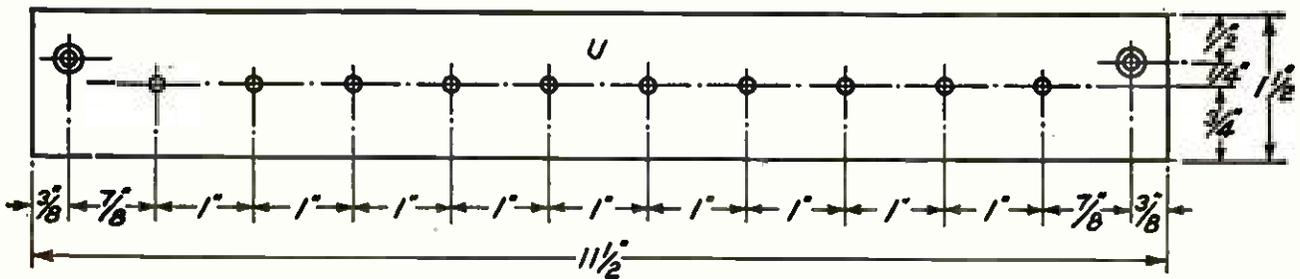
For best results the normal plate current will be found to be around 8 to 10 milliamperes. This condition may be arrived at, as stated before, by experimenting with the adjustment of the grid-leak, the resistor and the tube filament currents.

The tubes used by the author were C-301-a tubes and UV-201-a tubes. In turning up the filaments they should not be increased beyond the point where no additional signal strength is gained by doing so. If this precaution is observed it will add to the life of the filaments.



THE DIMENSIONS FOR THE WOODEN PANELS THAT FORM THE CABINET

FIGURE 8: At the top (left) is shown the three pieces which form the hinged lid for the top of the cabinet. At the top (right) is the wooden panel for the back. At the bottom (left) is the drawing of the piece used for each side, and at the right is the base. This drawing may be turned over to a cabinet maker if desired.



THE DIMENSIONS FOR THE CONNECTING BLOCK

FIGURE 9: This block is made of panel material and is drilled (as shown above) for the ten binding posts and also for the two screws, one at each end, which are used to attach it to the amplifier frames.



From a photograph made for POPULAR RADIO

INSTALLING THE AMPLIFIER IN ADDITION TO A SINGLE-TUBE, FOUR-CIRCUIT SET

FIGURE 10: *The amplifier uses four tubes of the thoriated filament type, and the total drain on the storage battery is only one ampere. The "C" batteries used on the last two tubes keep the plate current small and improve the quality of the received signals.*

Be sure that when the amplifier is connected to a single-tube regenerative receiver, the amount of regeneration is not increased to too great a point, for if this is done the signals will be subjected to distortion in the detector circuit, as mentioned previously in this article. All the amplifier could do in this case would be to amplify the distorted signals thus supplied to it and the

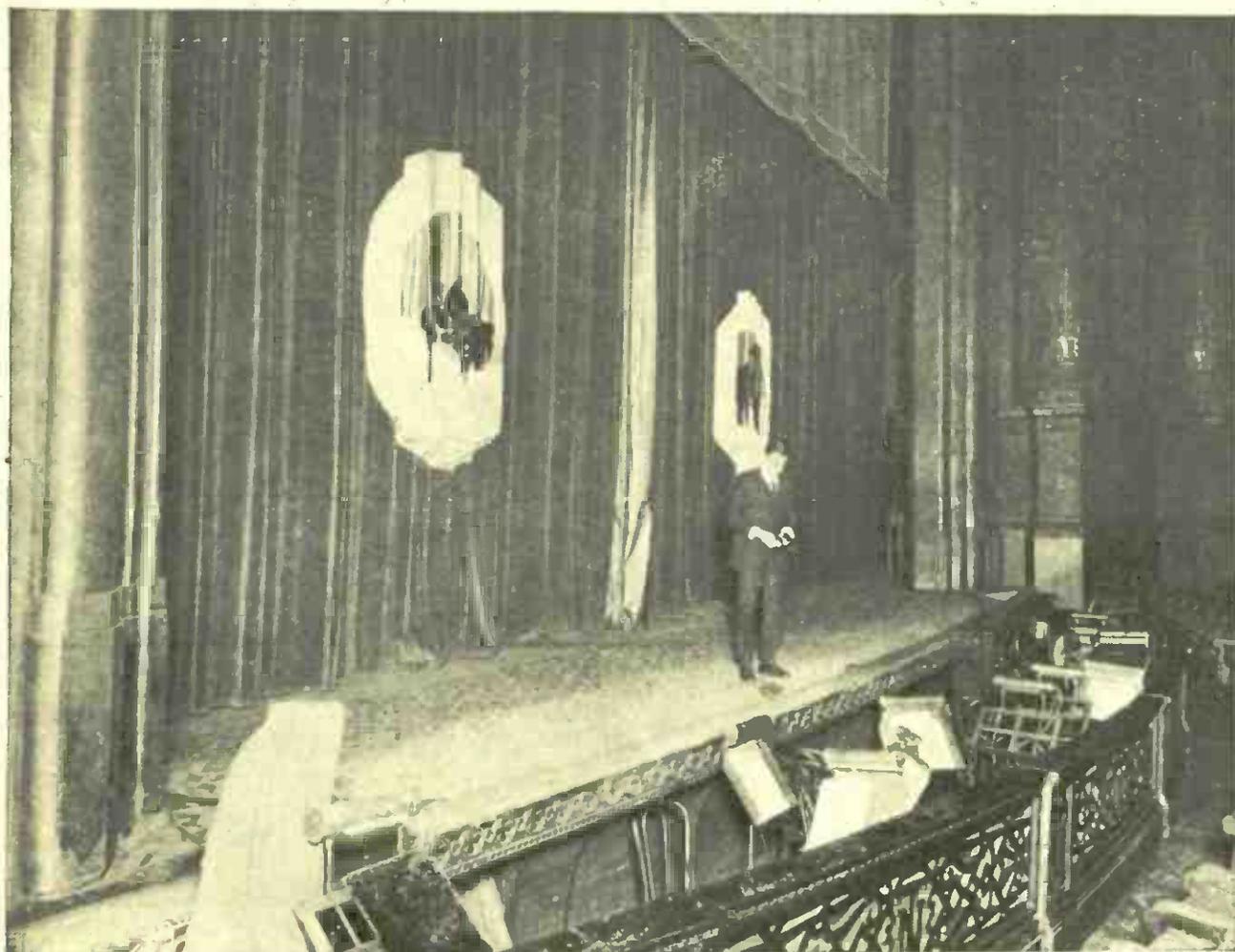
result would be anything but pleasant to listen to.

It is a requisite, then, that a good detector and tuner be used with the amplifier in order to get the results that can be obtained.

Be sure, in getting a loudspeaker for use with this device, that one with a large volume capacity is obtained; otherwise it will vibrate or rattle.

How to Build a Receiver that Works on an Indoor Antenna

DON'T worry even if your landlord won't let you put up an antenna! In the next issue of POPULAR RADIO will appear another of these constructional articles telling how to build a set that operates on an indoor aerial. This set has been carefully tested in the laboratory for several weeks and will prove a boon to those who are so situated that they cannot put up an outdoor antenna, and who cannot afford a multi-tube receiver.



From a photograph made for POPULAR RADIO

HOW PLAYS ARE BROADCAST DIRECT FROM THE STAGE

Microphones are installed among the footlights and the performance is transmitted by wire to the broadcasting station. The above picture was made at the Century Theatre in New York.

Will Radio Create a New Form of Dramatic Writing?

“The broadcasting of dramatic compositions that are written to be acted cannot be given a proper performance by a reading alone,” is the opinion of the present-day dramatists, whose spokesman is himself a famous dramatist—

EDWARD CHILDS CARPENTER

READERS of the newspapers were recently surprised to read in glaring headlines the statement:

DRAMATISTS OPPOSE RADIO

The “story” that followed explained that the Board of Directors of the

American Dramatists and the directors of the Playwrights’ Association (whose membership embraces nearly all the active and successful dramatists in the country), had recently met and had taken definite action to prevent the broadcasting of their plays—without

the author's consent. Following the meeting this statement was made to the press:

"The majority of the playwrights are opposed to the broadcasting under any circumstances, and propose to deny the release of their plays for that purpose, contending that in the radio they are hurting the value of their play for use on the stage. We are notifying all the radio stations and all the dramatic agents of our decision, at the same time sending them a copy of our resolution.

"The resolution passed by the playwrights reads as follows:

"At a meeting of the Board of Directors of the American Dramatists held on February 5th, 1924, it was RESOLVED: That henceforth the American Dramatists would not permit the broadcasting of the plays of any member without the written consent of the member to the broadcasting station;

"That this resolution is arrived at inasmuch as the plays of members are fully protected against unauthorized broadcasting, both under the copyright law and at common law, and inasmuch as it is a fundamental principle of literary property that dramatic, literary and artistic works may not be reproduced in any way without the consent of the author, either with or without payment of royalty;

"That it is essential to the best interests of the members of the American Dramatists that their plays be not broadcast without their written consent, since in the estimation of the American Dramatists broadcasting is injurious

to the production value of a play and tends to lessen the desires of the public to attend the regular performances."

Unusual interest has been aroused by this action of the playwrights because it raises, not only the question of what plays may be broadcast, but also how they may be broadcast. And it opens up the pertinent question as to whether or not radio may not develop an entirely new form of dramatic writing to fit its special needs. This possibility was more than hinted at by Mr. Edward Childs Carpenter, the president of the American Dramatists, when he told POPULAR RADIO that broadcasting a play would considerably lessen, if not wholly destroy, its artistic worth.

"Radio is, after all, but the *hearing* of the words of the play," stated Mr. Carpenter. "A play is written to be *performed*. Without actors any play is bound to lose its effectiveness. The appeal of any play is plus the action on the stage, and no play really has been properly presented, nor has the integrity of the author's idea been preserved without the complete presentation *in a theatre*, with production, costumes, scenery, music, lights and the other elements that go to cast the atmospheric spell intended by the playwright. Without all these



From a photograph made for POPULAR RADIO

"PLAYWRIGHTS ARE OPPOSED TO BROADCASTING PLAYS UNDER ANY CIRCUMSTANCES"

So states Mr. Edward Childs Carpenter, representing the American Dramatists.
 "Radio is but the hearing of the words of a play; a play is written to be performed."
 Will plays be written to be heard only?



International

"BEHIND THE SCENES" AT A BROADCASTING STATION

The broadcasting of plays and other theatrical entertainment is usually done from the studio—as shown above. This picture shows station WHN, atop the State Theatre in New York, while Will Morrissey, the comedian, is broadcasting a part of his act.

appurtenances no play can be said to be complete. Hence the mere hearing of the words of a play is a great injustice to both the author and his handiwork."

This point has already been anticipated by the radio experts as well as by some of the enterprising playwrights themselves, and several plays have already been broadcast that were written and presented with this specific form of presentation in view. It is not at all improbable that radio will evolve a technique all of its own in the matter of dramatic productions.

But there is another phase of the subject that is of no less interest to the professional dramatist; will the broadcasting of his play increase or decrease its commercial value to him? And this is the problem that directly touches the dramatist's pocket. On this point also Mr. Carpenter speaks for the dramatists.

"It is quite obvious," he states, "that a play, once broadcast word for word and scene for scene, would be so familiar to playgoers throughout the country as to quite destroy its value as an entertainment should a manager later decide to send it out on the road or to grant its release for presentation by stock companies. Obviously the surprise element in plays forms one of the attractions to playgoers. Very few persons would care to go to see a play whose every word and scene they had heard over the radio."

Here Mr. Carpenter hits upon a vital point. The dramatist, properly enough, wants broadcasting to increase the value of his play to him. Among the plays along Broadway today there are several whose value might possibly be jeopardized by the mere reading of their lines. As an example, there is the play of the

Dramatists' Theatre, Inc., "The Goose Hangs High," the worth of which lies to a great extent in the atmosphere created. It is doubtful whether the hearing of the lines of this play would give any conception of the play's atmosphere of a middle western home. A direct-from-the-stage broadcast might be unintelligible to the radio audience. There are at least a dozen plays in New York whose worth would be similarly underestimated by a radio presentation. Perhaps for this very reason the dramatist feels that he should be compensated for a broadcast presentation.

"The majority of our members," continued Mr. Carpenter, "are opposed to the broadcasting of their plays under any circumstances, but in cases where they may wish to release their plays, a fee will be charged on the same basis as that which obtains when a play is released for stage presentation, either as a road attraction or for presentation by a stock company. The amount of this fee would be a matter to be settled between the radio broadcasting station and the author or his representative, and the amount involved naturally would revert to the playwright as in all other cases where a play is released on a royalty basis."

"What," inquired POPULAR RADIO, "is

the attitude of your organization toward the broadcasting of plays direct from the theatre during an actual performance; that is, broadcasting by what is technically known as the 'pick-up' system?"

"I can see no difference whatever between this method and the reading of the text from a radio station," replied Mr. Carpenter, "except to say that it would be more life-like, more nearly like actually sitting and enjoying the performance. Therefore, since this method would rob the performance of all elements of newness when it is viewed later in the theatre by those who 'saw' it by radio, it is even a more harmful manner of broadcasting than the usual one, and we are utterly opposed to it."

But Mr. Carpenter sees no harm in a review of a play being sent forth by radio, any more than he sees harm in the reviews of dramatic critics as published in the newspapers and magazines. But even in this case, he does not believe the complete story of a play should be given, for the reason that two of the greatest elements in the theatre are atmosphere and illusion and once a play is robbed of these, its value as entertainment and its artistic worth are greatly impaired.



Photonews

Miss Almeda Fowler—who is reported to be "the only woman radio operator afloat"—taking a lesson from Chief Wireless Officer C. S. Rosenthal of the GEORGE WASHINGTON.

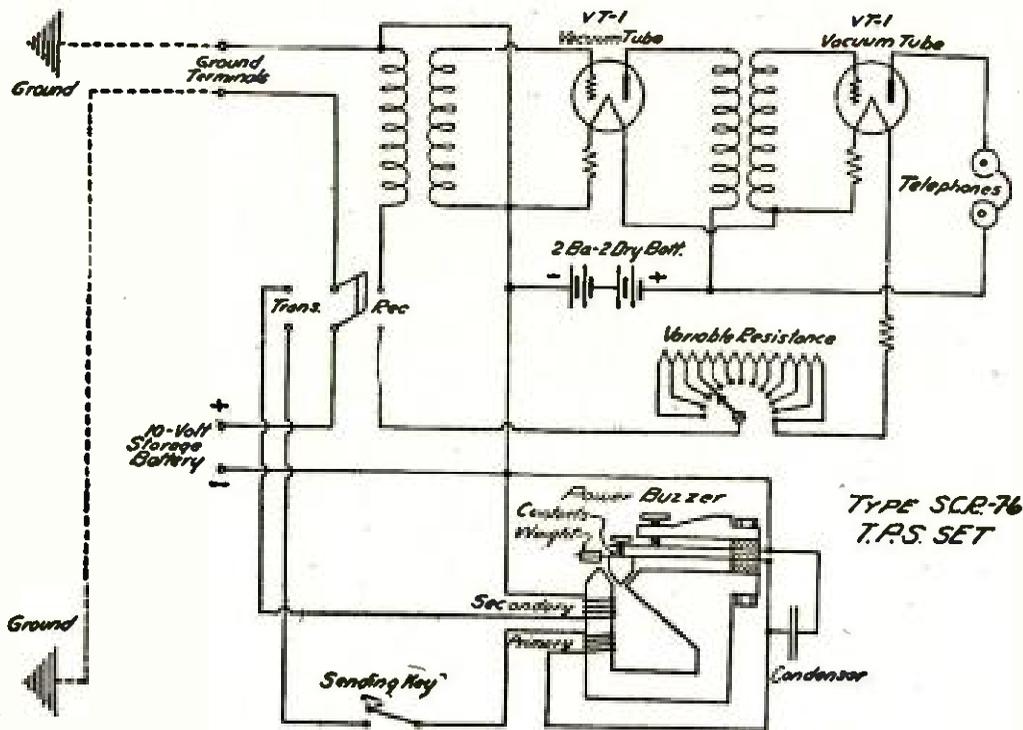


FIGURE 1: This diagram shows the electrical circuits for the common transmitter and receiver used in this audio-frequency system of underground telegraphy.

Underground Radio Telegraph

—THAT EXPERIMENTERS CAN REALLY USE

Four or five radio enthusiasts who live in the same neighborhood can easily install the unique underground telegraph system that is described in this article. Interference will not bother them—nor will they create interference for others.

By S. R. WINTERS

A DUPLEX radio-telegraph set, designed for communication over considerable distances and which is immune to both static and interference, has been developed by the Signal Corps of the United States Army according to what is called the T.P.S. or soil-telegraph system. In this apparatus the earth is used as a medium for the transmission of the radio waves.

This outfit, capable of both transmitting and receiving messages, consists of an adjustable-frequency power-buzzer, a Morse telegraph key and a two-stage

audio-frequency vacuum-tube amplifier. A 10-volt storage battery is employed to operate the power-buzzer and to light the filaments of the vacuum tubes.

The ordinary radio-telegraph receiving apparatus, when similarly connected to the ground, serves to intercept the communications thus conducted through Mother Earth. The pulsating currents impressed on the soil at the transmitting station are broken up into the dots and dashes of the code by means of an ordinary telegraph key. Identical ground connections and the same 10-volt

storage battery are employed for both sending and receiving messages through the earth. This twofold purpose is accomplished by the use of a switch mounted on the panel.

The power-buzzer is of a double-coil type with a closed magnetic circuit. A condenser is connected across the vibrator contact points to minimize sparking and to improve the tone of the buzzer. The screw on top of the buzzer is adjusted until a healthy, clear note is obtained; it is then locked by a set screw. The two-stage audio-frequency amplifier employs two vacuum tubes and two iron-core amplifying transformers; it is provided with jacks and binding posts to connect with the telephone receivers in the plate-circuit of the tubes. The filaments of the latter are placed in series with the 10-volt storage battery. The three fixed resistances have an aggregate value of 3.9 ohms; a 6 ohm vari-

able resistance in series with the filament circuit is used for adjustment.

A selector switch permits communication between a central station and any outlying stations, as illustrated in Figure 2.

In the Signal Corps' portable outfits twelve ground rods are supplied with each radio-telegraph set, six being used at each end of the wire marking the base line of the stations. At least four rods should penetrate the earth in a straight line at each end of the base, the distance apart being not less than two feet.

When a communication is to be transmitted the selector switch is rotated to the position indicated for transmission, the telegraph key is put into operating position, and the buzzer adjusted to a distinct note of the desired frequency. Dots and dashes impressed on the earth in this method spread themselves in all

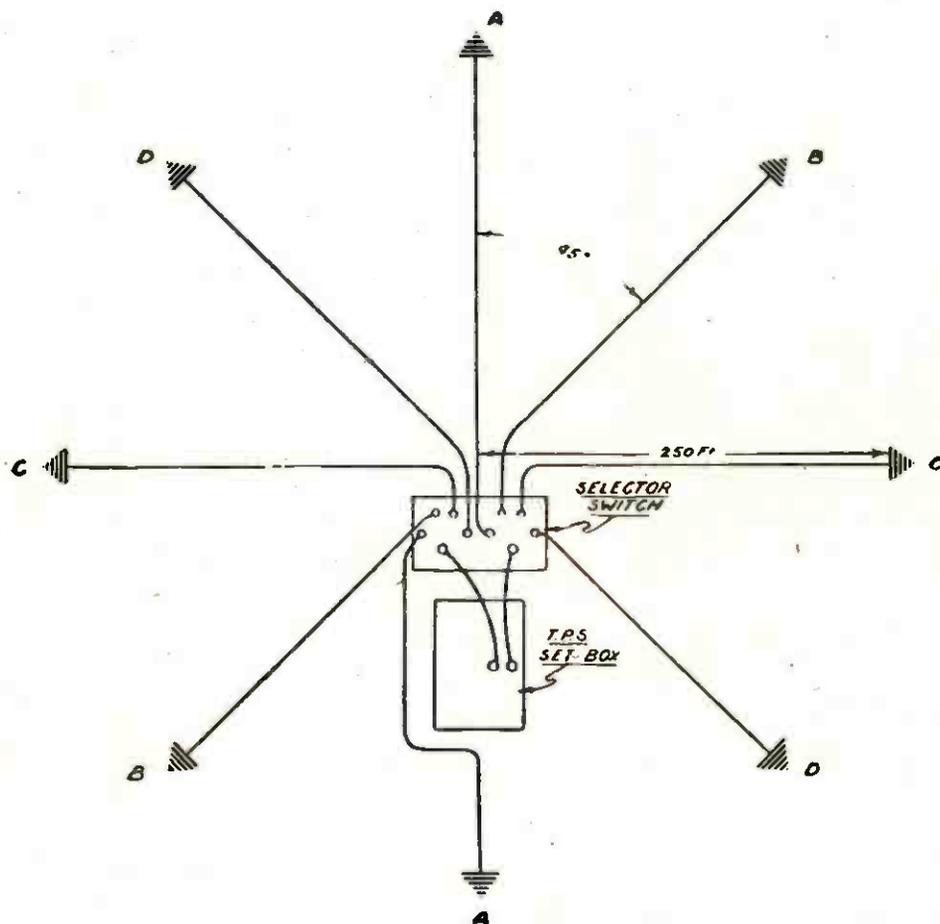


FIGURE 2: How the grounds and the selector switch are arranged to permit communication from a central station in various directions. The combination of grounds used determines the direction of transmission and reception.

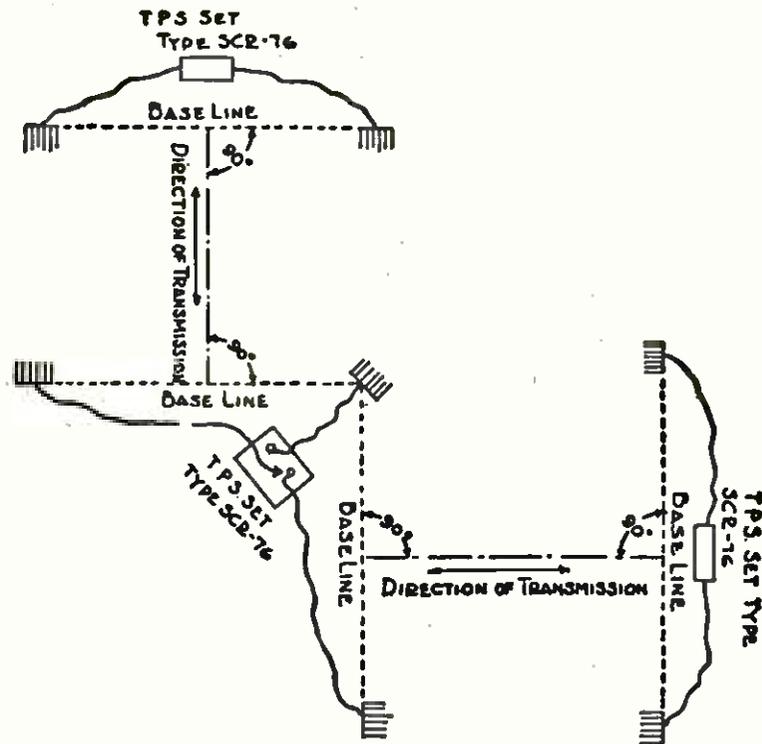


FIGURE 3: This diagram illustrates the arrangements for communication between the central station, in the lower left-hand corner of the diagram, and two outlying stations, one above and one to the right.

directions for interception by sensitive receiving devices.

These receiving devices are similarly grounded.

Urge the Passage of the White Radio Bill!

THE bill introduced by Congressman W. H. White, known as the "Radio Bill," is now pending in the House of Representatives. Its most important features provide for widening the regulatory powers of the Department of Commerce over broadcasting and over other forms of land radio. Many disquieting features of the present radio situation—for example, the prevalence of regenerative interference or the threat of a monopoly in broadcasting—will be much less dangerous if the Department of Commerce is given more definite powers. For this reason, particularly, Mr. White's bill deserves the support of the radio public.

Write your Congressman today and tell him so!



CONDUCTED BY DAVID LAY

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

School Education by Radio

THE first public school system to make radio an official part of its efforts toward general education is that of New York City. The Board of Education, which controls all of the city's schools, has appointed an official radio committee, a transmitting microphone has been installed in the offices of the Superintendent of Schools and a regular program of educational material will be broadcast from WJZ.

* * *

How to Locate Troublesome Re-radiation

THE engineers of the London broadcasting station keep a map of the city, into which they stick pins of different colors to indicate the locations of trouble reports from listeners. A black pin indicates reported interference by code, a green pin marks a report of annoyance by amateur transmission and a white pin shows a claim of trouble due to re-radiation from the oscillating receiver of another listener. When the white pins begin to be thick in some one part of the map the engineers go out on a hunt for the offending listener.

* * *

Delicate Thermometer is Disturbed by Radio Effects

IN recent experiments at the Mount Wilson Observatory, reported in *Popular Astronomy*, Dr. Abbott of the Smithsonian Institution made use of a photoelectric device for measuring the temperature of distant stars, one part of this device being an electric thermometer so delicate that it could record a temperature change of 1/100,000,000 of a degree. So sensitive was this apparatus to minute electrical impulses that disturbances originating from electric machinery in Pasadena, nine miles away, became a serious trouble. It is believed that these disturbances were conducted up the mountain along the power wires, just as the radio impulses of carrier-current telegraphy are conducted.

To Study Air Conditions by Experimental Explosions

THE fact that the transmission of sound through the air has some analogies to the transmission of radio waves has been noted several times in *POPULAR RADIO*. The sound waves going outward from great explosions display, for example, phenomena of "fading" of "dead spots" and others resembling in many ways the phenomena of radio. These sound effects are now to be studied more exactly by scientists attached to the French Government. In May of this year ten-ton quantities of high explosives are to be set off. The exact minute of the explosion will be announced in advance and a large number of observers will be prepared to record the loudness and the exact instants of arrival of the sound wave in all directions around the place of explosion.

* * *

Mountain Static Makes More Trouble

THE U. S. Forest Service has had to close its radio station on Medicine Bow Peak, Wyoming. It had been planned to use this station for broadcasting reports of forest fires but the static proved so troublesome that the station was of little value. Someone ought to find out why it is that static and mountains go together so often.

* * *

The Oldest Kind of "Wireless" Goes Over the Radio

STATION WHAZ broadcast recently the sounds of the drums, tom-toms and other instruments used by the Iroquois Indians in their methods of sending signals over long distances long before the discovery of America by Columbus. WHAZ is in Troy, New York, formerly the heart of the country ruled by the Iroquois Nation. Doubtless many Indian messages were broadcast over this same territory centuries ago but none went so far or so fast as this latest one.

Radio on the Round-the-world Air Flight

THE call letters WYZ have been assigned to the radio installation for the round-the-world airplane expedition to be attempted this summer by U. S. Army fliers. Radio will be used only on the last leg of the flight, from England to the United States. The necessary weight of the radio equipment persuaded the officers in charge not to attempt to use it on the trip across the Pacific or along the southern coast of Asia.

* * *

Germans Claim Interference with Their National Anthem

GERMAN newspapers are protesting that whenever "Deutschland über Alles" is broadcast from Berlin the ether becomes filled immediately with tremendous interference on the same wavelength "coming from the general direction of the Eiffel Tower." Who can it be?

* * *

British Broadcasting Received in India

"THE thrill that comes once in a lifetime" must have visited the listener in Calcutta, India, who recently received by accident a part of a program broadcast in England. Radio telegraphy between England and India has been in regular operation for some time but this is the

first instance of telephony between the two countries.

* * *

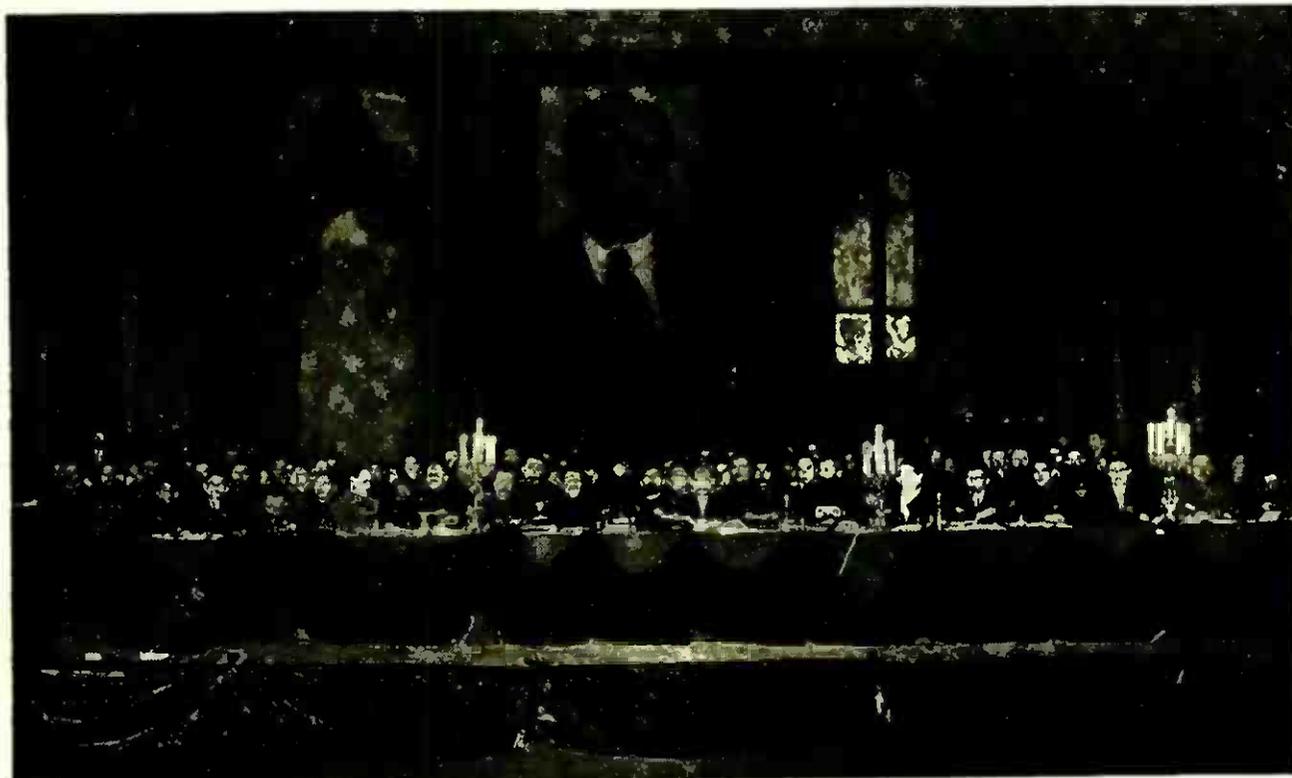
Fading Tests to be Made in France

TESTS of the fading of radio signals, along the same lines tried in the United States by the American Radio Relay League and the U. S. Bureau of Standards, are to be carried out this year in France. French amateurs are asked to make careful records of signal strength from moment to moment for both the French stations and the British broadcasting stations. The tests are being organized by the *Comité Français de Radio-télégraphie Scientifique*.

* * *

A Telephone Lineman Saves an Historic Broadcast Service

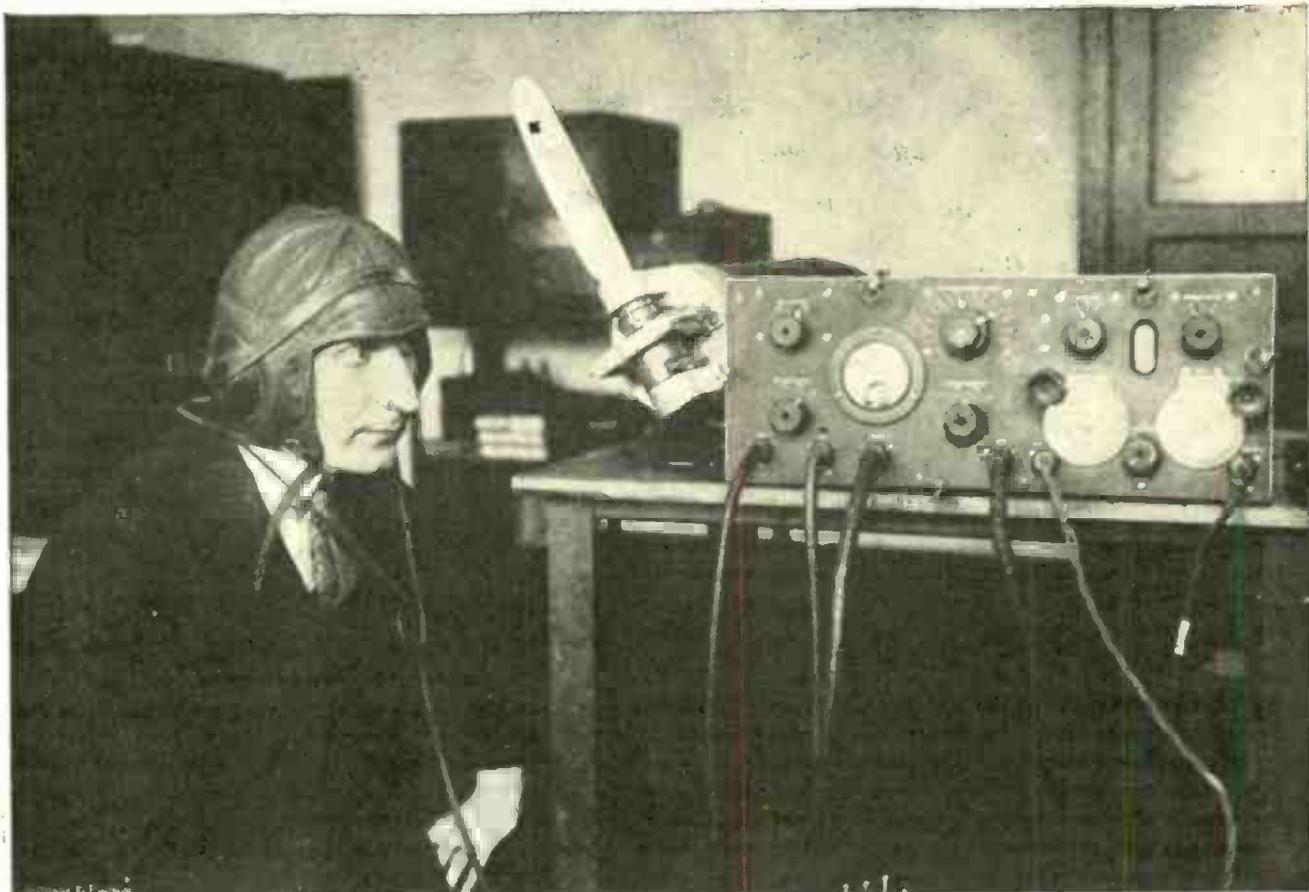
ON the afternoon when the memorial services for President Wilson were to be broadcast from WCAP, WEAJ and WJAR, it is reported that Mr. C. H. Williams, a telephone lineman of Providence, Rhode Island, noticed that a tree, damaged by the storm, was about to fall across the telephone line over which the services were to be relayed between Washington and Providence. Quickly throwing a loop of rope over the threatening tree, Mr. Williams wrapped the rope around another tree and hung on. There he stayed for two hours, until the services were safely over. Then he let go. The tree promptly fell and took the wire with it.



International

BROADCASTING THE LAST SESSION OF THE SOVIET CONGRESS

On the table directly under the draped picture of Lenin may be seen the microphone by means of which the proceedings of this meeting in the Congress Chamber of Moscow were transmitted—in much the same way as other political proceedings are now being broadcast.



Harris & Ewing

THE NAVY'S NEW VOICE FROM THE AIR

This new transmitter and receiver for airplane use has been designed by the Bellevue Research Laboratory of the United States Navy. The wind-driven dynamo at the left supplies the current. The set itself is completely air-tight and water-tight.

Attending Technical Conventions by Radio

ONE of the things that every engineer tries to do, if he possibly can, is to attend the annual conventions of the national engineering societies to which he belongs. But it is not always possible to go. Can one stay at home and attend too? It seems possible that this may happen through radio. The American Institute of Electrical Engineers has opened the way for broadcasting a part of its recent meeting at Philadelphia. Before long we may see the entire convention of this and other technical societies sent out, by relay, from a half dozen stations, so that engineers who cannot leave their business will be able, nevertheless, to listen to the papers and addresses that they most desire to hear.

* * *

Sunday Radio Listening Illegal in New Jersey

AN ancient law, passed in 1798, has been revived in New Jersey by advocates of "Blue" Sundays. Although the resurrection of this antique statute was intended primarily to close up the Sunday movies, it appears that the law makes illegal the operation of a phonograph or even of a radio receiver on the Sabbath. The penalty for violation is a fine of one dollar.

New Instrument Uses Principle of Carbon Grid-leak

THE Bureau of Standards has perfected a new instrument for indicating pushes and pulls in the beams of a structure of any kind, for example, in the metal trusses of a rigid airship like the *Shenandoah*. A little tube filled with carbon disks is inserted in the truss. The pressure or tension on this device changes the electric resistance of the pile of disks and this difference in resistance can be read off on a meter located anywhere; for example, in the control cabin of the airship.

* * *

The First Endowment of Broadcasting

A STEP which may have far reaching importance on the future of radio was taken recently in New York when an organization called the "Radio Music Fund Committee" was formed by Mr. Clarence H. Mackay, Mr. Felix M. Warburg, Mr. Frederick A. Juillard and Mr. A. D. Wilt, Jr. All these gentlemen are wealthy patrons of music and of the other arts. They propose to provide, themselves and by public subscription, a fund which will be available to pay artists and to defray the other expenses of broadcasting music of the highest type from New York.

Radio in Architectural Plans

RADIO equipment is becoming so necessary a part of the modern dwelling house that many architects in the eastern cities are now providing for the antenna, ground, wire conduits and the like when the house is built. In numerous cases receivers, loudspeakers and audio-frequency distributing systems have been actually built into the walls.

* * *

The Largest Dance in the World

ONE of the New York orchestras that sends out dance orders to its listeners recently received requests from more than 1,250 separate dance parties on a single night. At an average of ten persons at each party, which is probably below the truth, this would mean that over 12,000 persons were dancing to this orchestra's measure. And this leaves out of account the probable thousands of anonymous dancers who did not apply for orders at all.

* * *

Static in the Mexican Mountains

It is announced that communication between the new government station at the Panama Canal, operating as NBA, and stations on the California coast of the United States is almost impossible because of a "dead spot" that intervenes. A glance at the map shows that this dead spot occupies, in all probability, the loca-

tion of those northern mountains of Mexico whose role in the creation of static has been under discussion recently in POPULAR RADIO. There must be *something* unusual about those hills; maybe the ghosts of the Spanish conquistadors who died there are still in possession.

* * *

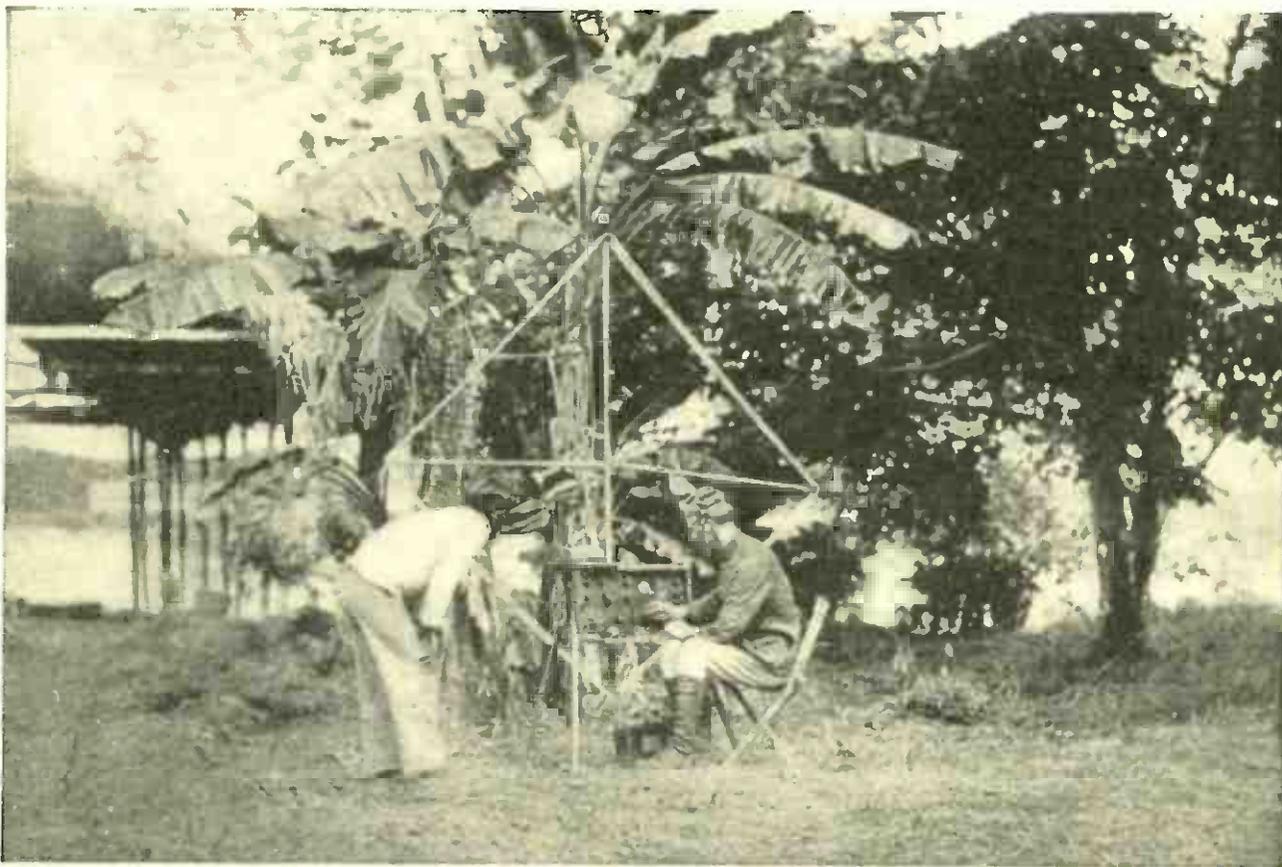
New Chemical Element May Find Its First Use in Radio

A FEW months ago a new chemical element, *Hafnium*, was discovered by Doctors Coster and Hevesey at the University of Copenhagen. Now it is suggested (in *Beama*, London) that this latest addition to the chemical family has properties that are likely to make it valuable for some of the parts of vacuum tubes.

* * *

Radio Restores the Lost English H's

A STORY from London is to the effect that listening to radio broadcasting has distinctly improved the spoken English of the youngsters in the city's East End. The "uncles" who do the announcing and tell the stories have the most impeccable Oxford accents. The result is that the listeners imitate them and the missing "h," so long a characteristic of the Cockney speech, seems to be coming back.



Gilliams Service

RADIO AMONG THE HEAD-HUNTERS

On his expedition among the savages of the Amazon country in South America, Dr. Alexander Rice kept in constant touch with civilization by means of his radio set. A new expedition now planned to the same region will have still more complete radio equipment.



Louis Zoul

A BLIND BUILDER OF RADIO SETS

This picture shows Joseph Alonso of New York, who for the past ten months has been sightless but who, despite this handicap, has built some of the receivers described in POPULAR RADIO. He uses sticks of various lengths for his measurements.

Should Personal Licenses be Required for Radio Operators?

ONE of the subjects now under active discussion at Washington is whether the present requirement of personal licenses for operators of commercial and amateur stations shall be dropped or shall be continued. Advocates of dropping this feature of the present law urge that a license for the *station* is sufficient, the owner being held responsible for its proper operation by a competent person, just as the railways are now held responsible for the competence of their locomotive engineers. The point will doubtless come up for discussion in Congress in connection with the new radio bill proposed by Congressman W. H. White. Radio fans who have strong opinions on the matter may write their Congressmen about it.

Radio Reaches the Sleeping Brain

THE discovery that code can be learned by listening while asleep was described by Mr. Kenneth Swezey in POPULAR RADIO for December, 1923. An additional fact comes from the Great Lakes Training Station of the U. S. Navy. A radio instructor was sending code to a number of sleeping sailors as a part of the use of the new sleep-listening method. As he finished he sent, also in code, this sentence: "Get up, it's five-fifty-five." To his astonishment, all the pupils promptly awoke. It is

evident that the sense of the message, as well as its code signals, reached the unconscious minds of the sleeping men.

* * *

A Remarkable Radio Relay Experiment

THE most ambitious experiment in radio relaying ever attempted was carried out successfully on the evening of February 8, 1924, when a speech by General John J. Carty of the American Telegraph and Telephone Company was broadcast simultaneously from seven stations, including two in California and one in Cuba. The speech was delivered in the Congress Hotel in Chicago. Land telephone lines aggregating more than 5,000 miles carried the general's words to the six American stations and the Cuban telephone cable took them to Havana. It is estimated that more than 100,000,000 people could have heard this speech with receiving sets costing less than twenty dollars each.

* * *

Still Another Name for Radio Listeners

CLOSE on the heels of "cohearers" the British fans have another suggestion of something to call the radio public. The new one is "com-radios" and it is due to the staff of the Cardiff station of the British Broadcasting Company.

WHAT READERS ASK



CONDUCTED BY LAURENCE M. COCKADAY

A Simplified Reflex Circuit

QUESTION: Please give me a simple reflex circuit for using one tube and a crystal with tuned-radio-frequency amplification.
JOSEPH P. BYRON

ANSWER: The circuit is drawn in Figure 1. The circuit shown includes a single stage of tuned-radio-frequency amplification with a crystal detector and a single stage of audio-frequency amplification. The plate circuit is directly coupled to the detector circuit by means of a tuned impedance. All the tuning is accomplished by means of two variable condensers.

You will need the following instruments and parts:

- L1 and L2—honeycomb or duolateral coils, size L-75
- VC1—variable condenser, .001 mfd.
- VC2—variable condenser, .0005 mfd.
- C1—mica fixed condenser, .0005 mfd.

- C2—mica fixed condenser, .0005 mfd.
 - C3—mica fixed condenser, .00025 mfd.
 - R—filament rheostat, 20 ohms
 - AFT—audio-frequency amplifying transformer
 - DET—crystal detector
 - TEL—telephones
- An amplifier tube should be used.

Choose a Loud Speaker Suitable to Your Set

QUESTION: What is the best loud-speaker to use for volume and clarity and which is usable on any set?

ARTHUR GRANT

ANSWER: We advise you to go to a reliable retail store and have them demonstrate the various types of loudspeaker, so that you can purchase the one that suits you best. If possible, have them make these demonstrations on a set like the one you are using. In this way you will be sure of satisfaction.

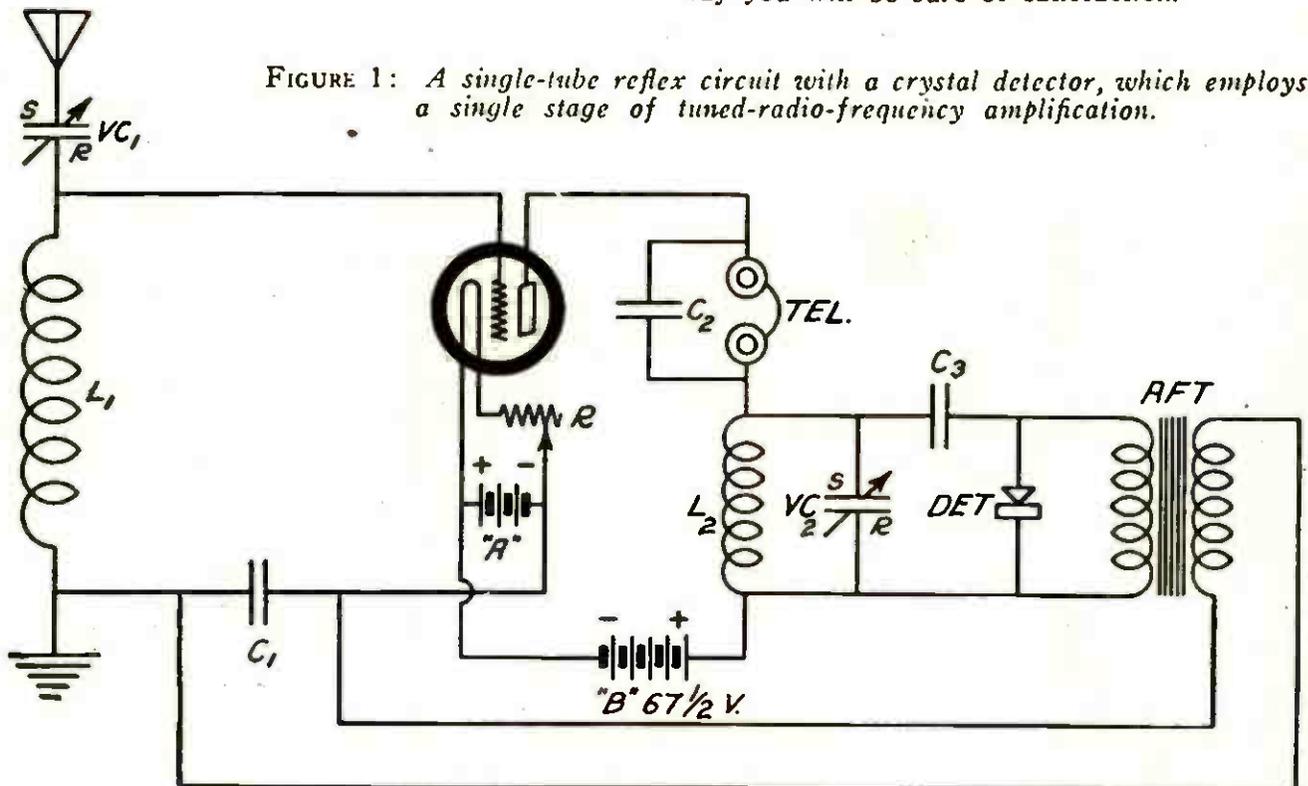


FIGURE 1: A single-tube reflex circuit with a crystal detector, which employs a single stage of tuned-radio-frequency amplification.

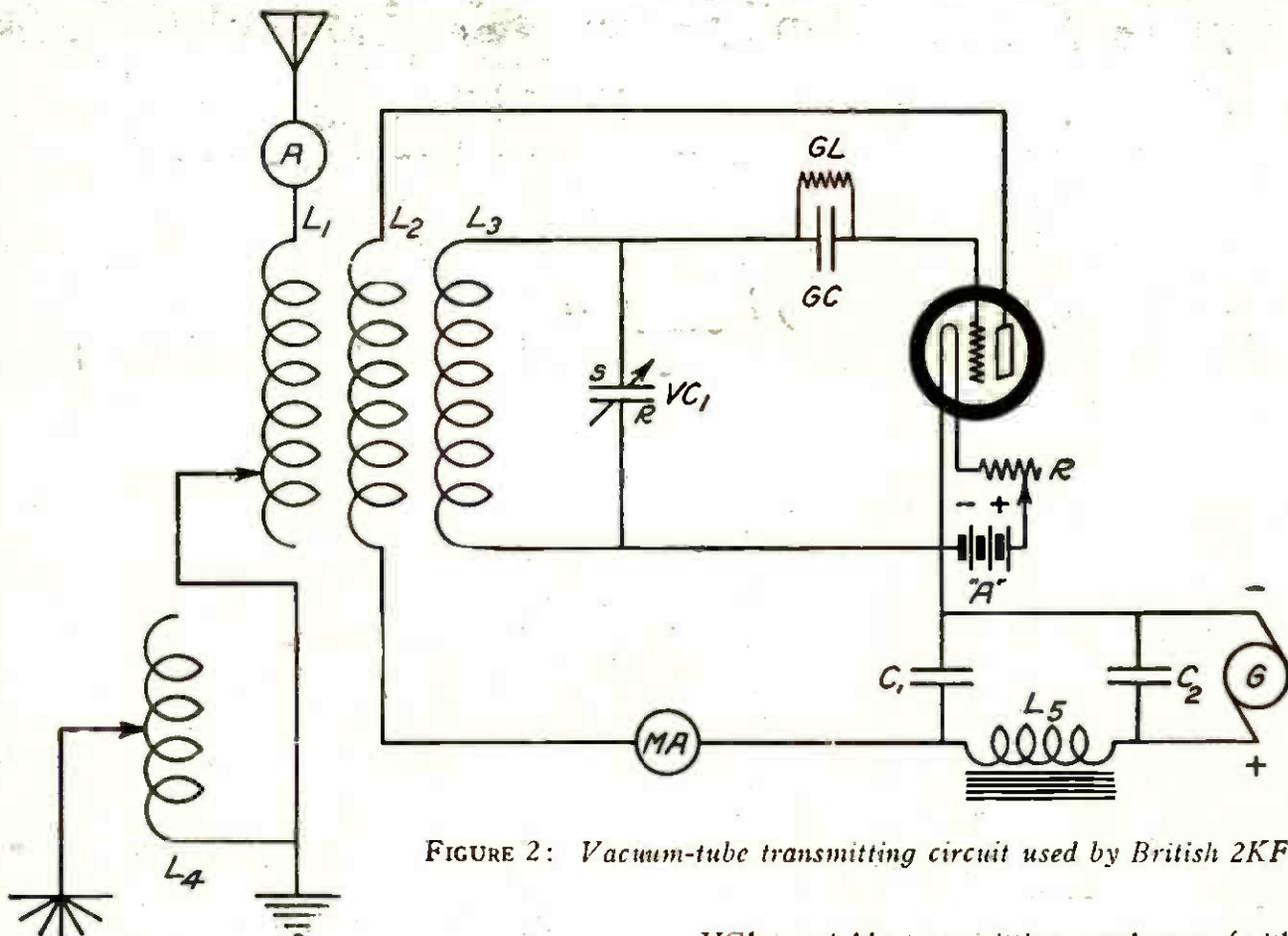


FIGURE 2: Vacuum-tube transmitting circuit used by British 2KF.

An Efficient CW Telegraph Transmitter

QUESTION: Will you please give me the circuit used by British 2KF in his station that has been heard in America. All I need is the circuit itself as I can figure out the proper constants for the apparatus myself.

A. E. J.

ANSWER: The circuit used is shown in Figure 2. The coils can be made in the following manner: Coil L2 can be made of 50 turns of No. 14 bare stranded wire on a 6-inch tube, with the wires spaced far enough apart so that clips can be used for getting the correct inductance in the circuit. Coil L3 may be wound of 40 turns of the same wire on a 3-inch tube inserted inside the coil L2. Coil L1 can be wound directly over the coil L2 with heavily insulated wire, with taps spaced about every two turns. Coil L4 is simply a loading coil for the counterpoise circuit and should be variable to tune it to the same frequency as the rest of the antenna circuit.

The other parts you will need are:

- A—hot-wire ammeter, with proper scale reading for the tube used
- MA—D.C. milliammeter, with proper scale reading

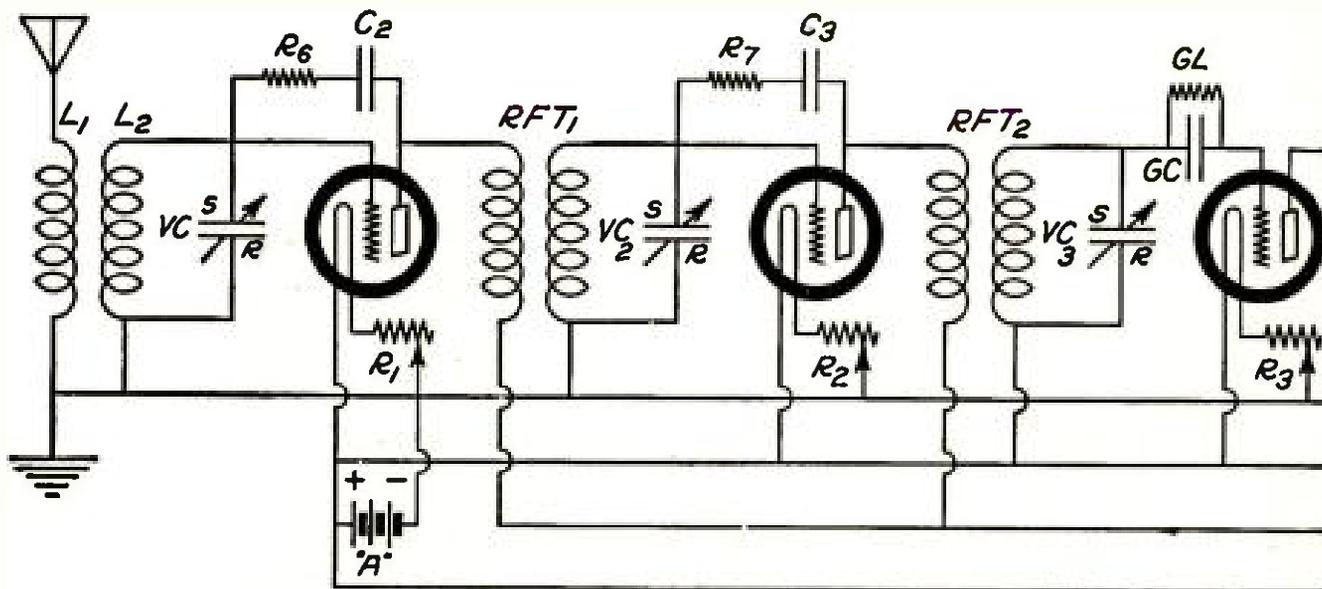
- VC1—variable transmitting condenser (with wide spacing), .0005 mfd.
 - R—filament rheostat, to suit tube
 - C1—paper condenser, 2 mfd., capable of standing plate voltage
 - C2—paper condenser, 2 mfd., capable of standing plate voltage
 - L5—radio-frequency choke coil
 - G—motor generator
 - GL—grid-leak, to suit tube used
 - GC—mica fixed condenser, .0005 mfd.
- Notice that both a regular ground and a tuned counterpoise are used.

Proper Resistance to Use in a Resistance-coupled, Audio-frequency Amplifier

QUESTION: Will you please give me the value of the coupling resistance that can be used for a resistance-coupling audio-frequency amplifier? Also what value of resistance should be used for the grid-leaks and what capacity for the grid condensers?

LAWRENCE J. FEENY

ANSWER: The coupling resistance should be approximately 100,000 ohms. The grid-leak should be variable, one that can be controlled down to a fairly low resistance. The grid condensers should be .005 mfd. (for the first stage) .015 mfd. (for the second stage) and 1 mfd. (for the third stage).



A New Method for Preventing Feed-back in a Radio-frequency Amplifier

QUESTION: Is there any other method for preventing oscillation in a radio-frequency set, other than the use of the potentiometer or the neutrodyne system? I am an experimenter and find a great deal of pleasure in trying out new ideas. I have a group of friends who are doing the same thing and we have quite a time in trying to outdo each other in a competitive way. Some of them are neutrodyne fiends, some of them are trying to get the super-heterodyne to work and some are boosters for the four-circuit.

So, if you can give me any dope on anything new I would be much obliged and possibly could beat them to it.

S. F.

ANSWER: We have drawn for you, in Figure 3, the circuit diagram of a receiver employing two stages of radio-frequency amplification, detector and two stages of audio-frequency amplification. The method for neutralizing feed-back in this receiver is known as the Farrand pliodyne system.

The feed-back is eliminated partly or wholly by employing a non-inductive high resistance in series with a small condenser connected across between the grid and the plate of the tubes.

The parts you will need are the following:
L1 and L2—ordinary variocoupler (primary and secondary windings)

VC1, VC2, and VC3—variable condensers, .00025 mfd.

C1—mica fixed condenser, .0005 mfd.

C2 and C3—small mica fixed condensers, about .0001 to .002 mfd.

GC—mica fixed condenser, .00025 mfd.

GL—variable grid-leak

R1, R2, R4 and R5—filament rheostats, 20 ohms

R3—filament rheostat, 6 ohms

R6 and R7—Lavite resistances, 25,000 ohms

J1 and J2—double-circuit jacks

J3—single-circuit jack

RFT1 and RFT2—radio-frequency transformers

AFT1 and AFT2—audio-frequency transformers

A soft tube such as the C-300 or the UV-200 is used for the detector (third tube) and all the others may be either UV-201-a's or C-301-a's.

The radio-frequency transformers may be made by winding 25 turns of No. 24 DSC wire on the center of a composition tube, 3½ inches long and 1¼ inches in diameter, for the primary coil. The secondary coil consists of 100 turns of the same sized wire wound centrally on a composition tube, 3½ inches long and 2 inches in diameter. The primary is then slipped inside the secondary coil and fastened. This insures close coupling between the two circuits.

The primary windings should be wound in one direction and the secondary windings should be wound in the other direction.

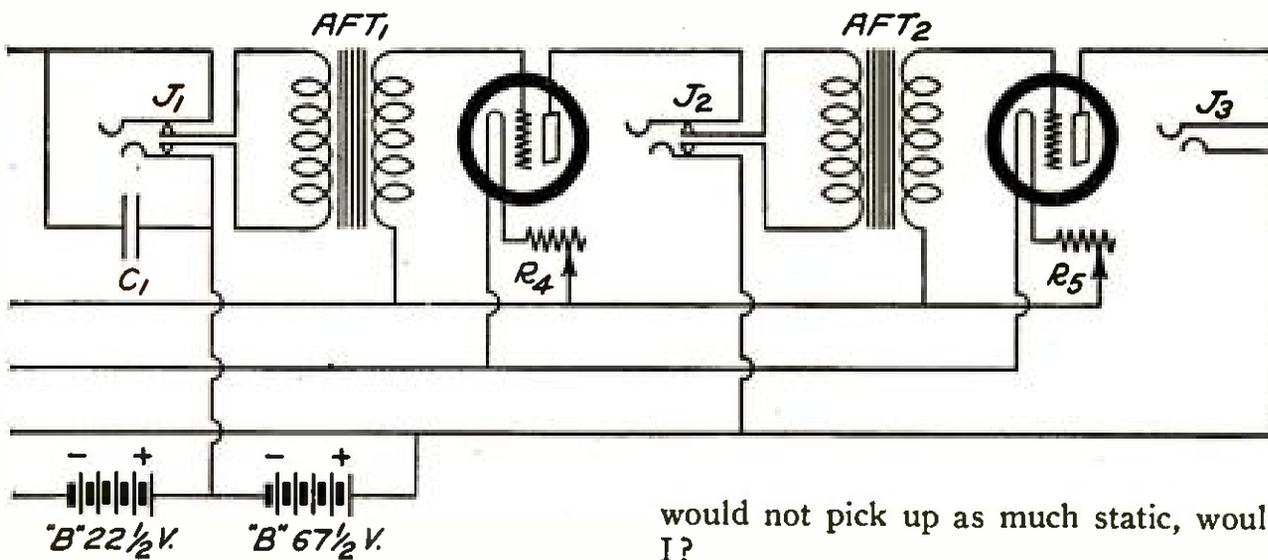
You will have to experiment somewhat in finding the correct capacity to use for the small condensers C2 and C3.

You may also add as many stages of radio-frequency amplification as you want to obtain the sensitivity necessary for your needs.

Tuning Out Inductive Interference

QUESTION: I live near the New York, New Haven and Hartford Railway and have just put up a fine receiving set. At times I can get nearly all the long-distance broadcasting stations in the eastern

FIGURE 3: The Farrand pliodyne receiver, with a new method for eliminating feed-back.



half of the country, but at other times I am bothered by a continuous crackling sound, something like static, which completely drowns out reception even from the local stations. Is there any remedy for this?

A neighboring amateur tells me that he has the same trouble and that it comes from electric leakage from the high-tension power lines of the railroad. Would a loop receiver help in eliminating this trouble?

JOHN H. WILLIAMS

ANSWER: This is probably what causes the trouble you experience. The loop receiver would help to tune out the interference only if the interference comes from some particular direction. This would be done by turning the loop until minimum interference was picked up from this direction. However, all signals from this direction would, at the same time, be eliminated. There has been no satisfactory solution for this interference up to the present time.

The Super-heterodyne on a Loop Antenna

QUESTION: Can the super-heterodyne receiver, described in the September, November and December issues of POPULAR RADIO, be modified to work on a loop antenna? If so, I would like to know where I can obtain information about it. I have the set now and would like to use it this summer, but I fear that it would be very susceptible to static. With the loop, I

would not pick up as much static, would I?

LAWRENCE MEEHAN

ANSWER: The super-heterodyne you mention will operate well on a loop antenna and this use of it will eliminate a lot of static interference in summer work.

An article describing the necessary modifications of the set will be found in the near future in an issue of this magazine.

The Best Detector to Use in the Super-heterodyne

QUESTION: Will a soft detector tube give better results in the super-heterodyne receiver described in the November and December issues of POPULAR RADIO? The article specifies a UV-201-a tube.

FRANK KELSEY

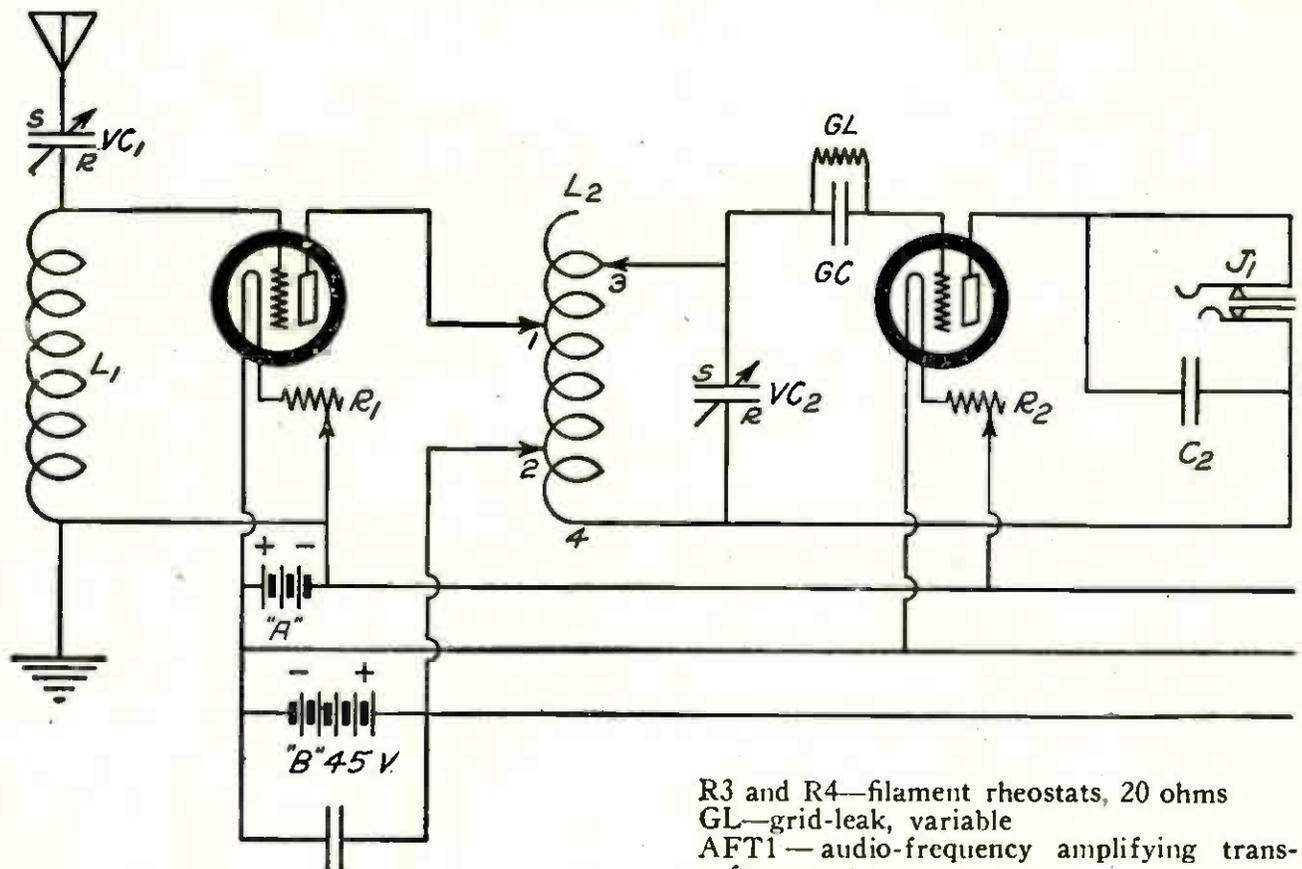
ANSWER: We recommend the use of the tube specified. This will give the same signal strength and reception will not be accompanied by the familiar hiss of the gassy tube.

The Whistle in a Single-tube, Super-regenerative Receiver

QUESTION: Can the whistle be eliminated from a single-tube super-regenerative receiver?

HOWARD BRENT

ANSWER: As far as we know, it cannot. It is not possible to put a filter in the detector circuit which will filter out the high-frequency whistle which accompanies reception with this type of receiver, without also filtering out some of the important frequencies which are necessary to reproduce good music and speech. It might be done if a crystal detector is used with a single tube in this circuit.



French Tuned-radio-frequency Receiver

QUESTION: Can you give me any particulars regarding the French circuit known as the Abelé circuit? I have a cousin who just arrived back from Paris and he tells me it is great, but he could not get the data on how to build it. Can you get it for me?

ANDREW H. BLONT

ANSWER: The circuit you want is shown in Figure 4. We have shown a single stage of radio-frequency amplification, detector and two stages of audio-frequency amplification, so that it may be used on a loudspeaker. It is interesting to note that in this circuit, the plates of the two first tubes are coupled together with the grid circuit of the second tube through a radio-frequency auto-transformer. The three couplings can be varied by means of the sliders or taps on the coil L2.

The parts you will require are the following:

- VC1—variable condenser, .001 mfd.
- VC2—variable condenser, .0005 mfd.
- C1—paper fixed condenser, .5 mfd.
- C2—mica fixed condenser, .0005 mfd.
- GC—mica fixed condenser, .00025 mfd.
- L1—60 turns of No. 20 DCC wire on a composition tube, 3½ inches in diameter
- L2—60 turns of No. 24 DCC wire on a composition tube, 3½ inches in diameter. This coil should be tapped every 2 turns
- R1—filament rheostat, 20 ohms
- R2—filament rheostat, 6 ohms

R3 and R4—filament rheostats, 20 ohms

GL—grid-leak, variable

AFT1—audio-frequency amplifying transformer

AFT2—audio-frequency amplifying transformer

The tubes used can be three UV-201-a's or C-301-a's for the radio and audio-frequency amplification, and a C-300 or a UV-200 tube for the detector.

You will have to gain a little experience in obtaining the correct ratios for the inductance taps included in the output of the first tube and included in both the input and output circuit of the second tube to get the best results from the circuit. When you have learned this it should be found an extremely sensitive circuit, although rather critical.

Small or Large "B" Batteries

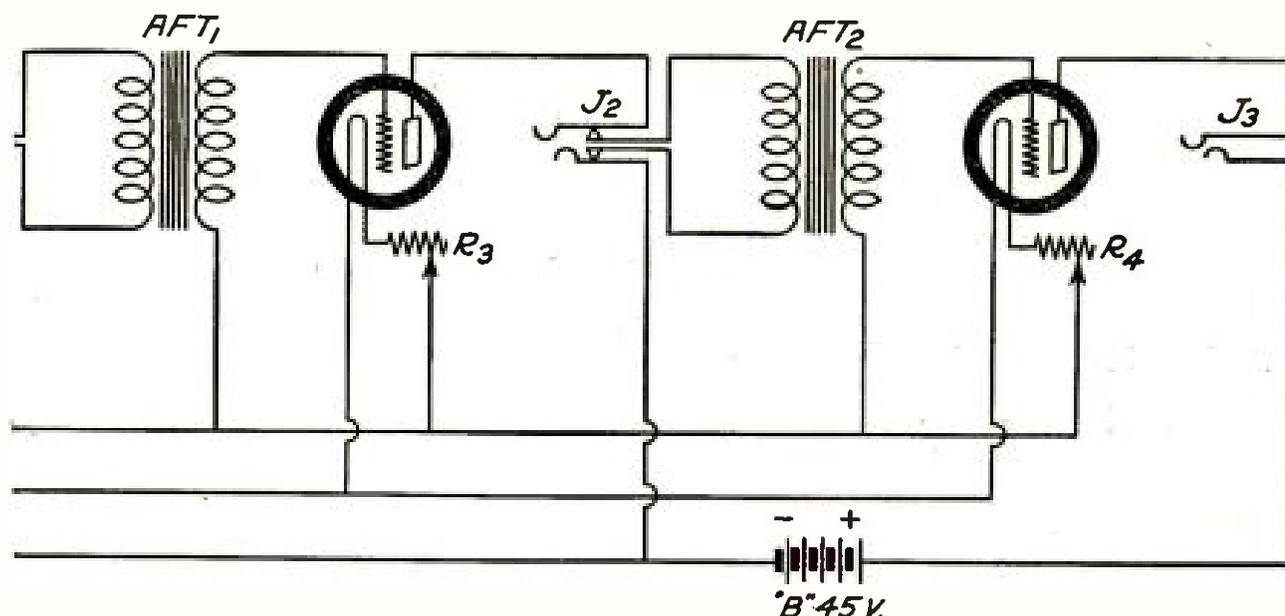
QUESTION: I have a five-tube receiver. I need 135 volts of "B" battery to operate it. Should I use small or large sized "B" batteries with it, or doesn't it matter? The large "B" batteries take up so much room that I would like to use the small ones if the efficiency of the set were not affected.

A. D. CROWLY

ANSWER: We recommend the use of the large size of "B" batteries wherever possible. Especially where there are more than three tubes used. The larger batteries have a much longer life than the other ones and there is less possibility of them running down and spoiling reception.

The small "B" batteries should be used only where portability is absolutely necessary.

FIGURE 4: The Abelé circuit comprising one stage of tuned-radio-frequency amplification, detector, and two stages of audio-frequency amplification.



How to Make a Neutrodyne

QUESTION: You have never shown the amateurs how to make a neutrodyne type of receiver in your magazine. Is this because you do not think it is an efficient circuit or is it too complicated for the ordinary radio fan to build with any success?

S. F. G.

ANSWER: It is rather difficult to completely neutralize the tube capacity in the regular neutrodyne on account of the extremely small value of capacity that is usually used for this purpose.

However, in Mr. Craig's article, "How to Build a Simplified Neutrodyne," in the April, 1924, issue, you will find that he has made this phase of the adjustment much easier by neutralizing with a larger capacity in a capacity bridge. This greatly simplifies the problem.

Grounding the Cores of Amplifying Transformers

QUESTION: I have a two-stage, audio-frequency amplifier that I made to use with my single-tube receiver, and which gives me good loudspeaker volume. The only trouble I find is that there is a constant high-pitched whistle which is on all the time I am receiving. I can eliminate this by turning down the last tube fila-

ment considerably, but then the signals sound strained and are reduced in volume.

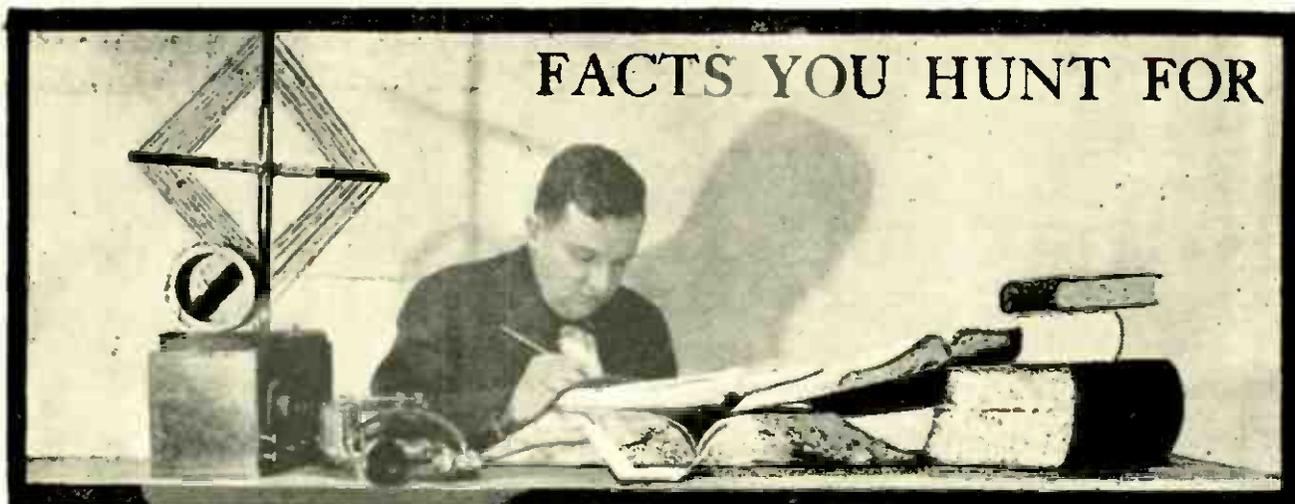
While experimenting with the set, I touched the core of the last transformer with my bare hand and the whistle vanished without affecting the volume of the set with the tubes turned up to the point where maximum amplification is obtained. Immediately I thought of grounding the metal parts of the transformer. I did this and the effect was the same. The whistle was eliminated.

I want to know if this harms the amplifier in any way? Does it damage the transformer? Will it run down the "B" batteries? If not, this would be a valuable thing for other experimenters to know, I think.

HOWARD BROECK

ANSWER: The method you used is standard practice and will not do any damage to the instruments. It is usually best to ground the negative terminal of the "A" battery and then attach a wire from there to the transformer core (underneath the screw which is used to fasten the transformer to the base).

This will do what you want and will help in eliminating body capacity in some of the circuits where the secondary coil of the tuner is connected direct to the grid and plate elements of the detector tube, instead of to the grid and filament elements.



FACTS YOU HUNT FOR

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 much amplification is possible in the best receivers yet devised?

IN theory there is no limit to the amplification that can be attained. Practically, however, very high amplifications are difficult to reach without introducing too much distortion. Many of the modern circuits will reach successfully an amplification of from 30,000 to 100,000 times the strength of the incoming signal. Amplifications of several million have been obtained experimentally and some sets, handled by an expert, will do this in practice.

What is "spaghetti" made of?

It is thin cloth, usually a kind of muslin, wrapped or woven into the form of a tube and saturated with insulating varnish.

Can condensers be connected in series and in parallel the same as resistances or batteries can?

THEY can be so connected but the capacity of the combined units will not be the exact sum or difference of the individual condensers. Capacities cannot be added or divided by the simple rules that apply to battery voltages.

Why is it that the carbon in carbon rheostats changes its electrical resistance with the amount of pressure you put on it?

THIS is not quite the right way to state what happens. The carbon is not all in one solid piece but is in powder or in flat disks or in some other kind of separate particles. The

electrical contacts between these particles are not perfect. The more pressure you apply the better the contact between the particles. They are merely pressed together more completely. This decreases the electrical resistance, not of the carbon itself, but of the mass of particles.

Has a perfect vacuum ever been obtained in vacuum tubes?

No. Science has never obtained a perfect vacuum in any way whatsoever. A really perfect vacuum is probably unobtainable under the conditions that exist on earth. See "The Bottle Filled with .000,000" in POPULAR RADIO for October, 1922.

Why are the iron magnets inside transformers, motors and other electric machines always made out of thin sheets of iron instead of solid castings?

To prevent what are called "eddy currents." If the iron is in a solid piece the electromagnetic waves that pass through it produce a lot of electric currents that merely flow around as eddies inside the iron itself and this wastes energy.

Why does dropping a telephone receiver sometimes ruin it, although nothing is broken?

THE shock when it hits the floor weakens the magnetism in its magnets. According to present day theories of magnetism, the magnetic force is due to the fact that every little atom of iron in a magnet is itself a tiny magnet. All these atoms are believed to be turned in the same direction so that their magnetic effects

reinforce one another. The shock of dropping the magnet turns some of the magnetic atoms in other directions so that they interfere with the magnetic force of the unturned atoms. This weakens the whole magnet.

How can I make tellurium for a crystal?

You cannot make tellurium. It is a chemical element, like copper or silver or carbon. Crystallized tellurium can be bought from most dealers in chemical supplies or in rare minerals. It is extracted commercially as a by-product of copper refining.

What are the "talking crystals" that I read about? Will they repeat radio signals without telephones?

You are confusing two entirely different things. The so-called talking crystals are not detector crystals for radio. They are crystals of rochelle salt that can act, under proper circumstances, like a microphone or a telephone. That is, they can convert sound waves into electric waves or *vice versa*. They have no present use in radio. There was an article about them in POPULAR RADIO for September, 1922.

Is there any kind of amplifier for radio-frequency currents instead of the vacuum tube?

THEORETICALLY there are a number of such amplifiers, for example, the magnetic amplifiers which make use of a magnet vibrating in a combined electric and magnetic field. But all these devices are very poor substitutes for a vacuum tube. They have a considerable inertia of the vibrating parts, which means that they affect the wave forms of the currents or potentials amplified and produce distortion. The vacuum tube is the only amplifier that has proved generally useful in practice.

How can I build a transformer for use on direct current?

THIS cannot be done. The principle of the transformer applies only to *alternating* current. Each time the direction of the current changes a magnetic wave is produced around the primary coil and this wave creates the pulse of current in the secondary coil. If the current does not change there is no such alternating

magnetic wave and accordingly no current is produced in the secondary.

How many electrons are there in the atoms of all the metals?

THE number varies for the different metals. The following table gives the number of planetary electrons in one atom of each of the chemical elements, including the metals. These numbers are for the electrons that revolve around the nucleus, or atomic sun, as the planets revolve around the sun of our solar system. There are additional electrons inside the nucleus, but these do not affect the ordinary chemical or electrical properties of the elements. This is explained in the article, "Bohr's New Theory of Atoms," in the April, 1924, issue of POPULAR RADIO.

Elements	Number of Planetary Electrons	Elements	Number of Planetary Electrons
Hydrogen	1	Silver	47
Helium	2	Cadmium	48
Lithium	3	Indium	49
Beryllium	4	Tin	50
Boron	5	Antimony	51
Carbon	6	Tellurium	52
Nitrogen	7	Iodine	53
Oxygen	8	Xenon	54
Fluorine	9	Caesium	55
Neon	10	Barium	56
Sodium	11	Lanthanum	57
Magnesium	12	Cerium	58
Aluminum	13	Praseodymium	59
Silicon	14	Neodymium	60
Phosphorus	15	Undiscovered element	61
Sulphur	16	Samarium	62
Chlorine	17	Europium	63
Argon	18	Gadolinium	64
Potassium	19	Terbium	65
Calcium	20	Dysprosium	66
Scandium	21	Holmium	67
Titanium	22	Erbium	68
Vanadium	23	Thulium	69
Chromium	24	Ytterbium	70
Manganese	25	Lutecium	71
Iron	26	Hafnium	72
Cobalt	27	Tantalum	73
Nickel	28	Tungsten	74
Copper	29	Undiscovered element	75
Zinc	30	Osmium	76
Gallium	31	Iridium	77
Germanium	32	Platinum	78
Arsenic	33	Gold	79
Selenium	34	Mercury	80
Bromine	35	Thallium	81
Krypton	36	Lead	82
Rubidium	37	Bismuth	83
Strontium	38	Polonium	84
Yttrium	39	Undiscovered element	85
Zirconium	40	Niton	86
Columbium	41	Undiscovered element	87
Molybdenum	42	Radium	88
Undiscovered element	43	Actinium	89
Ruthenium	44	Thorium	90
Rhodium	45	Undiscovered element	91
Palladium	46	Uranium	92

The elements beyond Bismuth are radioactive.

Working Blueprints of the Audio-frequency Amplifier

IN order to accommodate readers who may desire actual-size diagrams of this, the amplifier described on pages 476 to 485, a set of three blueprints has been prepared, consisting of—

One panel pattern (actual size);

One instrument layout;

One picture diagram of all parts, showing the wiring.

This set of three prints will be forwarded, postage prepaid, upon receipt of \$1.10.



CONDUCTED BY ALBERT G. CRAIG

Another Warning Against Re-radiation

Don't let your set oscillate while you are receiving on the broadcasting wavelengths. It will not be of any advantage to you and will prevent your neighbors from getting clear reception on account of your set re-radiating. *Don't do it!*

The Best Wire for Your Antenna

SEVEN-STRAND pure copper wire is the best material to use for an outdoor antenna. The size most generally used is No. 14 B. and S. gauge wire.

Of course, No. 14 bare copper wire may be used, but the stranded wire will give a greater surface, which makes it more efficient at radio frequencies.

Too Much Regeneration

If a regenerative receiver has a tendency to oscillate too much, even when the feed-back control is set as low as possible, the following suggestions may help to stabilize operation:

- A—cut down the plate voltage on the detector tube
- B—reduce the filament current
- C—use a larger by-pass condenser across the telephones
- D—connect the grid return to the positive side of the "A" battery
- E—if three honeycomb coils are used for tuning use the next size smaller coil for the tickler
- F—use a lower resistance grid-leak (a variable grid-leak would be best)
- G—use a smaller grid condenser

By following out one or more of these suggestions the trouble can be eliminated and the set will function much more smoothly. Try out all the schemes on DX reception and you may be able to increase the range of the set as much as one hundred percent.

Soldering Flux on Windings

BE sure (while soldering) that you do not allow the soldering flux to bubble and drop off a joint onto the windings of your tuning coils, as this destroys the insulation between turns and has been a frequent cause of inefficient operation of an otherwise really excellent set.

A Plate Milliammeter for a Receiver

To the experimenter who enjoys playing with new circuits when they come out, a D. C. milliammeter with a scale reading up to about 25 milliamperes will be a good indicator that the set is functioning properly. This is especially true for new amplifier hooks-ups. A meter which is reasonably "dead-beat" should be used.

Water Pipe the Best Ground

A WATER PIPE, if properly cleaned and a good joint made to it, will furnish a better ground, in most cases, than the radiator, the gas pipe, or a rod driven into the earth.

Your Window-pane as a Lead-in

A GOOD lead-in can be made by coating a piece of tinfoil with shellac, and pasting it to the outside of the window-pane, and then doing the same thing on the inside of the window. The two sheets of tinfoil should occupy the same relative positions on both sides of the pane of glass. The antenna is connected to the outer sheet and the antenna binding post of the set is connected to the inside sheet. The two pieces of tinfoil act as a series condenser in the antenna circuit but the capacity is so high that the impedance offered to the radio-frequency signals is negligible.

Materials for Panels

Do not use fibre for panels in a radio instrument. It absorbs a large amount of moisture. You may, however, use this same material after it has been thoroughly dried in an oven and impregnated with a synthetic resinous compound. In this condition it is protected (to a fair extent) from moisture.

A Tip for Restoring the Efficiency of Coils

A HONEYCOMB coil that seems to have lost its efficiency through the warm, damp weather may be restored to usefulness by taking off the soft black strip of material (by loosening the two screws) and then baking the coil in a warm oven. Then, replace the black strip with a strip of isinglass or celluloid cut to the same shape. The black strip often collects a large amount of moisture, sometimes so much that you can squeeze it out of the strip.

Keep an Eye on Your Storage Battery

USE a hydrometer for testing out your storage battery. You can get one at almost any radio supply store. The directions furnished with the hydrometer will tell you how to test the battery to determine when it needs recharging.

A Tube Precaution

WHEN testing out a set that is just completed, do not put in all the tubes at once. Try out each socket one at a time and save a few tubes if you have made a mistake in connecting up.

Tag Your Battery Leads

A GOOD stunt is to have the leads from the "A" batteries and the "B" batteries tagged with little tags marked with the voltage and polarity for each lead. This will prove a reminder and prevent mistakes in selecting the proper lead wire to use.

Broadly-tuned Antenna Circuits for Receivers

A SEMI-APERIODIC (broadly tuned) antenna circuit will eliminate one tuning control in a receiving set, and will give quicker tuning control with very slight reduction in signal strength, if a regenerative circuit is used.

An aperiodic circuit is a circuit which has no natural period of oscillation; an untuned or non-resonant circuit.

A semi-aperiodic circuit is one (as already stated) that is only roughly or broadly tuned. It consists of a few turns (not more than 10) included in the antenna circuit, and coupled inductively to the secondary circuit which should be *sharply* tuned.

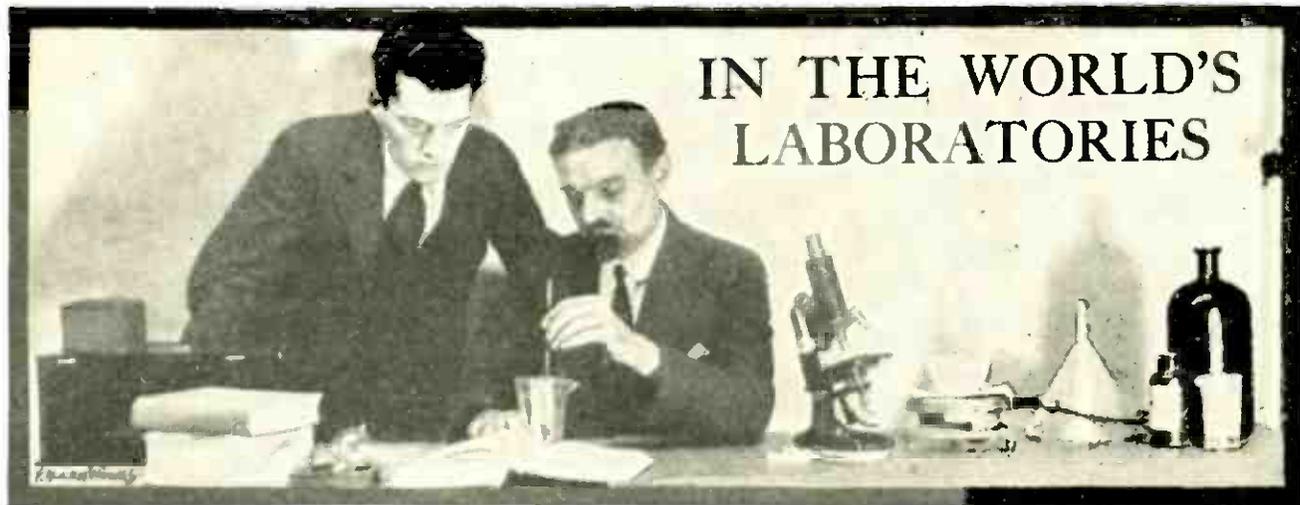
This is true of the Reinartz, Haynes, and some of the Cockaday circuits.

A Good Space Saver

THE use of a combination rheostat and socket is a good space saver in a receiver where compactness is one of your particular requirements.

Soft Tubes Best for Detectors

A SOFT tube, one that contains a lower degree of vacuum than a hard tube, is more sensitive as a detector, in a radio set. The hard tubes function best as amplifiers, however, while the soft tubes are not as suitable for this use.



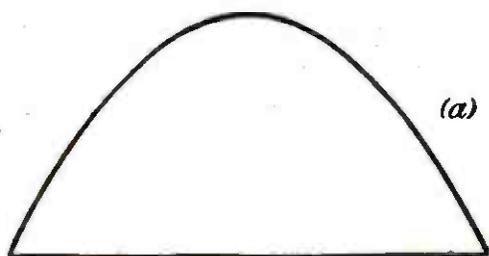
IN THE WORLD'S LABORATORIES

CONDUCTED BY DR. E. E. FREE

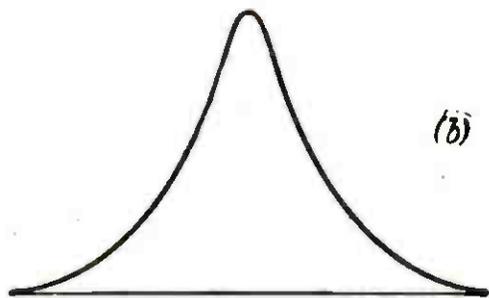
What Makes the Clicks and the Hisses in Static

THE pictures of different kinds of static obtained in England by Mr. Watson-Watt and his associates and described in an earlier number of POPULAR RADIO,* have recently been sub-

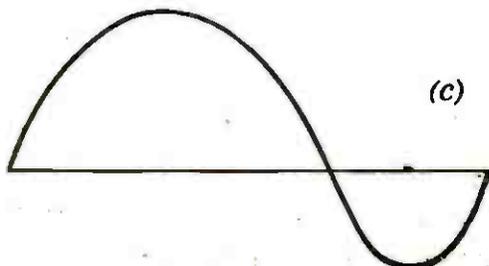
* POPULAR RADIO, vol. 5, pages 205-206 (February, 1924).



(a)



(b)



(c)

COMMON KINDS OF STATIC

These curves represent the three commonest kinds of static observed by Mr. Watson-Watt and studied mathematically by Mr. Moullin, as described on this page.

jected to mathematical analysis by Mr. E. B. Moullin.† A formula has been found which fits fairly well the curves actually measured and this formula has been used to approximate the effects of tuned and untuned antennas and of other modifications of the receiving circuit upon the troublesomeness of the static disturbances.

Mr. Moullin's results apply in the main to radio telegraphy but one feature of his conclusions has interest for the broadcast listener as well. He finds that the actual effect of static is much more troublesome than the simple mathematical theory indicates that it ought to be. This is not because the theory is wrong. It is, he believes, because the most troublesome feature of static is not the main wave of it, but is the presence of shorter waves superposed on this main wave, shorter waves that may be called ripples on top of the main disturbance.

In a telephone receiver these short-wavelength ripples will make the hisses; the main long waves make the clicks. If Mr. Moullin's results prove to have general applicability it is the hisses rather than the clicks that trouble most greatly the clear reception of radio signals. How this conclusion can be applied practically to radio telephone receivers is not yet apparent, but the first step in controlling any natural phenomenon is to find out exactly what it is and this step we are taking rapidly.

Using Static to Forecast the Weather

IF the origin of static disturbances is to be ascribed to storms, electrical or otherwise, as seems to be the probable conclusion from the well-known work of Mr. Watson-Watt and others, then it should be possible to make use of these static waves to locate approaching storms and to forecast their probable movement and intensity. That this is being actually

† "Atmospherics and Their Effect on Wireless Receivers," paper before the Institution of Electrical Engineers (London), February 14, 1924, to be published in the *Proceedings* of the Institution.

done in Europe at the present time appears from a brief review of the subject published recently by Mr. G. H. Daly.*

Experiments in both England and France have been promising. In particular, Professor Rothé of Nancy, France, has developed considerable skill in predicting the local weather from a study of the direction and character of static impulses received at his laboratory.

It would seem, however, that the mere direction of a static click is only part of the information that it can be made to yield about the weather. Nor is it the most important part, for the *location* of a distant storm can be learned without difficulty by telegraph from observers at that place, which is the present method of the United States Weather Bureau. A more valuable service of static to forecasting would be the determination, from the *character* of the static, of conditions in the higher levels of the atmosphere where there are no observers.

It is apparent to everyone who listens to radio that there are many different varieties of static. Some of the impulses are clicks, some are deep-toned rumbles, some are high-frequency hisses. Some of the more usual

forms are indicated by the diagram published in this Department this month in connection with the article of Mr. Moullin. It is probable that each of these varieties has a different origin and it is almost certain that the whole orchestral score that static plays for us in our receivers has a meaning, a meaning which will help us solve many of the problems of the atmosphere and the weather.

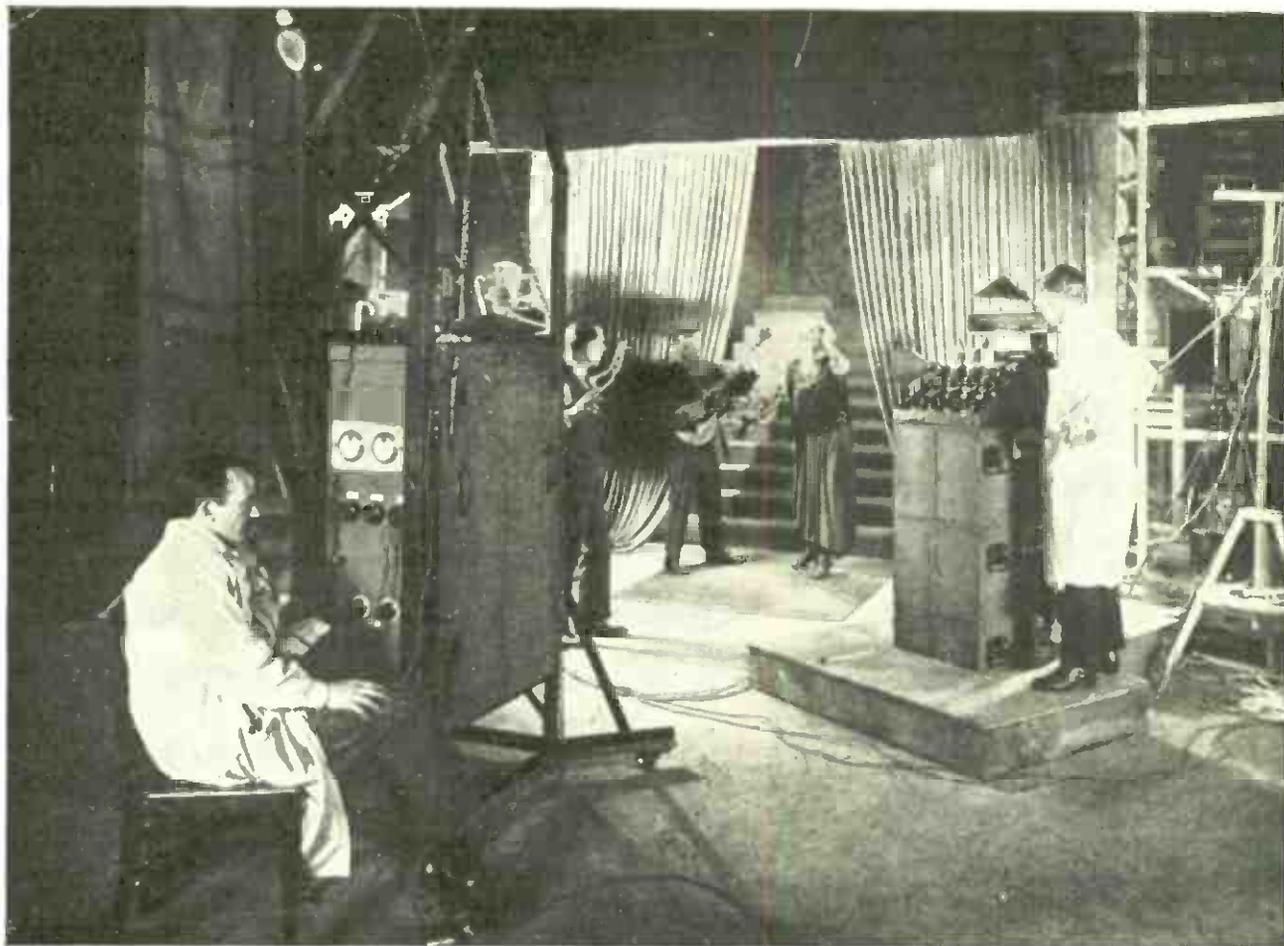
First, we must learn to read the meaning of this score and that will require, one imagines, a great deal of scientific observation and experimentation. But in the meantime, let us not regard static merely as an annoying nuisance. What it really is, is an incentive to scientific study, a signal that beckons to us from beyond the horizon of our present knowledge.

Progress with the Speaking Movies

THE phonofilm of Dr. Lee De Forest, a device already described in detail in *POPULAR RADIO*,* continues to approach perfection. It has been exhibited recently in a number of motion picture theatres with pronounced suc-

* "Forecasting Weather by Wireless," by G. H. Daly. *The Wireless Review* (London), vol. 2, pages 217-218 (January 26, 1924).

* "The Motion Picture Speaks," by Lee De Forest. *POPULAR RADIO*, vol. 3, pages 159-169 (March, 1923).



Mirzaoff

A STUDIO FOR THE NEW GERMAN "SPEAKIES"

While the motion picture camera records the action of the scene, the special sound-recording apparatus (shown at the right of the picture) makes a simultaneous record of the words and music. Note the three vacuum tubes that are used as amplifiers.

cess and with much apparent interest on the part of audiences.

The reports of listeners agree, almost unanimously, upon two conclusions. *First*, it is apparent that the problem of synchronization, long so difficult to surmount, has been solved. Dr. De Forest's device actually does produce the sound at the instant of the action on the screen. *Second*, the chief present imperfection of the apparatus is that the sound seems unnatural. It sounds, one listener reported, "like an old-fashioned phonograph."

Presumably this unnaturalness of quality can be corrected in the phonofilm, just as it has been corrected so successfully in the best of the modern phonographs. And possibly the detailed studies of speech and of other sounds by Dr. Fletcher and his assistants, as described elsewhere in this Department, will prove of much assistance here as well as in the problems of loudspeakers and telephones.

A Mystery of Short-wave Transmission

ONE of the most interesting experiments now being carried out in the whole radio field is the relay work from KDKA at Pittsburgh to KFKX at Hastings, Nebraska, and to 2AC at Manchester, England.

As all radio enthusiasts know, this relaying is done on wavelengths in the neighborhood of 100 meters and has proved to be entirely successful in practice; not only are the programs from KDKA received with reasonable regularity both at Hastings and at Manchester but on several occasions the linkage has been extended from Hastings to the Pacific Coast and WGY at Schenectady, New York, has also been linked to KDKA. There seems every promise that the linkage of stations in this manner, by short-wave radio, is destined to replace, more or less completely, the present custom of linking stations by land-wire telephones.

A recent description of the Hastings Station by Mr. D. G. Little and Mr. F. Falknor* contains, not only the technical details that will interest primarily the professional radio engineers, but also some matters of general interest to the radio public. One of these is the problem of local interference at Hastings.

Because of the shortness of the wave that was arriving from Pittsburgh, substantial interference was encountered from leaky power lines in and about Hastings and from the electric apparatus used by physicians and dentists in the city. To avoid this the engineers determined how far this interference spread outside the city. It was found to be about one-half mile. Accordingly, the receiver for the KDKA wave was located about a mile north of Hastings, which was well beyond the zone of strong local interference. In addition a loop, opposed to the main receiving antenna, is

* "Radio Station KFKX, the Repeating Broadcasting Station at Hastings, Nebraska," by D. G. Little and F. Falknor. Statement issued to the press by the Westinghouse Electric and Manufacturing Co., March, 1924.

used to cancel out what local interference remained.

Another ingenious expedient developed at Hastings has interest for experimenters everywhere; the vacuum tubes used on the transmitter used to re-broadcast the KDKA program to the Pacific Coast are water-cooled. The plates of these tubes come in contact with the stream of cooling water, yet they must be maintained at a high potential above ground.

To avoid using a self-contained and insulated system for the cooling water, the engineers connected the ordinary city water supply to the cooling circuit but made this water connection through twenty-foot lengths of rubber tubing $\frac{1}{4}$ inch in diameter. The electrical resistance of this long, thin water column is so great that practically no current leaks off the plates into the ground.

In deciding on the exact wavelength to be used in the relay link between Pittsburgh and Hastings some interesting observations were made on the variations in signal strength at different wavelengths. "Above 3,333 kilocycles (90 meters) it was found," say Mr. Little and Mr. Falknor, "that the signal was maximum about 7 P.M., central standard time, and would fall to about 10 percent strength before 8 P.M. At 3,000 kilocycles (100 meters) the signal strength increased until about 11 P.M. and then remained approximately constant until about 4 A.M."

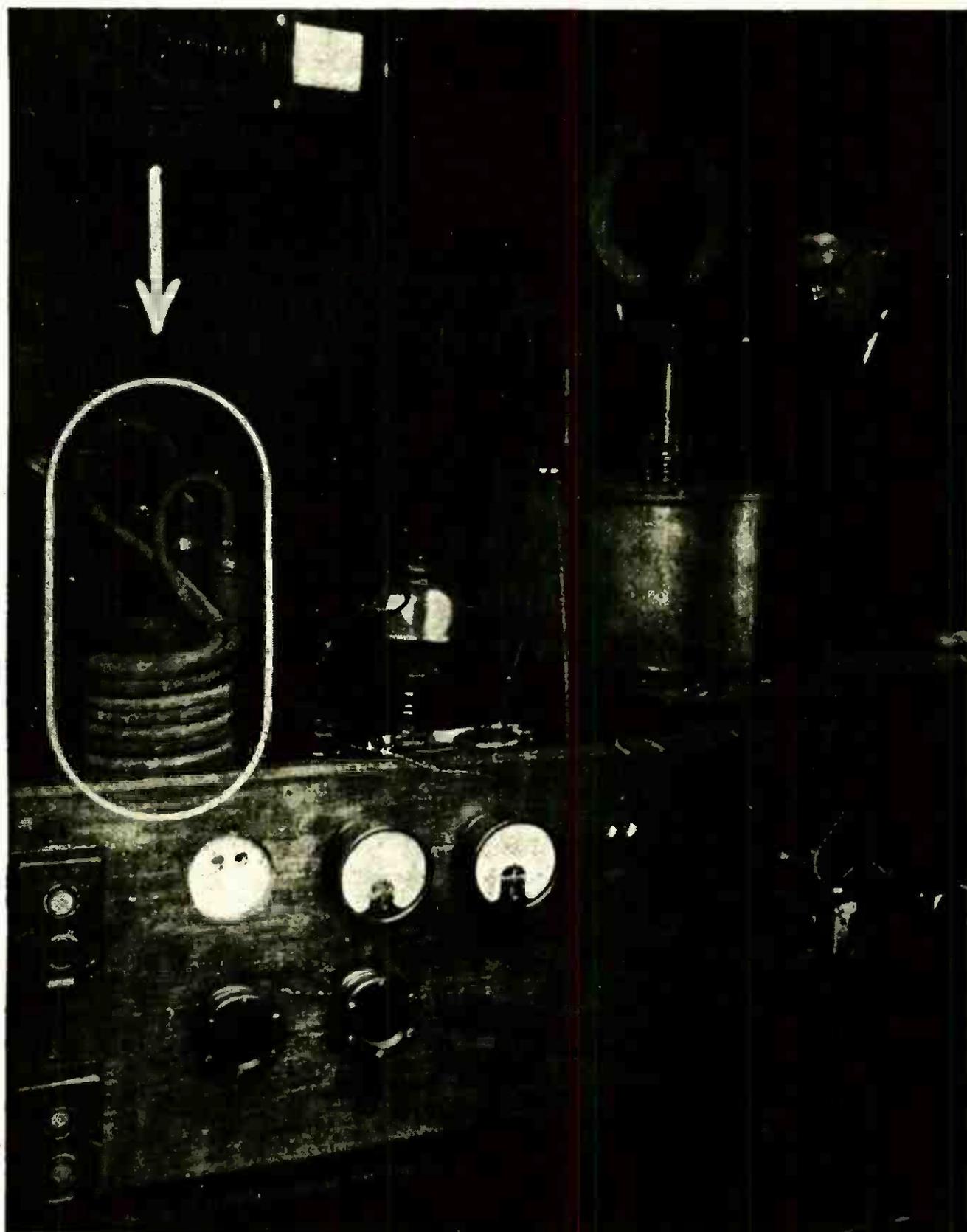
In general, the waves shorter than about 90 meters were stronger in the daytime and weaker at night. Waves longer than 90 meters (up to about 100 meters) showed an exactly reverse effect. They were stronger at night and weaker in the daytime. An intermediate wave, slightly longer than 90 meters, showed about the same strength at all times, though this strength was less than either the daytime maximum of the 80-meter wave or the night-time maximum of the 100-meter one. To take advantage of this curious constancy in the audibility of the wave of intermediate length, the relay wave from Pittsburgh to Hastings has been set at approximately 3,200 kilocycles (94 meters).

To the radio scientist the most interesting feature of these curious results is speculation about what causes them. Mr. Little and Mr. Falknor have no suggestions to offer, nor has the editor of this Department. The variation in transmission of the two waves between night and day must remain, for the present, one of the many mysteries of radio propagation which we know about but do not understand.

The Papa Machine

BEFORE the meeting of the New York Electrical Society on February 28, 1924, Dr. Harvey Fletcher of the Western Electric Company exhibited a remarkable electrical machine. This machine, when adequately coaxed by Dr. Fletcher and his assistant, said "papa" and "mama" quite distinctly.

It consisted of a system of oscillating vacuum tubes that produced the vowel sounds necessary to these two words, together with



Westinghouse

THIS STATION RELAYS RADIO FROM PITTSBURGH TO CALIFORNIA

This shows part of the transmitter used at KFKX, Hastings, Nebraska, to re-transmit the programs received from KDKA at Pittsburgh, Pennsylvania. Both legs of the trip are covered by short waves, in the neighborhood of 100 meters wavelength. Inside the white oval at the left is part of the rubber-tube water-resistance through which the city water supply is connected with the system that cools the plates of the transmitting tubes. The length of this water column prevents any important leakage of current to the ground.

devices for stopping and starting the sound in a fashion competent to produce the consonantal sounds, "p" and "m."

Although this machine was the most spectacular incident in Dr. Fletcher's address, there was apparent, back of this achievement in artificial speech, a vast amount of research and ingenuity that has great permanent interest for the radio engineer. Dr. Fletcher and his associates have been able to analyze the physical nature both of human speech and of human hearing. They have studied, also, the physical nature of noise and they have combined this information, finally, into valuable deductions concerning the transmission of speech and other sounds electrically; both by wire, as in ordinary telephone practice, and by radio.

The outstanding fact about speech is that each vowel sound, like "a" or "ah" or "oo," consists of *two* fundamental frequencies or pitches. By sounding these two frequencies simultaneously Dr. Fletcher made his "papa" and "mama" machine pronounce these vowels with considerable similarity to the human voice. The consonants represent, also, certain pitches or frequencies, as well as the mere starting or stopping of sounds. Dr. Fletcher has constructed a set of electric filters or wave traps adapted to remove or to let through any desired group of frequencies of sound. Using these he demonstrated to the Society which frequencies are responsible for the vowel sounds of speech, and which (in the main) for the sounds of the consonants.

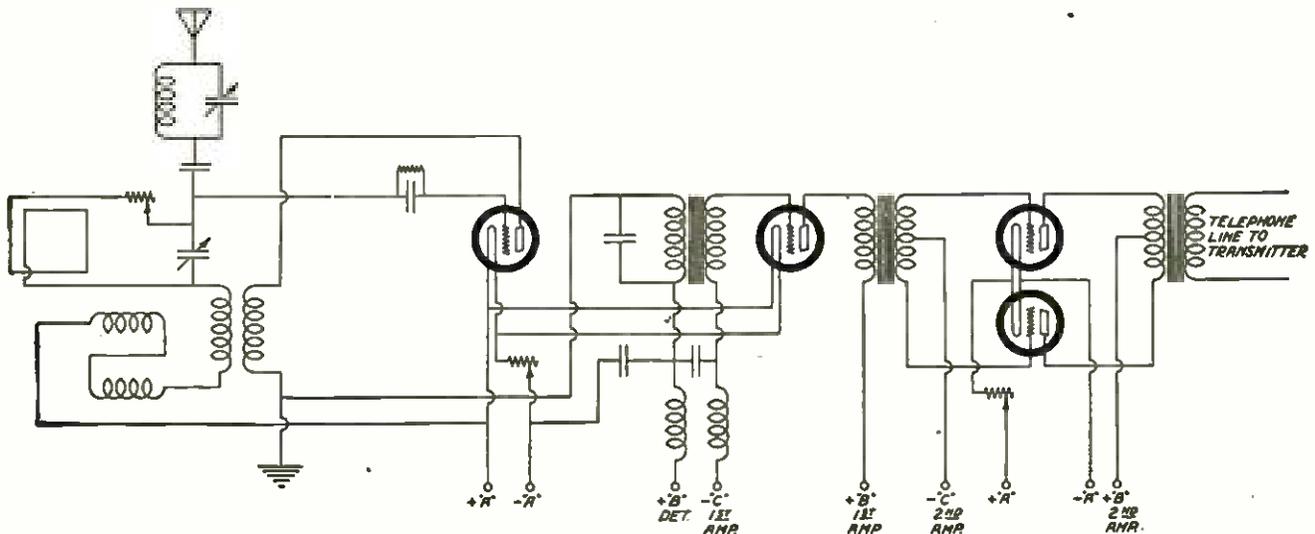
The range of frequencies necessary (or useful) in speech extends from some 30 or 40 vibrations a second up to about 6,000 vibrations a second; as the engineers say, the range is from 30 to 6,000 cycles. This is somewhat shorter than the perceptive range of the human ear, for many people can hear sounds down to 15 or 16 cycles and up to 20,000 cycles or even more. Some of these very deep and very shrill sounds are used in music, but they are not necessary to speech.

Dr. Fletcher's system of filters covers, however, the entire range of audio frequencies. They are divided into ten groups. The lowest-pitch group takes out all frequencies from zero to 125 cycles a second; the next removes the frequencies between 125 and 375 cycles; the third, those between 375 and 500 cycles, and so on. The tenth and last filter takes out all frequencies above 4,000 cycles, which is about the highest note used in ordinary orchestral music.

These filters can be used either separately or together, so that it is possible to remove from spoken sounds, or from music or any other sound, any desired group of frequencies, leaving the other frequencies to be heard alone.

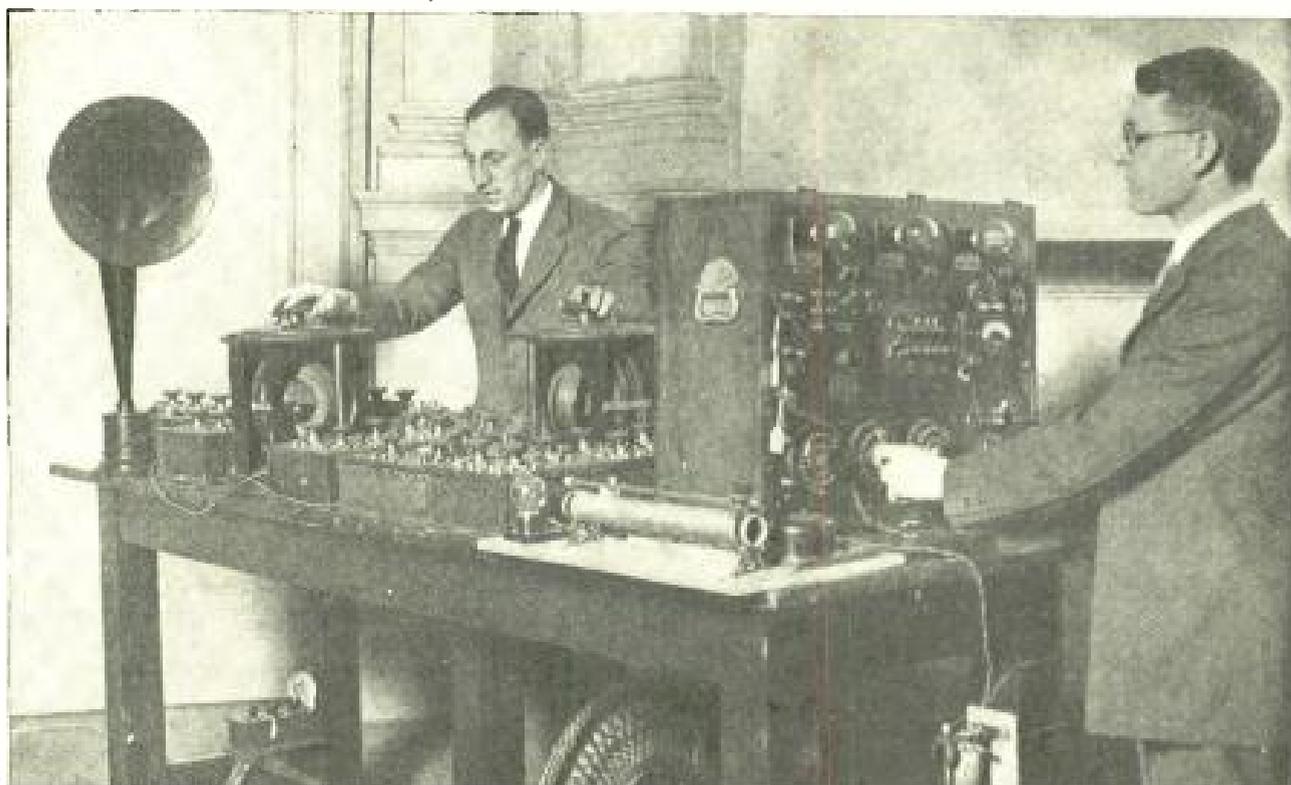
When Dr. Fletcher connected these filters to a microphone circuit over which speech was passing and thence to a loudspeaker so that the audience could hear the result, some remarkable characteristics of speech became evident. For example, the intelligibility of speech is found to depend mainly on the higher frequencies, these being the frequencies that carry the consonants. When Dr. Fletcher adjusted his filters so that all frequencies below 1,500 cycles were filtered out, leaving only those from 1,500 to 6,000 and above, the speech was still quite intelligible, though nasal and unnatural in sound.

But when, on the other hand, the frequencies *below* 1,500 were retained, those above this limit being filtered out, the speech became a mere throaty grumble, possessed, it is true, of considerable volume, but totally unrecognizable as our familiar spoken English. When the one-end filtering was not extended so far, being confined, for example, to the loss of frequencies below 500 cycles or above 3,000 cycles, there was no interference with intelligibility but there was an unnaturalness of tone. The loss of the lower frequencies produced what we commonly call a "nasal" tone. The loss of the higher frequencies made the speech sound thick and hoarse.



RECEIVER HOOK-UP AT THE STATION KFKX

This receiver picks up the 94-meter wave from Pittsburgh. Note the loop that helps to balance out the local interference.



Kadel & Herbert

THIS MACHINE SAYS "PAPA" OR "MAMA"

Using this collection of vacuum tubes, wave filters and other apparatus, familiar to radio, Dr. Harvey Fletcher (at the right) and Dr. John C. Steinberg demonstrated to the New York Electrical Society their ability to produce sounds recognizable as spoken vowels, as well as the two words, "papa" and "mama."

Perhaps the most interesting of all these experiments to the radio fraction of Dr. Fletcher's audience was one in which *both* ends of the frequency series were filtered out, leaving, for example, only the middle range between a frequency of 375 cycles and one of 3,000 cycles. This produced a tone much resembling that of the usual types of loudspeaker used on radio sets. The implication, Dr. Fletcher explained, is exactly what it seems. Most of the loudspeakers now in use do actually filter out these higher and lower frequencies. The problem of producing a better loudspeaker reduces itself, therefore, to perfecting a device that will not filter out these extreme frequencies. Here will lie, we imagine, the greatest importance of Dr. Fletcher's detailed and original studies to the radio art.

An Amateur Radio Detective Tracks Down a Buzz

A RECENT exploit of Mr. Perry O. Briggs, 1BGF, deserves to stand as a model of how the radio amateur can help make his neighborhood a good neighborhood for radio.* It happened in Hartford, Connecticut, where a most annoying buzz showed up suddenly and interfered with reception on the outfits of many local listeners. Mr. Briggs agreed to track down the source of the trouble, loaded his receiver

* "Cornering That Buzzing Interference," by Perry O. Briggs. *QST*, vol. 7, no. 8, pages 34-35 (March, 1924).

and an audibility meter into his automobile and went to work.

His first step was to occupy for brief intervals twenty-five separate receiving locations scattered over the city. At one of these locations the buzz was found to be substantially louder than at any of the others and the search was centered, therefore, in that neighborhood. With the set tuned in and the automobile moving slowly along the streets, Mr. Briggs hunted for the points of loudest buzz.

The troublesome locality was finally located on a short street that had but three street lamps and the interference was placed, with reasonable certainty, as some defect of the circuit lighting these three lamps. The Hartford Electric Light Company, being unable to locate the precise point of trouble, removed the whole wiring of the three lamps. Since then the buzz has been heard no more.

Radio Signalling with Live Frogs

A FRENCH scientist delving into the musty books of the great National Library in Paris, has discovered that an effect which we know now to be radio was discovered and described more than a hundred years ago.* The transmitter was a friction machine producing static

* "A French Pioneer in Radio," by T. Guinchant. *L'Onde Electrique*, vol. 2, pages 634-635 (November, 1923). The passage quoted from Biot is our own translation from a copy of his book in the Wheeler Collection in New York.

sparks; the receiver (or, more precisely, the detector) was a live frog!

The genius who devised these experiments so much earlier than anyone had suspected an origin of radio was Jean Baptiste Biot, a French physicist who was well known to the scientific world in the days just following the adventurous years of the Revolution and of Napoleon. In 1819 he published in Paris his "Treatise on Experimental Physics and Mathematics." Here is how he described his experiments on what we now know to have been radio:

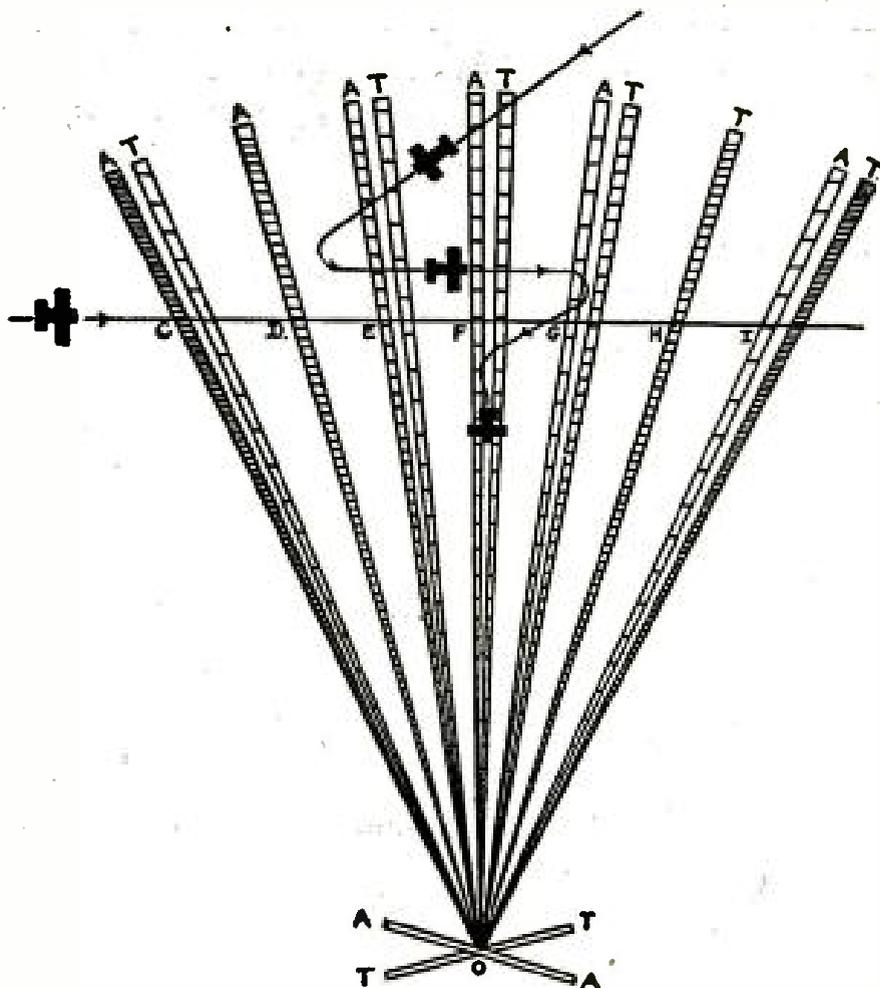
"Suspend a living frog by a silk cord, at some distance from the conductor of an electric machine and attach to one of the legs of the frog a light and flexible metallic chain, the lower end of which makes contact with the ground. Then, whenever you operate the machine, as the electricity develops on it sparks will escape from time to time from the conductor, especially if you present to this conductor a metal rod with a hemispherical end. At each explosion of the spark you will see

the frog jump, even though it is not in communication with the electric circuit."

Biot goes on to say that this experiment can be performed even with a dead frog, provided that it has been properly prepared, and he adds an observation which, in the light of our present knowledge, is especially interesting. "The muscular contractions may be produced," he says, "even at a distance of ten or twelve meters."

There can be no doubt that this ingenious Frenchman, working with sparks and frogs long before anything was known of the nature of electricity, to say nothing of electric waves, really had his hand upon the phenomenon of energy transfer by electromagnetic waves—a phenomenon that it took science over seventy years to rediscover.

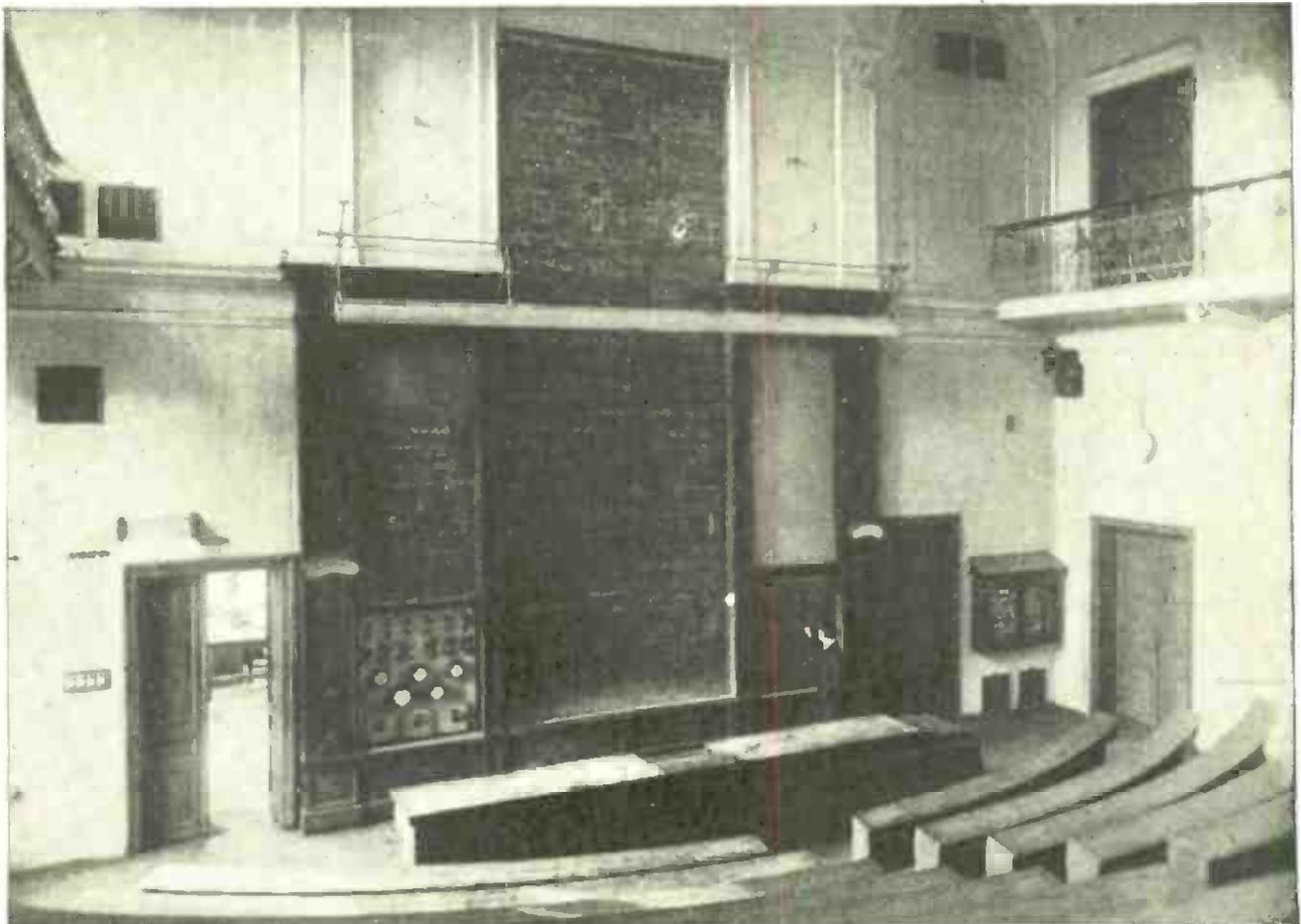
It is of interest, also, that the "frog detector" can still be employed with radio waves. A modern French scientist has been able, says Biot's recent rediscoverer, to detect the time signals from the Eiffel Tower, using a frog in much the same way that Biot employed.



Reprinted from Scientific Paper No. 480 of the U. S. Bureau of Standards

HOW AN AIRPLANE IS GUIDED BY THE NEW RADIO SIGNAL SYSTEM

The radio signals are sent out from the two coils shown at the bottom of the diagram, as described on the following page. So long as the airplane flies along the line marked F, the two letter-signals are heard with the same intensity. To the right or left of this line, one letter or the other is stronger.



Armstrong Perry

A REAL "RADIO LECTURE ROOM"

In this recitation hall of the Electrotechnical Institute in Vienna, Austria, all kinds of electric current are supplied at the desk, the blackboard is operated automatically and there is a special screen of ground glass for use with the oscillograph.

A New Radio Pathfinder for Airplanes

By means of a new invention, developed at the United States Bureau of Standards, it is now possible for an airplane to fly from one flying field to another one, or to fly, for that matter, along any determined air lane, and never deviate in the least from the direct line of flight. This can be done even in the thickest fog or if the pilot is blind. It is done by a new sound signal that comes to the pilot over the radio.*

At the flying field or other station toward which the airplane is flying there are two vertical coil antennas, their planes being placed at an angle of 135 degrees to one another. The transmitting set is connected alternately first to one coil, then to the other. One coil sends out the code signal for the letter A, the other coil sends out the letter T. All this can be attended to automatically, the change from one coil to the other being made, also automatically, every second.

Like all loop antennas these coils have di-

rectional properties, the signals which they send out being stronger in the plane of the coil than in any other direction. And therefore, since two coils are used in this case, there is a certain direction with reference to the positions of the coils in which direction the relative signal strength of the two letters, A and T, is the same. In any other direction one of the letters will seem to the aviator louder than the other one.

Suppose it is desired to guide an airplane between New York and Philadelphia: The coils are erected at Philadelphia and their position is adjusted so that the line of equal signal strength of the two letters points directly toward New York. Then let the aviator in New York take off and head, as he believes, toward Philadelphia. So long as he really does head toward Philadelphia, so long, that is, as his machine is close to the straight line between the two cities, he will hear the A's and T's in his headphones with exactly the same strength. But suppose he accidentally deviates from this straight line? Then he will hear one of the letters louder than the other. All he has to do is to keep his plane in that position where the two letters sound alike and he will arrive, without further attention on his part, at the station from which the signals are being sent out.

* "A Directive Type of Radio Beacon and Its Application to Navigation," by F. H. Engel and F. W. Dunmore. *Scientific Papers of the Bureau of Standards*, number 480 (being vol. 19, pages 281-295), January 5, 1924.



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.

Practical Hints on the Care of Radio Panels

A NEAT looking panel is an important factor in a radio installation. A set may approach perfection electrically yet give a poor impression because of a greasy or spotted panel. How to keep your panels clean is told by this reader from Oregon:

Radio panels can be divided into two classes, those with a polished surface, such as are generally used in receiving equipment, and those with a dull finish, such as slate, composition, fibre, or any of the resinous materials; sometimes rubber or similar products.

The type with polished surfaces quickly become marked, particularly in receiving sets, where the operator's fingers often come into contact with the panel when tuning. Such a panel should be rubbed over with a soft cloth occasionally to remove any spots that may appear on its surface. Even with this care, however, one finds that all of the dirt or grease that may accumulate cannot be entirely removed; the most effective method of cleaning then is to rub down the panel with a rag saturated in alcohol, finishing off with a soft, dry cloth.

If the panel is not unduly exposed to dust and dirt the cloth used for frequent cleaning may be used with a few drops of raw oil. This brings out a brilliant lustre on the polished surface without injuring the panel in any way.

The type of panel that has a dull or mat finish, does not show the dirt so easily as the type with a polished surface. Many amateurs and fans who construct their own apparatus prefer this type of finish. An occasional rub-down with an oily rag, using raw oil in small amounts, keeps the dull finished panels looking neat.

Slate panels, generally used on shipboard for switchboards, charging panels or starting de-

vices are best cleaned with an ammonia solution. These panels should be gone over whenever the bright work on them is polished, as some metal polish is frequently left on the slate, turning that particular spot lighter than the rest and detracting considerably from the generally good appearance of the panel.

A few pointers on the working of panels in the construction of radio sets may be of help to those who experience difficulty in making these up:

A center punch should be used for laying out all holes. A spring prick-punch is preferable for this.

In drilling holes, begin to drill from the front side, clamping the panel to a board or to a bench to avoid chipping. Use sharp metal twist drills.

To countersink a hole, use a reamer or a larger size of drill.

In polishing a panel for the first time use steel wool or sandpaper and raw linseed oil for surfacing. Follow this with a thorough rubbing down with pumice and oil, and then finish off with a few drops of oil and a clean, soft cloth.

—THERON W. BEAN

Stations You May Hear from Canada and Cuba

SUPPLEMENTING the list of American broadcasters in the January issue of POPULAR RADIO, and the list of European stations in the December, 1923, issue, here is a complete list of the stations now on the air with broadcast programs in Canada and Cuba:

CANADIAN STATIONS

Call Letters	Location of Station	Wave-length (meters)	Freq. (kilo cycles)
CFAC	Calgary, Alberta.....	430	698
CFCF	Toronto, Ont.....	400	750
CFCF	Montreal, P. Q.....	440	682
CFCH	Iroquois Falls.....	400	750

Call Letters	Location of Station	Wave length (meters)	Freq. (kilo-cycles)	Call Letters	Location of Station	Wave-length (meters)	Freq. (kilo-cycles)
CFCJ	Quebec, P. Q.	410	732	PWX	Havana	400	750
CFCK	Edmonton, Alta.	410	732	2AB	Havana	240	1,250
CFCL	Victoria, B. C.	400	750	2BY	Havana	260	1,154
CFCN	Calgary, Alberta	440	682	2CX	Havana	320	938
CFCO	Bellevue, P. Q.	450	667	2DW	Havana	300	1,000
CFCQ	Vancouver	450	667	2EV	Havana	220	1,364
CFCR	Sudbury	410	732	2HC	Havana	275	1,091
CFCW	London, Ont.	420	714	2HS	Havana	180	1,667
CFDC	Nanaimo, B. C.	430	698	2JQ	Havana	150	2,000
CFOC	Saskatoon, Sask.	400	750	2KD	Havana	350	854
CFRC	Kingston, Ont.	450	667	2KP	Havana	200	1,500
CFUC	Montreal	400	750	2LC	Havana	250	1,200
CHAC	Halifax, N. S.	400	750	2MG	Havana	280	1,071
CHBC	Calgary	410	732	2MN	Havana	270	1,111
CHCD	Quebec	410	732	2OK	Havana	360	833
CHCE	Victoria	400	750	2OL	Havana	290	1,034
CHCL	Vancouver	440	682	2TW	Havana	230	1,304
CHYC	Montreal	410	732	2WW	Havana	210	1,428
CJCA	Edmonton, Alberta	450	667	5EV	Colon	360	833
CJGC	London, Ont.	430	698	6AZ	Cienfuegos	200	1,500
CJGD	Toronto	410	732	6BY	Cienfuegos	300	1,000
CJCE	Vancouver	420	714	6CX	Cienfuegos	170	1,765
CJCI	St. John, New Brunswick	400	750	6DW	Cienfuegos	225	1,333
CJCN	Toronto	410	732	6EV	Caibarien	225	1,333
CJCX	Olds, Alta.	400	750	6KJ	Tuinucu	275	1,091
CJSC	Toronto	430	698	6KW	Tuinucu	340	882
CKAC	Montreal	430	698	8AZ	Santiago	240	1,250
CKCD	Vancouver	410	732	8BY	Santiago	250	1,200
CKCE	Toronto	450	667	8DW	Santiago	275	1,091
CKCK	Regina, Sask.	420	714	8EV	Santiago	180	1,667
CKOC	Hamilton, Ont.	410	732	8FU	Santiago	225	1,333
CKY	Winnipeg	450	667				

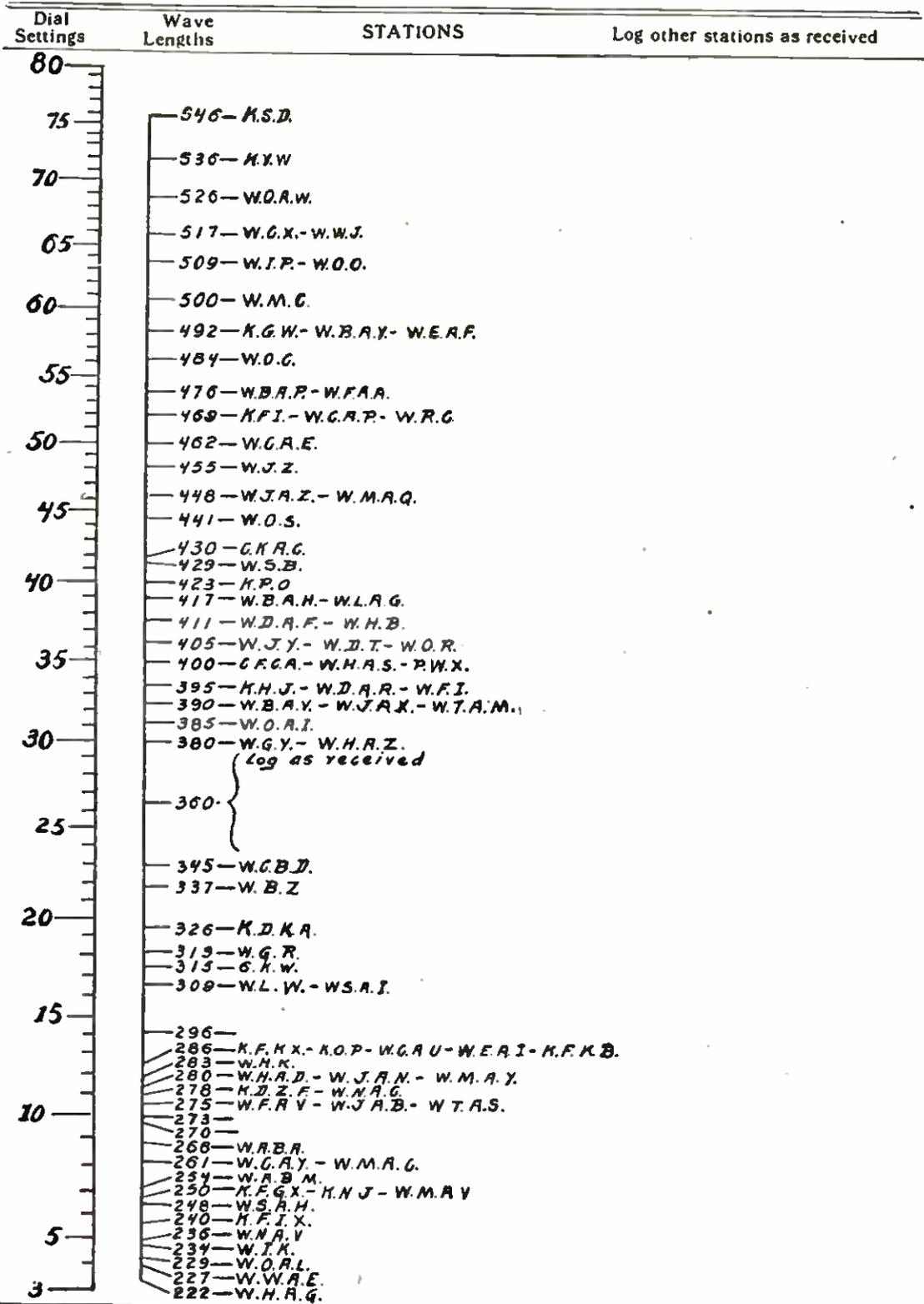


Wide World

RECORDING RADIO PROGRAMS ON A WAX CYLINDER

Here is the new "radio telephone" that registers automatically all the incoming entertainment that the radio receiver is tuned in upon; the cylinder records may be preserved and the programs repeated upon the talking machine. This novel device is the product of a German inventor.

A Straight Line Chart for Tuning a FOUR-CIRCUIT COCKADAY RECEIVER

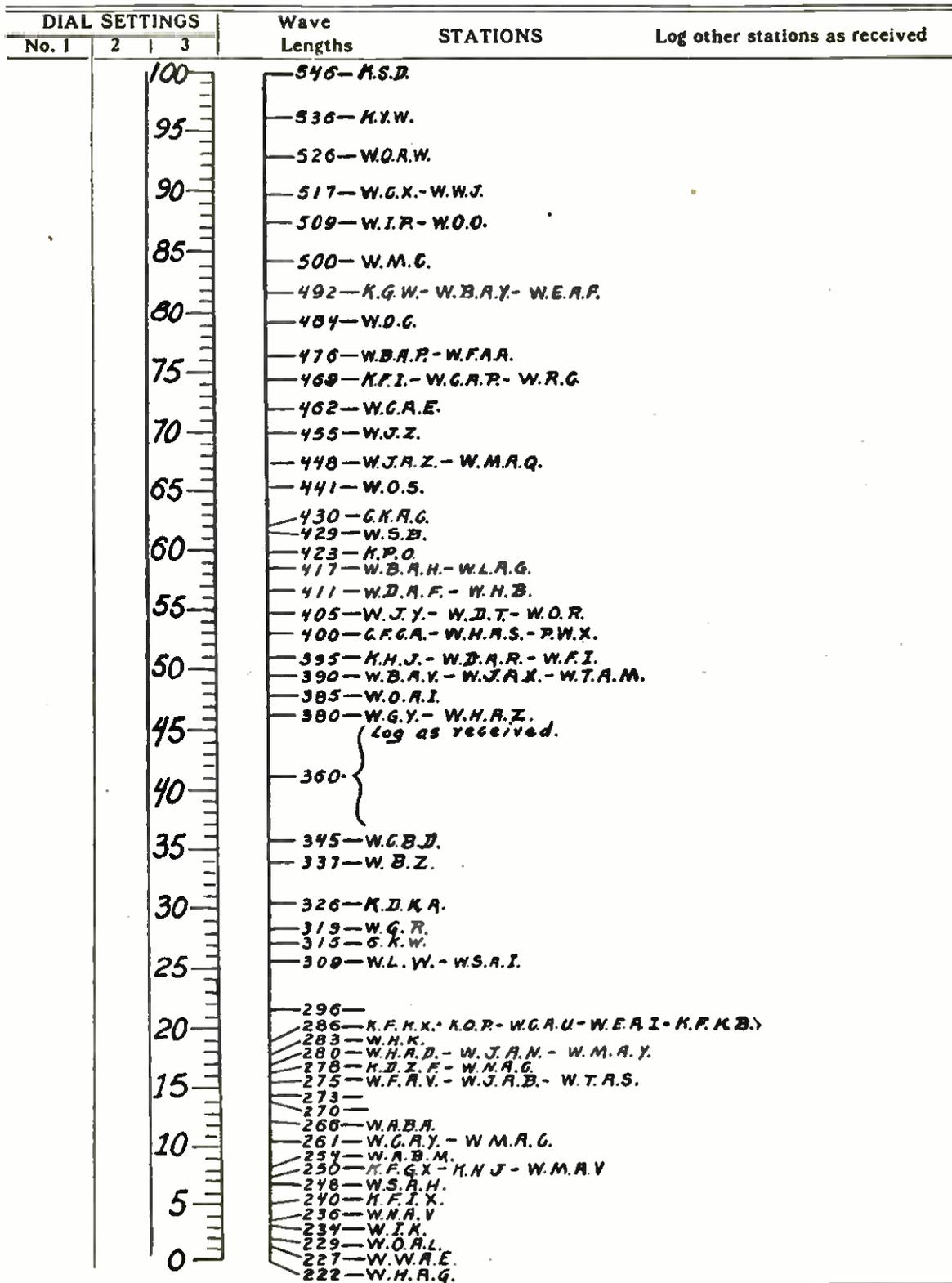


Copyright, 1924, by L. L. Dodds

CHARTS THAT HELP YOU TO TUNE IN

The charts on these two facing pages were designed to suit theoretical, ideal construction conditions of each particular circuit; as actual conditions vary from the ideal in individual receiving sets, the wavelength and dial-setting scales have been separated by a blank column, which provides ample space to connect the wavelength of any station tuned in, with the dial setting at which the signals come in loudest and clearest; for example, if you tune in W.G.Y. with your dials set at 33, you should connect 33 on the left-hand scale with 380 on the right-hand scale, by a straight line.

A Straight Line Chart for Tuning a NEUTRODYNE BROADCAST RECEIVER



Copyright, 1924, by L. L. Dodds

HOW TO USE THIS CHART

After tuning in a station sharp and clear, enter the No. 1 and 2 dial settings; then draw a straight line from the dial setting to station's wavelength. This list includes all wavelengths for stations of 200 watts and over and call letters of all stations of 500 watts and over—excepting those on 360 meters, which are omitted on account of the large number, and a few of which may be heard in any particular district.

The calibration of the dial scale is graduated by a special mathematical process evolved by Mr. L. L. Dodds, of Cleveland, O.

Better Results with Less Power

AMERICAN amateurs are today communicating with English amateurs with one thousandth of the power used with indifferent results twenty years ago, states J. T. H. Dempster, an engineer. To be specific:

Back in 1904, a few years after Marconi startled the scientific world with his experiment that promised to revolutionize long distance communication, the General Electric Company engineers were actively interested in the new art and they, like others, tried for a long time to offset the shortcomings of receiving apparatus by boosting the power at the transmitting end. Dr. R. A. Fessenden, formerly a professor at the University of Pittsburgh, was engaged to install transmitting and receiving equipment, with the expectation that this method of communication would replace the telephone and telegraph lines.

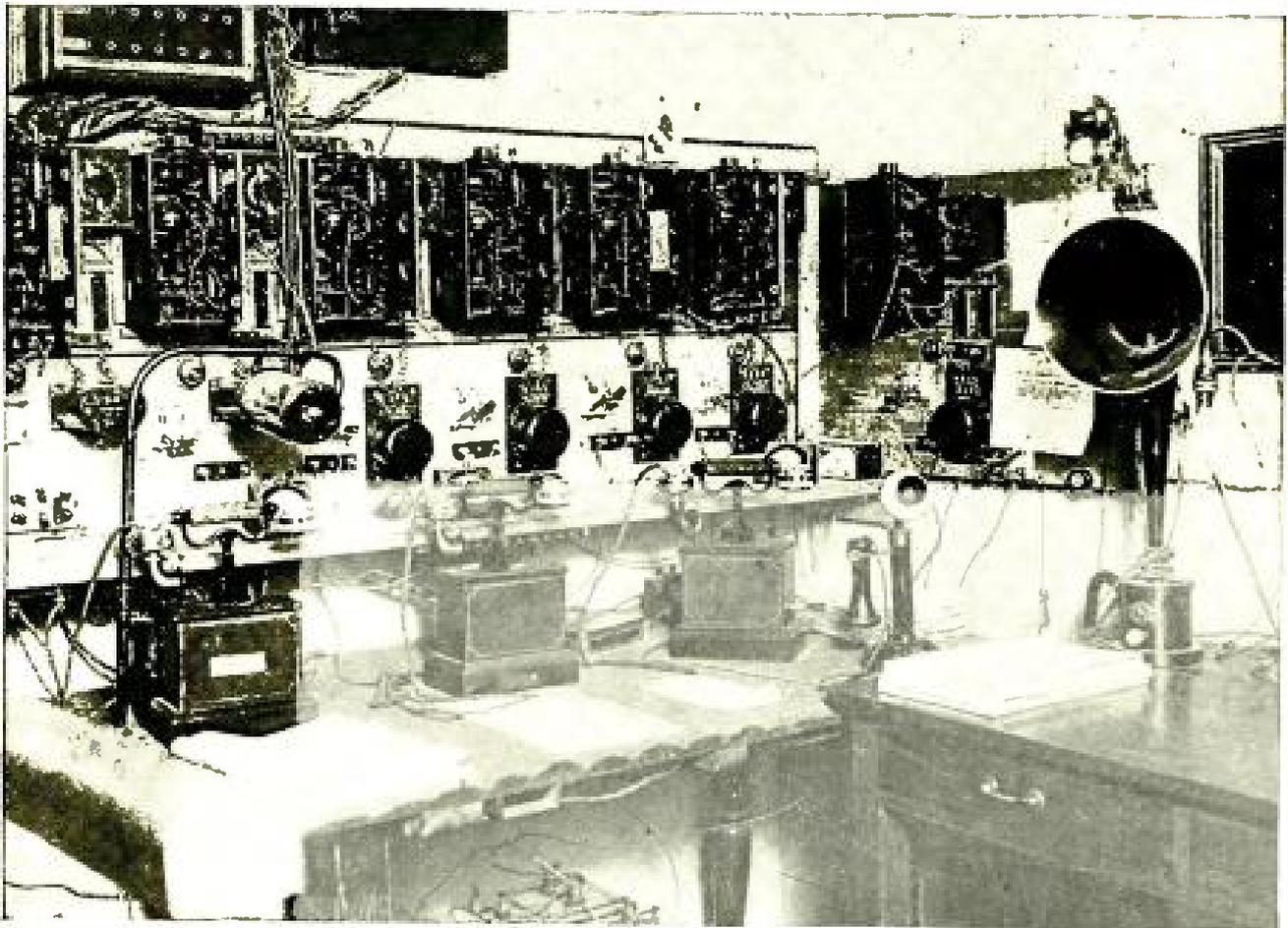
The receiving apparatus consisted of the famous Fessenden liquid barretter or, in better known terms, the electrolytic detector,

which was used in connection with the Fessenden interference-preventer circuit. The electrolytic detector consisted of a platinum wire coated with silver. This was known as "Wollaston wire." The silver coating gave mechanical strength to the wire which was less than ten thousands of an inch in diameter. The nitric acid in a platinum cup into which the wire dipped formed the electrolyte. The platinum cup was the other pole of the electrolytic cell.

The electrolytic detector was a marked advance over the Marconi coherer but it was still much less sensitive than the crystal detectors now in use. Static frequently burned the point from the platinum wire temporarily destroying the use of the detector.

The headphones adopted were especially made according to the navy standard and they were wound for the first time with enameled wire. These phones were about one twenty-fifth as sensitive as the cheapest headphones on the market today.

Today, an operator in Lynn with a three-bulb receiving set can get Schenectady signals 1,000 times stronger than was possible in 1903 and that from a transmitter using but five watts and a mast fifty feet high.



Kadel & Herbert

HAVE YOU HEARD THIS ENGLISH STATION?

Here is shown some of the line equipment that is used for picking up programs from points outside the studio in the London broadcasting station, 2LO. This equipment includes vacuum-tube amplifiers (which are shown mounted on the wall in boxes), and also the regular telephone apparatus for listening in and testing out the lines in use.

"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.**

REINARTZ HAS ANOTHER ADMIRER

THE Reinartz hook-up is praised by J. Sulouff of Altoona, Pa., who submits the following list of stations logged in four evenings: WEAJ, New York City; WIP, WDAR, WFI, WOO, Philadelphia, Pa.; WGR, Buffalo, N. Y.; WGY, Schenectady, N. Y.; KDKA, Pittsburgh, Pa.; WGAJ, Altoona, Pa.; WCR, Washington, D. C.; WSB, Atlanta, Ga.; WHAS, Louisville, Ky.; WOR, Newark, N. J.; WCAE, Pittsburgh, Pa.; WMC, Memphis, Tenn.; WOC, Davenport, Ia.; WGI, Medford Hillside, Mass.; WWJ, Detroit, Mich.; and WDAP, Chicago, Ill.

A CRYSTAL RECORD

NICK MANFREDI of 30 Van Houten Street, Paterson, N. J., makes bold enough to say that he receives PWX of Havana, Cuba, on his crystal set.

Others on his list are KDKA, Pittsburgh, Pa.; WGI, Medford Hillside, Mass.; WGY, Schenectady, N. Y.; WOC, Davenport, O., and PWY of Havana, Cuba.

HOW IT SOUNDS IN ENGLAND

STATIONS WGY and WJZ can be heard in England on three tubes, one radio-frequency, one detector and one audio-frequency, according to Bernard Caldwell of station 5VK in Warrington, Lancashire. That is to say in American terminology, he hears these two New York stations in the early morning with one stage of radio and one stage of audio-frequency amplification. He uses a single-wire antenna 35 feet high and 90 feet long.

"I sometimes receive complete programs, without any sign of fading, between the hours of two and five in the morning," he explains, "and I have letters from the General Electric Company and from the Westinghouse Electric Company in confirmation."

COCKADAY SET SPANS ATLANTIC

USING only one tube, three stations in the British Isles were heard on the Cockaday four-circuit tuner by Edward W. Kent, whose address is Box 263, North Sydney, Nova Scotia, Canada, "1,000 miles from anywhere and 3,500 miles from KFI," Los Angeles, Calif., which he also heard.

His only variation from the plans described in **POPULAR RADIO** was to use an English Mullard tube. His antenna, as suggested, was made longer than usual, about 195 feet from the set to the end, and about 40 feet high, with a counterpoise of 175 feet of bare copper wire, number 6, buried one foot deep directly under the antenna.

He says he has heard amateurs in every district in the United States, three in Canada and one in England.

Some of his record broadcasters are KHJ, Los Angeles, Calif.; WOAW, Omaha, Nebr.; WSB, Atlanta, Ga.; WFAA, Dallas, Tex.; WKAQ, San Juan, Porto Rico; PWX, Havana, Cuba, and WOC, Davenport, Ia. There are 120 others.

"WGY comes in so strong, a thousand miles away, that the phones rattle," he states. "On particularly good nights I can hear it fifteen feet from the phones."

DISTANCE IS A REGULAR THING

"I HAVE been receiving from KHJ, Los Angeles, every night since October 13, using your four-circuit tuner," is the news from Wilmerding, Pa., where S. K. Yundt, Jr., is trying a few tricks of his own.

"Use WD-11 tubes throughout and Cardwell condensers, with a 250-foot antenna about 50 feet high," is Yundt's prescription for success. Add to this a condenser of .00015 mfd. capacity, a rather critical thing, across the phones and make your coils without fluid covering of any kind.

WHAT THE REINARTZ CIRCUIT CAN DO

A RECORD of hearing thirty-eight stations more than 1,000 miles away is submitted by Carl H. Pastje of Denison, Ia. He does it with a Reinartz coil and two stages of audio-frequency amplification. By using a UV-200 detector tube and UV-201A amplifier tubes, he brings in most of the stations on a loudspeaker.

On the coil he is using, there are only 14 taps. His condensers are 23-plate and 43-plate vernier type, and his transformers are RCA 9 to 1 in the first stage and Thordarson 3½ to 1 in the second stage. The antenna consists of one strand of number 12 copper wire supported between two wooden masts at an average height of 45 feet, with two insulators at each end. Ground connection is made to a telephone ground rod 7 feet long and 5/8 of an inch in diameter, driven into moist earth.

The list includes WKAQ, San Juan, Porto Rico, 2,450 miles away; KPO, San Francisco, Calif., 1,525; PWX, Havana, Cuba, 1,575; KDZE, Seattle, Wash., 1,435; KGG, Portland, Ore., 1,465; WEA, New York City, 1,150; KFAN, Moscow, Idaho, 1,180; KFCB, Phoenix, Ariz., 1,125; WJAR, Providence, R. I., 1,265; WHAO, Savannah, Ga., 1,065; WHAV, Wilmington, Del., 1,080 and, WDAL, Jacksonville, Fla., 1,150.

HE PULLS IN 67 SPEAKER STATIONS

H. E. MUELLER of Pilot Grove, Mo., hears 67 stations on his loudspeaker "with enough volume to fill a good-sized room." He uses the Cockaday four-circuit tuner. His record speaker station is CYB of Mexico City, Mex. Others are WSY, Birmingham, Ala.; CFCN, Calgary, Can.; KLZ, Denver, Colo.; WBAP, Ft. Worth, Tex.; WHAB, Galveston, Tex.; KFKA, Greeley, Colo.; PWX, Havana, Cuba; KHJ, Los Angeles, Calif.; WMC, Memphis, Tenn.; WEA, New York City; WAAC, New Orleans, La.; WHAM, Rochester, N. Y.; WOAI, San Antonio, Tex.; WLAL, Tulsa, Okla., and WJAD, Waco, Tex.

SET REACHES TWELVE STATES IN FOUR HOURS

IN one evening in Chicago, Wm. B. Metcalf, Jr., heard seventeen stations in twelve different States with his Cockaday four-circuit tuner. He writes that most of them were heard on a loudspeaker.

The stations he heard are KDKA, Pittsburgh, Pa.; WWJ, Detroit, Mich.; WOC, Davenport, Ia.; WGY, Schenectady, N. Y.; WLW, Cincinnati, O.; WGR, Buffalo, N. Y.; WTAS, Elgin, Ill.; WCB, Zion, Ill.; WOS, Jefferson City, Ia.; WMC, Memphis, Tenn.; WHAZ, Troy, N. Y.; WOAW, Omaha, Nebr.; WFAA, Dallas, Tex.; WBAP, Ft. Worth, Tex.; WLAG, Minneapolis, Minn.; WSB, Atlanta, Ga.; WDAF, Kansas City, Mo.

Through the local stations he heard KDKA, Pittsburgh, Pa.; KSD, St. Louis, Mo.; WBAP, Ft. Worth, Tex.; WFAA, Dallas, Tex.; WSAI, Cincinnati, O.; WOC, Davenport, Ia., and WOAW, Omaha, Nebr.

HE DOES THIS IN DAYLIGHT

ANOTHER mystery similar to that of the "fading" of WGY, Schenectady, and the "dead spots" of WEA, New York, and similar freaks of other stations, is reported by F. P. Morrow, of Arnaudville, La. Some near-by stations he cannot hear at all, while he receives unusually well from other stations during the day.

"I am in a very small town," he writes, "away from any large city, and there are no powerful broadcasting stations near me, except one 100-watt station in Baton Rouge, 60 miles away, and stations of similar power in New Orleans. For some queer reason I am unable to hear these stations at any time, on my four-tube set.

"I get the weather report every morning from WHAB, a 200-watt station at Galveston, Tex., and from WCAK at Houston, Tex., a 10-watt station 215 miles away."

"I listen in on the Normal Teachers' School at Cape Girardeau, Mo., at three o'clock in the afternoon. Last Sunday afternoon at 3:30, I heard WTAS, Elgin, Ill., and now, at 4:00, I get WHAS at Louisville, Ky., and KDKA at Pittsburgh, Pa. Most other powerful stations in the southern part of the country come in well at night."

* * *

ONE EVENING'S TRAVEL

SIXTEEN stations in one evening, using a dry-cell tube, is the record of Franklin Wernli of Minneapolis, Minn. He uses only a variocoupler and a 23-plate variable condenser for tuning. For DX hunting, his single-circuit hook-up is one of the simplest, but for sharp tuning and clear reception without interference, the double circuit is always better.

On the night of September 21, he heard WCAE, Pittsburgh; WWJ and WCX, Detroit, Mich.; WOAW, Omaha, Nebr.; WJAZ, Chicago; KSD, St. Louis, Mo.; WSAI, Cincinnati, O.; KYW, Chicago; WSB, Atlanta, Ga.; KFI, Los Angeles, Calif.; WMC, Memphis, Tenn.; WMAK, Lockport, N. Y.; WDAF, Kansas City, Mo.; WHN, New York City; WFAG, Syracuse, N. Y.; KGW, Portland, Ore.

* * *

HE IMPROVES HIS COCKADAY SET

THE wrong coil was all that was keeping his Cockaday four-circuit tuner from spanning the continent, according to Joseph Waring of 441 East 164th Street, New York. When he replaced his first coil with one which is specified for the circuit, he picked up Los Angeles, Calif.

"At twelve-fifteen I tuned in Station KHJ of Los Angeles," he writes, "and held it continually until one-thirty A. M., and am delighted to say that I experienced no fading or interference. I consider this good, because I was using only one WD11 tube.

Others which he heard with his little dry cell are WJAZ of Chicago, Ill.; WOC, Davenport, Ia.; WCX, Detroit, Mich.; WSB, Atlanta, Ga.; WRK, Hamilton, O., and WCAP, Washington, D. C. This is a partial list for his first evening with the new coil.



WITH THE INVENTORS

CONDUCTED BY THOMAS ELWAY

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

Static Eliminator

No. 1,468,049. Invented by A. H. Taylor of Grand Forks, North Dakota, and assigned to the Radio Corporation of America.

This is a method of making a partial separation between signal impulses and static or other strays by using two or more antennas, one of which is more receptive to the signals while the others are more receptive to strays. The antennas are then opposed electrically so that the effect of the strays in the signal-receiving antenna is more or less neutralized. Detailed arrangements of circuits and antennas for this purpose are described and covered by the patent.

Removing Vertical Strays

Nos. 1,468,059 AND 1,468,061. Invented by R. A. Weagant of Douglas Manor, New York, and assigned to the Radio Corporation of America.

These patents are applications of a theory formulated by the patentee to the effect that the impulses of static are mainly vertical, while the signal impulses that one wishes to receive are mainly propagated horizontally. Circuits are arranged to receive selectively the up-and-

down waves of static and to oppose these to the impulses in ordinary antennas, thus balancing out the effects of static in the latter.

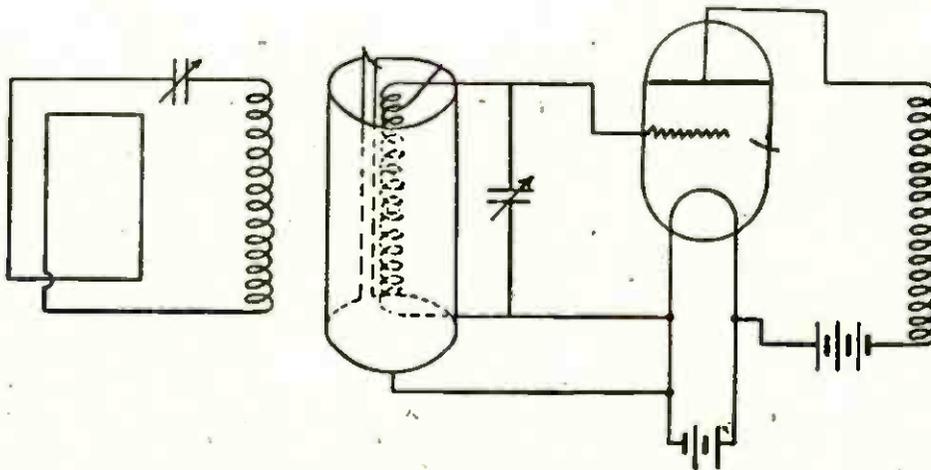
Shielded Transformer Winding Decreases Interference

No. 1,474,382, FIGURE 1. Invented by H. J. Round of London, England, and assigned to the Radio Corporation of America.

A metal sheet is bent into cylindrical form, but so that its edges do not quite touch, as is shown in the illustration. This partial shield is then placed around the secondary of the coupling transformer, which secondary is so wound that its self-capacity is a minimum. This arrangement is said to greatly decrease interference from short waves, as for example, interference from the engine ignition in airplane radio.

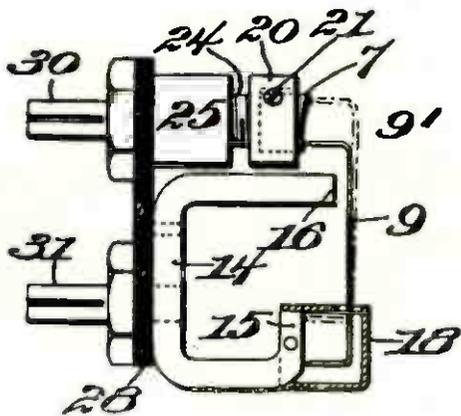
Magnetic Mounting for Catwhisker

No. 1,475,027, FIGURE 2. Invented by E. F. Randall of Medford, Massachusetts, and as-



A SHIELD FOR SHORT WAVES

FIGURE 1: The metal shield around the secondary of the transformer cuts out much of the interference from the ignition systems of gasoline engines.



MAGNETIC CATWHISKER

FIGURE 2: The magnet, 14, holds the catwhisker, 9, against the surface of the crystal, 7. The catwhisker is loose and may be moved up and down to get adjustment, being held in place thereafter by the magnet.

signed to the American Radio and Research Corporation.

The nature of this device will be apparent from the figure. The catwhisker is made of magnetic material and its point is held firmly against the crystal by the pull of the permanent magnet mounted just beneath it. The detector is said to be less sensitive to jar than are ordinary crystal detectors. The patentee believes, also, that the magnetic field of the magnet assists detection in some more direct fashion; which, if true, is a new effect hitherto unknown.

A Commutator for Antenna Circuits

No. 1,475,297. Invented by Robert B. Goldschmidt of Paris, France.

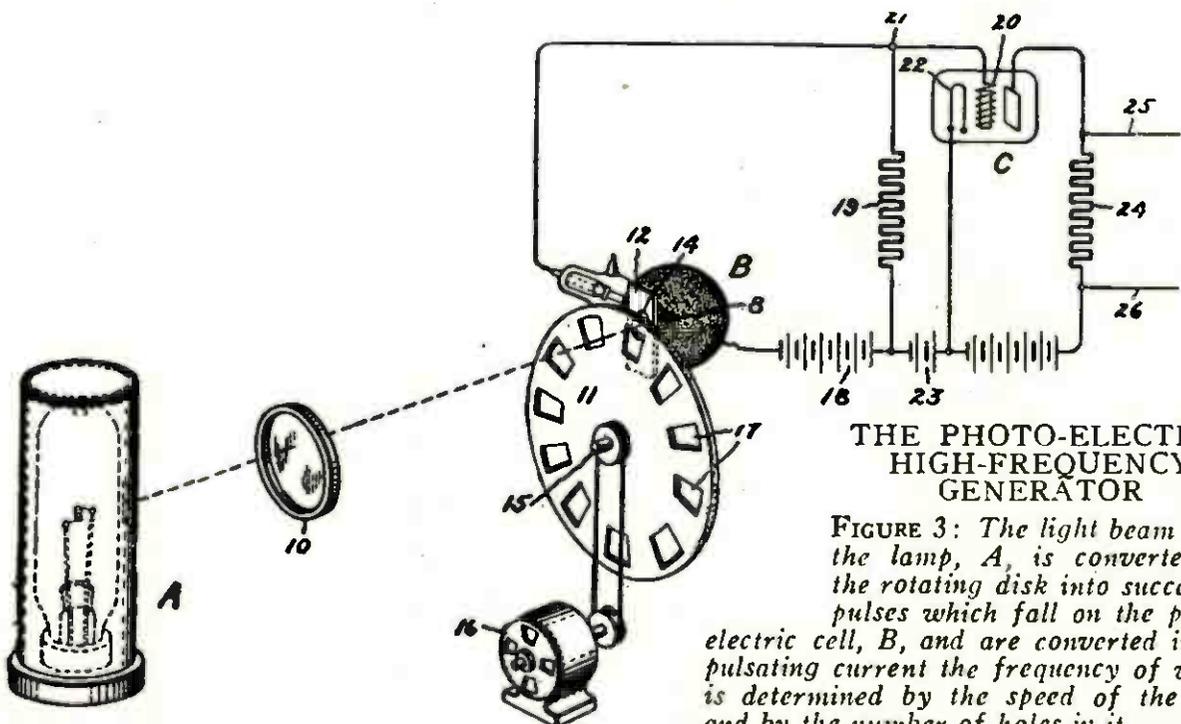
The patentee suggests that unwanted signals

can be blocked out of a receiving circuit by inserting between the antenna and the receiver a rotating contact wheel analogous to the commutator of a dynamo. Suppose, for example, that the signal consists of a wave train interrupted to give a frequency of 500 cycles. The wheel is then adjusted to connect and disconnect the antenna at this same frequency. It is necessary, obviously, that the synchronism of the sending and receiving stations be perfect and the device is apparently limited to telegraphy and to the transmission of radio-control signals, being without obvious application to radio telephony.

Light Beam Produces Audio-frequency Oscillations

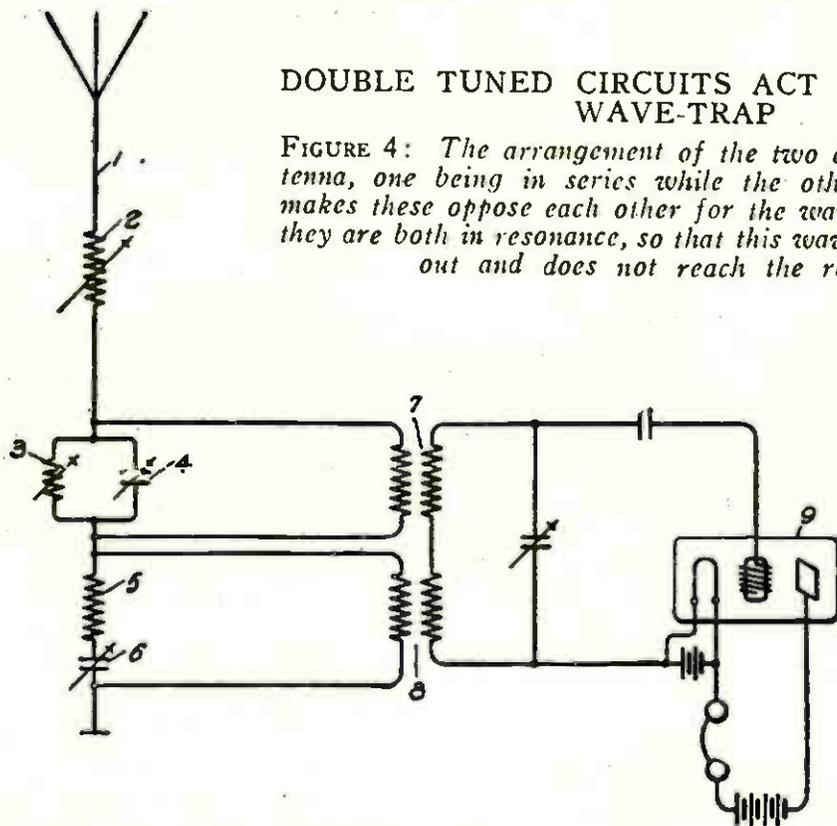
No. 1,475,583. FIGURE 3. Invented by Charles A. Hoxie of Schenectady, New York, and assigned to the General Electric Company.

This apparatus generates a pulsating or alternating electric current of any predetermined frequency by means of a beam of light, a perforated disk that rotates across this beam, and a photo-electric cell. Each pulse of light through a hole of the disk causes a pulse of electricity in the cell, which pulse may be amplified by a vacuum tube, as shown in the diagram. The photo-electric cell used consists of a coating of metallic potassium inside a vacuum bulb containing a little argon gas. Light falling on the potassium sets free some electrons from it and these electrons produce the pulse of current. When no light falls on the potassium in the cell, that is when the dark part of the disk is in front of it, no electrons are set free and no current passes. A somewhat similar arrangement used by General Ferrié to measure the intensity of starlight was described in POPULAR RADIO for April, 1924, page 408.



THE PHOTO-ELECTRIC HIGH-FREQUENCY GENERATOR

FIGURE 3: The light beam from the lamp, A, is converted by the rotating disk into successive pulses which fall on the photo-electric cell, B, and are converted into a pulsating current the frequency of which is determined by the speed of the disk and by the number of holes in it.



DOUBLE TUNED CIRCUITS ACT AS ANTENNA WAVE-TRAP

FIGURE 4: The arrangement of the two circuits in the antenna, one being in series while the other is in parallel, makes these oppose each other for the wavelength to which they are both in resonance, so that this wavelength is filtered out and does not reach the receiver.

Circuit Breaker for Overloaded Antennas

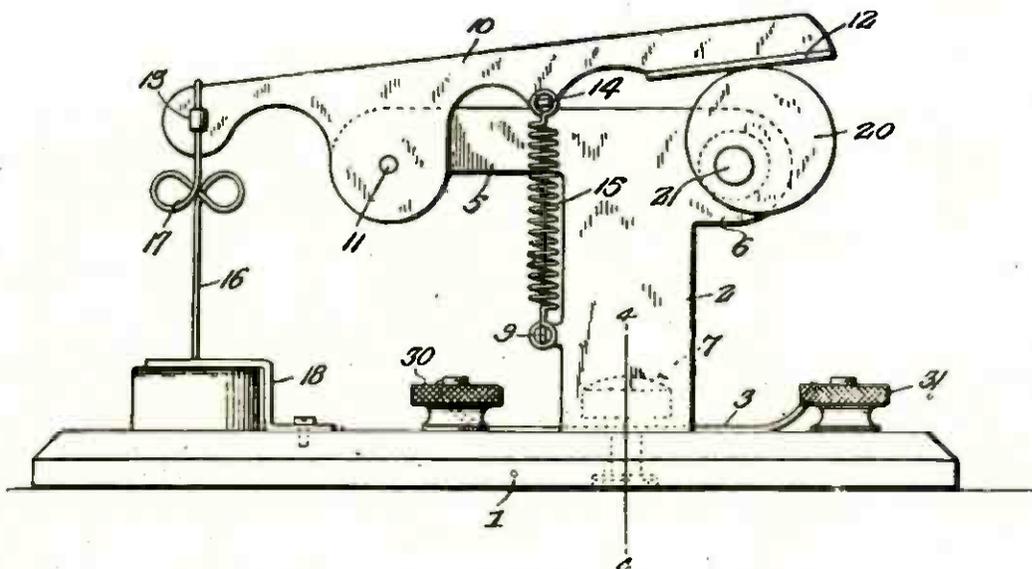
No. 1,475,632. Invented by Harold B. Herty of New Orleans, Louisiana.

When a receiving antenna is close to a powerful transmitting antenna the currents generated in it are sometimes too strong for safety. This device inserts in the antenna circuit a thermal relay, so arranged that if it becomes warm from an overload the current produced in the relay circuit operates a switch and grounds the antenna through a low-resistance metallic circuit, thus saving the coupling coils and the receiving set.

Doubly Tuned Antenna to Trap Unwanted Waves

No. 1,477,413, FIGURE 4. Invented by E. F. W. Alexanderson of Schenectady, New York, and assigned to the General Electric Company.

The problem of operating a receiving antenna close to a powerful transmitter operating on another wavelength is met, in this invention, by a double tuning in the antenna circuit; one tuning having its capacity and inductance in parallel, the other having them in series, as is clear from the figure. The values of the capacities and inductances in these two connected circuits are so adjusted that, for the



PRECISION MOUNTING FOR CRYSTALS

FIGURE 5: The cam, 20, mounted on the axis, 21, permits the precise raising or lowering of the catwhisker, 16. This cam may be turned by a knurled knob on the extension of the axis, 21. A proper tension is provided by the spring, 15.

wavelength which it is desired to tune out, the pick-ups in the coupled circuits are equal and opposite. Therefore, the interference from this wavelength is blocked out. For other wavelengths the voltage-drops across the two tuned circuits in the antenna diverge; one circuit becoming (effectively) a capacity, the other an inductance. The coupled circuits do not then cancel each other and the signal is detected.

Precision Adjustment for Crystal Detector

No. 1,477,826, FIGURE 5. *Invented by Robert J. Heitzman of Union Hill, New Jersey.*

This invention represents another attempt to solve the problem of a stable adjustment between the catwhisker and the crystal. A combination of springs, cams and levers permits the precise placing of the metal point on the crystal surface, not only with regard to the position of the point but also with regard to its exact pressure of contact.

Artificial Transmission Line for Selective Reception

No. 1,477,899, FIGURE 6. *Invented by C. W. Rice of Schenectady, New York, and assigned to the General Electric Company.*

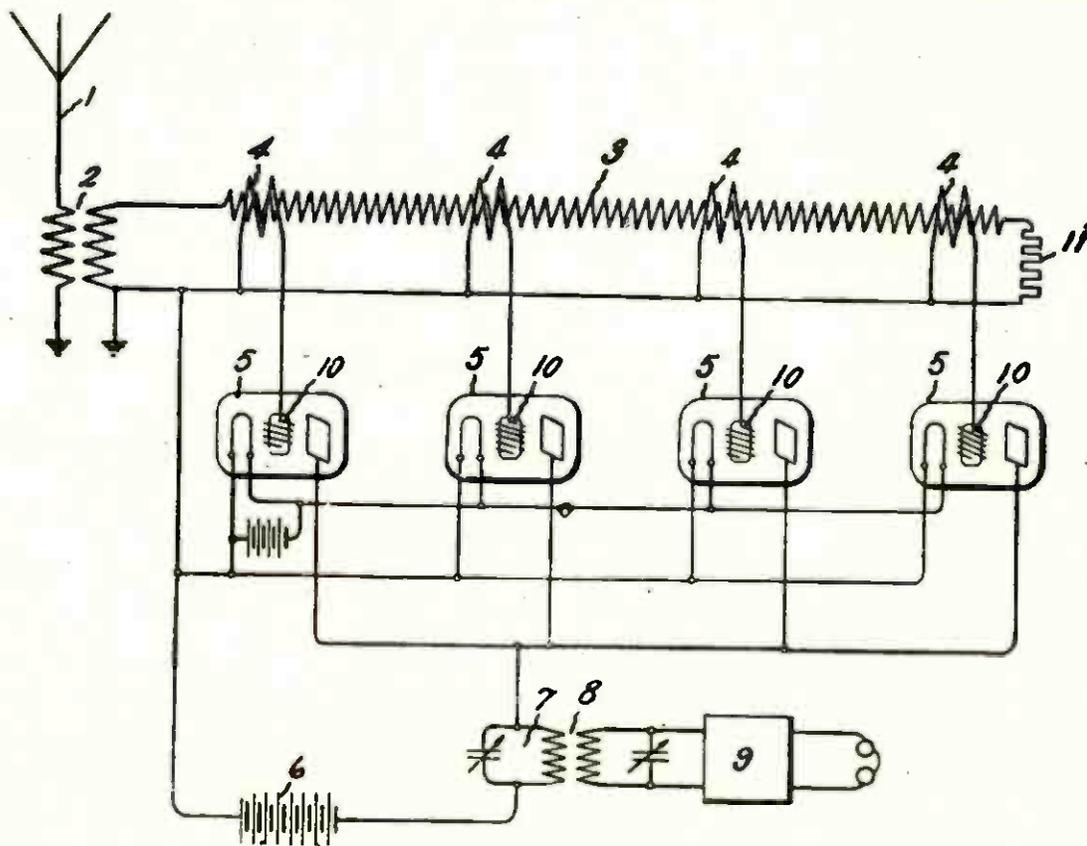
This invention introduces what is apparently a novel idea in selective reception of a

certain wave, to the exclusion of short-wave interference and strays. The received impulses from the antenna are fed into an artificial transmission line and are taken off this line at four separate points along it. Since the very short-time impulses of static and the like require an appreciable time to travel along the artificial line, they do not reach the four successive pick-up circuits in phase. They do not, therefore, reinforce each other in these circuits, while the impulses due to the wanted signal do reinforce each other.

Using a Dynamo as an Amplifier

No. 1,479,146. *Invented by Ralph E. Marbury of Edgewood Park, Pennsylvania, and assigned to the Westinghouse Electric and Manufacturing Company.*

To the list, already long, of possible principles for the amplification of received radio signals, this invention adds another. The received signal, with or without vacuum-tube amplification, is impressed on the winding of an electric dynamo in such fashion that the signal impulses produce alterations in the magnetic field of the dynamo. These alterations cause corresponding, but amplified, alterations in the output of the dynamo, the additional energy necessary for the amplification being supplied by the energy of rotation of the rotor of the machine. These dynamo-electric amplifiers can be arranged in successive steps, much as with vacuum-tube amplification.

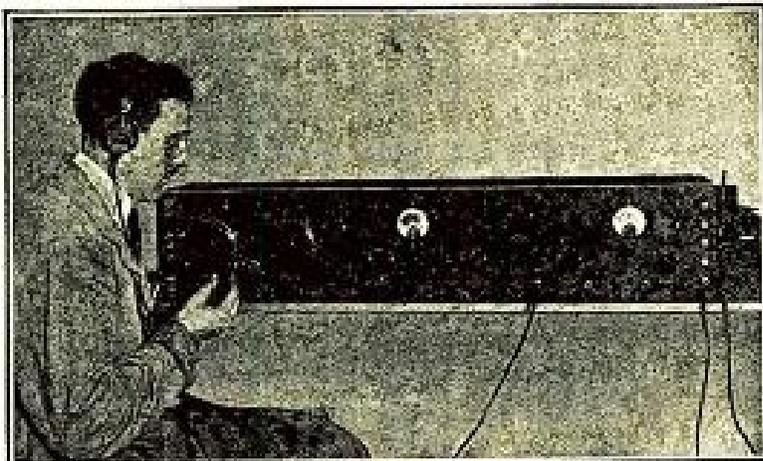


A NEW DEVICE FOR SELECTIVE RECEPTION

FIGURE 6: The signal is fed into the artificial transmission line at the top of the drawing, this line having an effective length equal to at least several times the wanted wavelength. The shunt resistance, 11, equals the surge impedance of the line and is used to prevent reflection of the wave.

For expensive, delicate parts— what panel will you use?

THE picture shows the front of a Super Heterodyne hook-up. This set has a normal range of 3,000 miles. When a radio fan builds this set he must use the best radio parts he can buy. And he needs a panel that will help those parts operate most efficiently.



A weak battery, a burned-out tube—any defective part merely reduces the range of a set instantly. A cheap radio panel can hinder the effectiveness of the best instruments made.

Radio fans all over the country construct their sets around Celoron Standard Radio Panels. One of them, Mr. Phil Davies, of Grand Rapids, Mich., writes about his Celoron panel:

"I bought a Celoron Radio Panel, first, because of the low loss of high frequency currents and its high dielectric capacity; second, because of its strength and durability; third, because of its beautiful finish; fourth, because of its convenient size."

Radio set manufacturers who use Celoron panels in their cabinets help fans get greater volume and clearer reception. Manufacturers of radio parts who mount their instruments on Celoron bases give insulation those parts need. In Celoron they have a bakelite product that is one of the best insulating materials known. Its dielectric strength has been proved time and again. The

U. S. Signal Corps and U. S. Navy approve it heartily.

Radio manufacturers can buy Celoron in sheets, tubes, rods and special forms. Leading radio part makers have already found that Celoron is an ideal material to use for cabinets, switch bases, and other radio and wireless equipment.

Radio fans who buy completed sets containing Celoron Standard Radio Panels and instruments insulated with Celoron can be sure of getting the insulation their sets need. Write us for complete information regarding

the use of Celoron in the manufacture of sets and individual radio parts.

To radio dealers: Send for special dealer price list showing standard assortments.

DIAMOND STATE FIBRE COMPANY

Bridgeport, Pennsylvania (near Philadelphia)

Branches in Principal Cities—Toronto, Canada London, England

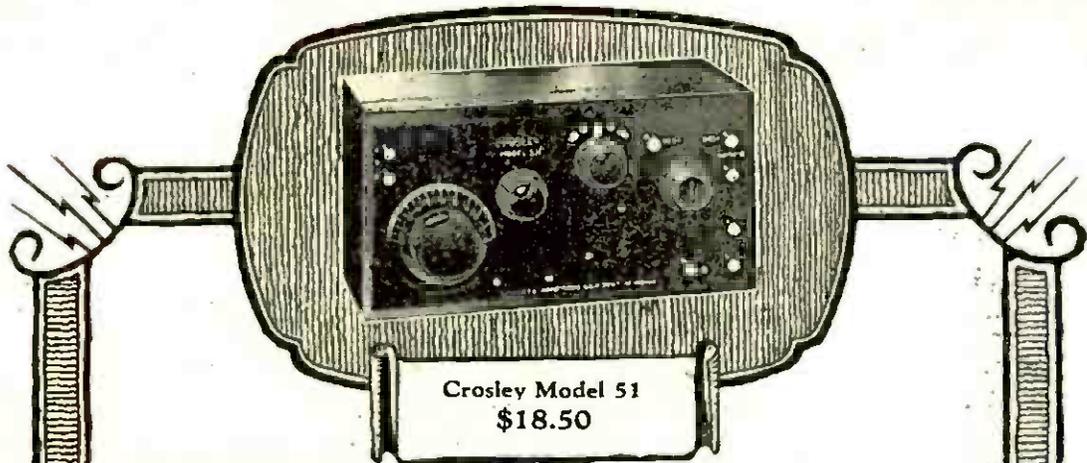
CELORON

STANDARD RADIO PANEL

Celoron Radio Panels come in the following standard sizes finished in black, mahogany or oak:

- 1—6 x 7 x 1/8
- 2—7 x 9 x 1/8
- 3—7 x 12 x 1/8
- 4—7 x 14 x 3/16
- 5—7 x 18 x 3/16
- 6—7 x 21 x 3/16
- 7—7 x 24 x 3/16
- 8—12 x 18 x 3/16
- 9—7 x 26 x 3/16

Special sizes cut to order from sheet stock. Write for our free booklet, "Getting the Right Hook-up with Celoron." It contains diagrams, list of broadcasting stations, and information every set-builder should have.



A CROSLLEY FOR EVERYONE

Priced Exceptionally Low

IT is our ambition that everyone in the United States be enabled to enjoy the innumerable pleasures and benefits that radio provides. We have, therefore, produced in the Crosley line such an extensive assortment of Radio Receivers at prices so reasonable as to bring them within reach of all.

Our newest receiver, the Crosley Model 51, a two-tube Armstrong Regenerative set illustrated above, is indeed a triumph in radio engineering. Although it consists of detector and one stage of audio frequency amplification, it sells at the very low price of \$18.50.



CROSLLEY
TYPE 3-C

CROSLLEY TYPE 3-C—\$110.00

A beautiful Console Model of Mahogany, adding greatly to the interior decoration of any home. It is an Armstrong Regenerative set containing the same units as the Crosley Type 3-B with the addition of a built-in loud speaker. Licensed under Armstrong U. S. Patent No. 1,113,149. Space is provided in the cabinet for housing the necessary batteries. A special mahogany stand for the Type 3-C may be had for \$25 extra.



CROSLLEY
TYPE V

CROSLLEY TYPE V—\$16.00

A one tube regenerative set, licensed under the Armstrong U. S. Patent No. 1,113,149. Actual performances of this little receiver have proven a revelation to the radio world. The MacMillan expedition has consistently been clearly brought in with this instrument as well as Honolulu and other far distant points.

Crosley instruments are sold by best dealers everywhere. Write for complete catalog of Crosley receivers and parts

The Crosley Radio Corporation

POWEL CROSLLEY, JR., President

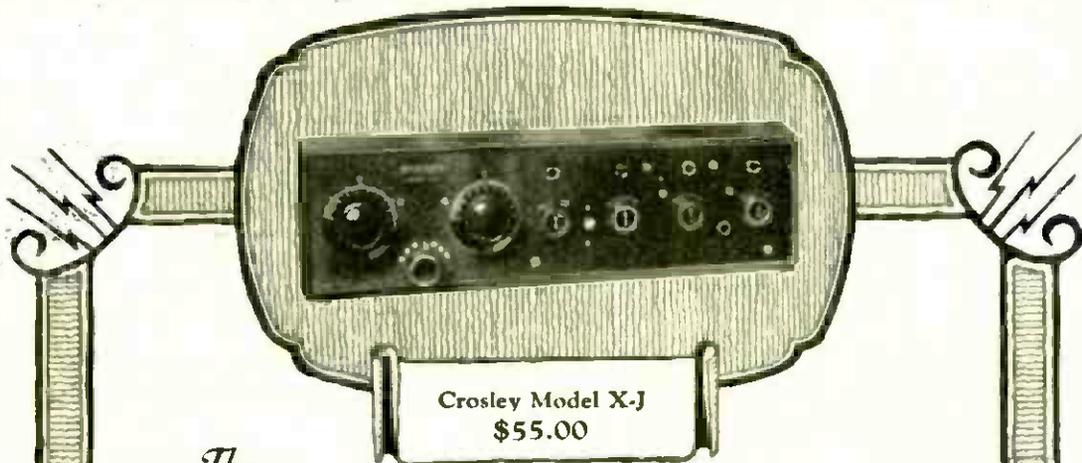
Formerly

The Precision Equipment Co. and Crosley Manufacturing Co.

516 Alfred Street :: :: Cincinnati, Ohio



Please refer to POPULAR RADIO when answering advertisements.



The
FAMOUS CROSLLEY MODEL X-J
 A Long Distance Receiver

PROBABLY the greatest single feature of this Crosley Model X-J receiver is its remarkable selectivity. It will tune through powerful local broadcasting stations and bring in distant stations clearly and with great volume. It is the most popular receiver in America to-day, we believe.

A four tube radio frequency set combining one stage of Tuned Radio Frequency Amplification, a Detector and two stages of Audio Frequency Amplification. A jack to plug in on three tubes for head phones, the four tubes being otherwise connected for loud speaker.

CROSLLEY TYPE 3-B—\$42.00

This three tube regenerative receiver licensed under Armstrong U. S. Patent No. 1,113,149 combines the Crosley Type V single tube receiver, and the Crosley two stage amplifier. In the hands of amateurs and professionals alike it has consistently out-performed sets costing a great deal more. A person hearing a broadcasting station may turn off the set by throwing switch and come back later without re-tuning.

CROSLLEY MODEL VI—\$24.00

A two tube medium range receiver of exceptional merit. Consists of one stage of tuned radio frequency amplification and detector. The one stage of tuned radio frequency amplification not only amplifies the signal before it reaches the detector, enabling the detector to work more efficiently, but it also eliminates interference to a wonderful degree.

Crosley instruments are sold by best dealers everywhere. Write for complete catalog of Crosley receivers and parts

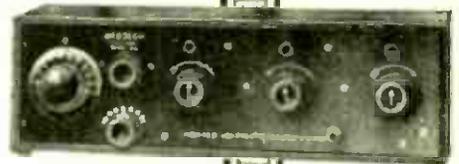
The Crosley Radio Corporation

POWEL CROSLLEY, JR., President

Formerly

The Precision Equipment Co. and Crosley Manufacturing Co.

516 Alfred Street :: :: Cincinnati, Ohio



CROSLLEY TYPE 3-B



CROSLLEY MODEL VI



Please refer to POPULAR RADIO when answering advertisements.

Haynes-Griffin

RADIO SERVICE, Inc.

41 West 43rd St., N. Y. City

Complete Parts
for the Haynes Set

\$15.00

Haynes .00023 Condenser
Haynes Bank Wound
Coupler
Fada Rheostat
Haynes-Griffin Socket
Switch Arm
4 Switch Points
2 Switch Stops
8 Binding Posts
2 3-inch Dials
Grid Condenser .00025
with leak mtg.
Grid Leak (1 meg)
Bus bar, solder, copper
lugs, and all miscellaneous
material
7 x 15 Hard Rubber Panel
Send 2c stamp for detailed
price list of parts and
accessories

PARTS FOR THE Famous Haynes Set

Manufactured by Clapp-Eastham Co.

Licensed under Armstrong Patent 1,113,149

1000 Miles for \$15.00

The identical parts used by A. J. Haynes in his own personal receiving set—assuring the utmost in Selectivity, Long Distance Range, Economy, and Simplicity of Arrangement.

The appeal of the Haynes Set is universal. To the experienced amateur because of its astonishing long distance reception and wonderful selectivity; to the radio novice because of its ease of construction and operation. So simple that no one can possibly go wrong.

Send 4c in stamps for interesting article on the Haynes Set described on the opposite page of this advertisement



\$12.50

J. Andrew White Loud Speaker!

Major White, "America's Favorite Broadcaster" and former Editor of "The Wireless Age," has embodied in this Loud Speaker the results of his thirteen years of radio experience.

Special non-metallic composition horn and all-wood base assure clear-toned reproduction, entirely free from distortion or metallic sound.

The J. Andrew White Loud Speaker stands 21 inches high with bell 9½ inches in diameter.

Parcel Post Prepaid to all points in the U. S. East of the Mississippi River.

HAYNES-GRIFFIN RADIO SERVICE, INC.

Mail Order Dept.—145 W. 45th Street, N. Y. City

Retail Store—41 W. 43rd Street, N. Y. City

Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City



A. J. HAYNES
Designer of the Haynes Set

Four Notable Articles on RADIO DESIGN

1: "How to Build the Haynes DX Receiver," by Laurence M. Cockaday, Technical Editor of "Popular Radio." (September, 1923 issue.) Mr. Cockaday finds the Haynes Set ideal for the average man who wants ease of operation, great selectivity, and excellent long distance reception.

2: "How to Build a Two-Stage Audio Frequency Amplifier," also by Mr. Cockaday (October, 1923 issue.) This article tells how to build the Haynes Amplifier to give loud speaker volume with the Haynes Set.

3: "A Simplified Super-Heterodyne," by A. J. Haynes (January, 1924 "Radio Broadcast"). The set described represents the result of Mr. Haynes's search for perfection after nineteen previous experimental models had been built.

4: "Shooting Trouble in the Super," also by Mr. Haynes (March, 1924 "Radio Broadcast.") Here Mr. Haynes gives many practical suggestions for meeting almost every conceivable difficulty which may develop in the super-heterodyne.

The Haynes Condenser

\$3.50

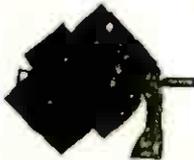
Meets every requirement — extreme low minimum capacity and maximum capacity of exactly .00023 mfd. No other condenser is exactly like it—no other achieves just the right balance between perfect selectivity and over-critical adjustment.



The Haynes Bank Wound Vario-Coupler

\$4.35

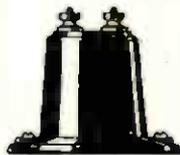
Furnished with only the taps you actually use and just the right number of turns on the secondary. Bank winding provides 100% efficiency on higher broadcasting wave lengths.



Haynes-Griffin Transformer

\$4.25

An efficient intermediate wave radio frequency transformer; uniformly tuned to a limited wave length range, and providing a degree of quietness heretofore unknown in transformers of this type. Haynes-Griffin Input Transformer also \$4.25.



THE DEMAND FOR THESE ARTICLES IS WORLD-WIDE

In the history of radio no articles on radio design have attracted more widespread enthusiasm. Thousands of letters from all parts of the world have asked us for copies.

Through the courtesy of "Popular Radio" and "Radio Broadcast" we are able to offer them to interested experimenters at the actual cost of printing and mailing.

Simply send 4c in stamps for each article wanted. Use the handy coupon.

New York's
Largest Radio Store

Haynes-Griffin

145 W. 45th St.,
New York City

Send me articles checked below. I enclose 4c in stamps for each one wanted:

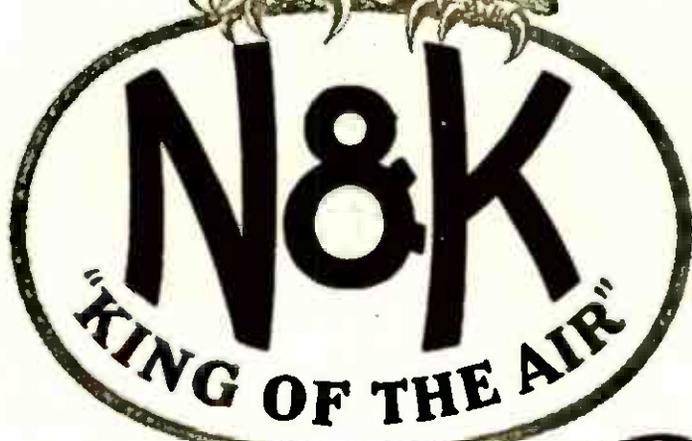
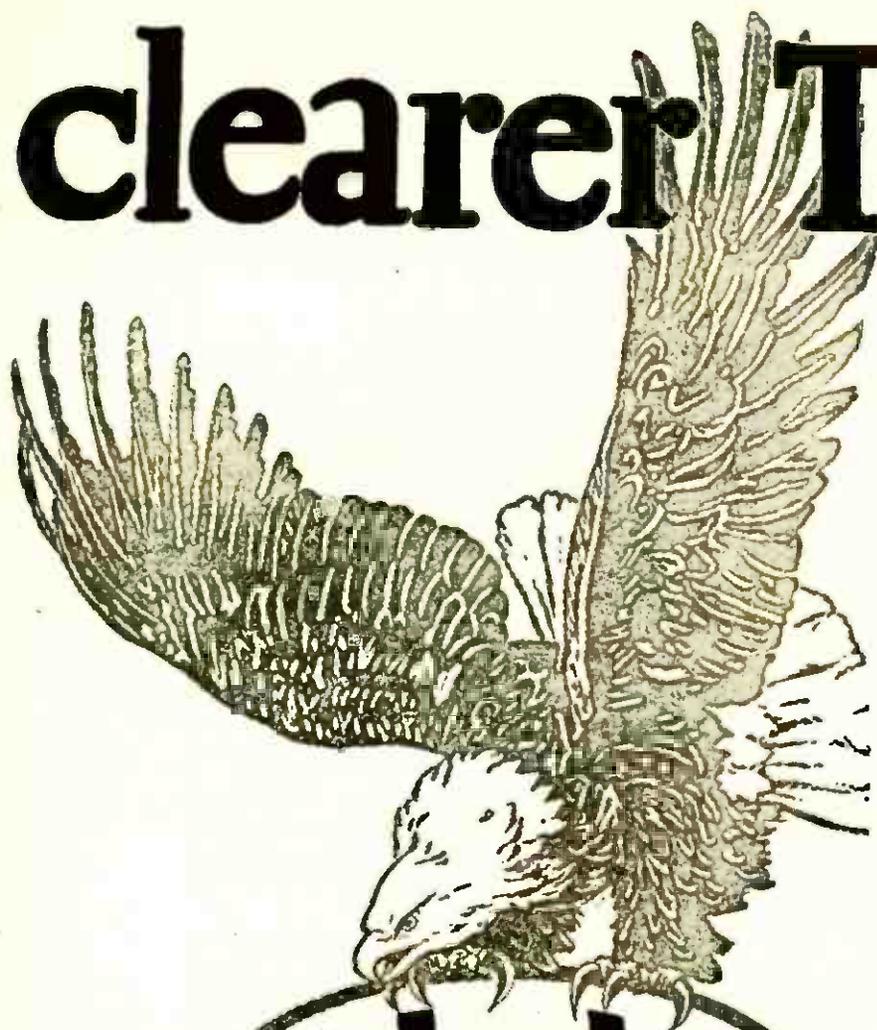
- 1: Haynes DX Receiver
- 2: Audio Amplifier
- 3: Simplified Super
- 4: Shooting Trouble

HAYNES-GRIFFIN RADIO SERVICE, Inc.

Mail Order Dept.—145 W. 45th ST., N. Y. City

Retail Store—41 W. 43rd ST., N. Y. City

clearer Tone!



TRADE MARK

PHONES

N&K Head Set, Model D, 4000 ohms, is a remarkable example of skillful workmanship. Made of nicked brass, with hard rubber ear caps, accurately machine threaded to insure proper seating of diaphragm. A special device insures uniform spacing between diaphragm and magnet poles. Magnets of finest German steel, wound by entirely new method. Sanitary headband, covered with genuine leather. Six foot cord. Price, \$8.50.



N & K Phones are designed for just one purpose—the *natural reproduction* of musical tones. They are sold under a guarantee to reproduce both high and low tones more clearly, with greater naturalness and mellowness. They will not increase the loudness of weak signals—because *all* the tones, high and low, have to be kept in *natural proportion*, to secure such mellowness as N & K gives. It's the job of your radio set to give volume.

Fans and mere beginners alike are enthusiastic over N & K's wonderful clearness. Out of several hundred amateur stations that tested N & K Phones last year, a full 90 per cent pronounced them the best they had ever used.

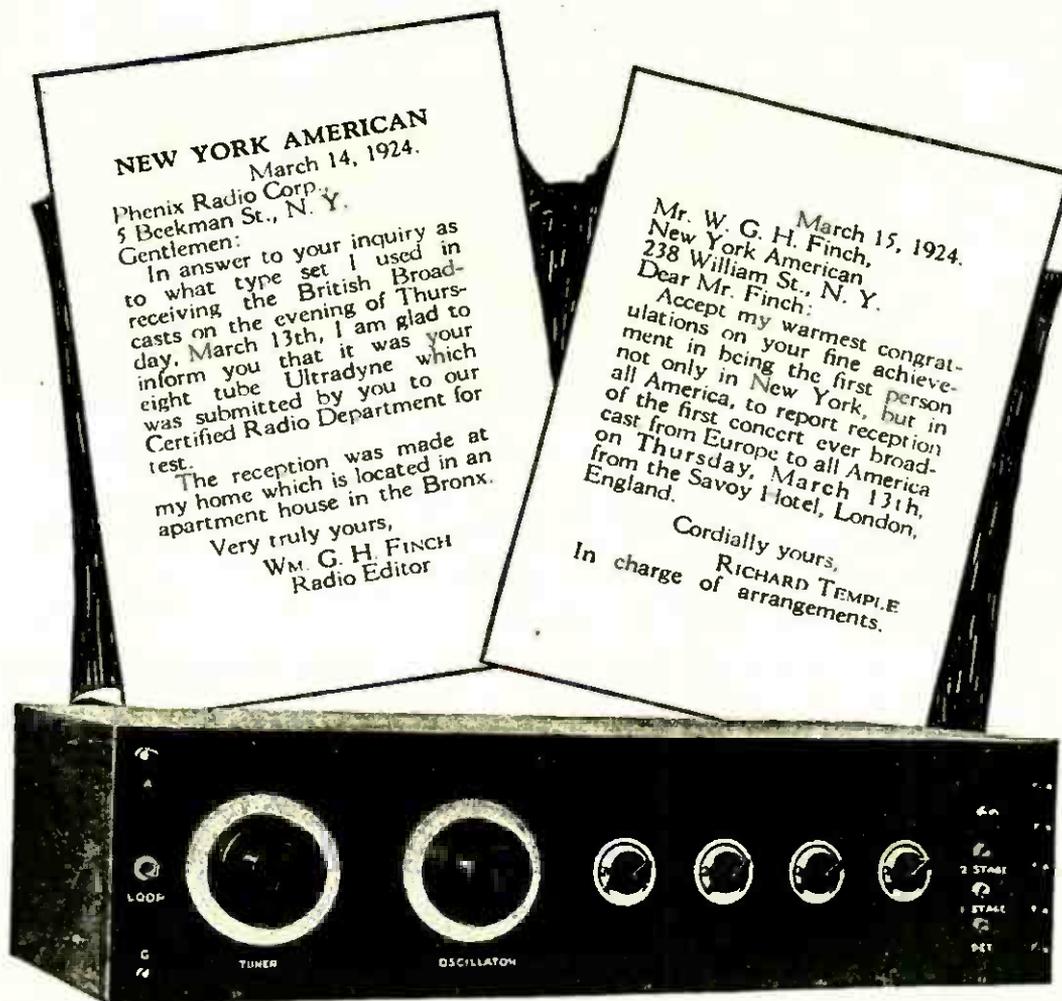
"Entirely free from mechanical sounds" says Station 1PX. "Exclude noise of visitors moving around operating room" says Station G. R. R. "Tone soft and clear as a bell" says 1FI; and so on. We will gladly send you our new folder reproducing other comments from fans and telling the real reasons *why* N & K Phones reproduce more clearly than other phones. *Write now.*

TH. GOLDSCHMIDT
CORP.
Department P5
15 William Street
New York, N. Y.

DEALERS:—N & K Phones are being backed by a wide advertising campaign that is already bringing a big increase in sales. Until the announcement of our complete distributor organization, we will see that

you are promptly supplied with N & K Phones if you order direct from us. N & K comes packed in cartons of ten with advertising display cards for window and counter and leaflets. Write or wire for carton today.

Please refer to POPULAR RADIO when answering advertisements.



"The Standard of Comparison"

ULTRADYNE

The Improved

SUPER-HETERODYNE

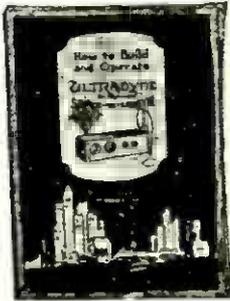
Employs "Modulation System," an entirely new principle of radio reception just developed and perfected by R. E. Lacault, A. M. I. R. E., technical editor of Radio News and formerly Radio Research Engineer with the French Signal Corps Research Laboratories.

This principle is of such a basic character that the sensitiveness is increased over that of any known receiver. Weakest signals are made to operate the loud speaker. Results secured by the Ultradyne exceed by far those obtained with Reflex, Super-Regenerative, Neutrodyne and even with the well-known Super-Heterodyne. This is true in regard to selectivity, range, signal audibility, simplicity and general efficiency.

The "Modulation System" is employed exclusively in the Ultradyne, the improved and simplified Super-Heterodyne.

Write for descriptive circular

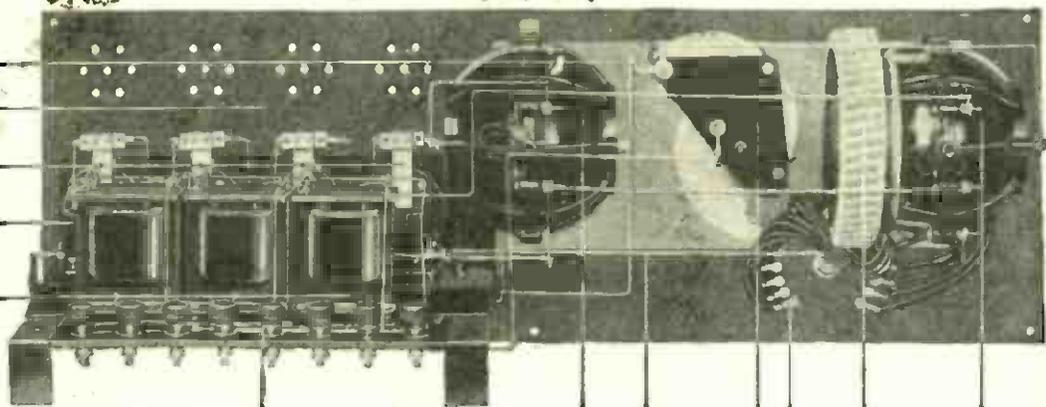
PHENIX RADIO CORP.
7-9 Beekman Street :: New York City



Send for the 32-page illustrated book giving latest authentic information on drilling, wiring, assembling and tuning 6 and 8 tube Ultradyne receivers.

50c

A NEW CIRCUIT DIAGRAM—READ IT!



It's Not the Face of the Watch, It's the Works that Tell the Story.

1. **Variable Condenser.** Contains forty-three plates of heavy aluminum with five plate vernier for fine tuning. Mounting plates of heavy Bakelite. Ends of rotor plates bolted, preventing bending or "shorting." Large bearings make smooth easy operating.
2. **Inductance Coil.** Increases the wave range of the variocoupler to 3000 meters. Diamond wound for minimum distributed capacity. Tapped for selective tuning.
3. **Variocoupler.** Coupler shell and rotor built of solid Kellogg Bakelite, treated to avoid "distributed capacity." Many radio experts consider this the best coupler obtainable today.
4. **Variometer.** Rotor shaft accurately and permanently held in bearings. No sliding contacts. This variometer gives great added selectivity, more value.
5. **Transformers.** Designed to overcome defects of existing types and to furnish distortionless amplification of all audio frequencies. Sheet metal case heavily enameled. Primary and secondary binding posts most accessibly placed on the transformer, plainly marked.
6. **Rheostats.** Have strong, wide springs, grasping the rotor resistance on two sides with strong, positive contact. The control varies on the half turn of the coil wire on the rotor, giving vernier effect and enabling the operator to secure great selectivity, and freedom from noise and trouble.
7. **Tube Sockets.** All Bakelite. Bayonet slot reinforced with brass plate. Terminals plainly marked. Heavy springs inset into base, so they cannot touch mounting surface. With Kellogg tube sockets there is no worrying about proper connection with your lamp terminals.
8. **Binding Post Assembly.** Symphony Binding Posts connect through separate openings in the rear of the set. Each of these openings have an insulating bushing. This does away with unsightly and unnecessary wiring connections on the front panel.
9. **Bakelite Panel.** This slender, strong, highly polished panel has the equipment located upon its face in the most advantageous positions. These mountings fit most accurately drilled openings and this face equipment is a model of proper radio assembly.
10. **Aluminum Shielding.** One who has not operated a radio set cannot appreciate the importance of careful shielding and grounding. Symphony shielding is pure aluminum and ample size, correctly drilled.
11. **Circuit.** The circuit of the Symphony is controlled by the apparatus above described, and mechanically wired as indicated, produces receiving of the highest order.
12. **Contact Points.** Heavy, silver plated for minimum resistance, an instance of the fine and all important attention to details that makes for successful radio receiving.

In addition to the important, accurate and successful units pictured above, there are also the other Kellogg radio parts to complete this most efficient circuit

Jones RADIO Company

1066 W. Adams Street, Chicago, Ill.

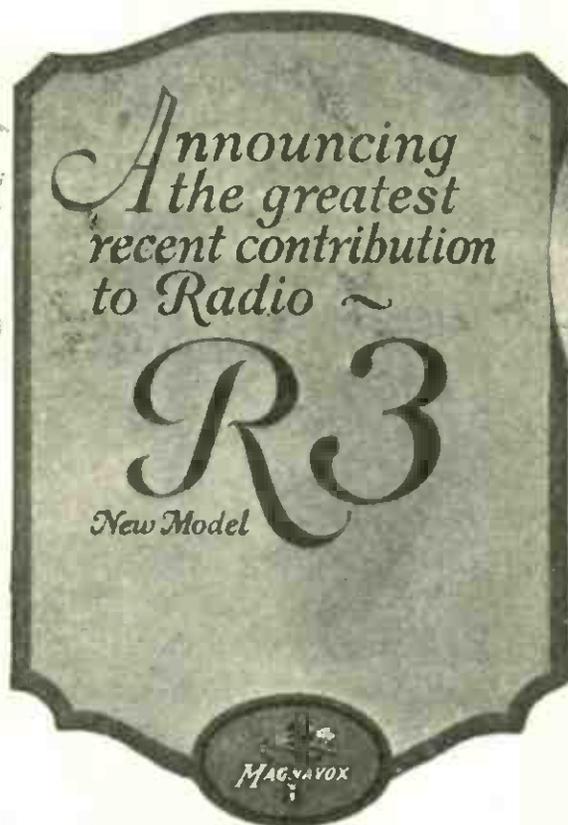
The Symphony is manufactured under the U. S. Patent No. 1113149, Armstrong Regenerative Circuit

All parts used in the Symphony are built and guaranteed by the Kellogg Switchboard & Supply Company, manufacturers for twenty-five years of complete telephone equipment

Mr. Dealer:
Write for our bulletins and discount sheet. The Symphony will increase your profits.

Mr. Radio Fan:
If your dealer does not carry Symphony receivers, send us his address. We will send you our illustrated Symphony catalog by return mail.

Pioneers in the development of sound reproducing and amplifying equipment



THE new model R3 is distinguished by two important features—a Volume Control, and reduction of current consumption to a point where it need no longer be taken into consideration.

Volume Control
→

THIS instrument sets a new and higher standard of adaptability, refinement and also economy of operation. By means of the new Volume Control, reproduction can be adjusted at any degree from very loud to very soft.

- R3—(As illustrated) with Volume Control \$35.00
- R2—(New Model) with Volume Control . 50.00
- M1—Requiring no battery for its operation 35.00

Magnavox Reproducers, Power Amplifiers and Combination Sets may be had of good Dealers everywhere. Write for catalog.

THE MAGNAVOX CO., OAKLAND, CALIF.

New York Office: 370 SEVENTH AVENUE

Canadian Distributors: Perkins Electric Limited, Toronto, Montreal, Winnipeg

MAGNAVOX PRODUCTS

There is a Magnavox for every receiving set

5R

"The Best That Money Can Buy"

"GOLD SEAL" HEADSETS



"GOLD SEAL" HEAD SETS are electrically and mechanically,—as well as from a radio standpoint,—as perfect as the highest-priced Head Set on the market,—yet, with all their perfection, they retail at only \$6.00 for 2200 Ohm and \$8.00 for 3200 Ohm.

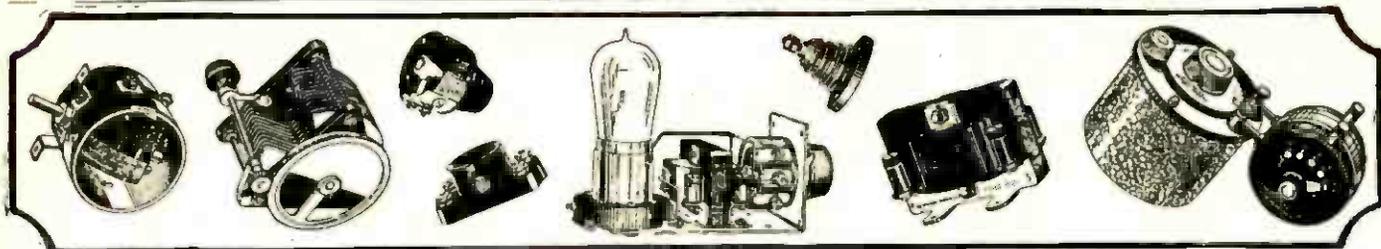
The trade mark "DEVEAU" has stood for the highest quality in telephone apparatus for thirty years,—a guarantee that every known advantage in design and manufacturing has been taken into careful consideration.

Magnets are extra-heavy one-piece units; cups are of aluminum to keep down the weight but unlike other Head Sets, every exposed metal part of the set is finished in genuine 24-karat gold,—under a protective lacquer so that the finish will last for years; the terminals of each unit are concealed,—no contact possible with users' hands.

"DEVEAU GOLD SEAL" HEAD SETS are like a piece of fine jewelry in appearance, but with all the radio niceties that the most advanced radio enthusiast can desire. DEVEAU Units exactly match each other in tone,—each has maximum sensitivity and perfection of tone quality.

"DEVEAU GOLD SEAL" HEAD SETS are guaranteed to be electrically and mechanically perfect,—our Guarantee protects every purchaser.

STANLEY & PATTERSON 27 WARREN STREET
23 MURRAY STREET
NEW YORK CITY, U. S. A.



Standards of Excellence



TYPE 231-A AUDIO TRANSFORMER

The first closed core transformers on the market available for use in broadcast receivers were built by the GENERAL RADIO COMPANY, nearly a decade ago.

Today the type 231-A is the standard of excellence in transformer construction.

Thousands of these transformers are in use by fans throughout the entire radio world. They have proven a source of delight to "listeners-in" everywhere because of their volume and quality of amplification.

Many of the leading manufactured broadcast receivers are using GENERAL RADIO CO. transformers as standard equipment—because of their unflinching satisfaction.

Whether you are building a set or buying one, the question of "Quality Amplification" will be settled once and for all if you insist upon the GENERAL RADIO CO. transformers.

Winding Ratio 3.7 to 1. Impedance Ratio 10 to 1.

PRICE \$5.00

Write **TODAY** for our Instructive Folders on "Quality Amplification" and "Quality Condensers" and our new Radio Bulletin 917-U



"Products of Proven Merit"



TYPE 247-H VARIABLE CONDENSER

The 247-H geared variable condenser is the product of extensive laboratory research by skilled radio engineers.

In its design are incorporated features which promote the utmost electrical and mechanical efficiency.

Its method of vernier adjustment is particularly commendable.

By using the counter-balanced gear, operated by a pinion, capacity may be accurately controlled to a minute degree—thus making possible extreme selectivity.

Its bearings are smooth running and its dielectric losses are low.

Due to its critical capacity control and general over-all efficiency, the 247-H condenser is readily adaptable to use in a wavemeter and filter as well as in the receiver circuit.

Capacity of the 247-H condenser .0005 microfarad.

PRICE \$5.00

GENERAL RADIO Co

Manufacturers of
RADIO AND ELECTRICAL LABORATORY APPARATUS
Massachusetts Ave. and Windsor St.

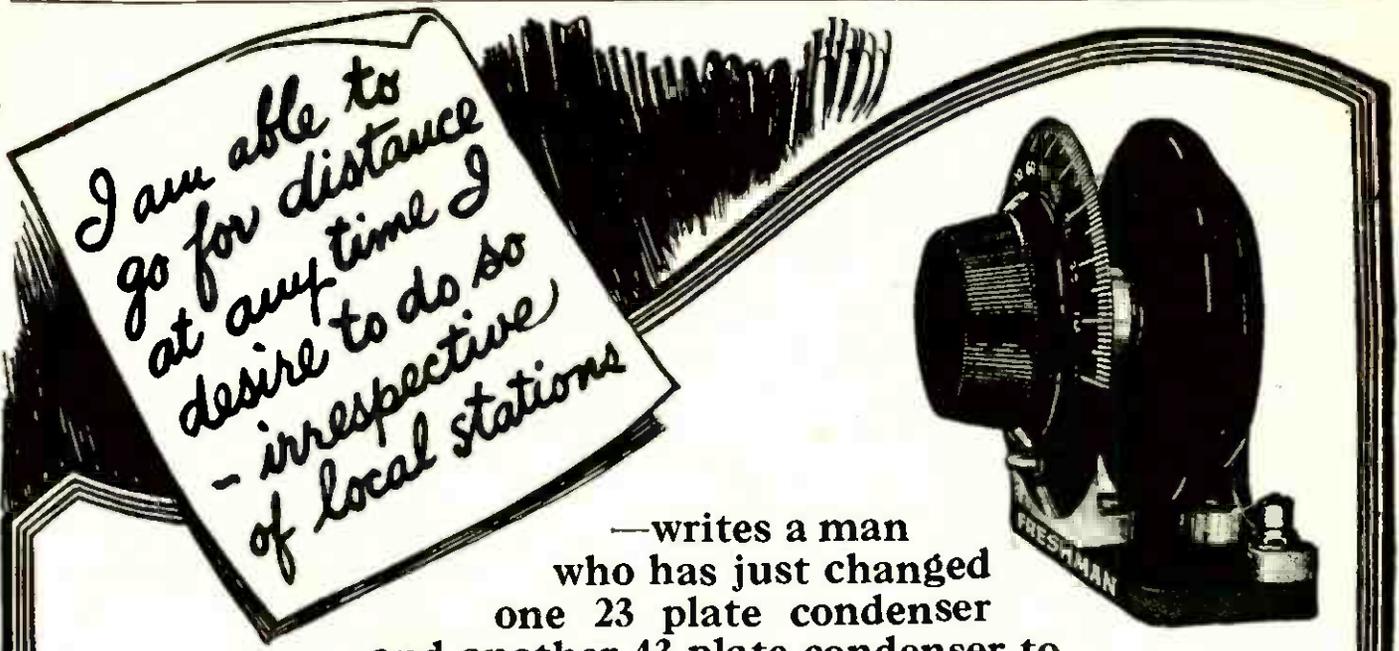
CAMBRIDGE

..

..

MASSACHUSETTS

Please refer to POPULAR RADIO when answering advertisements



I am able to go for distance at any time I desire to do so - irrespective of local stations

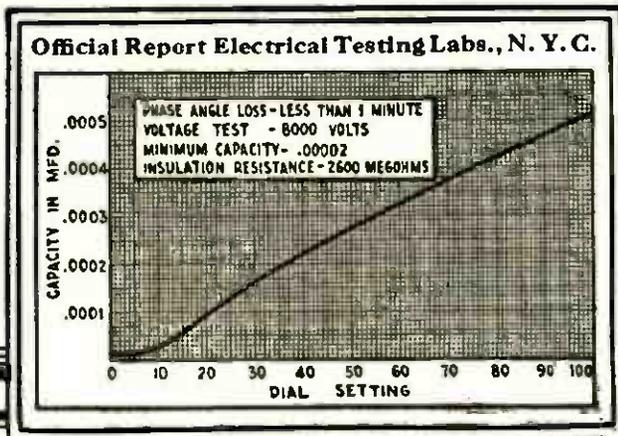
—writes a man who has just changed one 23 plate condenser and another 43 plate condenser to

“FRESHMAN SELECTIVE” VARIABLE CONDENSERS

THIS is only one of the many unsolicited letters we are receiving from people who have changed from the ordinary plate type condenser to the Freshman Selective. You are missing fully 50% of the real thrill and enjoyment of radio if you have not equipped your set with Freshman Selective Variable Condensers. Engineering tests have proved their high efficiency, low phase angle loss, high insulation, freedom from leakage. These tests have been substantiated in actual practice in Neutrodyne, Super-Heterodyne, Reflex and other popular circuits.

For Transmission or Reception

Attractively compact.
Quiet in operation.
Withstands 8,000 Volts. Cannot short circuit.
The only variable condenser, the plates of which actually vary in area.



Prices:
.0003 MF..... } \$5
(Equiv. to 17 pl.)
.0005 MF..... } EA.
(Equiv. to 23 pl.)
.001 MF..... }
(Equiv. to 43 pl.)
With 3 inch Vernier Dial \$5
With 4 inch Vernier Dial 50c. extra.

Ask your dealer or write for our free diagram of Neutrodyne, Super-Heterodyne, Tri-Flex and other good circuits.

Chas. Freshman Co. Inc.

Radio Condenser Products

106 Seventh Avenue, New York City

At your dealer's otherwise send purchase price and you will be supplied without further charge.

Clear from the skies

You can get greater clarity with a good storage battery than by any other means. If you are in any doubt about this important matter, try some friend's set that is hooked up to an Exide Battery.

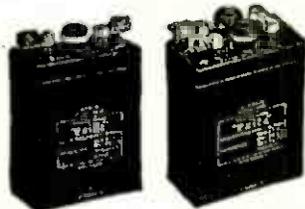
It is a fascination to see how far distant a station you can tune in, but still more fascinating to get it so clearly that you actually enjoy the concert.

Two things to remember

There are two things to remember about Exide Batteries: They give uniform current over a long period of discharge. This means not only clear reception but economy.

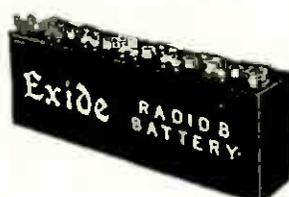
The second thing to remember is that there is an Exide Radio Battery made for every type of tube. In addition to the "B" battery there are Exide "A's" for 2-volt, 4-volt and 6-volt tubes.

From the "midget" five-pound battery for low-voltage tubes to the larger battery for six volts, each Exide is powerful, rugged, silent, and so long-lasting that it makes for true economy.



For low-voltage tubes

Specially designed for WD-11 and UV-199 vacuum tubes, but can be used with any low-voltage tube. The two-volt Exide A Battery consists of a single cell. It will heat the filament of a WD-11 or other quarter-ampere tube for approximately 96 hours. The 4-volt A battery, having two cells, will light the filament of a UV-199 tube for 200 hours.



Exide "B" Battery

Exide

RADIO BATTERIES



For six-volt tubes

Made in four sizes—of 25, 50, 100, and 150 ampere hour capacities. Like all Exides this battery is conservatively rated. It has extra-heavy plates assuring constant potential over a long period of discharge.

And the reason is obvious

The Exide Radio Battery results from experience in the radio field dating far back of amateur radio. In fact, a majority of all government and commercial radio plants are equipped with Exide Batteries. The giant dirigible Shenandoah and the great ship Leviathan are Exide-equipped.

Go to any radio dealer or Exide Service Station and ask for Exide A and B Batteries. If your dealer cannot supply you with free booklets describing the complete Exide line of radio batteries, write to us.

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA

In Canada, Exide Batteries of Canada, Limited, 133-157 Dufferin Street, Toronto

Please refer to POPULAR RADIO when answering advertisements.

RADIO FREQUENCY AMPLIFICATION with the BALLANTINE VARIOTRANSFORMER

How to get increased distance with your crystal set

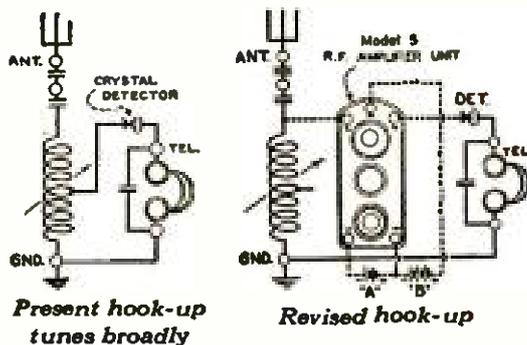


with BALLANTINE VARIOTRANSFORMER UNITS

YOUR crystal set is the starting point on which to build a good distance receiver. For authorities agree that there is nothing finer than a good crystal for clean-cut detection—not so loud as a tube, perhaps, but much clearer. Simplicity itself is the crystal. And its improved modern forms and mountings make adjustment easy. By all means, keep this element with which you are already familiar.

Use tubes to best advantage

Tubes, of course, are needed for amplification—to build up weak distant signals so that they may operate your crystal detector. But, by putting your money for tube equipment into one or more stages of radio frequency amplification, tuned with BALLANTINE VARIOTRANSFORMER Units, you will get increased distance. And with this method there comes a greater selectivity, accompanied by a reduction of



interfering noises. In fact, BALLANTINE amplification into a crystal detector may be made as clear as a victrola. Furthermore, the full possibilities of your tubes may be developed without annoying your neighbors.

Easy changes quickly made

The above diagrams show how one popular make of crystal set can be brought up to date quite readily—only a slight rearrangement of wiring to hook in the first BALLANTINE Unit. And it's just as easy with any other crystal hook-up. Additional BALLANTINE Units may be inserted from time to time.

Try this instrument. Then, if there's anything you don't understand, our staff engineers will help you out.

Booklet tells how to improve crystal sets

"Radio Frequency Amplification with the BALLANTINE VARIOTRANSFORMER," is the title of our 25-page booklet, packed with useful data, charts and diagrams. Send for your copy now.



Complete radio frequency amplifier unit with \$15.00 socket and rheostat
Transformer only \$9.60 for panel or base
At dealers or postpaid



BOONTON RUBBER MFG. CO.
Pioneers in Bakelite Moulding

224 Fanny Road, Boonton, N. J.

RADIO FREQUENCY AMPLIFICATION with the BALLANTINE VARIOTRANSFORMER

ATWATER KENT

Philadelphia

**Highly Selective and Easy
to Operate**

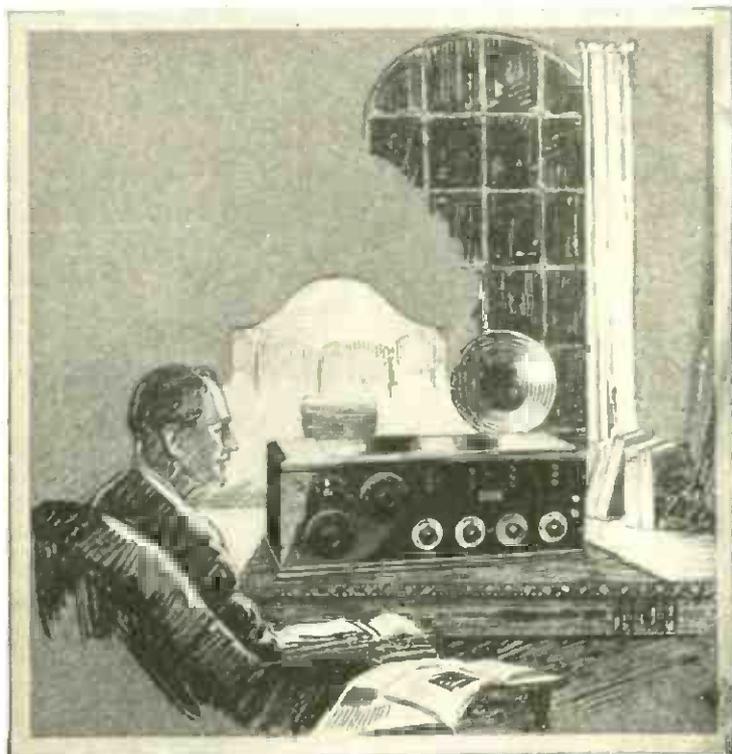
IT is easy to operate an ATWATER KENT Receiving Set—anyone can tune in a distant station and obtain clear reception — its wide range, accuracy, and simplicity have made it an outstanding preference among families the nation over.

The tonal fidelity of an ATWATER KENT Loud Speaker is the delight of every owner.

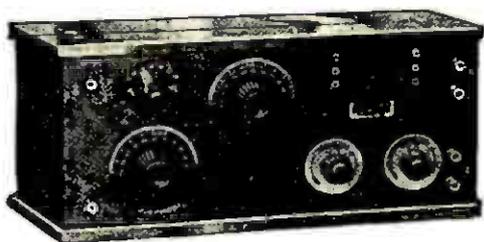
ATWATER KENT MFG. COMPANY
4933 STENTON AVE., PHILA., PA.



Please refer to POPULAR RADIO when answering advertisements.



Everyone Can Now Own a Quality Radio Set



This is Model K—the much-talked-of outfit with which Mr. E. D. Elliott of Milford, New York, got London, England, Fairbanks, Alaska—La Palma, Panama, San Francisco—Los Angeles and about 122 other long distance stations.

It's a two-tube outfit that sells for only **\$29.50**

MODEL MW

Shown in the illustration at the top of the page is our 4-tube outfit that can be used with a loud speaker. It sells for only \$54.50.

Write for Bulletin

THESE two Improved Miraco models make it possible for every family to own their own set—to have a choice seat for the opera or symphony or jazz concert right in their own living room.

Improvements and refinements that appear in expensive sets only are built in each and every MIRACO. In other words, *highest quality at the lowest price* has been solely responsible for the sale of thousands of our sets that are bringing radio-joy to each and every family who own one. Users of Miraco sets report getting as many as fifty stations in one evening.

The cabinets are of solid mahogany and workmanship is unexcelled. Easy and simple to operate and always dependable. Fully **GUARANTEED** against any defects in workmanship.

Write for our new bulletin TODAY

Dealers—Jobbers: Write for proposition quickly

Agents: There's still some territory open—write or wire

THE MIDWEST RADIO COMPANY
812 Main Street, Cincinnati, Ohio

The Improved
MIRACO

Considering The MOZART Baby GRAND



OUR new reproducer is now under consideration by thousands of radio enthusiasts throughout the country. Singularly, many of the most expert are making quick decisions and below we quote from an opinion, entirely unsolicited, given us by Mr. C. E. Mattson, Baltimore.

"I gave the sample a test at one of the radio stores. About 15 customers crowded round and all agreed it was equal to the \$35.00—and won by several lengths against the \$30.00—. My own opinion is that the M-G is going to be the greatest hit in radio this and next season—"

Within five days (date of going to press) from receiving above, we have had orders for immediate shipment, aggregating exactly 146 complete reproducers and a large quantity of extra units for other makes of horns and phonographs

from Mr. Mattson and his customers.

Prices. An Explanation.

We have been reluctantly obliged to slightly increase our price and to prospective purchasers a full explanation will be mailed on receipt of a postal card.

Complete with (gold plated) unit and cord, ready for attaching.	\$12.00
West of the Rockies.....	\$12.65
Unit only (gold plated) with cord ready for attaching.....	5.00
Unit only (nickel plated) with cord ready for attaching.....	4.00

The MOZART-GRAND CO.

Manufacturers of Fine Instruments

NEWARK, N. J.

U. S. A.

“Take No Chances—Use Como”

The World's Standard Push-Pull Transformer



“COMO DUPLEX” TRANSFORMERS

(Push-Pull Power Type)

Send for Copy of—

**“How to build a Power
Amplifier”**

Over 10,000 replies were received from one article pertaining to power amplification using “Como Duplex” transformers—most of those who replied are now enthusiastic users. Why not join them?

PRICE \$12.50
Per Pair

THE first and best power type transformers offered the radio enthusiast. In competition COMO stands alone! We can prove it. Mr. Laurence M. Cockaday, well known Radio Engineer, specifies COMO push-pull transformers in his latest radio receiver—the four circuit tuner—Take advantage of Mr. Cockaday’s experience and use COMO yourself to obtain greater Volume, better quality and freedom from tube noises that ordinary transformers produce. A great deal of the noise that is blamed on “static” is really tube noise amplified by improperly designed transformers. COMO may be used with your present amplifier, giving you more volume on weak signals that more of the ordinary amplification would kill.

COMO APPARATUS COMPANY
446 Tremont Street Boston, Mass.

THEY ARE FOR SALE AT LEADING DEALERS

\$25 for \$10

The Famous BEL-CANTO Acoustical Amplifier

Direct from
Manufacturer
to you

You cannot buy the
BEL-CANTO from
any dealer

Only direct from us. We
save you these three profits
DISTRIBUTOR, JOBBER
and DEALER

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.

Tel. Vanderbilt 8959

C. O. D. Delivered to your door

Price
\$10

BEL-CANTO MFG. CO.

BENSEL-BONIS Co., Inc.

General Office and Factory, Dept. P. R. 417-419-421 East 34th St., N.Y.C.



THE ACOUSTICAL AMPLIFIER
BEL-CANTO
TRADE MARK

GUARANTEE

Money back any
time within ten days
if dissatisfied. We
further guarantee to
the publication carry-
ing this advertisement
that each and every
speaker sold will be
exactly as advertised
in this issue.

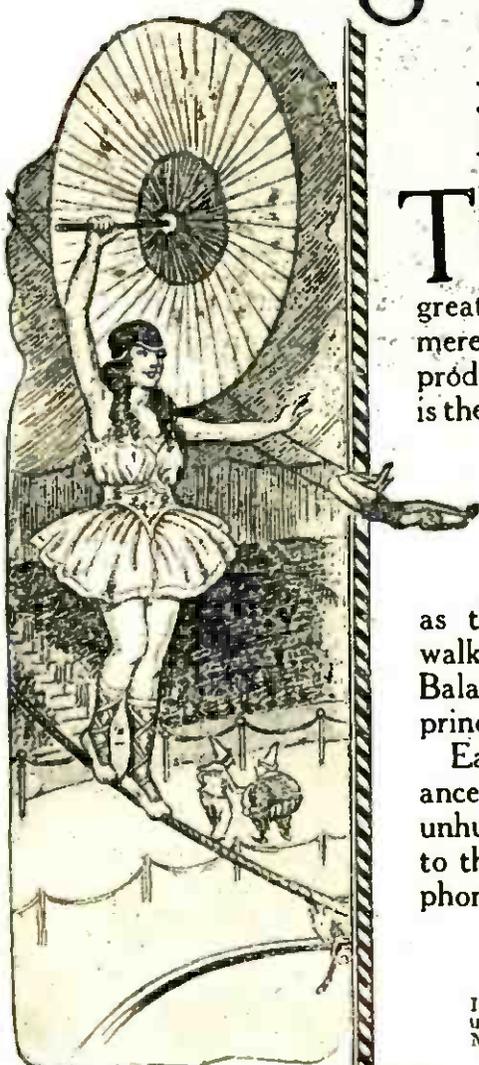
7 POINTS OF BEL-CANTO SUPERIORITY

1. Our own fiber horn. Crystalline finish.
2. Our own adjustable-loud speaking unit, giving a wide range of tone quality and volume without distortion.
3. The base of cast iron, weighing four pounds, eliminating top heaviness.
4. All other metal parts are of heavy cast aluminum, highly polished.
5. Complete instrument stands 24 inches high, 10 inch bell.
6. Guaranteed for one year from date of purchase against mechanical defects of any kind.
7. No auxiliary batteries required. Just plug in on 2nd stage.



Eagle Neutrodyne

Balanced! RADIO RECEIVER



THE sheer weight of overwhelming merit, has given to the name "Eagle", in a short time a tremendous significance — the greatest of neutrodyne receivers. Hearsay, mere "claims" or boasting could not have produced such sensational prominence. This is the verdict of radio engineers, leading authorities and of radio fans who have made an absolutely unbiased comparison.

The secret of the EAGLE'S marked superiority is its infinitely fine balance — as perfect, as flexible, as dependable as that of the carefully trained tight-rope walker to whom balance means life itself. Balanced tube capacities is the fundamental principle of the EAGLE Neutrodyne Receiver.

Each EAGLE Neutrodyne Receiver is balanced by a neutrodyne expert with the same unhurried, painstaking precision as devoted to the first EAGLE. As easily operated as a phonograph. Guaranteed without reservation.

Write for literature.

Licensed by Independent Radio Manufacturers, Inc., under Hazlett Patent No. 1,450,080, dated March 27th, 1923, and other patents pending.

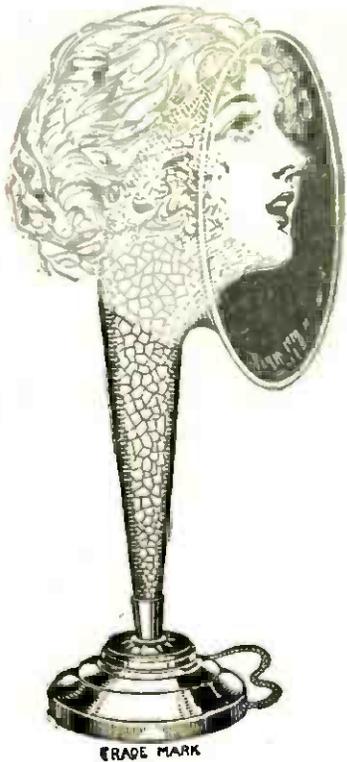
Write for Illustrated Leaflet

*Perfect Balance
Secret of
Eagle
Supremacy*



18 Boyden Place

Attend the Presidential Conventions !



TRADE MARK

Complete \$25



Atlas Unit with phonograph coupling..... \$13.50

Through the
Atlas
TRADE MARK
RADIO-REPRODUCTION
LOUD SPEAKER

HEAR the famous speakers as distinctly as though you were actually present. The ATLAS produces this marvelous illusion. Give your family and friends a real treat. Order your ATLAS Loud Speaker now.

Booklet "B" Upon Request

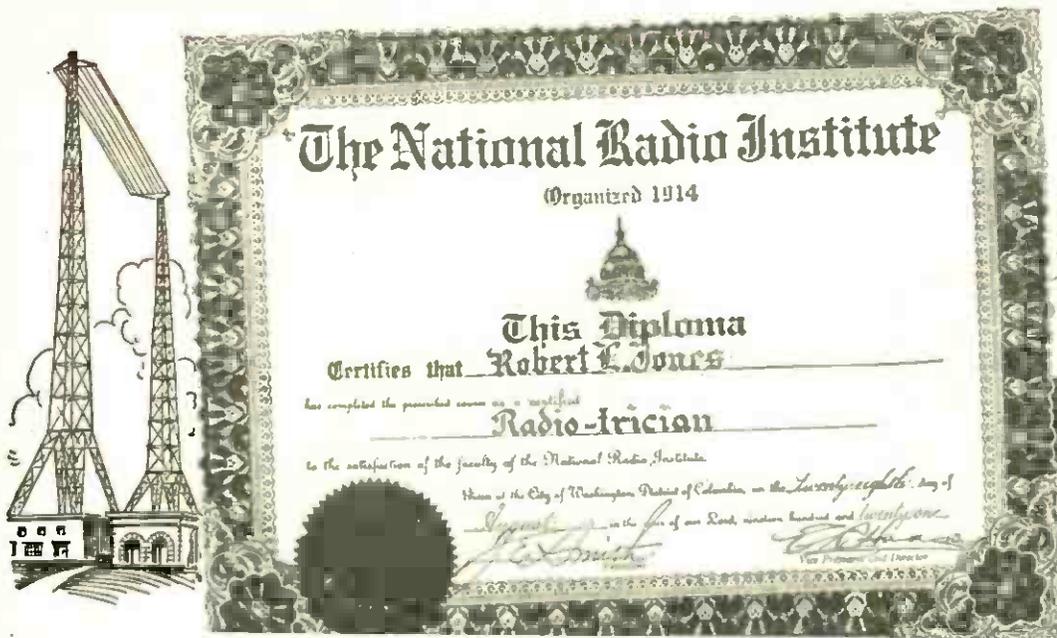
Multiple Electric Products Co. Inc.

Makers of Time-Lag—MONO-FUSES—Multiple
2 ORANGE STREET :: NEWARK, N. J.

District Offices in
BOSTON, MASS. PHILADELPHIA, PA. BALTIMORE, MD. BUFFALO, N. Y. ROCHESTER, N. Y.
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

Please refer to POPULAR RADIO when answering advertisements.



This Certificate Opens the Way to the Best Radio Positions

Get It - You Can Earn Big Money With It

No previous experience in Electricity or Radio is necessary. In a few short months, you can easily win this certificate and qualify for one of the splendid, big money positions in Radio.

Merle Wetzel of Chicago Heights, Ill., advanced from lineman to Radio Engineer, increasing his salary 100 per cent. even while taking our course! Emmet Welch, right after finishing his training, started earning \$300 a month and expenses. Another graduate is now an operator of 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. Hundreds of other men are occupying equally attractive positions after winning our Certified Radio-technician certificate.

Easy Now to Become A Certified Radio-technician

No other work in the world today offers such opportunities, such big money, such rapid advancement, such a promising future as does Radio. And the Expert Radio-technician is the man who is in a position to choose the best of these opportunities—to jump farthest ahead in this newest and fastest growing industry.

Become an Expert Radio-technician. You can easily and quickly. The National Radio Institute, America's first and largest Radio School, has devised a remarkable method that makes it easy for anyone to qualify right at home during spare time. Prominent radio experts give you personal advice and instruction through the mail. They grade your papers, answer your questions, and in every possible way help you in your work. And you learn the practical, wonderful side of radio by actual practice on patented instruments we send you free. The Certified

A Few of Many Letters We Receive Which Explain How We Place Graduates in Radio Position

We are in need of the services of a competent radio engineer who has a thorough knowledge of radio, together with selling ability, and would appreciate it if you could recommend to us any person or persons that could fill a position as outlined above.
DX-INSTRUMENT CO.

Good Future

I want a man who can show the customer about circuits, and answer questions. One who can set up sample sets. He must hold at least a third grade commercial license in order that our broadcast station may be operated at least twice a week. This position offers a fine future to the right man.
JOHN R. KOCH

Executive Position

We thought you would be in a position to cooperate with us in securing men with executive ability as well as knowledge of the Radio business to take charge of our offices as local managers.
UNIVERSAL RADIO CO.

Radio-technician Certificate awarded you on the completion of your course is government recognized, counting for 5 to 10 points on all government license examinations.

Instruments Free to Students

An extraordinary feature of this course is the use of four patented instruments, owned exclusively by us, which give practical training in radio operation, installation, maintenance and repair—all of which you must have to become an Expert Radio-technician.

Also, now included free with course, are circuits and parts for building the latest receiving sets.

Send for Radio Book

Thousands of positions are open to Certified Radio-technicians. Find out what your opportunities are in this fascinating profession. Send for interesting book, "Rich Rewards In Radio," which gives complete details on plan by which the National Radio Institute quickly qualifies you at home in spare time as a Certified Radio-technician. Send the coupon or a postcard for free book NOW. NATIONAL RADIO INSTITUTE, Dept. 32EA, Washington, D. C.



Radio Operator



Radio Mechanic



Radio Salesman



Radio Engineer

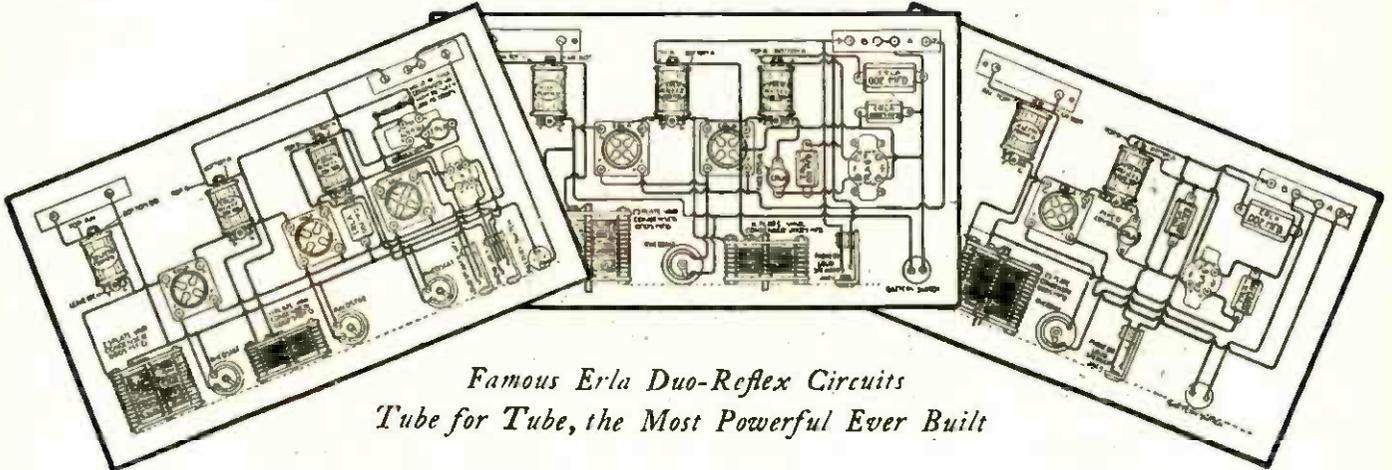
NATIONAL RADIO INSTITUTE, Dept. 32EA, Washington, D. C.

Send me your book, "Rich Rewards In Radio," with full particulars about the opportunities in radio, and how you will quickly train me in my spare time at home to win a Certified Radio-technician Certificate. Also about your employment service

Name Age
 Street Occupation
 City State

Please refer to POPULAR RADIO when answering advertisements.

No Circuits Equal These In Range, Purity, Volume!



*Famous Erla Duo-Reflex Circuits
Tube for Tube, the Most Powerful Ever Built*

TIME serves only to emphasize the superiority of Erla Duo-Reflex Circuits—tube for tube, the most powerful circuits ever built.

An Erla circuit introduced efficient one-tube loud speaker reception, and still stands unsurpassed. So too, Erla two and three-tube circuits remain unchallenged, outstripping four and five tubes otherwise employed.

Even in minor phases, Erla superiority is pronounced. Control is positively fool proof, eliminating reradiation and distortion, while stability is so complete that every station is heard invariably with the same dial setting.

Underlying the efficiency of these circuits, and the mainspring of their success, are Erla radio and audio transformers. Through synchronizing perfectly received radio, reflexed radio and reflexed audio frequency currents, they enable vacuum tubes to do triple duty, multiplying amplification without flaw.

Equally indispensable to maximum efficiency are Erla Selectoformer, Erla fixed crystal rectifier and Erla condensers, meeting completely the exacting requirements of reflex design.

For complete information, ask your dealer for Erla Bulletin No. 20; or write direct.

Electrical Research Laboratories
Dept. R. 2500 Cottage Grove Ave., Chicago

ERLA



Maximum range, selectivity and volume are positively assured through Erla radio frequency transformers. Reflex and cascade types. \$5



Superior quality of Erla audio transformers stands clearly revealed in their ability to amplify three stages without flaw. \$5



Extreme sensitiveness and perfect stability of Erla fixed crystal rectifiers meet every requirement of reflex operation. List, \$1



Erla Selectoformer betters coupling between any antenna and any receiver, with resultant increase in range and selectivity. List, \$5



Erla condensers alone bear the words "tested capacity" on their labels, guaranteeing superior accuracy at no extra cost. 35c to 75c ea.



Exclusive features of Erla sockets are now available in 199 as well as standard size. Quality and workmanship unequalled. 65c and 75c

Please refer to POPULAR RADIO when answering advertisements.



*If you closed your eyes you'd think
you were in the Fifth Row Center*

You can hear the softer tones

PLUG in a pair of Murdock Radio 'Phones—and tune-in on New York. You'll think you are in the fifth row center at a Broadway musical show—at the Symphony Concert, or the Opera. Everything is reproduced—the clear notes of the singer's voice, the high and the low tones of the violin, the saxophone of the jazz orchestra.

Perfect diaphragm adjustment the secret

THE correct seating and clamping of the diaphragms are important factors in the success of Murdock Radio 'Phones. This adjustment keeps the diaphragms in place—and prevents distortion. The sensitivity of the diaphragms gives natural reproduction to voice and music.

Light and comfortable

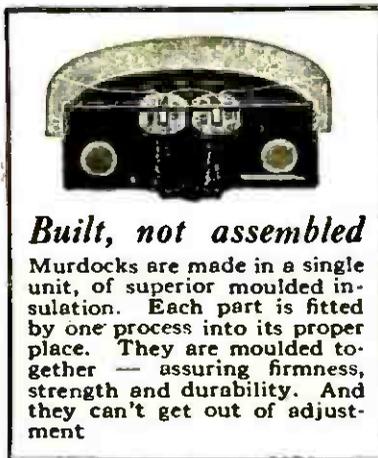
THE Murdock weighs only 13

ounces. This extremely light weight makes it possible for the user to wear these 'phones for hours without discomfort. Ear caps are especially designed to exclude outside noises. The improved flat head-band is feather-weight, and does not bind the head. And there are no screws in the band or adjusting rods, which means added comfort to the wearer.

Over 1,000,000 Murdock's are in use today. Quantity production has enabled us to standardize our price—so that when you buy a Murdock you are sure of getting the best possible value. Get a Murdock today and test it out. It is fully guaranteed.

Murdock Multiple Plug Jack

THIS effective plug jack permits the use of one to four 'phones at the same time. Get one—and let the whole family listen in.



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

WM. J. MURDOCK COMPANY, 373 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.,
373 Washington Avenue, 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

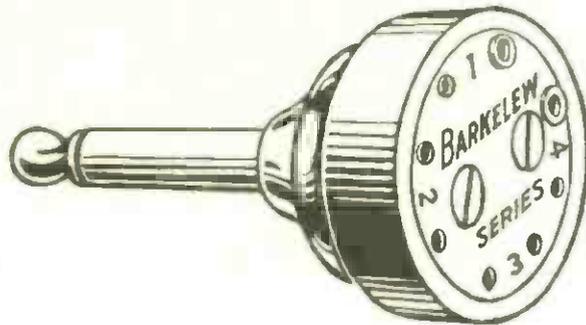
Please refer to POPULAR RADIO when answering advertisements.

Barkeley Four-Phone Plug

PATENTS PENDING

Connects four phones or less in series to
any Radio Set employing standard
telephone jacks

□ □ □



Cat. No. 616
Price \$1.50

It adds to the appearance of any set.
With all phone tips adjusted, the
diameter is but $1\frac{1}{4}$ inches

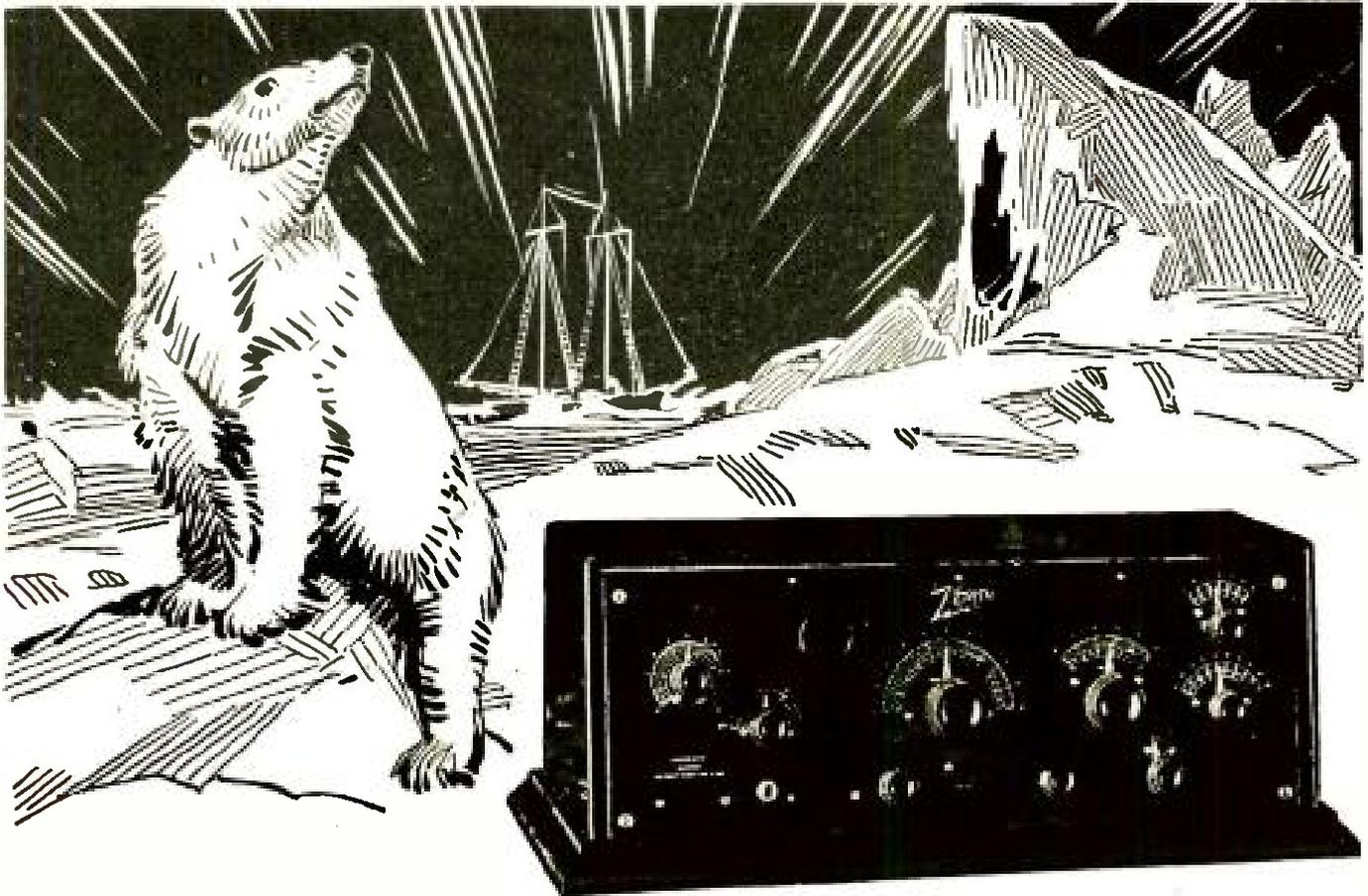
CHICAGO, ILL.
15 S. CLINTON ST.

BARKELEY

SAN FRANCISCO.
75 FREMONT ST.

ELECTRIC MANUFACTURING CO.
MIDDLETOWN, — OHIO.

Please refer to POPULAR RADIO when answering advertisements.



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

Eleven Degrees from the North Pole

Ice—endless miles of ice, as far as the eye can see. And frozen fast in the ice, amid the deadly stillness and the unearthly lights of the Arctic, a staunch little eighty-nine foot schooner! But Donald B. MacMillan and his band of brave explorers are not alone tonight.

Under their ice-bound hatches they listen eagerly to the news of the outside world, broadcast to them from the Zenith-Edgewater Beach Hotel Broadcasting Station, Chicago—to violins in Newark, Schenectady, Los Angeles—to singers in Atlanta—to a lively orchestra in Honolulu.

Stations in all these cities—and in several hundred others—they have readily tuned in; yet the Bowdoin tonight is only eleven degrees from the North Pole!

Out of all the radio sets on the market, Dr. MacMillan selected the Zenith exclusively—because of its flawless construction, its unusual selectivity, its dependability and its tremendous REACH.

And you can do all that Dr. MacMillan does, and more, with either of the two new models described at the right. Their moderate price brings them easily within your reach. Write today for full particulars.

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 readily accomplished in full volume, using any ordinary loud-speaker. No special skill is required. 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. R, 328 South Michigan Avenue, Chicago, Illinois
Gentlemen:
Please send me illustrated literature on Zenith Radio.

Name

Address

At Last—An Authoritative, Practical Radio Book

THE OUTLINE OF RADIO

(What Radio Is and How It Works)

By JOHN V. L. HOGAN

Mr. Hogan, one of the best-known radio engineers in the United States, in his book, "The Outline of Radio," gives the history of radio from its earliest days, and describes practically all that is now known regarding the essentials of this wonderful science.

In a clear and simple way, he explains the relation of electric currents to radio waves, their characteristics and properties, and the leading and fundamental features of the operation of radio telegraph, and radio phone transmitters and receivers are succinctly and accurately described.

All the different steps in radio are discussed: transmission, modulation, and wave-propagation; reception, detection, selection, and amplification. The adaptation of radio to weather reporting, marine signaling, and other forms of public service, is clearly set forth; and the expansions of the radio art, in various applications, are interestingly forecast.

Kendall Banning, Editor of POPULAR RADIO, says: "The logical sequence in which the subjects are handled, the generous number of illustrations and particularly the simple and understandable style of diagrams which have been selected, combine to make the book remarkably easy to read and to comprehend."

Third Printing. With Illustrations and Diagrams. \$2.00 at All Booksellers

Boston

LITTLE, BROWN & COMPANY

Publishers

Grebe and **BAKELITE**

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

The character of broadcast reception enjoyed by users of Grebe Radio Sets is due, in no small measure, to the extensive use of Bakelite.

The excellence of Bakelite and the dependability of its qualities is indicated by the fact that a large majority of Radio Manufacturers choose Bakelite as insulation, and for improving and simplifying the design of their sets and parts.

Bakelite combines in ONE material the essential properties of many. It is highly di-

electric and mechanically strong; it is unaffected by moisture, temperature or climatic changes; its color will not fade, even in strong sunlight; it will not warp, bloom or crack—but the most important property of "The Material of a Thousand Uses" in its relation to Radio is that of providing *permanently* effective insulation regardless of temperature or atmospheric conditions.

Write for a Copy of our Radio Booklet K.

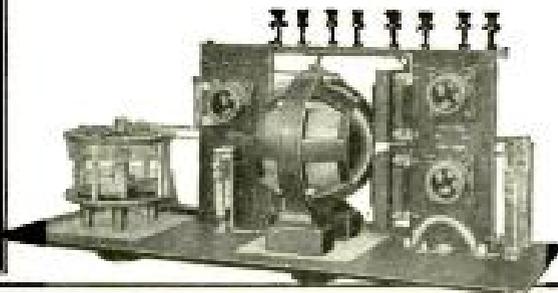
Send for our Radio Map

Enclose 10c. and let us send you the Bakelite radio map. It lists the call letters, wave length and location of every broadcasting station in the world. Address Map Department.

BAKELITE CORPORATION

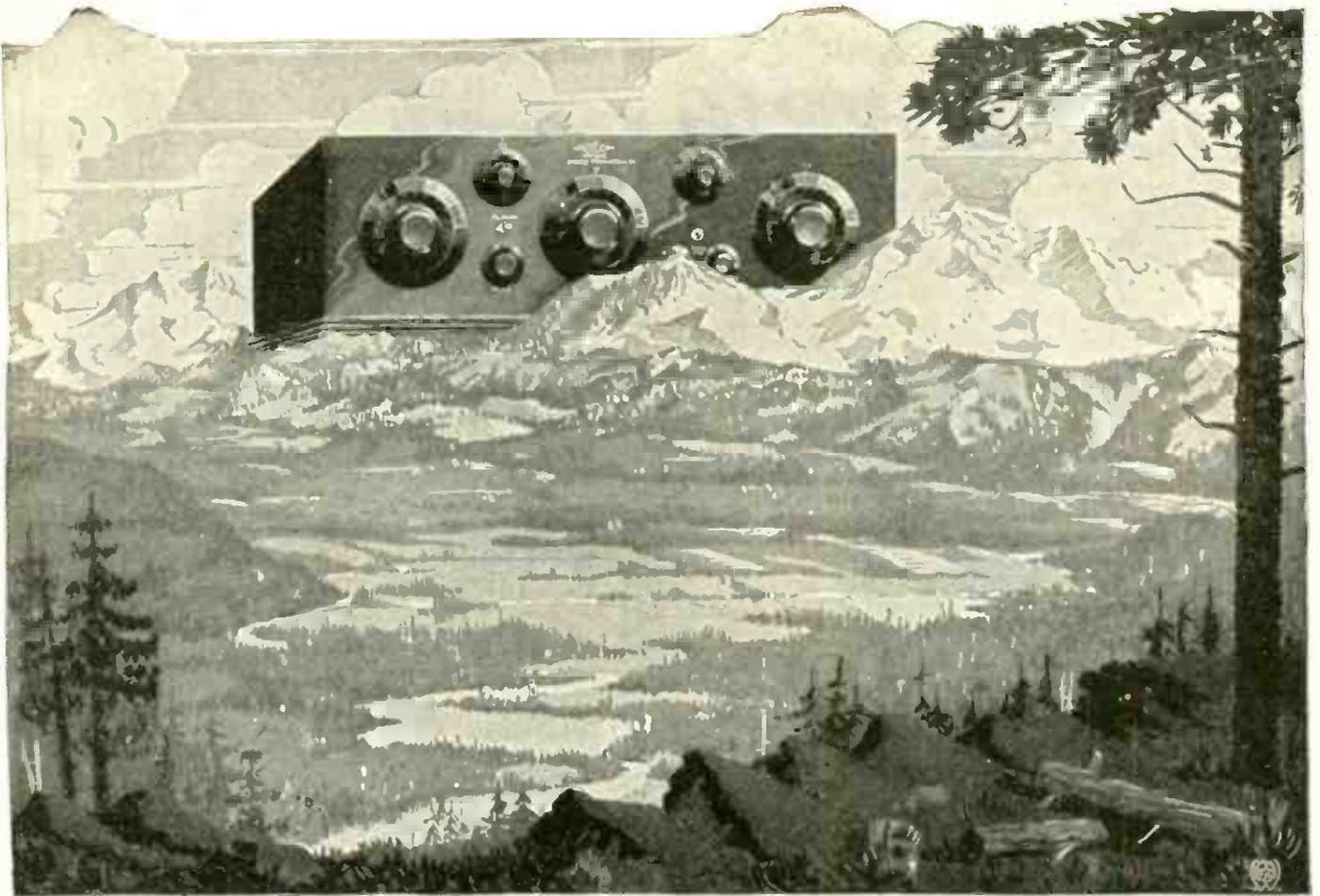
247 Park Avenue, New York, N. Y.

Chicago Office: 636 West 22d Street



THE MATERIAL OF A THOUSAND USES

Please refer to POPULAR RADIO when answering advertisements.



A C H I E V E M E N T

FOR ages the battle between Man and Nature has gone on. The harnessing of rivers, the bridging of oceans, the conquest of space and time,—all give evidence of Man's relentless efforts to overcome the barriers which Nature sets up to challenge his skill and ingenuity.

With the unflinching courage of pioneers, Melco attacked the last barriers of the ether, bringing the treasures of the radio art within the

reach of all. Today, the Melco receiver is supreme in its achievements.

Melco was the first to level the sinister mountains of *Interference*, *Distortion* and *Signal Losses*. By its improved design and intensive engineering, the Melco-Supreme has made distance reception the servant of the non-technical user. It has set new standards of selectivity and freedom from interference and its superb tone quality has captivated even the most critical.



AMSCO PRODUCTS, INC.
Broome and Lafayette Streets, New York, N. Y.



Please refer to POPULAR RADIO when answering advertisements.

“Wouldn't trade my
THOROPHONE

TRADE MARK REG. U.S. PAT. OFFICE

for a Rolls-Royce”

says HARRY H. HECKMAN

High
Power
Model
S-5
\$45.00



COMPARISON tells. Listen to the Thorophone and learn how perfect a loud speaker can be. Every tone, every note is given its true value. You would think speaker or musician were right before you.

Make the Thorophone your permanent loud speaker investment—you'll never want to change it. The Thorophone makes any set sound better.

Made by America's oldest manufacturers of loud speaking devices. A power horn, taking only one ampere from a 6-volt storage battery. It actually amplifies weak signals, yet handles the greatest possible volume with the same natural quality—quality that satisfies.

Write for booklet

WINKLER-REICHMANN CO.
4801 S. Morgan Street Chicago, Ill.



“See! Dad
how much stronger it's coming in since you bought me

BURGESS
RADIO BATTERIES

SOMETIMES it's Dad who does the buying for his radio family, but you may be sure that that youngster of his sits in on the advisory board.

In all events, whether it be the boy or his father who buys receiving set equipment, the service of Burgess Radio Batteries provides a most satisfactory and economical means to greater enjoyment of the evening's radio entertainment.

“ASK ANY RADIO ENGINEER”

BURGESS BATTERY COMPANY

ENGINEERS • DRY BATTERIES • MANUFACTURERS
FLASHLIGHT • RADIO • IGNITION • TELEPHONE

GENERAL SALES OFFICE: HARRIS TRUST BLDG., CHICAGO
LABORATORIES AND WORKS: MADISON, WISCONSIN

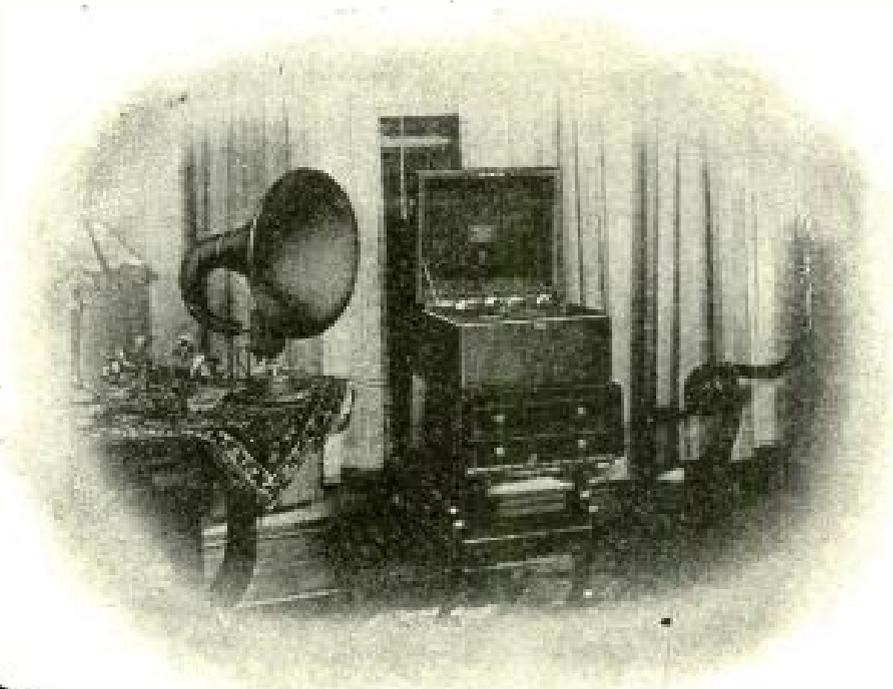
BRANCHES

NEW YORK BOSTON KANSAS CITY MINNEAPOLIS
WASHINGTON PITTSBURGH ST. LOUIS NEW ORLEANS

IN CANADA

PLANTS: NIAGARA FALLS AND WINNIPEG
BRANCHES: TORONTO MONTREAL ST. JOHN

Bristol Single Control Radio Receiving Set together with Bristol Senior Audiphone Loud Speaker as used in One of the Finer Homes.



Radio Reception Simplified to Single Control Dial

It is an easy matter for any member of the family to operate a set like this. A good illustration of the absolute simplicity of

BRISTOL SINGLE CONTROL RADIO RECEIVER

is the fact that a set is installed in the home of a blind woman who operates it herself and is able to bring in station after station at her will.

Powerful enough to get reception from coast to coast. It is a four-tube set using Grimes Inverse Duplex System, which makes it equal to six tubes because the first two tubes are utilized for both Radio and Audio Amplification.

Non Reradiating—will not disturb your neighbors' reception when you tune in.

Many refinements, including panel with telephone jacks on back of the case for making connections.

Used with Aerial or Loop, and in some locations short Inside Antenna will give good results. When Aerial and Loop are both provided it is only necessary to operate a lever to change from one to the other.

The case is solid mahogany finish with walnut stain. It is handsome in appearance, and at the same time provides a rugged protection for the working parts.

Price of Bristol Single Control Radio Receiver without accessories \$190.00.

BRISTOL

AUDIOPHONE

LOUD SPEAKERS

made in three models, Senior \$30.00, Junior \$22.50, Baby \$12.50.

The most recent development in these models is the fibre horn with which the Baby Audiophone is now furnished, as illustrated below.

Write for Bulletin No. 3013-L



MADE AND SOLD BY
THE BRISTOL COMPANY
Waterbury, Conn.

KEEPS THE RADIO SET ALIVE

HANDY CHARGER

A Battery Charger that gives a quick charge economically. No Sticking Contacts. No bulbs nor Liquids. Fully enclosed — beautiful.

SIMPLEX MODEL—For 6 volt Batteries only. The Most Practical, Most Complete Battery Charger, for only **\$16.00**



ULTRA MODEL—Charges Them All, Charges 2 volt, 4 volt, 6 volt, 8 volt, 10 volt, 12 volt and 1 to 4 "B" Storage Batteries, with WESTON AMMETER, **\$18.00**

All prices f. o. b. St. Louis

INTERSTATE ELECTRIC COMPANY of St. Louis, Mo. 4015 Laclede Avenue

Your Condenser Makes a Difference



Pick up those distant stations louder and clearer. Eliminate noise and interference. Get more pleasure out of your receiving with

Elgin Elraco Precision Condensers

Fully Guaranteed

Size	Capacity	Plain	Vernier
3 Plate	.000063 M. F.	\$1.75	
11 Plate	.00025 M. F.	2.40	\$4.00
17 Plate	.00035 M. F.	2.75	
23 Plate	.0005 M. F.	3.00	4.50
43 Plate	.001 M. F.	4.00	5.50

3" diameter composition dials, 50c extra

See your local dealer. If he cannot supply you send his name with your order to

Elgin Radio Corporation

Radio Division of The Elgin Tool Works, Inc.
69 No. State St. Elgin, Illinois

"Hard to Get" Parts

We specialize in parts for hook-ups published in this magazine. Here is a list of "hard to get" parts we can ship from stock.

- Genuine Cockaday coils..... 5.50
- Amsco 26 Plate Condensers..... 4.50
- AmerTran Transformer..... 7.00
- Como Push & Pull ".....pair 12.50
- Lavite Resistances..... 1.50
- Parts for Special Variocoupler and Radio Frequency Transformer (for Craig Neutrodyne receiver) 3.25
- Cardwell 21-Plate Condensers .. 5.00
- " 41- " " 6.00
- " 11- " " 4.25
- Dubilier .0025 Condensers40
- General Radio Transformers . 5.00
- Alden Napier Products:
- Amsco Products:
- Acme Celatsite Wire—30 inch lengthseach .25

Try us on ANY radio parts you have been unable to secure: Mail orders will be shipped promptly.

Morison Electrical Supply Company, Inc.

15 East 40th Street

New York City

Super-Heterodyne

Resistance Coupled **No Transformers**

The New Improved Type Employing Resistance Coupling
for Broadcast Reception

Free from Distortion

Write for Details

Cockaday Four Circuit Receiver

Special Service to Builders

of the New Improved Four Circuit Receiver as Described in **January Popular Radio**

Complete Parts for the Four Circuit Receiver **\$59.00**

Drilled Machine and Engraved Bakelite Panel according to **Cockaday's Specifications** **\$6.50**

Genuine P. L. Resistances The Original in the following Capacities

For **COCKADAY, REINARTZ, SUPER-HETERODYNE and FARRANDS' SUPER-PLIODYNE CIRCUITS**

1,000 Ohms 30,000 Ohms
12,000 Ohms 48,000 Ohms
20,000 Ohms 50,000 Ohms
25,000 Ohms 80,000 Ohms
100,000 Ohms

List Price **\$1.00**

Dealers: Write for Discounts

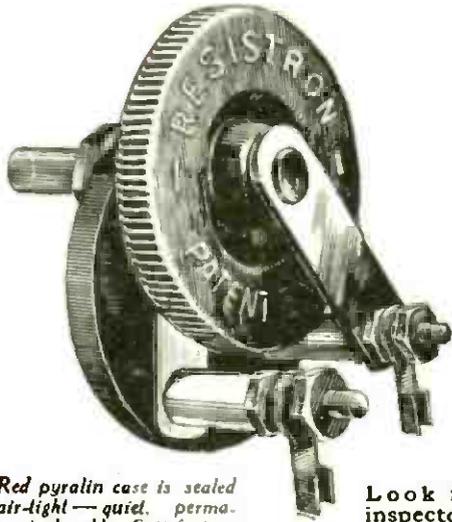
All Mail Orders Shipped Promptly Send Money Order, Including Postage
WRITE FOR OUR NEW CATALOG "G"



The Radio Mail Order House—Where you get the right goods at the right Prices

1480 BROADWAY, CORNER 42nd STREET
LONGACRE BUILDING **NEW YORK CITY**

The Precision Variable Grid Leak



Red pyralin case is sealed air-tight — quiet, permanent, durable. Satisfactory results guaranteed.

Look for inspector's number on the label.

Resistron

Two Dollars

Maybe your detector tube is playing 'possum. RESISTRON will make it "snap out of it." Turning the dial picks the point of greatest sensitivity. Then the tube wakes up, stretches for DX — and gets on the job, increasing your list of stations. Try it!

If your dealer cannot supply you we will ship parcel post C. O. D.

TEMPLE INSTRUMENT COMPANY

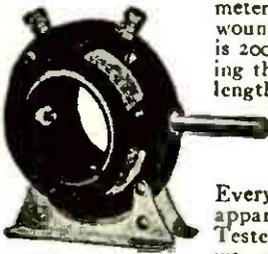
Camden, New Jersey

Coto

"Built First to Last"

"So Much Better than you claimed it to be"

So says one of the users of Coto Compact Moulded Variometer. Letters from all quarters praise this remarkably efficient variometer with the honeycomb wound stator coils. Range is 200 to 600 meters covering the broadcasting wavelengths. Type 8000. \$5.



Read Our Guarantee

Every piece of Coto Radio apparatus is Laboratory Tested before shipment. So we are perfectly safe in authorizing dealers and jobbers to guarantee you absolute satisfaction.

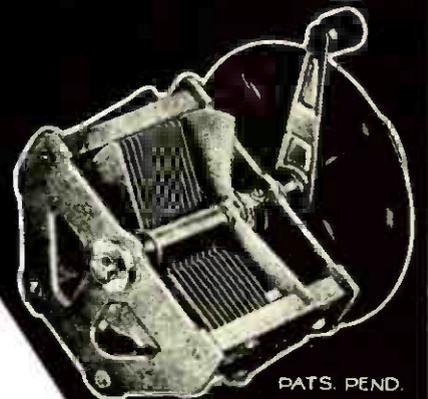
If your Dealer cannot supply you, send us your order and his name and address

COTO-COIL CO. 87 Willard Ave. Providence, R. I.

Los Angeles, 329 Union League Bldg.
Minneapolis, Geo. F. Darling, 705 Plymouth Bldg.
Atlanta, C. P. Atkinson, Atlanta Trust Co. Bldg.

Canada, Perkins Electric Co., Ltd.
Montreal, Toronto, Winnipeg

DUPLEX



PATS. PEND.

Series "FR" Condenser

In this model we have, we believe, made a distinct contribution to the art.

Mechanically perfect. We have reduced the electrical losses to an immeasurable minimum.

Some profitable jobber territory still open.

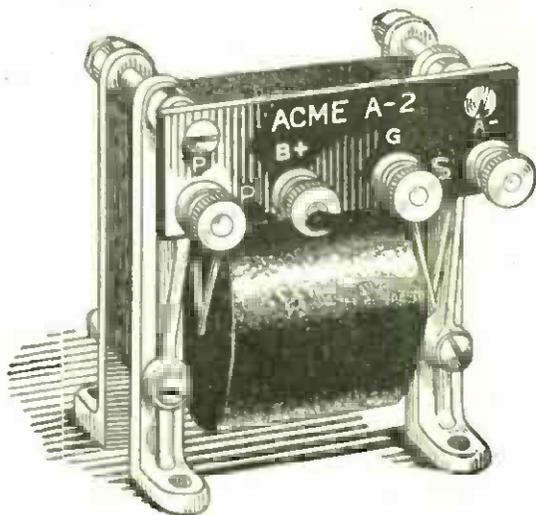
Write for Bulletin "Facts for Fans" on Condensers

The DUPLEX ENGINE GOVERNOR CO., Inc.
50 Flatbush Ave. Extension
BROOKLYN, N. Y.

TRADE MARK
NONE OTHER

To get amplification without distortion—use ACME

Thousands of radio owners find Acme Transformers give louder, clearer radio. Letters from users show increased range—“amplification without distortion,” important factor in success of Acme audio and radio frequency transformers.



ACME A2
for volume

“**M**Y RANGE at once increased so that I get stations that I never got before,” writes one amateur who installed Acme transformers in his set. Thousands of amateurs who have experimented with different hook-ups and different apparatus to get the best results insist on Acme transformers.

Acme transformers are the result of long research by the Acme Apparatus Company, specialists in the manufacture of amplifying transformers. When broadcasting was in its early stages Acme engineers recognized that “Amplification is the key to radio.” They set out to make the Acme amplifying transformers give maximum amplification without distorting the sound. So well did they succeed that today Acme transformers are the most popular transformers made.

The Acme R-2, 3 and 4 Radio Frequency Amplifying Transformers increase range. Acme A-2 Audio Frequency Amplifying Transformer gives greater

volume to any set *without distortion*. The ratio is 4.25 to 1 and exhaustive tests show that this is the correct ratio, even for three stages.

Rigid inspection means uniform apparatus

TRAINED inspectors in the Acme factory, carefully test each transformer before it leaves the factory. This means that each piece of Acme apparatus is up to Acme standard when it reaches you. Every transformer carries a guarantee tag— but the best guarantee is the name Acme.

Send for booklet

OUR booklet, “Amplification without distortion,” clearly explains how to get the most out of your set by using the proper amplifying apparatus. It contains diagrams for the Acme “Reflex” circuit. Mail the coupon for your copy.

ACME APPARATUS COMPANY

Dept. 43

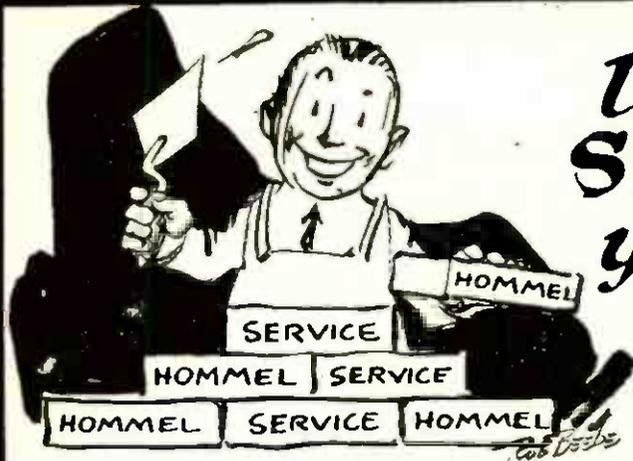
Cambridge Mass.

ACME

~ for amplification

ACME APPARATUS COMPANY
 Dept. 43, Cambridge, Mass., U. S. A.
 Gentlemen:—I am enclosing 10 cents (U. S. stamps or coin) for a copy of your book, “Amplification Without Distortion” containing wiring diagrams for the Acme “Reflex” Circuit.

Name.....
 Street.....
 City..... State.....



Use **HOMMEL SERVICE** to build your radio business

Complete stocks of strictly high grade nationally advertised radio apparatus are constantly carried by this Company to enable you to build your radio business on the right foundation. Your success is dependent largely on the products you sell, and your ability to serve your customers promptly.

Aligning yourself with the HOMMEL organization makes it possible for you to always have access to ample stocks of the leading lines of radio equipment without the necessity of tying up your working capital.

Let us show you how you can advantageously use Hommel Service. Write for encyclopedia 246-P

LUDWIG HOMMEL & CO

530-534 FERNANDO ST.

PITTSBURGH, PENNA

DISTRIBUTORS FOR
Radio Corporation of America



Westinghouse General Electric
Atwater-Kent
Baldwin Brandes Burgess
Crosley Cutler-Hammer
Dubilier Fada Freed-Eisemann
Freshman Frost
General Radio Grebe
Homecharger
Remler Rhamstine
U. S. Tool Western Electric
Workrite
And other
leading manufacturers

COAST TO COAST on the R.C.S circuit, using RayCoils



RayCoils "A" for Reinartz, Ray Coils "B" for RCS and Ultra Audion Circuits, RayCoils "C" for RCS, Ultra Audion and Tuned Radio Frequency for All Circuits. RayCoils "D" for Neutralizing Circuits 4 & 5 Tubes.

A = \$2.50
B = 2.00
C = 2.00
D = 2.00

Use the RCS Circuit with or without Radio Frequency for Simplicity in operation and results. Not equalled by any set for volume and distance.

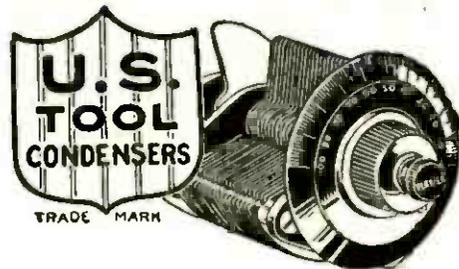
Coils in Separate Box With Wiring Diagram

Working Blue Prints of four sheets 12 x 18 of all standard circuits, such as The Variometer, Reinartz, RCS one and three tube sets and five tube Neutralizing Circuit 50 cents a set.

We also carry a complete line of Carter, Howard, Kellogg, All American and Trimm parts.

If your dealer cannot supply you, we will mail direct.

R. C. SCHOONHOVEN
Major Q. M. R. C.
ELGIN ILL.



Approved by Public Demand

The huge sale of U. S. Tool Condensers proves that these condensers are RIGHT.

100% Guaranteed

End Plates of
CELORON

For Superheterodyne, Superdyne, Inverse Duplex, New Four Circuit Tuner

Use 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.

Write for Booklet

U. S. TOOL CO., Inc.
116 Mechanic St. Newark, N. J.



Boys' radio interest knows no "off season"

THE HARDER the battle the sweeter the triumph. That's part of every live boy's code. And when it comes to radio, the greater the difficulties the more he strives to overcome them, or failing that, to succeed in spite of them. This spirit of boydom, together with the unquenchable enthusiasm boys have for radio, is the radio manufacturer's bridge across the summer doldrums.

No matter where a boy goes—to camp, the mountains or the shore—he's sure to have two things with him: His appetite and his radio set. And each trip to the general store has a double purpose—soda for the appetite, and some new device for the beloved radio. The desire for one is as unremitting as the desire for the other. The volume of sales for both is amazing.

THE AMERICAN BOY

"The Biggest, Brightest, Best Magazine for Boys in All the World"

is guide and authority to 500,000 radio-hungry boys averaging 15½ to 16 years old. These boys are sons of well-to-do parents, possessors of substantial allowances with which to buy desired objects. And all through the summer this great army of boys will be buying radio equipment.

Advertise your radio products to them. Tell them not only of the

goodness and up-to-dateness of your products—tell them of your distribution, and how they can get your goods wherever they spend the summer. Start them using your name—and thinking about radio in terms of your name. Keep your name and your product constantly before them in the one great publication they know to be their own—THE AMERICAN BOY.

THE SPRAGUE PUBLISHING COMPANY

(Member A. B. C.)

548 Lafayette Boulevard, Detroit, Michigan

Please refer to POPULAR RADIO when answering advertisements.

Bakelite Jack



No. 30-Single circuit open \$.80
 No. 31-Single circuit closed .85
 No. 32-Double circuit .90
 No. 33-"A" Battery Switch .90

Every CICO PRODUCT is packed in a distinctive GREEN BOX and unqualifiedly guaranteed against all defects.

2-Way Plug



Price 60c

WHY CICO PRODUCTS LEAD THE FIELD

CICO Bakelite Jacks

Moulded completely from Bakelite. Connections made to neat binding posts. Smaller and more compact than other jacks. Special phosphor bronze springs. Sterling Silver contact points. Mechanically and electrically perfect in every detail.

CICO

CICO 2-Way Plugs

Constructed so that loud speaker and head-phones can be connected simultaneously or individually as you wish (note two slots in each terminal). Fit all standard jacks. Take all types of tips, forked, straight and plain wire. Sturdily made and finely finished.

Consolidated Instrument Co.
 of America, Inc.

41 East 42nd Street, New York

*Announcement
 of prize-winning name
 to replace "Acmedyne"*

TELOMONIC

WELL over 1000 names were suggested in the contest for a circuit name to replace "ACMEDYNE."

The judges, Charles Hardy, S. E. Bramer, R. H. Butler, H. I. Danziger, and Lester L. Jones, after careful deliberation, selected "TELOMONIC" as most expressive of this principle of tuned R. F. amplification.

The winner, Dr. M. Ohlbaum, receives a complete knock-down set of the essential Telos instruments for the TELOMONIC circuit.

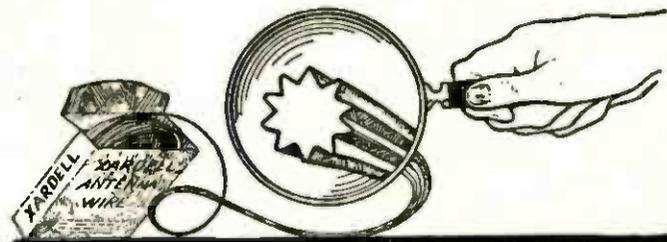
Danziger-Jones, Inc. desires to express sincere thanks to all those who participated in this contest.

TELOS



RADIO

DX-10-POINT



ANTENNA WIRE

\$2⁰⁰

PER
 HUNDRED
 FEET

Designed for long distance reception and is different and better than the usual make-shifts, being hard drawn from the finest copper, having a corrugated surface with ten collecting points on the circumference. This gives a greater collective surface to the high frequency radio currents. The result is extreme sensitiveness and increase in range and clearness of any set from the simplest Crystal to the finest multiple tube receiver.

Use this antenna wire and enjoy the full possibilities of your set.

Sold in coils 100 feet, 200 feet and 500 feet. Order direct or from your nearest dealer.

Dept R

Xardell Corp.
 UTICA, NEW YORK

Announcing

TYPE AF-7 (Turn ratio $3\frac{1}{2}$)

AMERTRAN

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

*Improve your set
with an AmerTran*

*This summer you will
be able to enjoy radio
as never before*



Price, either type, \$7.
—at your Dealer's
or sent carriage charges collect

THE AmerTran, Type AF-6 (Turn ratio 5), has long been acknowledged the Standard of Excellence for audio amplification.

Type AF-7 (Turn ratio $3\frac{1}{2}$), is now, after long study and experiment, offered in response to the demand for a companion transformer for second or third stages of sets provided with powerful regeneration or radio frequency amplification and more especially those sets wherein one AF-6 does not give sufficient volume under all conditions, and 2 stages are too powerful for the

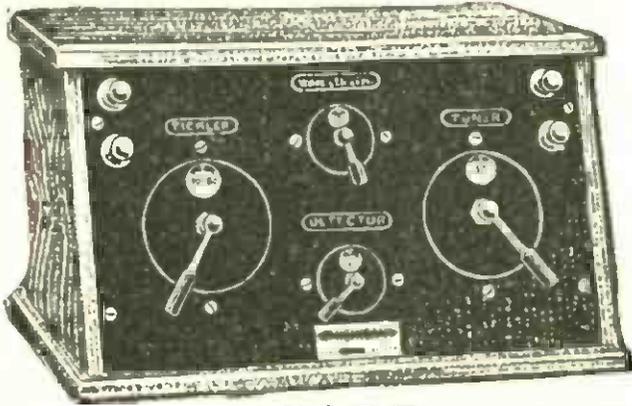
tubes unless negative biasing batteries are used.

Type AF-7, like AF-6, provides an unusually flat amplification curve with well sustained amplification at very low audio frequencies. It is not intended as a substitute for AF-6, but where a low turn audio transformer must be used, nothing has been sacrificed in making Type AF-7 the very best for its purpose.

Type AF-6 is finished in black and is packed in a box printed in dark blue. Type AF-7 is finished in brown and packed in a box printed in red.

Send for Circular

American Transformer Co., 175 Emmet Street, Newark, N. J.
Designers and builders of radio transformers for over 23 years



M. R. C. 10

Pleases the Whole Family

It pleases the boys, for they can out-distance their friends—no matter what set they've got.

It pleases the girls, for they can quickly tune into any station—The Midjet is simple to operate, nothing difficult.

It pleases Mother because its attractive appearance does not spoil the setting of her room. And when cells are used there is no fear of acid spoiling her rugs or floor. Mother also can enjoy cooking lectures and afternoon concerts, for she can soon tune in her station.

It pleases Dad, for he has to pay the bill.

Nothing to equal the Midjet has ever been offered at anything like the price. It will do anything any other set will do, and costs about half as much. Yes, sir—the whole family is pleased, and Dad, he too, soon tunes in, enjoying himself till Mother calls him to bed.

MICHIGAN RADIO CORPORATION

MICHIGAN MIDJET

\$27

Michigan One-Tube Receiving Set has no equal for range, clearness, selectivity or volume. The same stations always come in at the same dial numbers.

Distance
Volume
Selectivity
Simplicity

Licensed under Armstrong U. S. patent, 1,115,149 and pending letters of patent 807,388.

34 Ottawa Street
GRAND RAPIDS, MICHIGAN

The B-T Prize R-F Circuit

can be built up and tested *on the air* step by step.

This method insures success.

It is non-regenerative and does not re-radiate.

Write for circular

BREMER TULLY MFG. CO.
534 So. Canal St.
CHICAGO

GOLDWHISKER

Gets Greater Distance. Pure gold makes the best contact known. We guarantee a GOLD-WHISKER for greater range and louder signals out of any crystal. 50c prepaid—send coin or stamps, or we'll send C. O. D.

REP RADIO CO.

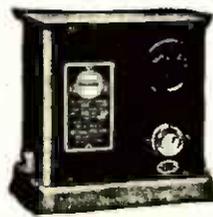
Dept. N-2 3231 Nebraska Ave., St. Louis, Mo.

CRESCENT LAVITE RESISTANCES

12,000	} Ohms.		LIST \$1.50
48,000			
50,000			
100,000			

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.



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

RUSONITE

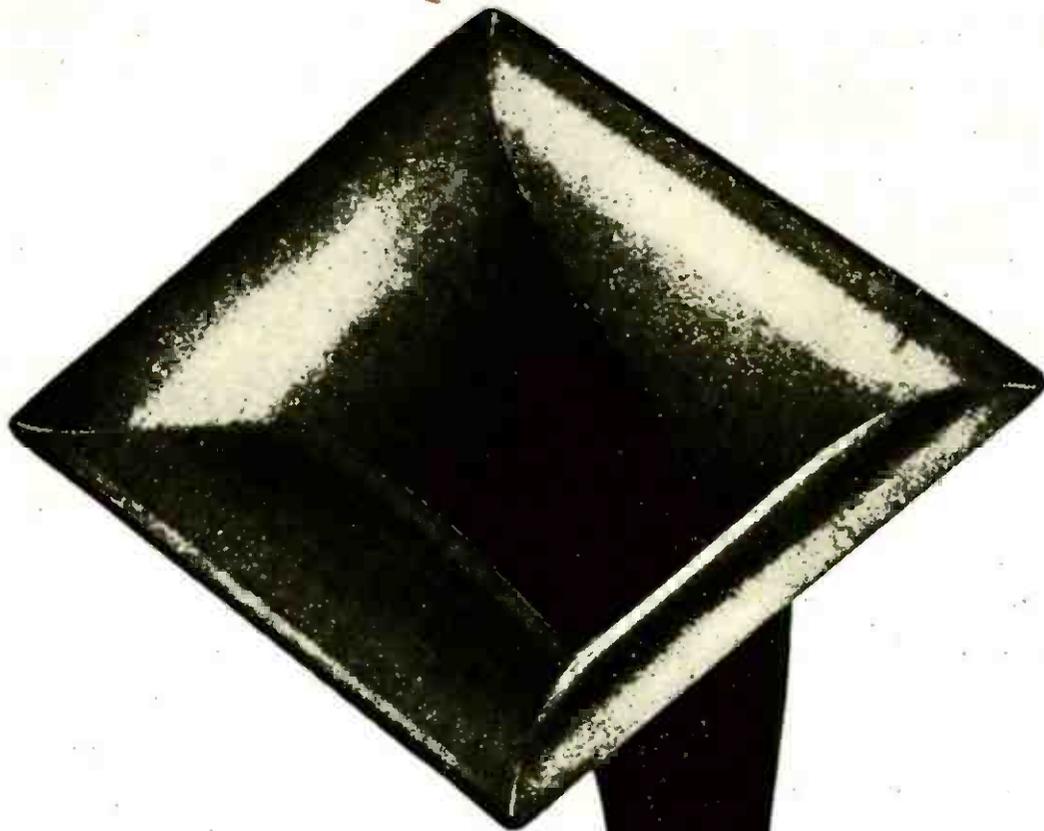
FIXED DETECTOR

TONE ADJUSTER - BAKELITE BASE

Guaranteed. Price \$1.25

Rusonite Perfect Radio Crystal Supersensitive. Price, Mounted, 50c
Rusonite Catwhisker 14k. Gold, 25c

Rusonite Products Corporation
15 Park Row, New York, N. Y.



The CLEAR

Loud Speaker!

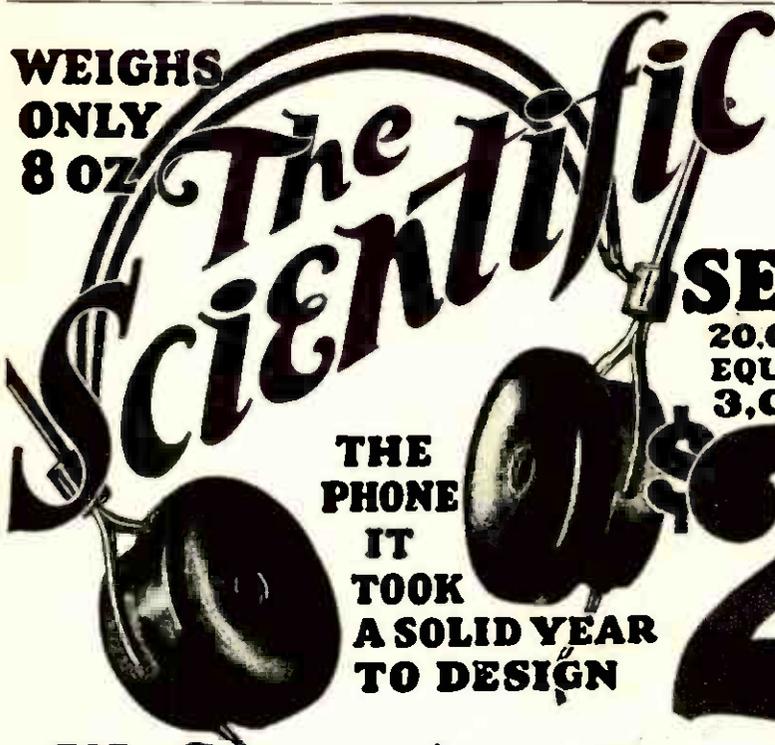
Herald



THE Herald stands up under power without rattling. Like other good musical instruments, it improves with age because of its laminated core, mica diaphragm and permanent magnet. The adjustable diaphragm makes it possible to get the most out of a weak set. Height 30 inches, 6-foot cord. Price \$30. Slightly more on Pacific Coast and in Canada. Write for folder and enclose your dealer's name.

Herald Electric Co., Inc., 113 Fourth Avenue, New York

Please refer to POPULAR RADIO when answering advertisements.



WEIGHS ONLY 8 OZ

A \$200,000.00 COMPANY stands squarely back of the guarantee on every Scientific headset

SEND NO MONEY!

20,000 TURNS EQUIVALENT TO 3,000 OHMS

Order TODAY by Postcard

and Pay Postman on arrival

THE PHONE IT TOOK A SOLID YEAR TO DESIGN

\$2.95

POST-PAID

LOUD SPEAKER UNIT \$1.95

We Guarantee The Scientific Headset to be the greatest value on the market. Try it for five days. If not satisfactory send it back and your money will be refunded immediately. Circular on request. Dealers wanted.

THE SCIENTIFIC ELECTRIC WORKS
98 Brookline Ave. DEPT. J BOSTON, MASS.



LOUD SPEAKING UNIT
(Phonograph Attachment)

\$6.50

Floating Mica Diaphragm
Loud—Clear—Natural

C. I. C. Loud Speaker with 20" Acoustene Fabric Horn—the latest and best. . \$16.00

All C. I. C. instruments are unconditionally guaranteed.

If your dealer cannot supply you order direct from us.

Connecticut Instrument Co.
Stamford, Conn.



Perfect Panels



for any set, big or little!

SUPREME for super-heterodyne or single circuit! No other material known possesses the many combined advantages of Bakelite-Dilecto for radio paneling! Tell it by its center red stripe.

bakelite-dilecto

(A Laminated Phenolic Condensation Material)

Once the installation is completed, Bakelite-Dilecto panels remain absolutely unchanged, no matter what abuse it is given by heat, cold, water, steam, oil, solvents and weather elements. They do not warp, swell, shrink, crack, check or split. Highest in dielectric strength. Surpassingly tough, yet readily machined. Your dealer can get it cut and drilled to fit your needs.

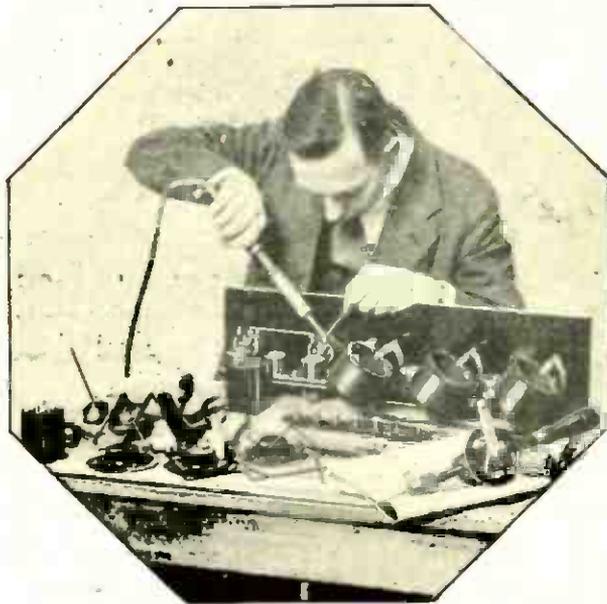
THE CONTINENTAL FIBRE CO.
Factory: Newark, Delaware

Service on Bakelite-Dilecto (also Continental-Bakelite, Conite, Contex and Vulcanized Fibre) from:
New York, Woolworth Bldg. Chicago, Wrigley Bldg.
Pittsburgh, 301 Fifth Ave. San Francisco, 75 Fremont St.
Los Angeles, 307 S. Hill St. Seattle, 1041 Sixth Ave., So.
Offices and Agents Throughout the World



Get This Book!
"How to Build
Neutrodyne Radio
Receivers"

This 48-page book is the standard authority on making five-tube Neutrodyne receivers. Fully illustrated with picture wiring diagrams and a full-size drilling template for a five-tube receiver. Complete instructions on assembly, wiring, neutralizing and tuning. Also includes detailed trouble-shooting information. Sent post-paid anywhere in the U. S. for 50 cents. Write for this new edition today.



FADA Knock-Down
Parts for Five-tube
Neutrodyne
Radio Receivers

165-A—Three Neutroformers and two Neutrodons with "How to Build It" book. The heart of the Neutrodyne receiver—\$35.00.

167-A—Everything for five-tube set down to last screw and binding post. Complete with book, panel, baseboard, sockets, telephone jacks, audio frequency transformers, Neutroformers, Neutrodons, etc.—\$65.60.

Ask your dealer for FADA parts.

Make yourself a FADA Neutrodyne receiver
and enjoy the best in radio

THOUSANDS and thousands of successful Neutrodyne receivers have been built by radiophans using only FADA Neutrodyne parts. With the famous FADA "How to Build It" book (over 150,000 of which have been sold) anyone can build a five-tube Neutrodyne receiver that will amaze by its fine performance.

FADA Neutrodyne receivers have made wonderful records for distance and volume, for selectivity and ease of operation. A resident of Forrest Hills, Long Island, writes, "Heard London and Glasgow on loud speaker evening of March 13th with FADA five-tube set."

Because the Neutroformers and Neutrodons require special engineering design, they are naturally the heart of the receiver. FADA parts are made accurately to scientifically correct specifications—they've got to be right and are right before they pass our rigid standards of inspection.

If you want to own the most satisfactory radio receiver, buy FADA Knock-Down parts and build yourself a five-tube Neutrodyne receiver. Get genuine FADA parts—don't take unknown parts and expect them to work. Dealers everywhere sell genuine FADA Neutrodyne parts—look for the name and trade-mark on every package.

F. A. D. ANDREA, INC., 1581 Jerome Avenue, New York City

FADA
Radio



F. A. D. ANDREA, INC., 1581 Jerome Avenue, New York City

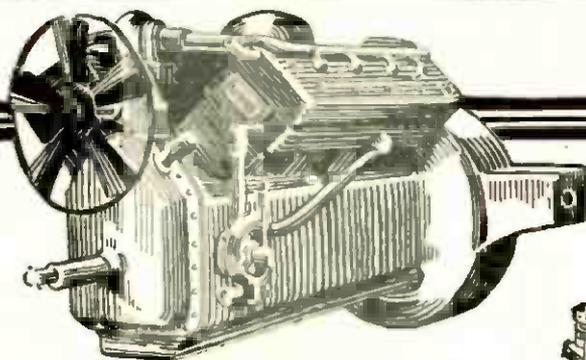
Gentlemen: Enclosed find fifty cents { Stamps } for which send me your book on "How to Build Neutrodyne Receivers."

Name.....

Street Address or R. F. D.....

City or Town..... State.....

Please refer to POPULAR RADIO when answering advertisements.



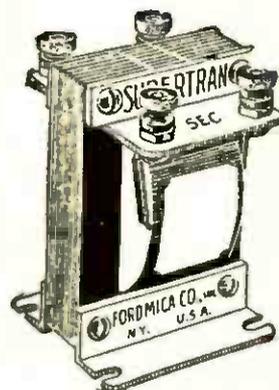
The Engine of Your Radio Set

WOULD you select a two-cylinder engine for pleasure driving? Would you use a marine engine to propel a motor truck? Would you use an air-cooled, aero-plane engine in a racing car? When you select audio transformers without considering their qualities you are putting the wrong engine in your radio set.

Supertran high speed smoothness with multi-cylinder reserve power makes it an ideal audio engine to drive your loud speaker. It represents the best engineering because you have no back-fire distortion or poor timing regulation to introduce howling.

Ford Mica Co.

33 East 8th Street
New York City



New England Distributor:
Wetmore-Savage Co., Boston, Mass.

Midwest & Southwestern Distributors:

Beckley-Ralston Co.
Chicago, Ill.

Reg. U. S. Pat. Office

Howard
Radio Co. Inc. Chicago, U.S.A.

<p>HOWARD No. 1001 6½ Ohm Rheostat . . . \$1.10 25 Ohm Rheostat . . . 1.10 40 Ohm Rheostat . . . 1.10 Patd. 870,042</p>	<p>HOWARD No. 1002 6¼ Ohm Micro-rheostat . . . \$1.50 25 Ohm Micro-rheostat . . . 1.50 40 Ohm Micro-rheostat . . . 1.50 Patd. July 10, 1923</p>
<p>HOWARD No. 1003 200 Ohm Potentiometer . \$1.50 400 Ohm Potentiometer . 2.00 Patd. 870,042</p>	<p>HOWARD No. 1004 Multi Terminal Receiver Plug, instantaneous connection for as many as six pairs of standard receiver tips . . . \$2.00 Patd. Aug. 28, 1923</p>

Ask the man behind the counter to show you the Howard line of quality Radio Merchandise. Every piece is sold with the guarantee of satisfactory performance.

Jobbers write for discounts.

Send two cents for folder.

HOWARD RADIO CO., Inc.
4248 North Western Ave., Chicago, U. S. A.

BLANDIN TRIPLE A

And NOW Super Radio Cabinets

Panel size 8 x 40-8 inches deep. Made of solid select mahogany with basswood bottom, varnished and hand rubbed to a piano finish. Built by experienced workmen—experts on cabinet design and construction.

BLANDIN TRIPLE "A" DE LUXE SERIES

Full De Luxe equipment including extra mounting board—inlet flush lid—continuous piano hinge—folding lid supports—rubber feet.

Also Neutrodyne sizes, 7 x 24-7" and 7 x 26-7".
Smaller sizes, 7 x 14-7", 7 x 18-7" and 7 x 21-7".
Write for illustrated price list and name of your nearest jobber or dealer.

Jobbers and dealers, write for discounts

BLANDIN PHONOGRAPH COMPANY, INC.
1500 16th St. :: :: RACINE, WIS.



NEWS OF



MARATHON

AFTER the great battle of Marathon, 490 B. C., between the Athenians and Persians, a runner named Phidippides carried news of the Greek Victory to Athens about 25 miles away. So great were his exertions that, delivering the message, he fell dead. Our annual Marathon race commemorates this event.

Radio now enables us to learn of great events almost instantaneously.

This great agency of enlightenment is available to anyone possessing a receiving set, but for its true enjoyment, only the best in Radio instruments should be used.

The Holtzer-Cabot Electric Company has spent years in scientific experiment and development, so that its Loud Speakers and Headphones faithfully reproduce the messages which come to us through the air.

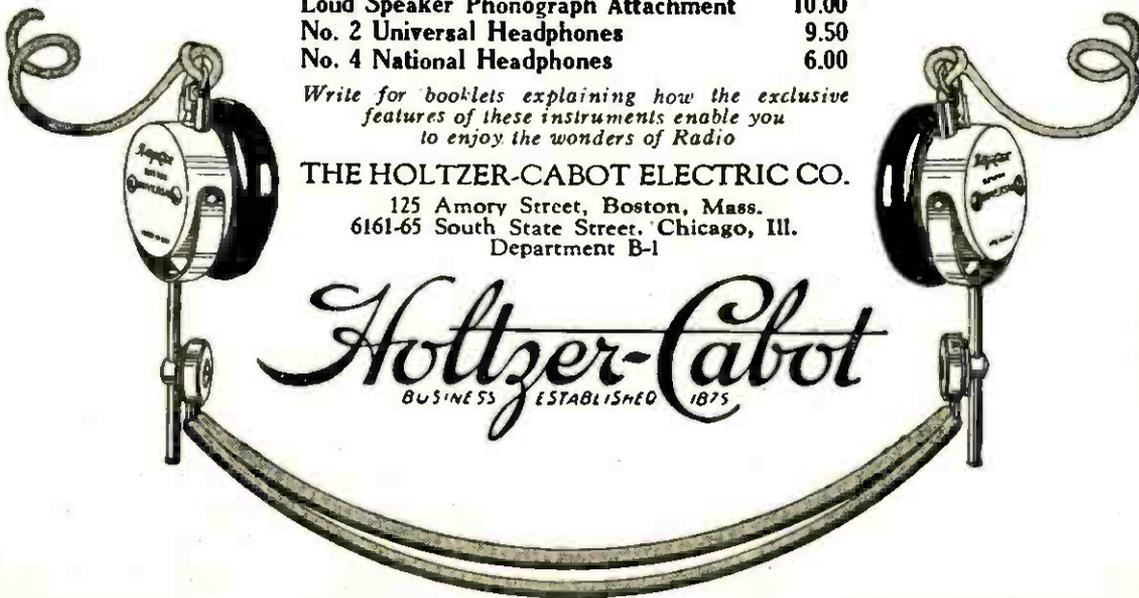
- | | |
|------------------------------------|---------|
| Holtzer-Cabot Loud Speaker | \$25.00 |
| Loud Speaker Phonograph Attachment | 10.00 |
| No. 2 Universal Headphones | 9.50 |
| No. 4 National Headphones | 6.00 |

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

Holtzer-Cabot
BUSINESS ESTABLISHED 1875



Please refer to POPULAR RADIO when answering advertisements.



COCKADAY UNIT

Full Set A, B, C and D Coils

Made strictly in accordance to Mr. Cockaday's Specifications



Range 150 to 600 Meters

For 1, 3 and 5 Tube Set

Price \$5.50

Best quality Radion hard rubber tubing 1/8" wall wound with No. 18 double silk covered wire.

Three Large Blue Prints, Illustrated Instructions, and Material Lists for Building the 1, 3 and 5 Tube Cockaday Sets. Price 50c

(Free with order for unit)

Guaranteed mechanically and electrically perfect. The outstanding features: Complete set of A, B, C and D Coils with beautifully knurled binding posts, eliminating loose end wires, insuring perfect contact and easier wiring. Made of the best quality material combined with expert workmanship. Distributed capacity or leakage and dielectric losses practically eliminated. Insures selectivity with maximum sensitivity and volume.

Unconditionally Guaranteed to Give Absolute Satisfaction
At Your Dealer, Otherwise Shipped to You Postpaid
Dealers and Jobbers Write for Attractive Proposition

GENERAL RADIO WINDING CO. 214 FULTON ST. NEW YORK, N.Y.

Radio Wherever You Go

Vacation — Outing — Touring

This year go with **Radio**. Camp, fish, hunt, tour with **Radio**. Make your vacation complete. Liven up the rainy days and long, dull evenings. Take the new, wonderful **Ozarka Portable, Long-Distance Receiver** with you. Get the sports returns—the concerts—the special features of hundreds of broadcasting stations. And, best of all, you'll have it for home use when you return. **Ozarka** is built for long distance—1000 miles is not unusual. Simple to operate. Convenient and light to carry. Only weighs 15 lbs. complete. Case is 16x10x5 inches. Completely equipped with aerial, "A" and "B" Batteries, three No. 199 tubes, and one set of head phones. Ready for instant use. Price complete ready to listen in \$65.00. Extra phones \$5.50. Big demand. Order at once. Send \$10.00, pay balance on delivery. Satisfaction guaranteed.

Local Representatives Wanted

Ozarka Radio offers the greatest opportunity to make money. Big market—easy sales. Over 1800 **Ozarka Agencies** now doing wonderful business. Some territory now open. You're interested, so write today for the "**Ozarka Plan**," but don't fail to give name of your county.

OZARKA, Inc., 67 N. Peoria Street, CHICAGO



A
True-tone
Non-Directional
Ornamental
Solid Mahogany
Loud Speaker

—

Ask Your Dealer
or
Write Us Direct



TYPE B FRUIT BOWL

The VAN-LE REPRODUCER

(Pat. App. for)

Mfd. by
VAN-LE CORP'N
100 Sip Ave., Jersey City
N. J.

AN
INTERESTING
AND
ATTRACTIVE
PROPOSITION
FOR
DEALERS

—

WRITE FOR DETAILS



YOUR SET WILL BE A MUSICAL INSTRUMENT

WHEN YOU USE

THE THORDARSON SUPER AUDIO FREQUENCY AMPLIFYING TRANSFORMER

Heretofore, amplifying transformer manufacturers have given too much attention to volume of amplification and have sacrificed the most important function of their transformers,—that of perfectly reproducing the broadcasted programs. Consequently many listeners in have complained about the musical qualities of radio reception.

No matter how good your phonograph, you could not expect to obtain good music from a poor record. Likewise, although your loud speaker be the best, you cannot expect to enjoy radio reception if the signals you put into it have been distorted in the process of amplification.

The new THORDARSON SUPER Audio Frequency Transformer was designed to correct the shortcomings of amplifying transformers of the past and embraces the following cardinal features:

- (1) **Perfect reproduction of voice and instrument**
- (2) **Even amplification over the entire musical range. (You will be surprised to hear the amazing reproduction of the bass notes.)**
- (3) **Increase in volume to the extent that tonal purity will permit.**

This SUPER TRANSFORMER is the result of several months research work in the thoroughly equipped Thordarson laboratory and represents the culmination of twenty-eight years experience in manufacturing small transformers.

Such leading set manufacturers as the Colin B. Kennedy Company, Chicago Radio Laboratories Company (Zenith) and the Western Coil and Electric Company (Radiodyne) along with many others proclaim the merits of the THORDARSON SUPER TRANSFORMERS.

Install a pair of Thordarson Super Transformers now and your receiving set will be converted into a real musical instrument.

Even Amplification over the entire musical range

THORDARSON

ELECTRIC MFG. CO.

CHICAGO, ILLINOIS

Timmons Talkers

Where a Violin is not a Flute

The tones of Timmons Talkers are so natural, rich and vibrant that they make an especial and immediate appeal to musicians.

Listening to a Timmons Talker you hear a flute as a flute and a violin as a violin—you would never mistake one for the other.

A large diaphragm— $3\frac{1}{8}$ inches—and the “reflecting” of all sounds through two horns are responsible for the deep, pleasing naturalness of the Timmons’ tones.

But you’ll have to hear a Timmons Talker to appreciate this naturalness. In doing this we are asking you to make your loud speaker choice in your own home. Don’t make a five minute choice, take an entire evening.

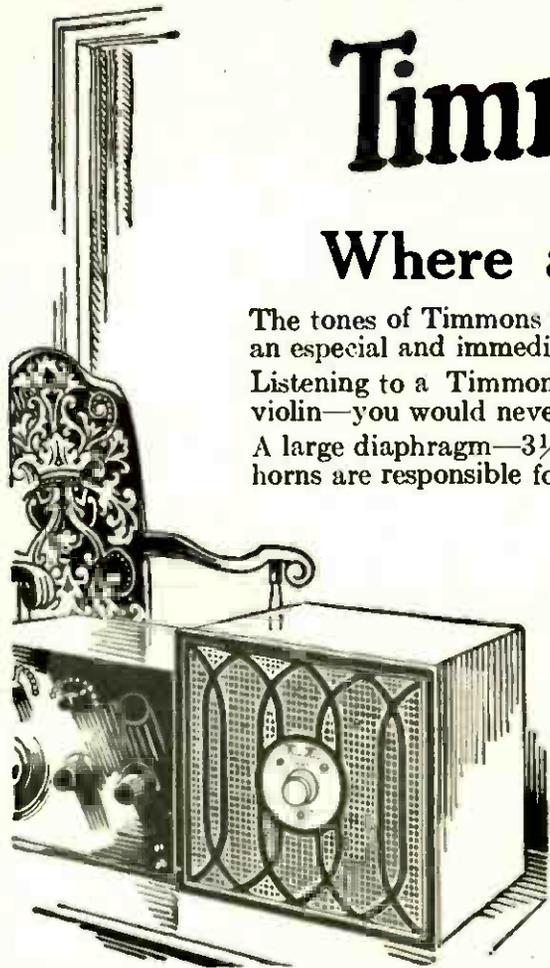
We’ll be glad to help by sending an illustration detailing how a loud speaker works. We’ll also send our folder “Volume Without Noise.”

Type A (adjustable), \$35
Type N (non-adjustable), \$25

J. S. TIMMONS

339 E. Tulpehocken St.

Germantown, Phila., Pa.



For Best Tone Quality—and Distance

Use the “BLUE STAR”
Audio-Frequency-Amplifying-Transformer

Better
Built—
Quality and
Material



Our
Standard
Ratio 4-1

List Price
Five Dollars

The Transformer that Equalizes Tone and Volume; prevents distortion from unnecessary causes.

Multiply the pleasure of your set by installing a “Blue Star Transformer.”

DEALERS: Write us for our sales proposition

STAR SUPPLY CO.

1512-1516 So. Wabash Ave., Chicago, Ill.

World's Greatest BATTERY BARGAIN



Written 2 Year Guarantee
Your Proof of Satisfaction

FREE

Hydro-
meter and
45V. “B”
Battery

SAVE 50%

Thousands of POPULAR RADIO Readers will profit by this amazing offer. They will buy the famous 2-year guaranteed, World battery at the lowest price ever quoted—They will get a hydrometer and a 45V. “B” Battery FREE. And they get the best battery built. It is “World” quality that makes possible our 2-year ironclad guarantee. It is “World” quality that makes “World” owners “tell their friends”—that’s the best proof of performance any product can have.

Compare These Prices:

Special 200 Hour Recharge-able Storage Batteries	6 Volt 60 Amp...	\$8.50
2 Volt for W.D. 11 and 12 tubes	6 Volt 80 Amp...	10.00
4 Volt for U.V. 199 tubes	6 Volt 100 Amp...	12.50
	6 Volt 120 Amp...	14.50
	6 Volt 140 Amp...	16.00

Send No Money

You need not send a penny. Just clip this ad and attach your name and address. The battery will be shipped to you the day your order is received. When the battery arrives, inspect it—read our 2-year guarantee before paying C. O. D. charges. Convince yourself you are protected from every angle—that the World battery price saves you 50%. Get the 45V. “B” Battery and hydrometer FREE. Order today.

Special Offer

Clip and mail this ad with your World battery order and get this hydrometer and 45V. “B” battery free. 5% disc. for cash in full with order.

WORLD BATTERY CO.
Dept. 3, 1219 So. Wabash Ave., Chicago, Ill.



World

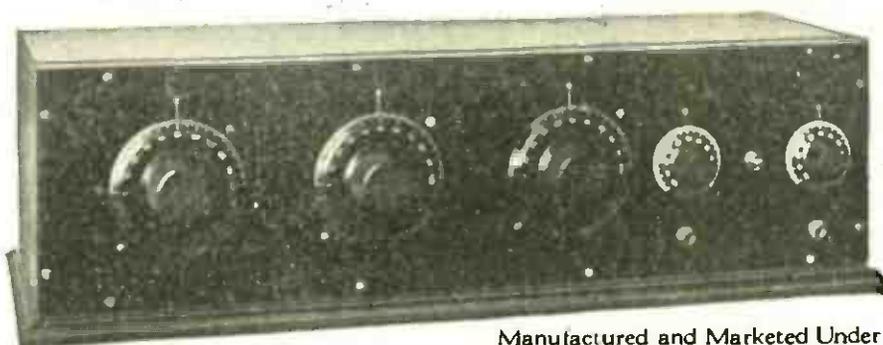


"MINUTE MAN"

Radio Receiving Set

incorporating

Pathé Type "P" Phusiformers



Manufactured and Marketed Under License Agreement, Patent Pending

Price \$125.00
(tubes, batteries extra)

THE new five-tube "Minute Man" was specially constructed to meet the demand for a receiving set embodying these features:

NO SQUEALS

Tune in either with a loud speaker or head phones without any squeals or rasping. At any setting of the dials there is none of the unpleasantness so prominent in many other sets.

PURE TONE

The reproduction of broadcasting by the "Minute Man" is remarkable for its clarity and sweetness of tone, increasing your enjoyment a hundredfold.

SIMPLICITY

The "Minute Man" is simplicity itself to operate. The dials can be adjusted by a child — and the set is "fool-proof." The dial settings are constant. A station once located can always be brought in without preliminary searching.

Free Booklet

Booklet "How to Build a 5-Tube Receiver, Using Three Phusiformers," sent free on request. Address Dept. 195.

Genuine mahogany cabinet and panels. Gold engraved dials.

PATHE PHONOGRAPH & RADIO CORP.
20 GRAND AVENUE :: BROOKLYN, N. Y.

At Last!
SUPER-HETERODYNE
You can build it yourself



THE LAST WORD IN RADIO RECEPTION

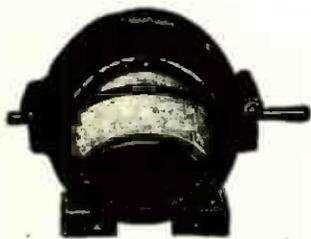
Build this 8-tube set DeLuxe with our kit of guaranteed knock-down parts. Our kit includes all the necessary parts, together with loop aerial, panel, cabinet (8" x 40") and complete working plan and diagram. If you are interested in *selectivity, volume, clearness, long distance*; and if you want to *save money*, take advantage of this offer. *Send stamp for bulletin.*

PRICE COMPLETE \$125 *f.o.b. Newark, N. J.*

THIS PRICE DOES NOT INCLUDE TUBES OR BATTERIES

NEW JERSEY RADIO SUPPLY CO.
76 SPRINGFIELD AVE. Dept. A. NEWARK, N. J.

GET DISTANCE
USE THE FAMOUS



Moulded Bakelite
VARIOMETER \$5.00

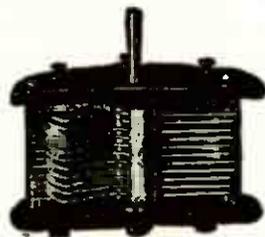
Scientifically accurate for long distance tuning. Moulded of Mahoganite Bakelite.

"Guaranteed to Satisfy"

Dealers—Write for Attractive Proposition

RADIO PRODUCTS CO.
Westport, Conn. U. S. A.

R. P. C.
NON—
MICROPHONIC



23-Plate
CONDENSER \$1.50

Affords precise calibration at all wave lengths. Mechanically rugged, Electrically correct.

**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

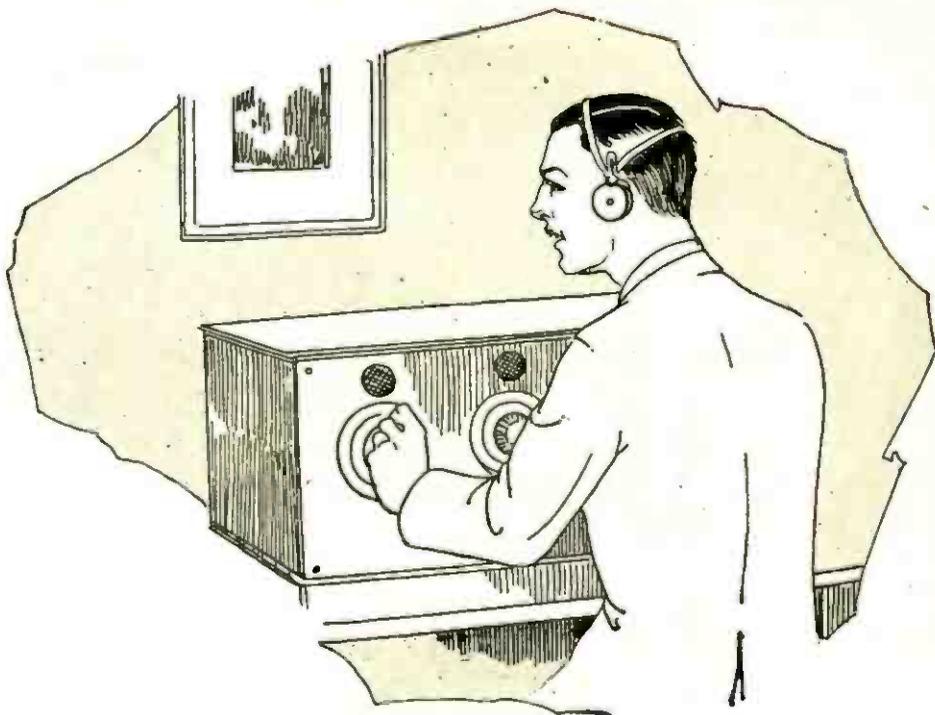
The RELIABLE
PARTS
MFG. CO.
2819 Prospect Ave.
Cleveland, O.

*This
Combination
Does It!*

RADIO FREQUENCY
AMPLIFYING TRANSFORMER AUDIO FREQUENCY
AMPLIFYING TRANSFORMER

Please refer to POPULAR RADIO when answering advertisements.

hours spent to solder
connections carefully
... wires shortened
... circuits altered ...



and still energy leaks away

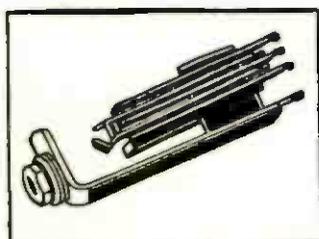
WHAT a tiny fraction of broadcast energy actually gets to your set! How vital it is to prevent a particle of that energy from leaking away!

Yet in the most carefully constructed set, there are scores of places where stations you particularly want can literally leak away!

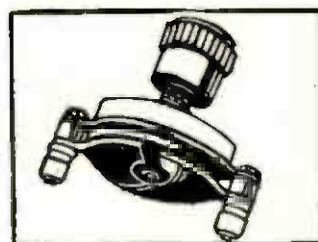
For every small part must convey current before energy gets to your phones or speaker. It's mighty important to you to know that every one of them is doing its full duty to prevent energy leaks.

MAR-CO small parts are made with precision, by the makers of scientific instruments—designed to stop leaks and conserve precious energy!

The compactness, the sure contacts hundreds of thousands have found in MAR-CO instruments, would be worth high prices. Actually, they save you money when you buy . . . just as they save stations that might otherwise leak away—when you use them!



Eliminate short circuits with MAR-CO SHUR-GRIP jacks—Formica insulation, sterling silver contacts, hooked terminals for quick, leak-proof connections—60 cents to \$1.00 and well worth it.



The compact, leak-proof construction, and the amazingly smooth, easy operation, of MAR-CO neutralizing condensers works wonders in R.F. circuits. Perfect neutralizing of tube capacity for \$1.25.

MAR-CO

PLUGS · JACKS · RHEOSTATS · SOCKETS



SWITCHES · NEUTRALIZING CONDENSERS

Please refer to POPULAR RADIO when answering advertisements.

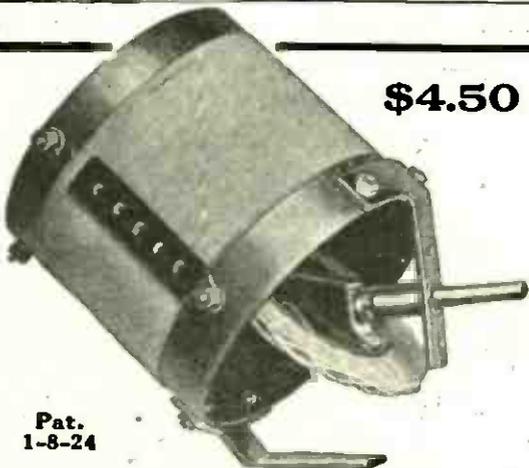
It's a



Radio Plate Battery

Night after Night—
**They Continue to Serve
 After Others are Scrapped**

On Sale at All Good Dealers
DIAMOND ELECTRIC SPECIALTIES CORP.
 102 So. Orange Ave., Newark, N. J.
 Dealers, Jobbers: Write for Proposition



Pat. 1-8-24

\$4.50

Radio **HARTMAN** Products

NEW HARTMAN VARIOCOUPLER
with 180° Spider Web Wound Rotor. Small compact size saves panel space. Clearer reception with minimum coupling insured. Dead shaft has no capacity effect in tuning. Pig tailed contacts; no live brackets.

If dealer can't supply you, write us

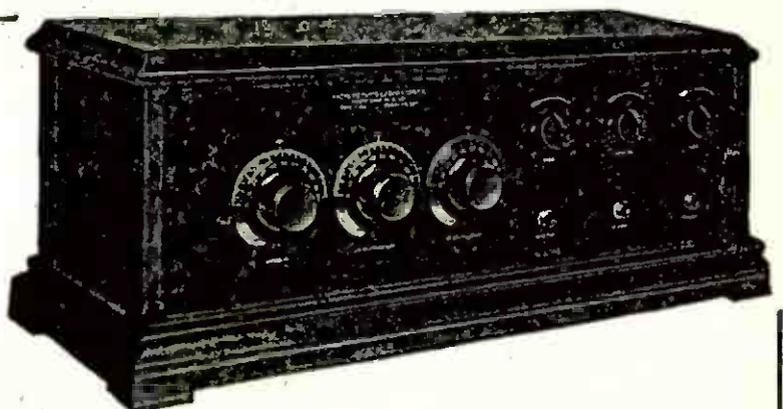
THE HARTMAN ELEC. MFG. CO.
 33 East 5th Street :: Mansfield, Ohio

**"The Best Built Set in
 America" R-212**



Licensed by I. R. M., Inc.,
 under Hazeltine Patents

Embodying the Hazeltine Neutrodyne circuit in an improved form as to neutralization, workmanship, quality, appearance and efficiency of operation.



Radio Service Laboratories, 1000 11th Ave.
 Asbury Park, N. J.

Please refer to POPULAR RADIO when answering advertisements.

The Transformer is the Heart of Your Set

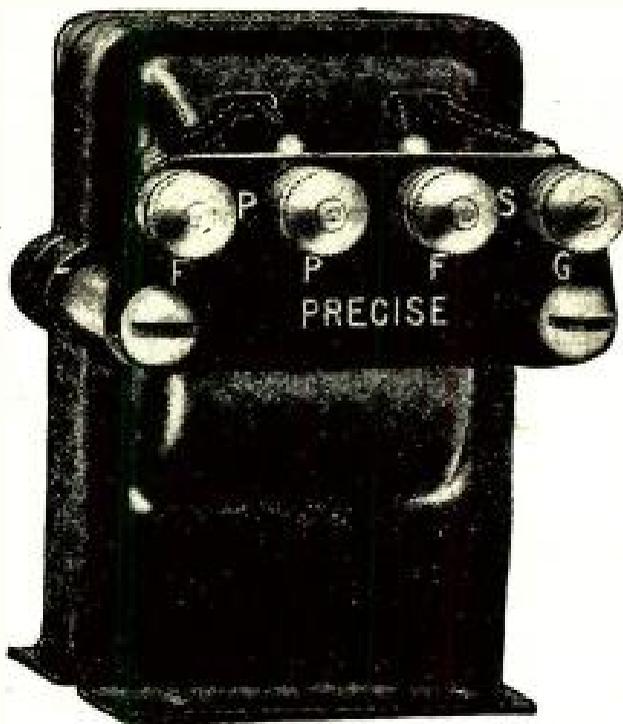
THIS AUDIO FREQUENCY TRANSFORMER, by actual use and scientific test, has proved its reliability and dependability beyond question. In three-stage tests it has obtained perfect results, giving full tonal value of any instrument or voice from the bass viol to the piccolo and the deepest bass voice to the highest soprano.

THIRTY DAYS' TRIAL

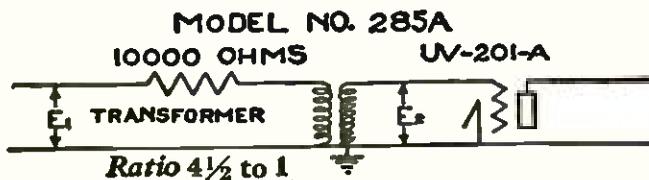
The Precise Transformer is so superior that you owe it to yourself to insist upon having it. If your dealer cannot supply you, order one direct. Purchase price refunded if thirty days' trial fails to prove every claim we make.

Attractive Proposition for Jobbers and Dealers

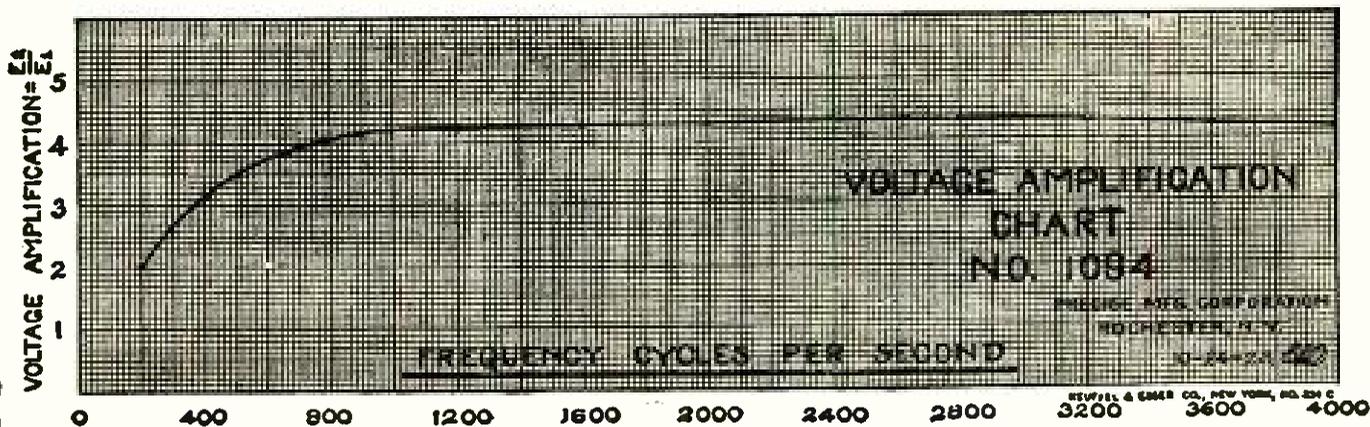
This unexcelled Transformer only \$5
RATIO 4½ to 1



TEST OF PRECISE TRANSFORMERS



This chart has been plotted showing the results of tests made in one of the best equipped laboratories in the country. These results are of vital interest to radio engineers and discriminating users of radio apparatus.



PRECISE MANUFACTURING CORPORATION

53 W. Jackson Blvd.
Chicago, Illinois

Rochester, New York

821 Market Street
San Francisco, Cal.

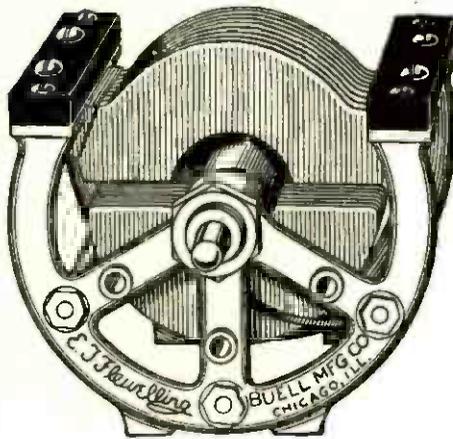
Canadian Distributors:
PERKINS ELECTRIC, LTD.

TORONTO MONTREAL WINNIPEG

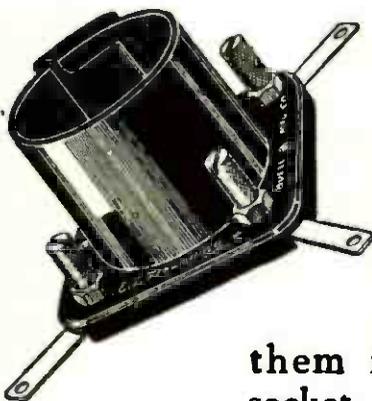
Eastern Sales Office: NIAGARA SALES CORP., 3-5 Waverly Place, New York City

Genuine-
E. J. Flewelling
 Radio Apparatus
 De Luxe

A new condenser, built in a new manner — and a better manner. Since its appearance on the market it has met with popular favor everywhere. You will be pleased with the extra high grade performance of such an instrument. At your dealers — or direct.



Flewelling Sockets are of efficiency — *second to none*. Short direct contacts of the improved *side-wiping* design make assured contacts with the tube terminals — that is why we use them in this superior socket. Ask your dealer to show them to you or write us direct.



Sockets—Tuners—Condensers

BUELL MANUFACTURING COMPANY

2979 Cottage Grove Avenue
 CHICAGO

**AMPL-TONE
 PHONES**



A THREE DOLLAR
**LOUD SPEAKER
 UNIT FOR
 HOME MADE SPEAKER
 FREE**

With Pair of Phones
 | Money Back Guarantee
Dealers Wanted

C. M. FRENCH MFG. CO.
 SEYMOUR, CONN.

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; \$36.50 and 1 Specially designed Coupler for using Antenna.



R-91 Branston Intermediate Radio Frequency Transformer.



R-90 Branston Oscillator Coupler

Branston Guaranteed

This apparatus is of standard Branston Quality, rigorously tested and proved better than anything heretofore obtainable. Its efficiency and superior performance will delight you.

Our Book, "Super Heterodyne Construction"

(\$1.00.) The amateur can easily make complete and efficient Super Heterodyne Receiver that will be extremely selective, give remarkably fine quality of tone and be noticeably free from interference. See your dealer at once, or write us today for all information.

Chas. A. Branston, Inc.
 811 Main St., BUFFALO, N. Y.

*Manufacturers of the famous
 Branston Violet Ray High
 Frequency Generators
 In Canada*

Chas. A. Branston, Ltd.
 Toronto, Ont.



Add miles and smiles with
 Branston Radio Paris

**Every fan
who wants
a better set —
will send for
this booklet!**



THE first edition of this brochure pointed the way to amazing results for thousands of set builders.

It enabled Mr. J. Tuckerman, President of the Federal Engineering Co., to build a set of which he says, "We not only get the local stations with remarkable clearness and absolutely without distortion, but we are able at any time to tune out these stations and receive from far away stations with equal facility. The tuning is so extremely selective and sharp that we can truthfully say we have never before listened with more pleasure and enjoyment to radio broadcasting."

Another typical report comes from Mr. G. V. H. Cairns of the Oakland Motor Car Co., who says, "I have tried all R. F. transformers on the market, but none of them can compare with Telos for volume, clarity, ease of operation, and best of all—they bring in the DX station!"

The second edition is now ready—packed with new ideas, proven hook-ups, and simplified instructions. It explains the Telos principle of tuned R. F. in complete detail. It gives you an entirely new viewpoint toward the possibilities of tuned radio frequency. Send for your copy. Write or use the coupon below.

Dealers: Assembled sets, construction kits, and separate parts for the Telomonic circuit are distributed by our licensed manufacturers, Amsco Products, Inc., New York, and Musio Radio, Inc., Pittsburgh.

Telos Radio

Danziger-Jones, Inc.,
Dept. A, 25 Waverly Place,
New York, N. Y.

Send me a FREE copy of "Success with R. F. Amplification" and complete description of the Telos principle.

Name.....

Address.....

(By Courtesy "Popular Radio")

3000 MILES

on a Loud Speaker



with COCKADAY IMPROVED 4-CIRCUIT KIT

Build Your Set The "Amplex Kit Way" SAVE 1/3

DISTORTIONLESS AMPLIFIER KITS

2 TUBE:—Using one step of Transformer and one step Variable Resistance Coupling.

Kit Price, \$17.50

4 TUBE:—Above with x Step Como Push Pull Amplification.

Kit Price, \$35.00

48,000 Ohm Genuine "Lavite" Resistances, each \$1.25

FREE Send for Kit catalog showing how to build your set the "Amplex Kit Way."

HERE IS PROOF

Dear Sirs: On the night of March 14th, during the Trans-Atlantic Test, I distinctly heard 2LO (London) on the set built with your 5 Tube Kit. At 8:27 P. M. I heard almost the entire selection called "Arcadia" played by a string orchestra. It all came in on a Loud Speaker.

(This was subsequently verified by newspaper reports.)

Gentlemen: The first night I had my set in operation I heard KGO (Oakland, Calif.) to say nothing of 25 other stations.

I never constructed a radio set in my life before I bought your 5 Tube Kit and certainly agree with you that no technical skill or knowledge is required the "Amplex Kit Way."
D. P. Riker, 1865 East 1st St., Brooklyn, N. Y.

Parts	List Price Each	Parts	List Price Each
1—Panel 7" x 24" Drilled . . .	\$6.00	3—48,000 Ohm Res.	\$1.25
1—4 Circuit Coil	5.00	1—Res. Mounting	1.25
2—Amplex 24 Pl. Vern. Cond. .	5.00	1—.0005 Mica Cond. . . . .	.45
5—Amplex Sockets . . . . .	.75	1—.00025 Mica Cond. . . . .	.45
1—6 Ohm Amplex Rheostat. . .	.75	2—P. P. Transf. (Como), pr.	12.50
3—20 Ohm Amplex Rheostat. .	1.00	1—Potentiometer	1.00
2—Grid-Densers	1.25	1—Baseboard	1.50
2—Grid Leaks, Var. . . . .	.75	1—Set of plans (blue print) .	1.50
1—Amplex Improved Jacks S.C.	.65	12—Binding Posts . . . . .	.10
2—Amplex Improved Jacks D.C.	1.00	Bus bar, etc. . . . .	.50
2—Amplex Transformers	5.00		
2—Switch Levers, etc. . . . .	.50		

AMPLEX INSTRUMENT LABORATORIES
Dept. 5 :: 57 Dey Street, New York, N. Y.

Dealers—Write for Terms

KIT FOR THE SUPERDYNE

A 4 Tube circuit that is taking the country by storm employing 1 step tuned R. F., combined with regeneration.

Includes everything from the bus bar to the drilled Panel and an exceptionally efficient special Coil and Coupler.

List, \$45.00—Kit Price, \$33.75.

"Amplex" Grid-Denser \$1.25 Each

DRILLED PANEL AND COMPLETE BLUE PRINT INSTRUCTIONS

for wiring and assembling with each Kit. No special skill or technical knowledge required. Safe and Simple.

Every part in every Kit is tested, guaranteed. Individual parts may be purchased separately at list price.

As You Gaze at the Stars—

The gentle calm of a bright starry night fills us with mystery. Little did we dream a while back that today, far and wide in the unknown, thousands of voices, hurled by electrical energy, are rushing at unheard of speed through space to all points of the compass.

A person here, a group there—in fact, in a million or more homes people are anxiously tuning in on their radios, groping in the air, hoping to catch the sound of a far-away station. Scarcely a sound, a slight turn, a faint noise,

another adjustment and then clear and clearer comes voices, a quartet is singing; so clear and distinct comes the soft gentle melody that the listeners close their eyes, the singers seem to be in the very room with them.

If you desire clearer reception, greater volume and the elimination of howling and distortions, install Jefferson transformers in your set.

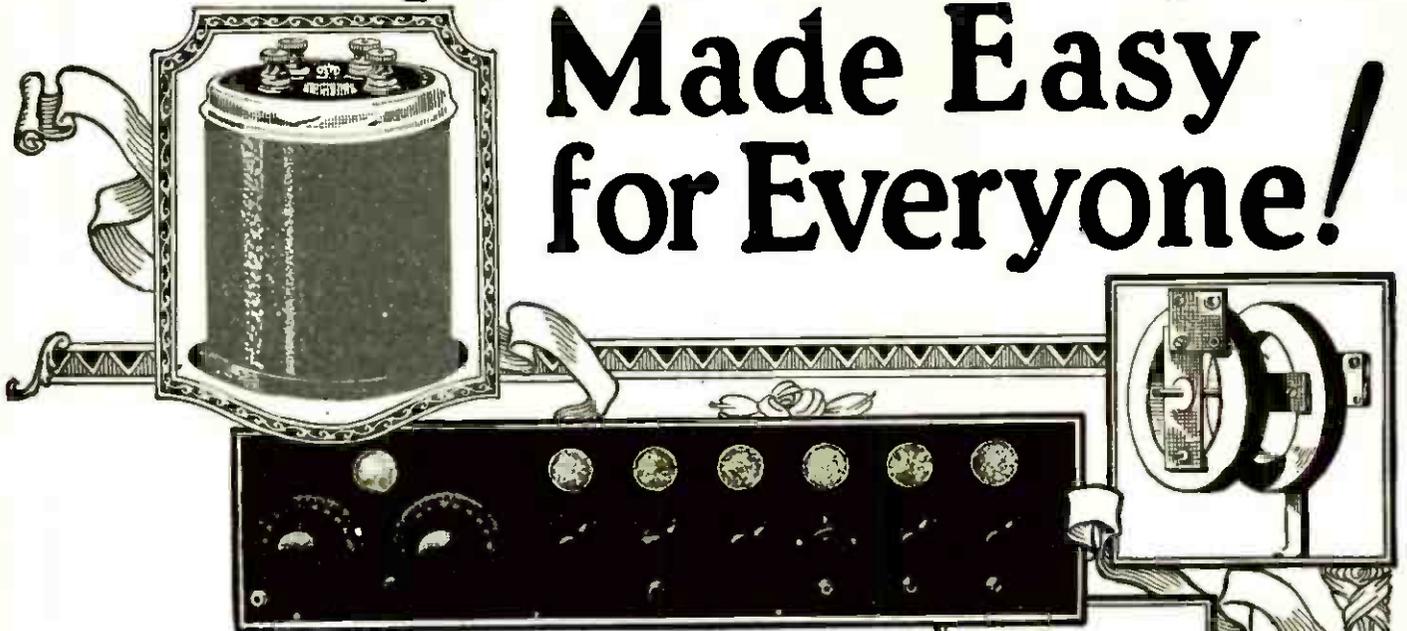
There's a Jefferson Transformer for every circuit

Write for amplification data and interesting descriptive literature.

Jefferson Electric Mfg. Co.
427 So. Green St., Chicago, Ill.



The Super-Heterodyne Made Easy for Everyone!



WITH the publication of *The SUPER-HETERODYNE MANUAL*, Receptrad has attained the leadership in its specialization on the Super-Heterodyne Circuit.

Whether you are an experienced builder or novice, Receptrad construction helps are so easy to follow that you are certain to achieve success when you start building.

Follow the *Manual* and your path will be easy. Results undreamed of will become commonplace in your radio enjoyment.

The Super-Heterodyne Manual \$1.50

Written by Victor Greiff, giving the fullest details and explanations on theory and practice. Includes three full size blue prints for panels, drilling, circuit, etc. The only complete and authoritative text book on the subject.

Transformer, Type 1716 \$8.50

Used in the Intermediate Frequency Amplifier. Covers frequencies from 5,000 to 25,000 meters. Self shielding. Steel core guarantees power and stability.

Oscillo-Coupler, Type SW-21 \$6.00

Covers wave-lengths between 200 and 750 meters.

Filter-Coupler, Type H-34 \$7.50

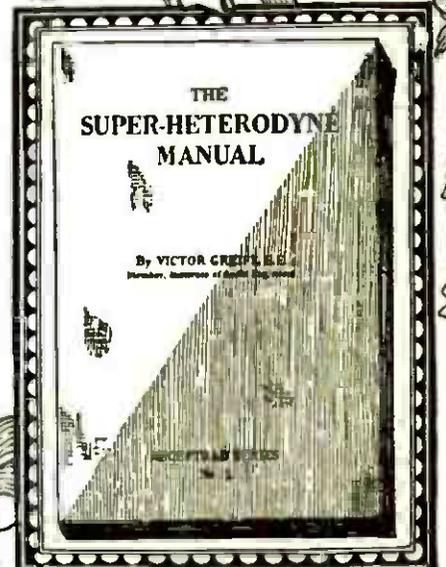
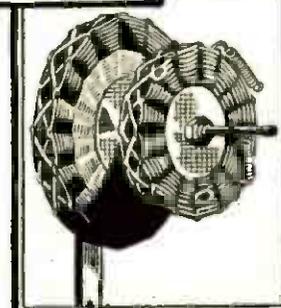
Tuned, with condensers, to 8,500 meters.

By-pass Condenser, Type C-1000 \$1.50

Special construction, capacity 1 Mfd.

Transformers, Type ATX and AT3 \$5.75

Audio, specially developed for the circuit.



Order at your dealer's

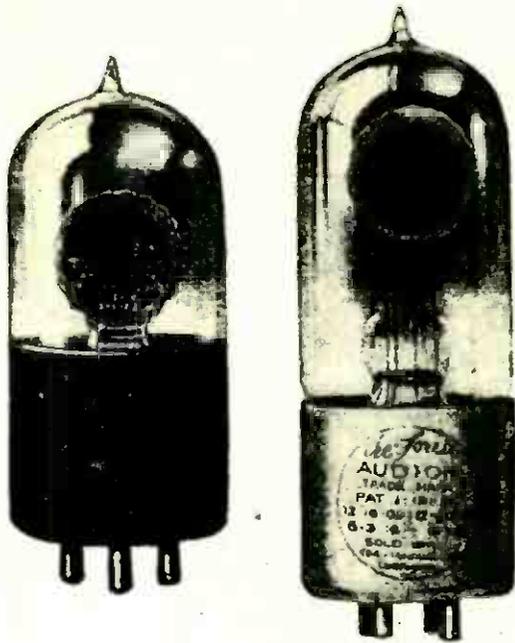
RADIO RECEPTOR CO.

57 BANK STREET

(INCORPORATED)

NEW YORK, N. Y.

Please refer to POPULAR RADIO when answering advertisements.



DV-3
Audion for
Dry Batteries

DV-2
Audion for
Storage Batteries

DE FOREST Audions are of especial interest to radio enthusiasts because it was Dr. De Forest who originally invented the three electrode vacuum tube which makes present-day radio possible.

The DV-3 Audion for dry batteries is designed to consume a very small amount of filament power. It operates at a filament potential of three volts and consumes a filament current of six-one hundredths of an ampere.

The DV-3 has a Yttrium filament, giving an unusually high flow of electrons; Bakelite base of standard dimensions; is remarkably free from microphonic noises.

The DV-2 Storage Battery Audion was developed for operation in all usual circuits, including a power amplifier circuit.

The DV-2 is a hard tube with Isolantite base and Yttriated filament and it is a particularly powerful tube for power amplifier work.

The price of these audions is \$6.50, plus 6 per cent. for territories west of the Rockies.

All De Forest tubes are subject to three progressive inspections, all of them being burned for several hours and tested carefully.

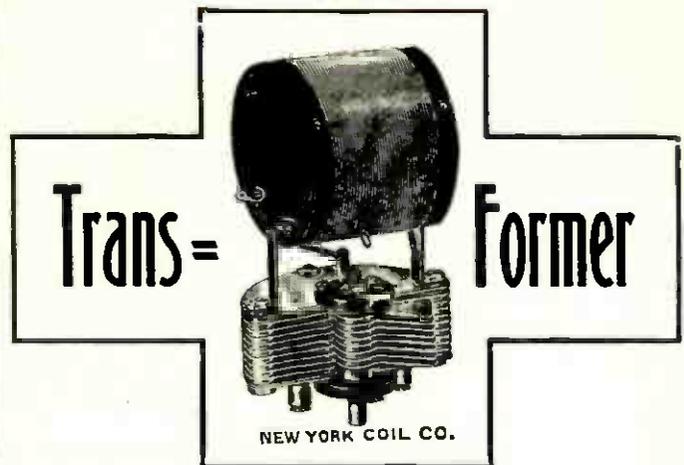
The De Forest Company guarantees its products and backs this guarantee by a liberal replacement policy sufficient to cover all defects. Send for circular on De Forest Audions.

De Forest Radio Tel. & Tel. Company
DEPT. P. R. 9
Jersey City, N. J.

De Forest Audions

"Made By The Man Who Invented Broadcasting."

TYPE 4



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.

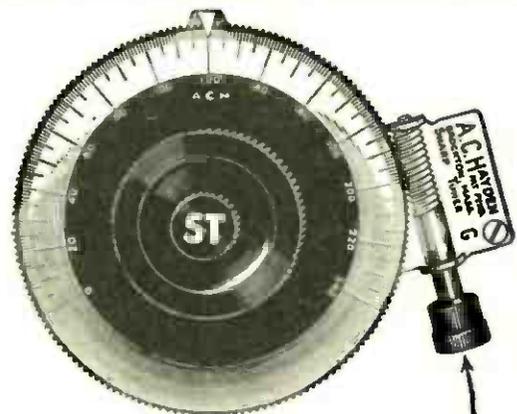
Price, including Condenser, \$4.50

NEW YORK COIL CO.

338 Pearl Street

New York

A Pleasant Surprise Awaits the User of
the A. C. H. Sharp Tuner Dials



Why the A.C.H. is different

3 in. DIAL → ACH → 156-10-1

4 in. DIAL → ACH → 215-10-1

Will improve any receiving set, making difficult tuning easy

Money Back Guarantee

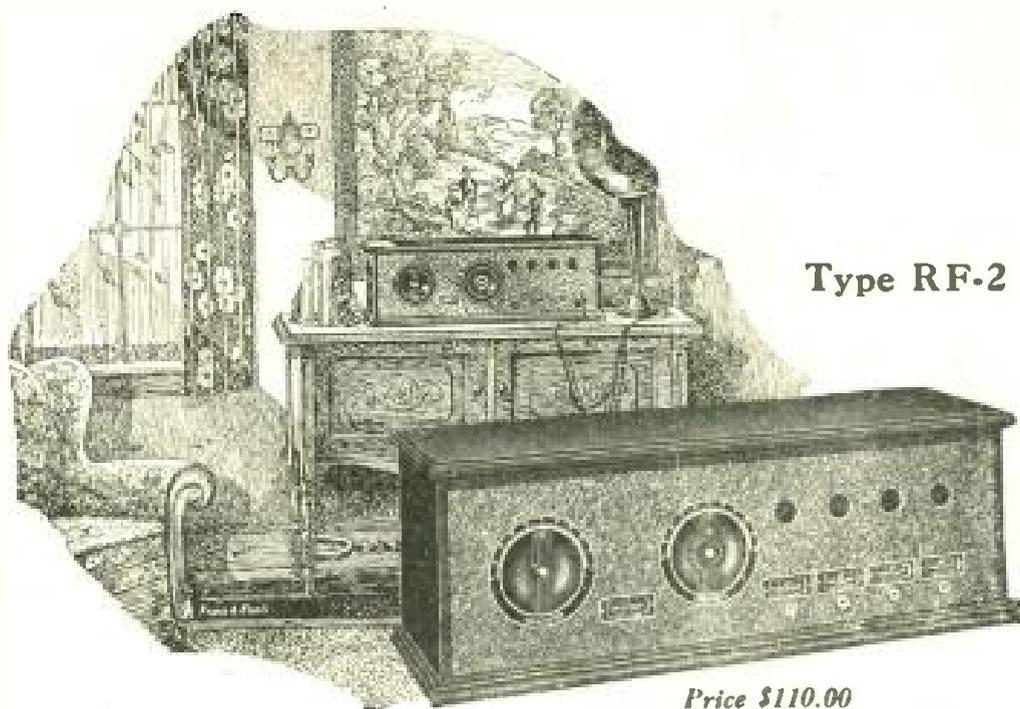
Price 3-inch size... \$2.50 Price 4-inch size... \$5.00
Regular fitting 5/16 shaft 1/4 and 3/16... 6c each extra

Extra Advantage of the A.C.H.

1. Can be attached or removed from any instrument.
2. Rough tuning same as any dial.
3. Movement so fine that the eye cannot detect but the ear can.
4. Automatically locks instrument so no jar can disturb it.
5. Dial grounded reducing the body capacity to a minimum.
6. Special dial 2 graduations where ordinarily one.

MAIL ORDERS SENT PREPAID IN U. S. A.

A. C. HAYDEN RADIO & RESEARCH CO.
25 E. Battle St., BROCKTON, MASS., U. S. A.



Type RF-2

Price \$110.00
(Without Tubes and Batteries)

Pride of Possession—

Ownership of the new Eisemann Broadcast Receiver imparts a sense of keen satisfaction.

Little is left to be desired—not simply because of distinctive appearance, but by reason of the remarkable performance of the RF-2.

New distance records have been reported almost daily since the introduction of this latest receiver.

A transformer—coupled tuned radio frequency circuit is employed, with two stages of audio frequency amplification.

ASK YOUR DEALER

Descriptive Literature on Request

EISEMANN MAGNETO CORPORATION

William N. Shaw, President

46 Thirty-Third Street

Brooklyn, N. Y.



Na-ald No. 499 Na-ald Small Space No. 401 Na-ald No. 411 Na-ald Adapter No. 429

Cross Section De Luxe Socket

NA-ALD

IT'S THE CONTACT THAT COUNTS

Na-ald Sockets

For 200 Tubes
 No. 400, Price 75c
 No. 401, " 35c
 3 for \$1.00

For U. V. 199
 No. 499, Price 50c
 No. 429, " 75c

For W. D. 11
 No. 411, Price 75c

The best radio engineering practice of today calls for the elimination of as much material as possible in the neighborhood of those parts of the set which carry the radio frequency current. This applies not only to metallic substances, but to insulating materials as well. Na-ald Sockets provide for this by having uniform walls of Bakelite, giving the material its highest di-electric properties. "Frying" noises, often attributed to B batteries, are in reality caused by poor connection. Na-ald De Luxe contacts not only press on the bottom of tube terminals but cut into the sides, automatically making a bright, perfect connection. *De Luxe is the standard for Neutrodyne and Superheterodyne sets.*

Send cover of Na-ald dial or socket carton or 15c for new 16-page rotogravure booklet "What to Build."

ALDEN MANUFACTURING CO.
 Dept. C. 52 Willow St., Springfield, Mass.

"I would not use any other battery after KIC-O"

says Frank W. Harris, a radio fan of Ottawa, Canada. KIC-O Storage "B" Batteries will improve any radio set. Try one on yours. Our guarantee protects you. The life is unlimited. Recharge from any 110 volt A.C. line with small home rectifier.

Volts	Price, plain	With panels
22	\$5.50	
32	7.25	\$11.75
48	9.50	14.00
68	12.50	17.00
100	17.50	22.50
145	23.50	28.50

Unmounted Rectifier... \$1.00
 Mounted Rectifier... \$2.50

GUARANTEE
 Your money back on any KIC-O Battery if not satisfied within 30 days' trial. Write for full information on "A" and "B" Batteries.

KIC-O Storage "B" Batteries
 Long Service, Low Cost

KIMLEY ELECTRIC COMPANY, Inc.
 2667 MAIN STREET, BUFFALO, N. Y.

COCKADAY COILS

Improved type, silk covered wire, bakelite tube, complete \$4.00

Regular coils, cotton covered wire \$2.50

Complete parts for single tube set \$10.95

All parts for improved five tube set \$55.00

Shipped C. O. D.

RADIO Surplus Stores
 HELENA, MONTANA

Genuine LAVITE RESISTANCES

12,000 OHMS } \$1.50
 48,000 " }
 50,000 " } Each
 100,000 " }

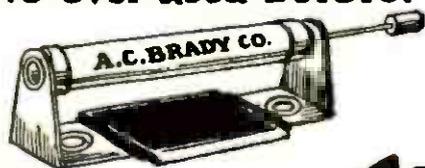
Money Orders and Checks Only
 NO STAMPS
 Dealers Write

HAROLD HERBERT Inc.
 160 W. 46th St., N. Y. C.

The New
and Perfect
Variable Grid Leak
65¢

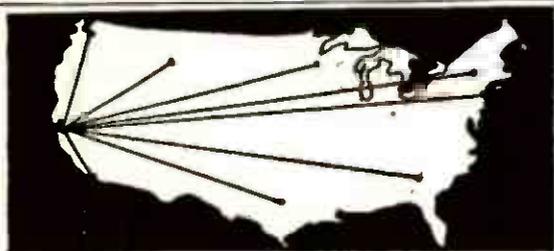


Although it is cartridge type
it is different in principle from
any Variable Grid Leak you
have ever used before.



COMPLETE WITH MICA CONDENSER
AND PERFECT LEAK MOUNTING **\$1⁰⁰**
At your dealer—or postpaid
on receipt of purchase price.

A.C. BRADY CO.
Improved Radio Apparatus
108-SEVENTH AVE. NEW YORK CITY



ON ONE TUBE

Broadcasting from Atlantic Coast, Canada, Mexico, Cuba & Hawaii heard in Calif. by users of the CROSS COUNTRY CIRCUIT. Range due to simplicity. One tuning control. ANY NOVICE can build easily and cheaply. Dry cell tubes used. No soldering. Complete instructions, Blue print panel layout, Assembly Photo, etc., postpaid 25 cents. Stamps accepted.

VESCO RADIO SHOP, Box PR-117, OAKLAND, CALIF.

UNITY VERNIER RHEOSTAT



The Highest Type
Instrument Made

Any Resistance \$2.00

"Hear a Set
That Uses One"

ELIMINATE THE NOISES IN YOUR SET

The book "TUBE CONTROL," written for the amateur, and for the benefit of Radio Reception, by J. Elliott Jenkins, Engineer of Broadcasting Station W. D. A. P. will tell you how to clear up your signals.

Every set owner should have this book.

10c at your dealers, or 14c postage to UNITY MFG. CO., 224 N. Halsted St., Chicago



The Pacent RHEOSTAT a Favorite

The merit in the Pacent Rheostat is evidenced in its choice by leading radio authorities and its selection as standard equipment by leading set manufacturers.

It is ideal, considered from standpoints of design, operation and attractiveness of appearance. Construction in only two units simplifies installation. Fastening a single set screw insures against parts loosening or knob turning beyond its range. The Rheostat is supplied entirely complete with screws for mounting, knob and silvered dial.

Pacent Rheostats are made in a number of resistances for various needs.

Cat. No.	Resistance	Capacity Amperes	Price
85-A	6 Ohms	1.5	1.00
85-B	10 Ohms	1.	1.00
85-C	20 Ohms	.6	1.00
85-D	30 Ohms	.5	1.00
85-E	50 Ohms	.3	1.00
85-F	2½ Ohms	2.5	1.20
88	375 Ohms	.2	1.25

Write for Catalog P-5

Pacent Electric Co., Inc.
22 Park Place, New York, N. Y.

Pacent

RADIO ESSENTIALS



Mr. Fred A. Fort, graduate Radio Institute of America, Radio Operator on Munson Line ships to Central America and the West Indies.

More Men Needed in Radio

The demand for trained radio experts has taken hundreds of men out of the discouraging rut of opportunity-less jobs—started them with good pay—shown them the world—and put them in line for a big future.

Many graduates of the Radio Institute of America have now reached big success in radio. The government operator's license is the opening wedge. And that license you can now earn by a few months of home study.

The Institute, oldest radio school in America, is under the auspices of the Radio Corporation of America, which places more men in Radio jobs than any other organization in the world. And its graduates are preferred, for their training is known to be thorough. Write today. Learn more about your chances for big success.

Advanced Radio Course

Great popular demand by the advanced student, experienced amateur and wireless operator has led to the opening of an **ADVANCED HOME STUDY RADIO COURSE**, specializing in C. W., I. C. W., telephone and radio measurements. Investigate!

Radio Institute of America

(Formerly Marconi Institute)
Established 1909

322A Broadway, New York City

Indicate by a cross X the course you are interested in:

Radio Institute of America,
322A Broadway, New York.

Please send me full information about radio opportunities today, and your

COMPLETE RADIO COURSE
ADVANCED RADIO COURSE

Name.....

Address.....

.....

.....

.....

.....

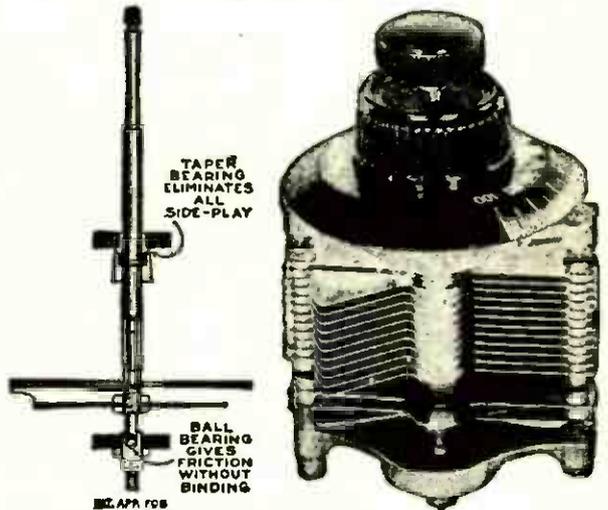
.....

.....

.....

.....

For Sturdiness and Accuracy Use Lombardi Condensers



Made in the most popular sizes, with aluminum plates, aluminum end brackets, with a 1" diameter insulating bushing therein. (A perfect insulator, high in dielectric strength.)
The tension as well as adjusting is accomplished by tightening end

thrust plug, which has a spring plunger, causing a thrust of proper tension between a hardened steel ball and a 45 degree tapered brass bushing, this insures smooth running and a contact equal to a soldered joint; also a take up for wear in years to come.

Also makers of coils and sockets

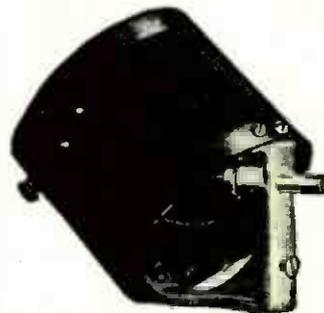
Literature and prices furnished upon request

Lombardi Radio Mfg. Co.

67 MINERVA ST. DERBY, CONN.

THE NEW SIMPLEX

180° Vario-Coupler
With a Special Woven Rotor



will bring in those distant stations you are trying for. An exceedingly efficient and neat coupling device combining all of the best features that have been developed in the past year and which will cover all broadcast wave lengths up to 600 meters.

Price - - \$3.50

SIMPLEX RADIO CO.

1015 Ridge Ave. Phila., Pa.

CATALOG L-25-148 PAGES FREE!

Latest Reflex Neutrodyne and Super-Heterodyne Circuits. 40 Diagrams, latest Hook-ups. Largest Complete Stock.

SPECIAL American Reflex Super - Sensitive Crystal, 35c ea. Hot as Hot, Every Spot. Hear stations clearly. **GUARANTEED ONE YEAR**. Jobbers and Dealers write for Quantity Discounts.

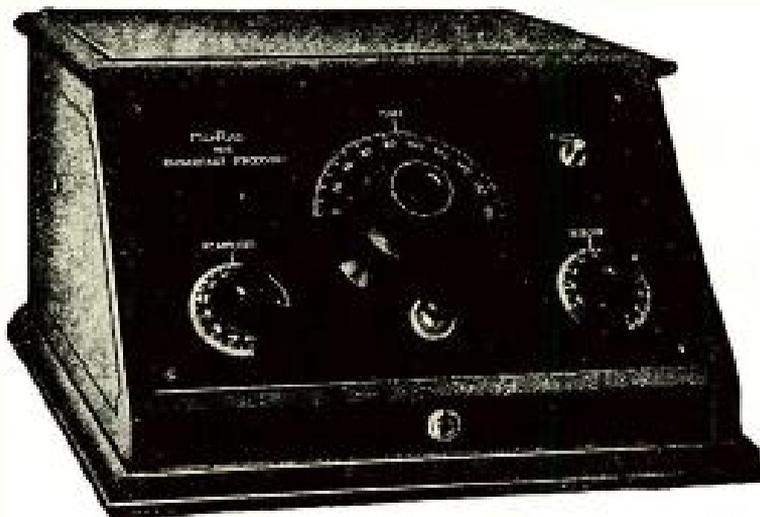


AMERICAN RADIO MFG. CO. WHOLESALE DISTRIBUTORS

10 HOUR SERVICE
Dept. P 6 WEST 14TH ST. KANSAS CITY, MO.

Write for Information Today

DESIGNED TO MEET A POPULAR DEMAND



A NEW 5 Tube MU-RAD RECEIVER

*Selective—Sensitive
Non-Radiating—Single Control*

THE peak of Mu-Rad skill and ingenuity. Coast to coast reception under proper conditions. Loud speaker reception on a thousand mile range, all wavelengths. Completely cuts out the strongest local stations. Surprisingly simple control—just one dial, the settings of which are *always* the same for each station, regardless of your location or type of aerial. Requires only a single wire antenna. Uses either dry cell or storage battery tubes. Tubes and batteries last twice as long as in other 5 tube receivers, because the new circuit used permits burning tubes at low temperatures. Like other Mu-Rad Receivers the MA-18 towers above competition and imitation.

Write for literature!

SPECIFICATIONS

Circuit 2 stages of R. F. Amplification, detector and 2 stages A. F. Amplification—an entirely new circuit.

Antenna—single wire—20 feet to 150 feet long.

Cabinet Hand rubbed solid mahogany with rubber feet. 12¾ inches by 7½ inches by 15 inches deep. Engraved Formica Panel.

Wave Length Range—230 to 550 meters—practically the entire broadcasting spectrum.

PRICE \$110
(without accessories)

MU-RAD LABORATORIES, INC.
809 FIFTH AVE. ASBURY PARK, NEW JERSEY

Beginning Monday
April 26th
All Advertising Copy
and Cuts
for insertion in
Popular Radio

and all checks in payment for advertising space, should be addressed to E. R. CROWE & COMPANY, Inc., at 25 Vanderbilt Avenue, instead of 9 East 40th Street.

All other mail, including subscriptions and contributions, should be addressed to POPULAR RADIO, at 627 West 43d Street, New York.



E. R. Crowe & Company, Inc.

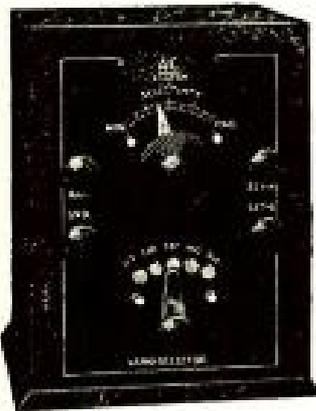
New York
25 Vanderbilt Avenue

Chicago
225 North Michigan Avenue

Do You Own a Single Circuit Set?

If so it will pay you to consider

THE COPP VARIO-SELECTOR



Patent Applied For
Copp Vario-selector
Price \$11.50

Because:

1. It will **CHANGE** any single circuit set to a double circuit set without re-wiring and without rebuilding. Simply connects to Antenna and ground and it is done.
2. **ELIMINATES RE-RADIATION.** This will be a great help to Broadcast Stations and to all owners of Broadcast Receiving Sets.
3. **GIVES SELECTIVITY** to a Single Circuit Set equal to any three-circuit tuner, preserving the Single Circuit simplicity of tuning.

NOTE.—The Copp Vario-Selector is **NOT** a Wave-Trap.

No necessity for the single circuit set owner to discard his set because of its lack of selective quality. No need to worry about disturbing the neighborhood with re-radiation. The Copp Vario-Selector will correct all these faults the minute it is added to the set.

Sold thru your dealer or direct.

If your dealer cannot supply you with a Vario-Selector, mail the coupon direct to us today.

The A-C Electrical Mfg. Co.
Dayton, Ohio

Gentlemen:

Being unable to secure a Copp Vario-Selector from my dealer, you may send me { check enclosed } one Copp Vario-Selector, it being understood that in case I am not entirely satisfied with its operation in connection with my set, I reserve the right to return the Vario-Selector to your factory (in same condition as received by me) any time within ten days, full purchase price to be returned to me at once without further question.

Dealer's Name..... Name.....
 Address..... Address.....
 Address..... City..... State.....

The A-C ELECTRICAL MFG. CO. Dayton, Ohio

Makers of Electrical Devices for over 20 years

Standardize NOW on PREMIER PARTS

"The Better the Set the More You Get"

1/2 Actual Size

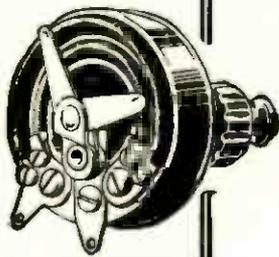


\$3.50

PREMIER "HEGEHOG" Audio-Frequency Transformer

Trade Mark

The wonder of the Radic world. A more efficient transformer than you could ever buy before. And the smallest, most compact instrument of its kind. About the size of an English walnut and yet "HEGEHOG" is a wizard for reproduction value, tone quality and consistent performance. Less distortion. No foreign noises. The secret is in its patented construction. It is shielded 100 per cent. Fully guaranteed. Ratios 1 to 3, 1 to 4, 1 to 5, \$3.50; 1 to 10, \$4.50. You'll want "HEGEHOG" in your next "hook-up," so get all the facts NOW.



MICROSTAT \$3.00

PREMIER "MICROSTAT" A Super-Vernier Rheostat

Trade Mark

"MICROSTAT" is in a class by itself as a precision instrument for the perfect control of the filament current in detector tubes, and everyone knows that you must control this current to the finest degree if you are going to get the ultimate from any set—"MICROSTAT" does all this. Built on an entirely new principle. Two windings in parallel—one 6 ohm—other 40 ohm. Absolutely noiseless—infinite control—handles any tube. Capacity 3 Ampere Bakelite moulded—silver etched dial. Do not install a Rheostat until you know all about the "MICROSTAT." Send for our Free Bulletin No. 92.

And Worth It

Ask for and Insist on PREMIER Parts at Your Dealer

Premier Electric Company
3807 Ravenswood Ave., Chicago

19 Years Making Quality Electric Apparatus

30 STATIONS in one hour!

—heard with one Myers Tube (name and address furnished on request). The remarkable results being obtained with Myers Tubes are due largely to the elimination of socket with its bunched leads.



(1/2 size)

Myers Tubes

(practically unbreakable) give you distance with clarity. They add 50% to the efficiency of any set by reducing interference.

See that you get the New Improved Myers. Others are not guaranteed. Insist on Myers at your dealers'—otherwise send purchase price and be supplied postpaid.

Two types: Dry Battery and Universal (for storage battery). Write for free circuit diagrams.

\$5 EACH, complete with clips ready to mount on your set; no sockets or other equipment necessary.

E.B. Myers Co. Ltd.
Radio Vacuum Tubes

240 Craig St. W. Montreal, Canada

Guaranteed Head-Sets

"RED-HEADS" are guaranteed radio phones. You run no risk when you buy them. Money back if, after 7 days' trial, you're not satisfied that they're the best receivers on the market at the price. Why not act right now and get a pair? It'll mean getting the maximum from broadcasting from the day you put them into use.



RED-HEAD RADIO RECEIVERS

NOW READY

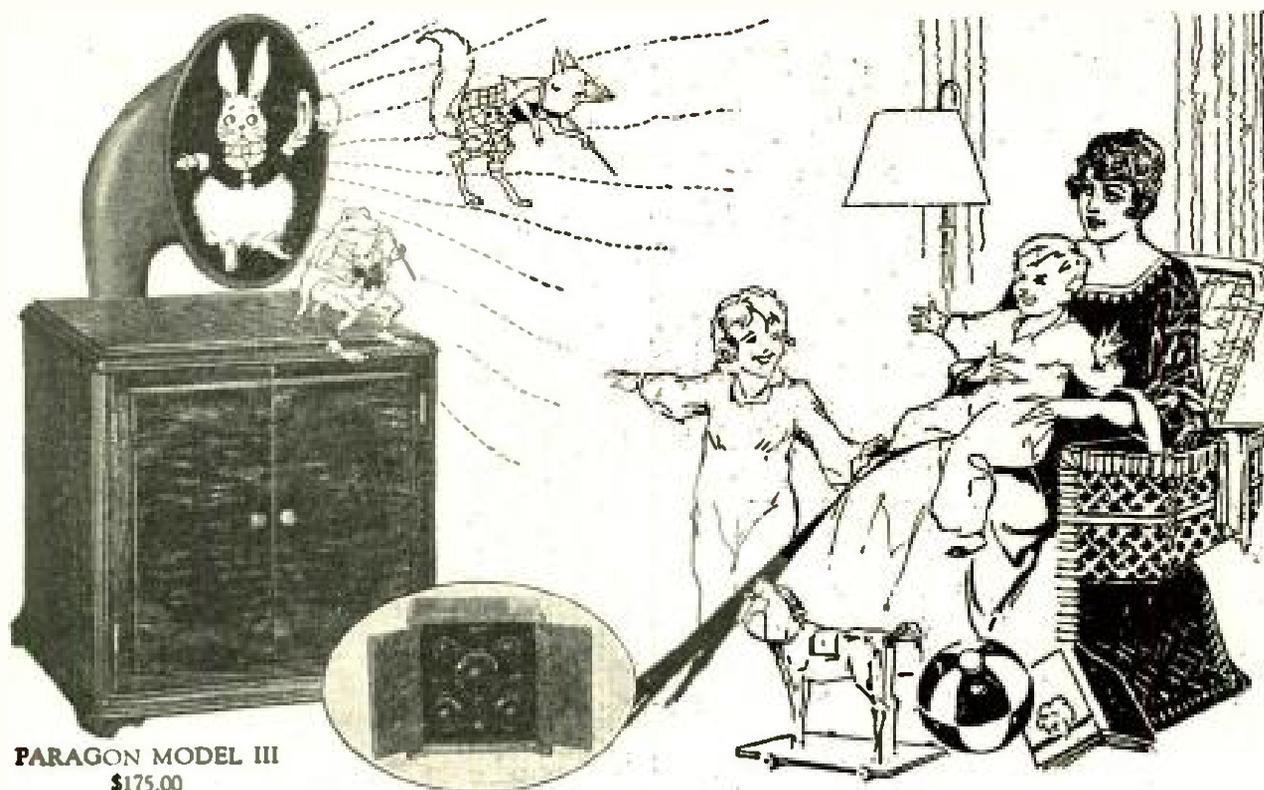
The new 1924 Model F Per Pair Complete \$6.50

The new "Red-Head" Jr. Per Pair Complete \$5.00

"Red-Heads" sent prepaid on receipt of price if you are unable to get them at your dealer's.

The NEWMAN-STERN COMPANY
Dept. PR : Newman-Stern Bldg. Cleveland





PARAGON MODEL III
\$175.00

"IT WAS PETER RABBIT—"

"... and all dressed up in his new suit to go on the journey with Reddy Fox", comes the voice over the radio. The children sit spellbound. Mother, thankful for this few minutes' rest every evening, closes her eyes and leans back in her chair. Now the radio will take care of the children—she needn't worry.

Paragon Receivers are rich in tone value. Music, from the crash of a chord to the sob of a saxophone, is reproduced clearly just as it is played.

Voices are distinct and understandable. Static noises are reduced to the absolute minimum.

Because of Paragon selectivity and sensitivity you can tune in on and get any station you want, and hear the program without interruption or jamming from other stations.

The Paragon Model III comes in a finely finished mahogany or burlled walnut cabinet which is an addition to any home. This instrument offers you the ultimate in radio enjoyment.

Write for illustrated Bulletins of Paragon Radio Receivers

ADAMS-MORGAN CO.

20 Alvin Avenue, Upper Montclair, N. J.

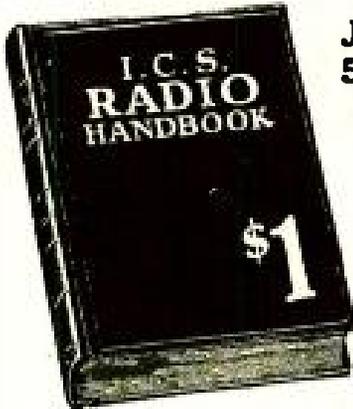
PARAGON

Reg. U.S. Pat. Off.

3-CIRCUIT RECEIVER

Every Question ANSWERED for only \$1

At last you have under one cover
a Complete Radio Handbook



**JUST OUT
514 PAGES**

Compiled by
**HARRY F. DART,
E.E.**

Formerly with the
Western Electric
Co., and U. S.
Army Instructor
of Radio. Techni-
cally edited by
F. H. Doane.

40,000 ALREADY SOLD

NO more need you turn from book to book, hoping to find what you want. It is all here, in 514 pages crammed full of every possible radio detail. Written in plain language, by engineers for laymen. Clears up the mysteries, tells you what you want to know. A complete index puts everything within your reach in a few seconds.

IT EXPLAINS: Electrical terms and circuits, antennas, batteries, generators and motors, electron (vacuum) tubes, every receiving hook-up, radio and audio frequency amplification, broadcast and commercial transmitters and receivers, super-regeneration, codes, license rules. Many other features.

Under one cover. Yes, it is all in one volume of 514 pages of clear type with hundreds of diagrams and illustrations. Takes the place of eleven or more specialized texts, each costing from two to ten times the dollar you pay for this single book. Belongs in every radio-equipped home, on every amateur's table.

Send \$1 to-day and get this 514-page I. C. S. Radio Handbook—the biggest value in radio to-day. Money back if not satisfied.

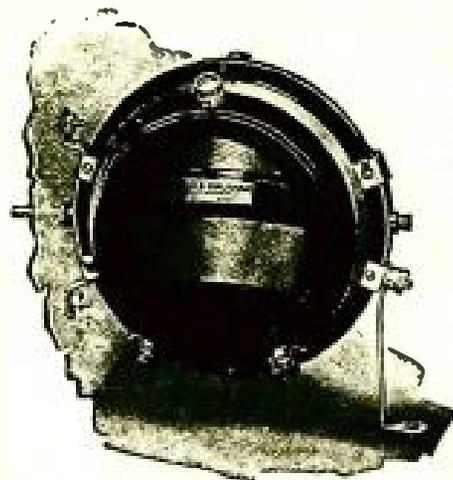
TEAR OUT HERE

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 8251-C, Scranton, Penna.

I enclose One Dollar. Please send me—post-paid—the 514-page I. C. S. Radio Handbook. It is understood that if I am not entirely satisfied I may return this book within five days and you will refund my money.

Name.....

Address.....



Amplify with

**LANGBEIN & KAUFMAN
TUNED RADIO FREQUENCY
VARIOTRANSFORMERS**

TYPE VT25 LIST \$8.50

Connected same as a fixed radio-frequency transformer, but continuously adjustable to the peak of the wave.

**MAXIMUM AMPLIFICATION AT ALL
WAVE LENGTHS**

SEND FOR DIAGRAM #101

THE HOME OF MOULDED TUNER SPECIALTIES

LANGBEIN & KAUFMAN

654 Grand Avenue

NEW HAVEN

CONN.

THE NEW Metaelectric Soldering Iron

Operates on any electric current with the simplicity, ease and efficiency of a writing instrument.

An indestructible all-metal quality product with a worth-while guarantee. Endorsed by the Tribune Institute.

Accepted as the logical solution to radio soldering problems.

NOW
ONLY

\$3.75



**Ample Heat
Interchangeable Tips
Handle always cool**

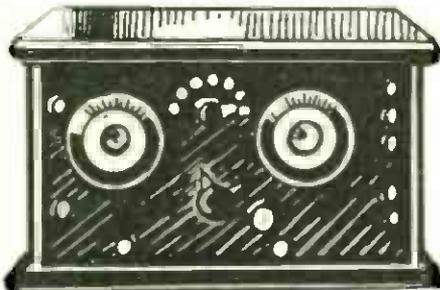
Descriptive circular on request

Purchase of your dealer or direct and pay postman

POST ELECTRIC CO., Mfrs.
Inst. Div., 30 E. 42nd St.
NEW YORK

"Tune in" on Success

Learn at Home To be a Radio Expert



Radio Pays Big

Free 1000 Mile Radio Outfit

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.

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?

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.

"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.

A. G. MOHAUPT, Radio Engineer
RADIO ASSOCIATION of AMERICA
4513 Ravenswood Ave., Dept. 55a Chicago, Ill.

MAIL COUPON

A. G. Mohaupt, Radio Engr., Radio Assn. of America, 4513 Ravenswood Ave., Dept. 55A, 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.....

Please refer to POPULAR RADIO when answering advertisements.



CHELTEN "SPECIAL" CONDENSERS

For High Oscillating Radio Frequency Circuits

Note carefully these eleven important features

1. Lowest Dielectric Losses
2. Special porcelain insulation used on stator Plates
3. Copper Pigtail Connections
4. Aluminum End Plates
5. Rotor Plates of heavy aluminum
6. Accurate spacing
7. Adjustable accurate bearings
8. Permanent Stops
9. With or without 9 plate Vernier
10. 9 plate Vernier makes possible sharp, close tuning
11. Vernier has same special insulating features

Made With Vernier in 45-23 Plate Type and in 45-23-17 and 11 Plate Type Without Vernier

Send For Our Complete Radio Catalogue

CHELTEN ELECTRIC COMPANY
4863 STENTON AVENUE PHILADELPHIA



Perfectone
TRADE MARK



Here is the loud speaker that through merit has become the standard of comparison.

At your dealers, otherwise send purchase price and you will be supplied postpaid.

Perfectone Radio Corporation
490-C Broome Street New York



No Two Receivers Are Alike
Connect In Multiple and One Will Get
Most Current

AJAX—MULTI—RADIO

Phone Plugs and Connectors
Allow One to Four Head Sets
or Loud Speakers

ALWAYS IN SERIES

No. 18—For Jacks
No. 18A—For B Posts

Gives Equal Results to All. No Others Like
AJAX—\$1.75 Each.—Dealers or Direct.

Liberal Discounts on Complete Line to Dealers
and Distributors

AJAX ELECTRIC SPECIALTY CO.

1926 Chestnut St. St. Louis



AMPERITE
The "SELF-ADJUSTING" Rheostat

PERFECT for every CIRCUIT

Simplifies wiring
eliminates
hand rheostats

RADIALL COMPANY
320 W. 42 St., N. Y.



\$1 10

From
Your
Dealer



COAST TO COAST

"Long 45"

REGISTERED

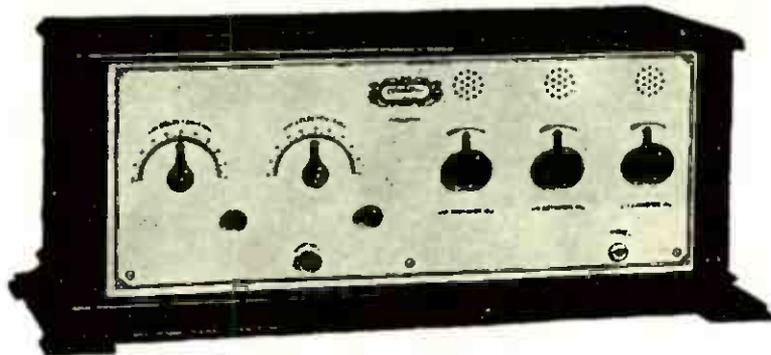
is the one tube sensation of the radio world. Letters are pouring in telling of its wonderful effectiveness at little cost. The New York and Chicago newspapers are fully covering the interesting news features regarding the "Long 45" tuner which is the heart of the new Long 45 set. Read what the papers are saying. See it at your dealers. Or write us for particulars.

MARCO MEYER & CO.

1319 MICHIGAN BLVD.

CHICAGO, ILL.

Announcing the New Goldcrest Clearodyne Models



Model 70

\$75.00

Cleartone engineers have perfected a new circuit, embodying the desirable features of **SELECTIVITY, LOG-ABILITY, EXTREMELY SIMPLE TUNING AND PERFECT CONTROL** in the new **GOLD-CREST CLEAR-O-DYNE FOUR TUBE MODELS.**

The beautifully etched, gold-finished panels and the distinctive, solid mahogany cabinets combine to give you a receiving set which is a valuable addition to any home, and a source of amusement, education and great pleasure for the entire family.

Long distance records are being established with these new models on which testimonials are being received daily. We want you to see and be convinced. Write today for free illustrated circulars, showing all of our beautiful cabinet models.

DEALERS and JOBBERS: Look at the prices below—then at the distinctive design and characteristics above. Write for our interesting proposition—a business builder.

Model 60	\$60.00	Clear-O-Dyne Model 70	\$75.00
Model 61	75.00	Clear-O-Dyne Model 71	90.00
Model 62	120.00	Clear-O-Dyne Model 72	135.00

The Cleartone Radio Company, Cincinnati, Ohio

The TWITCHELL AUXILIARY TUNER

PATENTS PENDING

NAME REGISTERED

More Than a Wave Trap



A TWITCHELL AUXILIARY TUNER connected to any make of tube receiving set will positively cut out any local broadcasting or code stations so you may tune in all long distance stations any time regardless of local conditions.

Unlike any wave trap, THE TWITCHELL AUXILIARY TUNER does not ever decrease but in many cases increases the volume from distant stations.

These TUNERS are in daily use within 400 feet of large broadcasting stations and enable their owners to easily and completely cut out the local station and bring in distant stations at any time on a loud speaker.

This instrument will also enable you to bring in programs sent out on longer waves than you can tune in without it, thus bringing all the broadcasting stations within the wave length range of the many sets of limited range now in use.

Copyrighted diagram of this tuner, 50c, or with all parts, \$9.00
Complete instrument in walnut cabinet, ready to use, \$15.00

A New and Wonderfully Efficient Coil, for the Reinartz circuit for those who want the best. Price, \$4.00, or with blueprint for either one or three tubes, \$4.50.

This circuit brings in both coasts loud and clear and is the most successful Reinartz modification yet produced.

All goods prepaid. These instruments are easy to build, easy to operate. Everything clearly shown

S. A. TWITCHELL, 1930 Western Avenue, Minneapolis, Minn.

Let This Amazing RADIO Book Answer Your Questions

106 Pages—260 Radio Questions and Answers—92 Illustrations—Radio Terms, Laws, Regulations, Symbols and Equations. List of Latest Broadcasting Stations—Explanations of All Types Receiving and Transmitting Sets. Over 10,000 sold—NOW ONLY \$1.00! Send Money Order, check or cash. (Guaranteed to satisfy or money refunded.) None sent C. O. D.



Now Only \$1.00

NATIONAL RADIO INSTITUTE
Dept. 32EQ Washington, D. C.

Like a Rare Old Violin—“Madera” Die-Cast Wood “Clearspeakers”

\$15

have a tone-quality unapproached by metal, natural wood or any other material. Equipped with special loud-speaker unit of great power.

No. 804 here illustrated 12 inches high with 10 inch bell, from your dealer or by mail prepaid. It is one of seven styles. Send for circulars.

American Art Mache Co.
351 W. Austin Ave. Chicago



Specify A Leather Covered Radio Set

Because—Experts found that *leather* is the only material that will withstand wear and hard usage.

Because—it reflects quality.

Because—it costs no more than imitations.

We are manufacturers of all grades of cowhide grains.

Manufacturers—You will need leather for PORTABLE SETS. Write us for free samples and full information.

Eagle-Ottawa Leather Co.

74 Gold St.
New York City

226 West Lake St.
Chicago, Illinois

AMPLEX GRID-DENSER IMPROVES ANY CIRCUIT

Specified by
L.M. COCKADAY
and other
prominent
engineers



Variable Condenser
0 To .0005 Mfd.

Absolutely Essential in

COCKADAY, SUPER-HETERODYNE, NEUTRODYNE, UL-TRADYNE, SUPERDYNE and All Sensitive Circuits for 100% results.

Every tube and every circuit requires a different fixed capacity. Good or poor results depend upon its exactness. A slight turn of the GRID-DENSER knob finds it for you and permits operation of set at highest point of regeneration, controls oscillations and maintains perfect stability, giving **GREATER Distance and Louder and Clearer signals.**

FREE Booklet with hook-ups showing how to double the efficiency of your set.

At your dealers or send \$1.25 to

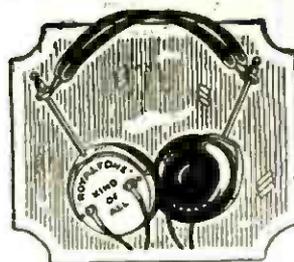
Amplex Instrument Laboratories
57 Dey Street Dept. 5a New York City, N. Y.

\$4.50
List

\$4.50
List



"ROYALFONE" KING OF ALL



Tune in those distant stations with a pair of "Royalphones."

JACK BINNS, says, "They will give an audible sound with a weaker signal than the average phone."

That is why you will get distance where you don't with your present pair.

If your dealer can't supply you, write direct.

Royal Electrical Laboratories
Dept P. R., Newark, N. J.

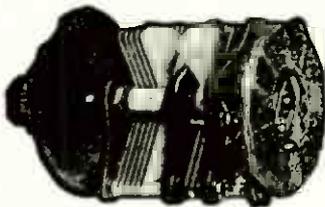
Royalphone
KING OF ALL

CHELSEA

SHARPER TUNING AND MORE VOLUME

with CHELSEA parts

No. 75 Radio Frequency Tuner



The proper amount of inductance and capacity to most efficiently tune between stages of a tuned radio frequency amplifier with minimum controls.

Wave length. all broadcast waves; price with dial and Vernier \$5.75

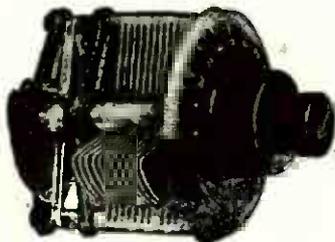
No. 70 Antenna Tuning Unit

Combining the correct amount of inductance and capacity for most efficient tuning of antenna circuit. inductance with four taps.



Wave length. all broadcast waves; price with dial and Vernier \$5.75

Variable Condensers



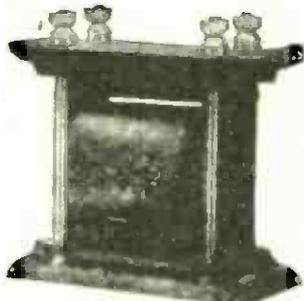
Low Loss

Genuine bakelite insulation. Pigtail connection to rotor Absolutely Guaranteed.

*10—23 plate with Vernier \$4.50

Amplifying Transformers

Genuine bakelite insulation. Highest grade silicon steel core. Tested to 500 volts. Easy to assemble in your set. Ratio 3¾ to 1.



Price \$4.50

Chelsea offers a complete line of parts and sets
At your dealers or write direct

CHELSEA RADIO COMPANY
183 SPRUCE STREET
Chelsea, Mass.

LISTEN-IN RADIO RECORD

REGISTERED U.S. PAT. OFF.

THE ONLY "LISTEN-IN" BOOK

KEEP A RECORD OF STATIONS HEARD, DIAL SETTINGS, RECEIVING CONDITIONS, ETC.

Flexible cloth binding. Gold stamping. 160 pages. Printed on Bond Paper. Contains introductory article "How to Receive Radio Broadcast," by Lloyd C. Greene, Radio editor Boston *Globe*. Many Radio Hints and Tips. Complete list of Broadcasting Stations and double page map of United States.

PRICE

75 cents

At Your Dealers
or Sent Prepaid
on Receipt of Price

**LISTEN-IN
PUBLISHING CO.**

110 MAIN ST.
CAMBRIDGE, MASS.

2 Transformers for 1 the price of 1 NEUTRODYNE

No Distortion
Greater Volume
Half-Price

For \$6 we will send postpaid TWO of the famous Globe Audio Transformers made especially for Neutrodyne sets.

MONEY BACK GUARANTEE

If you are not fully satisfied with the transformers, return them within 5 days and your money will be refunded.

COYNE RADIO SERVICE
Suite 603

507 Fifth Avenue, New York City

RADIO TUBE EXCHANGE

We Repair All Standard Makes of Tubes, Including

W.D. 11 or 12
U.V. 199 or C. 299
C. 11 or 12
U.V. 201A or C. 301A
D.V. 1 or D.V. 2
U.V. 200 or 201
C. 300 or 301

\$2.50



All tubes guaranteed to do the work
RADIO TUBE EXCHANGE
200 BROADWAY, NEW YORK CITY, N. Y.

All Mail Orders Given Prompt Attention
Orders Sent Parcel Post C. O. D.

Supremacy Proven by Every Test

FILKOSTAT

THE SCIENTIFICALLY CORRECT
RADIO RHEOSTAT



WHOLESALE RADIO SERVICE COMPANY

9 Church St. N.Y.C.

IMPROVED 4 CIRCUIT TUNER

Complete Parts as Specified \$53.50

This is the set that Cockaday described as being able to receive over distances of 3,000 miles. You can't build anything better! It uses five tubes.

(Complete with Push Pull Amplifier)

- | | |
|-----------------------------------|--|
| 1 Cockaday Improved Bakelite Coll | 2 Switch Levers |
| 2 Amsco 26 Plate Ver. Condensers | 11 Switch Points |
| 2 Amplex Gridensers | 2 Switch Stops |
| 1 Bradley Leak | 1 Dubilier Cond. .0005 |
| 5 Melco Sockets | 1 Dubilier Cond. .00025 |
| 1 Amsco 6 ohm Rheo. | 1 Durham Var. Leak |
| 3 Amsco 20 ohm Rheos. | 3 Lavite Resistances, 48,000 |
| 1 Pacent Shute Jack | 1 Amsco 400 ohm Potentiometer |
| 2 Pacent Dble. Jacks | 1 7 x 24 Panel |
| 2 Amertran Trans. | 1 3 x 2 1/4 Sub-Panel |
| 1 Como Push-Pull Input | 1 12 x 12 Panel |
| 1 Como Push-Pull Output | 1 7 x 24 Baseboard |
| | Blueprints, Wire, etc., with each order. |

This is an outstanding bargain. **\$53.50**
Send for the parts at once for

COCKADAY 3 TUBE SET

The Cockaday 3 Tube Set (the original Four Circuit Tuner) is still a favorite with the DX fans. We have grouped the complete parts—everything needed to build the set,—for **\$19.50**

We Sell Retail At Wholesale Prices!

YOU SAVE —

by buying from us. Our service enables you to buy for at least 20% less! And the shipments are made promptly.

We ship C. O. D. if you wish—or else you can make remittance by money order when ordering.

WRS NEUTRODYNE

A dandy 5-tube Neutrodyne that will bring in the long distance stations without squeals or howls. The parts are the very best.

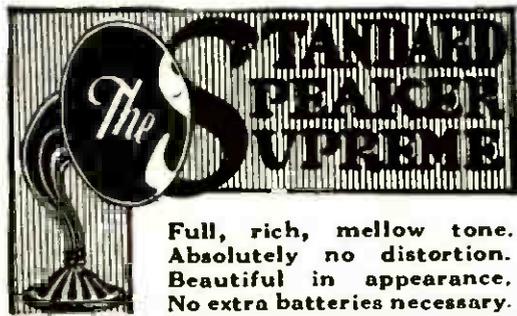
- | | |
|-------------------------------|---|
| 1 7 x 26 Baseboard | 1 30 ohm Bestone Rheo. and Dial |
| 3 Neutroformers | 1 7 x 26 Drilled Panel |
| 2 Neutrodons | 1 .00025 Dubilier Condenser |
| 5 Nat'l Bakelite Sockets | 1 2 Meg. Leak |
| 2 Jefferson Trans formers | 2 .006 Mica Condensers |
| 2 Filament Control Jacks | 8 Initialed Binding Posts |
| 1 Cut-Hammer Battery Switch | Spaghetti, Wire, Blueprint and Booklet. |
| 1 Bestone Power Rheo and Dial | |

The complete parts with DRILLED panel

\$32.50

Other Bargains

A trial order will convince you that every purchase from Wholesale Radio Service is a bargain. Write for our wholesale prices on any part or set you may wish to get.



FULLY GUARANTEED..... **\$7.50**
(By Parcel Post, 15c. Extra)

Send for Complete Catalogue

STANDARD RADIO CO.

611 E. MARKET ST. PHILADELPHIA, PENN.

VACUUM TUBES REPAIRED

WD-11, WD12, \$2.50
UV-201A, UV-199,
And others for **2**

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.

U.S.A. Did YOU get London? ENGLAND LONDON

Just Turn-It

TWO of the three Philadelphia stations that tuned in London were equipped with "Turn-it" Adjustable Grid Leak—the perfect grid control

- Varies 1/2 to 5 megohms.
- No carbon or graphite.
- No sliding contacts.
- Eliminates microphone noises on DX Stations.

TURN-IT RADIO SALES, INC.
Sole Distributors for Charles E. Bonine
30 Church Street NEW YORK

At your dealer or direct upon receipt of **\$1** price **TURN-IT ADJUSTABLE GRID LEAK**

Blueprints

“Improved” Cockaday 4-Circuit Tuner and Tuned-Radio-Frequency Receiver

SO great has been the demand for POPULAR RADIO’s Blueprints of the “Improved” Cockaday 4-Circuit Tuner, that we have now prepared similar actual size Blueprints of the Non-Regenerative Tuned Radio-Frequency (neutrodyne) Receiver described last month.

EACH of these sets of Blueprints has been drafted by our own staff under Mr. Cockaday’s personal supervision. They are full size, accurate, authoritative—and so simple to follow in all details that a novice can work from them without difficulty.

The two complete sets of three prints each, covering all constructional requirements for these two highly-efficient receivers, include an exact panel pattern, an actual size instrument layout, and a picture diagram of all parts showing every wiring connection.

With these actual size Blueprints you can drill your panel without taking a single measurement; you can arrange your instruments and parts in exactly their correct places without guess or hesitation—and you can connect all terminals without even knowing how to read a hook-up diagram.

To make these Blueprints available to all, they have been priced at the very low figure

of only \$1.10 postpaid for each complete set of three prints. The complete set of three prints on the “Improved” Cockaday 4-Circuit Tuner may be had at \$1.10 postpaid. The complete set of three prints on the Non-Regenerative Tuned Radio-Frequency (neutrodyne) Receiver may also be had at the same price, \$1.10 postpaid.

It will interest our readers to know that we have also prepared a set of Blueprints covering an Audio-frequency Amplifier that will not distort. A detailed description of this Amplifier will be found on page 476 of this issue. The complete set of three Blueprints will be sent on receipt of your remittance of \$1.10.

We cannot break Blueprint sets to supply single prints. Any Blueprint set of three sheets will be sent by return mail on receipt of \$1.10; any two sets for \$2.20; all three sets for \$3.30. For convenience use the coupons below.

POPULAR RADIO, INC.

627 West 43rd Street

Dept. 54

New York City

POPULAR RADIO, Inc., Dept. 54
627 West 43rd Street, New York City

Enclosed is \$1.10 payment in full for the set of three Blueprints checked.

- “Improved” Cockaday 4 Circuit Tuner.
- Non-Regenerative Tuned Radio Frequency Receiver.
 - (a) Exact panel pattern.
 - (b) Actual size instrument layout.
 - (c) Picture diagram of all parts (actual size) showing complete wiring.

Name.....

Address.....

.....

POPULAR RADIO, Inc., Dept. 54
627 West 43rd Street, New York City

Enclosed is \$1.10 in full payment for a complete set of three Blueprints for the Audio-frequency Amplifier consisting of the following:

- (a) Exact panel pattern.
- (b) Actual size instrument layout.
- (c) Picture diagram of all parts (actual size) showing complete wiring.

Name.....

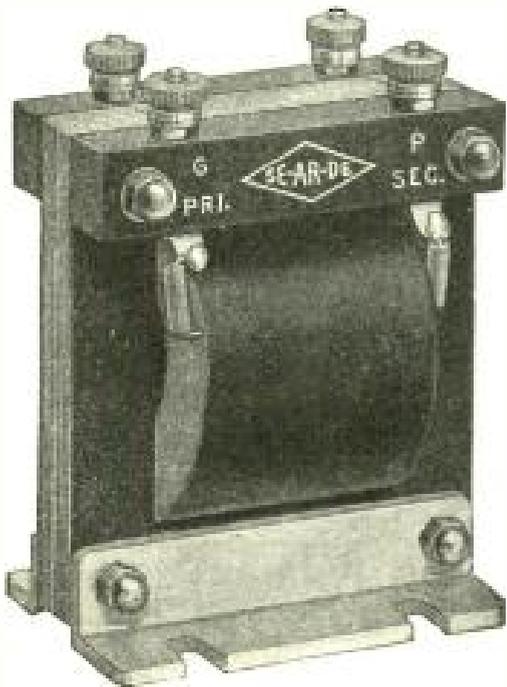
Address.....

.....



QUALITY

**HERE IS A
WINNER**



SE-AR-DE
Amplifying Transformer
Turn Ratio 4-1

20% louder signals with less distortion than any transformer on the market.

Large! But oh boy, you should send for copy of the amplification curve.

Price \$5.00

R. MITCHELL CO.
255 Atlantic Ave. Boston, Mass.
EXPORT OFFICE
44 Whitehall Street New York
PACIFIC COAST OFFICE
Mission Street San Francisco, Cal.

Spintite Wrenches

**MAKE THE
HEX "BEHAVE"**

That's exactly what this new tool does for you—makes the hex nut "behave!" Puts an end to fussing and mussing with pliers in cramped corners.

Held securely in the hexagon head of "Spintite," a hex nut can be screwed *tight*, no matter how confined the working space.

Hollow stem goes over projecting screw-end. Ebonized handle, built to fit the finger grip, spins hex on in a jiffy. Hooking up becomes a joy with the "Spintite." You'll get greater distance and volume.

Sizes $\frac{1}{16}$ " to $\frac{3}{8}$ ", 35c each.
Large phone jack sizes, $\frac{1}{8}$ " to $\frac{1}{2}$ ", 65c each.

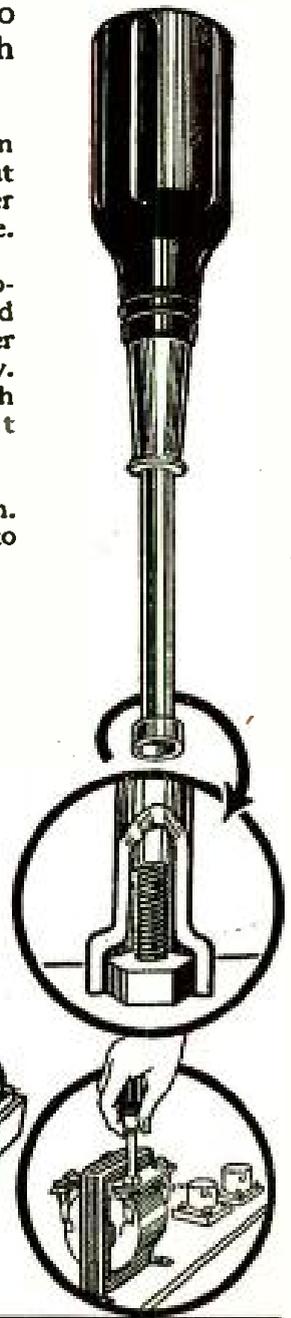
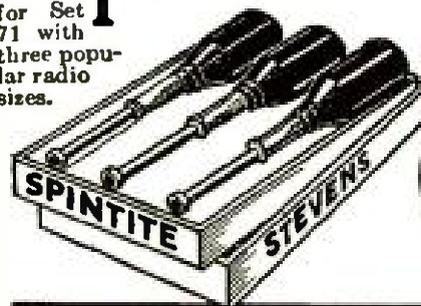
*If your dealer can't supply you
send his name and write to
us direct*

STEVENS & CO.

Toolsmiths since 1899
379 Broadway New York

Send **\$3.50** for Set 73 (professional): 7 sizes, $\frac{1}{16}$ " to $\frac{1}{2}$ " in handsomely finished metal base.

Send **\$1** for Set 71 with three popular radio sizes.



Stevens **SPEED UP**  **Tools**



MAHOGANITE Dials that match the set

Like all other distinctive products, Mahogany has its imitators. But these imitations are on the surface only. Mahogany is not a surface finish. The electrical values of Mahogany extend through the material.

The only way to assure yourself of genuine Mahogany Panels, or Dials which match the panel, is to make sure that the RADION Trademark is on every one that you buy.

21 Stock Sizes Mahogany and Black

6 x 7	7 x 14	8 x 26
6 x 10½	7 x 18	9 x 14
6 x 14	7 x 21	10 x 12
6 x 21	7 x 24	12 x 14
7 x 9	7 x 26	12 x 21
7 x 10	7 x 30	14 x 18
7 x 12	7 x 48	20 x 24

RADION

The Supreme Insulation

PANELS



Look for this stamp on every genuine RADION Panel. BEWARE of substitutes and imitations.

At good Radio Shops
or write to

American Hard Rubber Co.
11 Mercer St. New York

RATHBUN

SINGLE-HOLE MOUNTING

SUPERIOR CONDENSERS

Special—13 Plate

NEUTRODYNE CONDENSERS

Ordinary condensers will not do for the Hazeltine Neutrodyne circuit. A special 13-plate Rathbun Condenser is being widely used because it answers every demand of this circuit so perfectly. Plates are held in better alignment due to single hole mounting and anchoring of plates in accurately milled posts. Every bearing is true and hard wearing. Hence adjustment is always uniform. The success of your Neutrodyne Receiver is worth your insisting upon RATHBUN Condensers.



Capacity
.0003 MFD

LIST
\$3.00

Write TODAY for the name of
the nearest Rathbun dealer
and for illustrated literature.

Rathbun Mfg. Co., Inc.
Jamestown, N. Y.

\$2.50 WHY PAY MORE FOR CLEAR AMPLIFICATION?

use the



Republic Audio
Frequency
Transformer
for all tubes
all stages

Circular on
Request

**FLINT
RADIO CO.**
1774 Wilson Ave.
Chicago, Ill.

HEATH

Radiant Condensers

Precise, when you examine them at the store and, still more important, p-r-e-c-i-s-e always. Plates made PERMANENTLY FLAT, by the Heath process of stamping and hardening.

Micrometer-Adjusting Geared Vernier Reducing gear, engaging with teeth cut into the outer rim of the vernier plate, affords infinitely delicate adjustment.

Jobbers and Dealers: Write Immediately for Proposition.

HEATH RADIO & ELEC. MFG. CO.
204 First Street Newark, N. J.

The DE LUXE NEUTRODYNE

For Beauty and Distance
ALL PARTS MATCHED
ALL PARTS LICENSED

JUST PICTURE THIS—

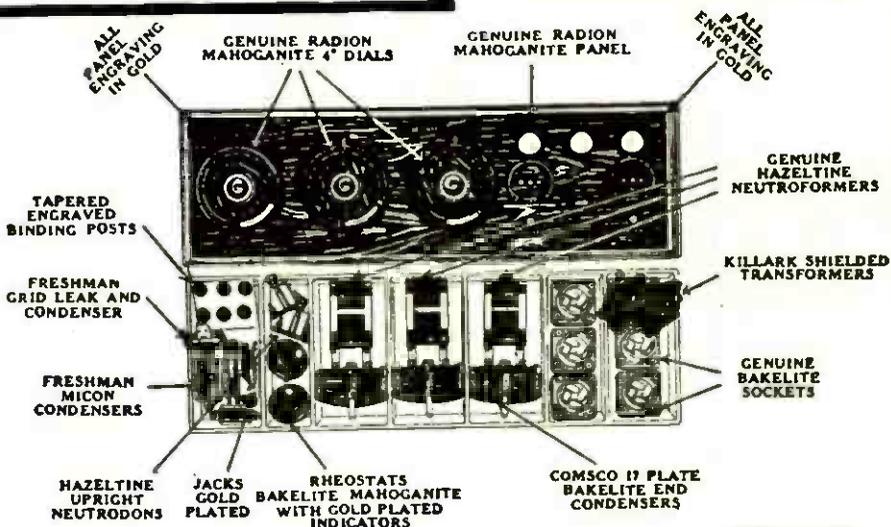
- 1 DRILLED Radion Mahoganite Panel, engraved in Gold.
- 3 Four-inch Radion Mahoganite Dials, Gold engraved.
- 2 Gold Plated Jacks.
- 3 Genuine Hazeltine Neuroformers Mounted on the famous Comsco Bakelite End Condensers. Positively the only Neurodyne Kit including these famous Comsco Condensers.
- 2 Hazeltine Neurodons.
- 5 Bakelite Sockets.
- 1 6-Ohm Rheostat with Gold Plated Knob to Match Panel.
- 1 30-Ohm Rheostat with Gold Plated Knob to Match Panel.
- 2 Genuine Killark Completely Shielded Audio Transformers.
- 1 Mahogany-Finished Baseboard.
- 20 Feet Tinned Bus-Bar.
- 1 .00025 Freshman Grid Condenser.
- 1 Tubular Glass Grid Leak.
- 1 Set Engraved Binding Posts.
- 1 .002 Micon Condenser.
- 1 .006 Micon Condenser.
- Exact size special panel. Base blue print, and instruction sheet.
- All packed in attractive partitioned box useful as a tool box.
- Written Money-Back Guarantee—Orders acknowledged by return mail.
- Shipped C. O. D. Send No Money.

INDEPENDENT RADIO MANUFACTURERS INC.
NEUTRODYNE
HAZELTINE PATENT NO. 1450080
OTHER PATENTS PENDING
REG. U.S. PAT. OFF.

5 TUBES

\$34.49

Complete Assembly Kit to
Build Your Own Genuine
Hazeltine Neurodyne



The RADIO-SHACK

AMERICA'S GREATEST RADIO STORES
Executive Office, 55 Vesey St., Dept. PR 5
NEW YORK CITY

Goods shipped C. O. D. within 48 hours. Just pay the postman. Every article sold on WRITTEN money-back guarantee. We answer every letter we get—same day we get it.

**SEND
NO
MONEY**

MODERN

"Push-Pull" Transformers

—were used in the hook-ups illustrated and described on page 1419 of April "RADIO NEWS"; also page 13 March "RADIO IN THE HOME."

Radio authorities everywhere are unanimous in their endorsement of the MODERN "Push-Pull" method of power amplification.

Modern "Push-Pull"

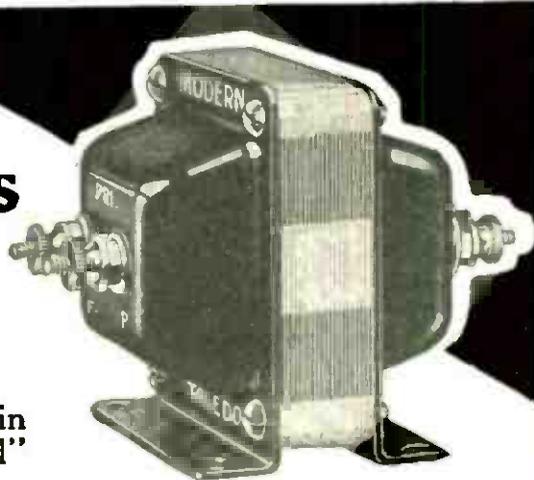
Used in addition to one or two stages of audio. Assures clearer and better reception than has heretofore been secured from audio frequency reception.

Modern "Reflex"

This is the transformer that makes one tube do the work of three in the Monoflex Circuit. Ask for bulletin on the Monoflex Circuit.

Modern Standard Audio 4 to 1 ratio

Designed especially for use in 2-stage amplifiers. Provides greater audibility than three stages using ordinary transformers.



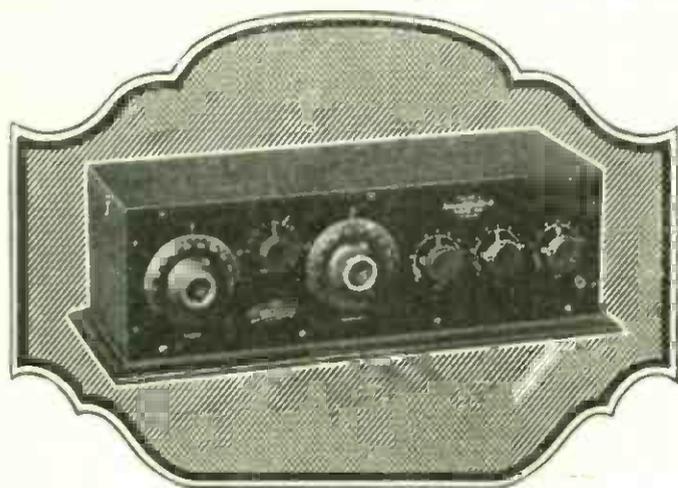
Sold by Good Dealers Everywhere

MODERN Transformers are guaranteed to give satisfaction. Ask your dealer for MODERN Transformers and new bulletin of latest hook-ups. If he can't supply you, write us giving dealer's name.

The Modern Electric Mfg. Co.
Toledo, Ohio



Coast-to-Coast Reception —and beyond



RADIODYNE

"The Voice of the Nation"

NO LOOPS - - - NO AERIAL

With the RADIODYNE you can select broadcast programs from all parts of the country. Honolulu and London have often been picked up by operators in the central states without interference from nearby stations.

The Radiodyne is ready for operation by simply grounding to a water pipe or radiator, and throwing a few feet of wire on the floor. Uses any standard tubes—dry cell or storage battery. Extremely selective. Simple to operate—*Only two controls*—you can tune in on any program you wish—any wave length from 200 to 700 meters.

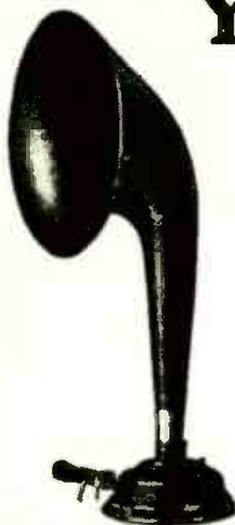
For use in apartments, boats, automobiles, railroad trains, etc., the RADIODYNE is enjoyable where other receiving sets would not be practicable.

PRICE \$150.00

Write for illustrated folder which describes the RADIODYNE in detail. Every radio fan will be interested in this new type (antennaless) receiving set.

WESTERN COIL & ELECTRICAL CO.
308 5th St. :: Racine, Wisconsin

Just Trust Your Ears



One reason the MacMillan Arctic Expedition uses Trimm Headsets is that when a man's life may be at stake, he wants equipment best beyond question.

HEADSETS
LOUD TALKERS
PHONO. ATTACHMENTS

TRIMM

RADIO MFG. CO., Dept. 59
24 S. Clinton St. Chicago

TUBE INSURANCE. 91½% OF ALL TUBES ARE NEEDLESSLY DESTROYED

RADECO SAFETY FUSES offer complete protection. Price 50 cents each

RADIO EQUIPMENT COMPANY, 20 Stuart St., BOSTON, MASS.

FOR SALE:

10 WATT SET FOR KEY OR BROADCASTING

For particulars write to
A. E. SCHILLING
108 Elm Street, Kalamazoo, Mich.
Will send photo on request. Station. W. L. A. Q.



SOLDER WITH INSULATION At Least 1,000 Miles More Distance

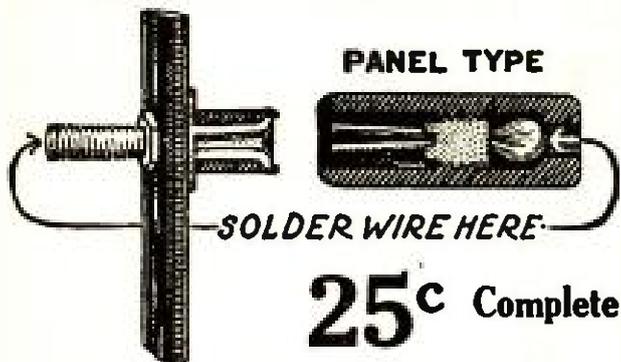
Is the usual reward if you can solder without impairing the insulation of your set.
If you are building a radio-frequency amplifier you should read our free booklet:

"HOW TO SOLDER RADIO SETS"

Write for it
THE VALLEY FORGE CHEMICAL CO., Valley Forge, Pa.

The Sodian Tube

GOODBYE! BINDING POSTS and Wrong Connections



PANEL TYPE

SOLDER WIRE HERE

25^c Complete

PANEL button only 10c
Cap only 15c

- Red + A
- Green—A
- Yellow—B
- Blue + B
22½v
- Pink + B
45 to 90v
- Brown—Ant
- Black—Ground

Hard rubber, all ends protected. Panel Button has panel disc to identify it. All caps in seven different colors.

Simple to connect. Solder connections positive contact. No metal part exposed. Neat and attractive—adds to the appearance of set. Ask your dealer or write us.

DOUBLE CAP TYPE



SOLDER WIRE HERE

TAKE APART WITH SCREW DRIVER

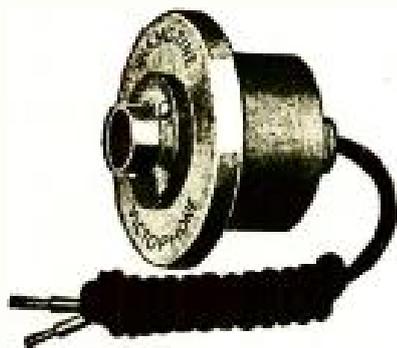
Dealers:
Send for prices.
Packed 36 in counter display box.
Ready for immediate delivery.

30^c Complete
Each Cap 15c

HOWARD B. JONES, 612 Canal St., CHICAGO, ILL.

RHAMSTINE* VICTOPHONE

For All Phonographs and Loud Speaking Horns



\$7.50 Postpaid
Complete with Cord

In addition to the large diaphragm used in the Victophone, every other detail has been given the closest attention. When incorporated with your phonograph or horn, it will reproduce with the utmost volume and purest tone. No battery required to operate it. Your money back if not satisfied.

It can be furnished to fit all phonographs—the Standard Type fits the Victrola, Columbia, Jewett or Sonora. Specify make of phonograph when ordering. List Price, Standard Type, \$7.50.

Order the New Victophone and test it before buying any other loud speaker

RHAMSTINE* MODEL B TYPE 3, AMPLIFYING TRANSFORMER

Especially Designed for Reflex Circuits, Ratio 5 to 1

Years of success in manufacturing Audio Frequency Transformers prompt the statement that you can find no better unit than the Model B. In reflex usage, the Type 3—ratio 5 to 1—is highly efficient. Order yours and secure greater range and volume with your set.

Manufactured by

J. THOS. RHAMSTINE*

Woodbridge at Beaubien

Detroit, Mich.

*Maker of Radio and Electrical Products



\$4.00
Postpaid

Free Parts for Your Radio Sets!

Your choice of these valuable premiums, free to you as a reward for securing only a few subscriptions to **POPULAR RADIO**

A FEW moments of your spare time spent in bringing **POPULAR RADIO** to the attention of your friends and acquaintances will yield you big rewards. Never before have we been able to offer such attractive and liberal premium values as these.

Glance over this broad list of radio parts and equipment that you can secure **FREE**, merely by introducing **POPULAR RADIO** to some of your friends

and acquaintances who will appreciate the opportunity of subscribing to this most interesting and helpful magazine.

Show this copy of **POPULAR RADIO** to other radio fans. The pages of the magazine will speak for itself. Then send us the names of your friends, with \$3 for each yearly subscription, and take your choice of any of the following premiums. They'll come to you *absolutely free*.

Any One of These for 2 Subscriptions:

Dubilier Ducon, and choice of any *three* Dubilier Micadon Grid Condensers of the following capacities: .00025; .0005; .001 or .002.

Pudlin Tubular Grid Leak (2 megs.); Dubilier Micadon Grid Condenser .00025; Cutler Hammer 6 ohm Rheostat, and *one* Alden Napier Socket, 201A or WD-11.

Three Pacent Jacks (*one* single circuit and *two* double circuit).

Bakelite Panel, size 7 x 18 inches.
22½ volt B Battery, large, choice of Burgess or Eveready.

One copy of Ballantine's "Radio Telephony."
Cutler Hammer 30 ohm Rheostat and choice of *one* Alden Napier Socket: 201A, 199 or WD-11.

Your Choice for Only 3 Subscriptions:

Bakelite Panel, size 7 x 24 inches.
Set of Mounted De Forest Coils; 35, 50, 75.
Amsco Compensating Condenser and choice of any *one* Alden Napier Socket: 201A, 199 or WD-11.

"Scientific" Headset.

Two Cutler Hammer 6 ohm Rheostats and *one* Cutler Hammer Potentiometer.

Diode Dry Cell Tube and Cutler Hammer 6 ohm Rheostat.

Big Value for 4 Subscriptions Each:

Lefax Loose Leaf Radio Handbook with full year's free supplement service.

Sleeper Variocoupler with switch lever and points.
Cardwell 21 Plate Condenser or General Radio 23 Plate Condenser.

Cardwell or Se-Ar-De 17 Plate Condenser.

Cardwell 11 Plate Condenser and Frost Jack.

U. V. 200 or C. 300 Vacuum Tube.

"Ampl Tone" Phones.

Free With 5 Subscriptions Each:

Cardwell 43 Plate Condenser.
Spiderweb Coil and Mounting.
Brandes or Holtzer. Cabot No. 4 National Phones.
Amertran Transformer.
Atwater Kent or Sleeper Variometer.

U. V. 201A or C. 301A Vacuum Tube.

U. V. 199 or C. 299 Vacuum Tube.

WD-12 Vacuum Tube.

WD-11 Vacuum Tube.

ALL premiums will be sent prepaid, immediately on receipt of your orders. If you want some particular part that is not listed here, write us and we'll tell you how many subscriptions you'll need to get it *free*. Or if you prefer *cash commissions*, just drop us a postcard asking for full particulars.

Renewals of old subscriptions or extensions

of present subscriptions count the same for you as new subscriptions. In other words, any subscription you receive entitles you to your reward in cash or in premiums. Simply send us \$3 to cover each subscription you take and we will send you your premiums.

Start today, and you'll have your required number of subscriptions in a jiffy!

POPULAR RADIO

Dept. 51 627 West 43d Street New York City

THE HINES RADIO DESK



"A Complete Home for Your Radio Set"

Radio set owners all over the country are rapidly taking to the Hines Radio Desk as they quickly realize that it is just what they have been looking for. It was designed by an experienced radio man with the sole idea in mind of giving the owner a complete home for his radio set. Some of the special features are the large roomy top for receiving cabinets and loud speaker with ample elbow room left; two good size drawers for extra tubes, pliers, voltmeter, parts, etc., moulding on the back of top to protect loud speaker and receiving cabinets; spacious battery compartments that gets the batteries up off the floor and out of the way yet easily accessible at all times; acid proof rubber mat that lines the battery compartment; invisible steel fasteners on doors and many others. Finished in Dark Red Mahogany and American Dark Walnut. Crated in a specially designed crate with two waterproof covers. If unable to purchase in your locality send name of dealer for further details and exact specifications.

Hines Radio Desk Company
Owensboro, Kentucky

ALL THE PARTS FOR

Latest Hook-ups

Large new catalog
just off the press

Dealers: Write for your copy today

R. S. PROUDFIT CO.

Distributors of Genuine RADIO Parts

143-145 South 10th

Lincoln, Nebr.

WE REPAIR The Following RADIO TUBES



WD-11.....\$3.00	DV-6A.....\$3.00
WD-12.....3.00	UV-199.....3.00
UV-200.....2.75	C-299.....3.00
UV-201.....3.00	UV-201A.....3.00
C-300.....2.75	C-301A.....3.00
C-301.....3.00	Marconi.....3.00
DV-6.....3.00	Moorhead.....3.00
DV-1.....3.00	6v.Plain Detector 2.75
DV-2.....3.00	6v.Plain Amplifier 3.00

Mail orders solicited and promptly attended to. Dealers and Agents Write for Special Discount.

H. & H. RADIO COMPANY
Clinton Hill Sta. P. O. Box 22-E. Newark, N. J.



The Most Important Event of the Year in the Radio World

It offers tremendous opportunities for display of Radio products right where thousands of Radio enthusiasts will see them.

Grand Central Palace
Main and Mezzanine Floors
New York City

October 2nd to 8th 1924
Inclusive

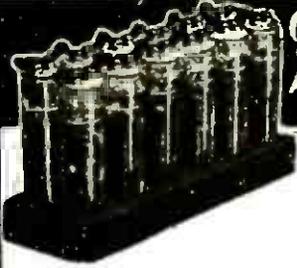
Every representative Radio firm should have its products featured in the **THIRD ANNUAL NATIONAL RADIO SHOW**. A nation-wide advertising and publicity campaign has already been launched.

For further details communicate with

**AMERICAN RADIO
EXPOSITION CO.**
522 Fifth Avenue :: New York

Telephone: Vanderbilt 0068

"Profit Sharing With Exhibitors"



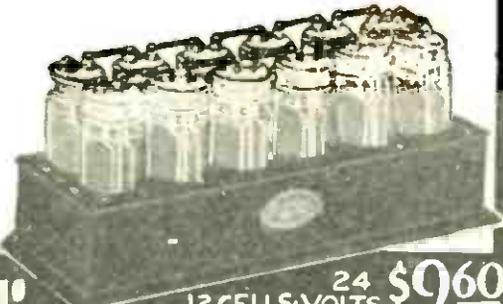
The RāBAT Junior \$3.96

A Rechargeable Wet 'B' Battery. Capacity 800 Mil-Amps.
12 CELLS 24 VOLTS

Here are two acid type wet "B" radio batteries that are entirely free from internal current leakage. All elements visible through clear glass cells. RABATS have longer life with higher and more continuous voltage. Noiseless and compactly constructed—The Rabat Junior with a capacity of 800 mil-amps at \$3.96 and the Rabat Senior with a capacity of 2800 mil-amps at \$9.60 represent more actual battery value at a lower cost. More economical to buy—more economical to maintain. Easily recharged from ordinary house current. If your dealer cannot supply you send direct.

Prices F.O.B. Cleveland, Ohio

The Radio Rabat Company
714 Bangor Building, Cleveland, Ohio



The RāBAT Senior

A Rechargeable Wet 'B' Battery. Capacity 2800 Mil-Amps.

12 CELLS 24 VOLTS **\$9.60**

48 VOLTS **\$17.88**

Sterling

PORTABLE RECTIFIER

"The Battery Charger Without a Weakness"



AN old stand-by made according to latest radio improvements. A 5 amp. maximum charging rate. Number of contacts reduced to one. Freezing and sticking eliminated. Quiet in operation. Almost total absence of sparking. Connect to any 110 volt A.C. lighting circuit. Cannot be used incorrectly nor harm plates.

THE STERLING MFG. COMPANY
2843 Prospect Ave., Cleveland, O.

\$16.00

West of Rocky Mountains **\$17.00**



Better Tone for Your Radio!

FRANK D. PEARNE, famous Radio engineer, says TRANSCONTINENTAL RIBBON Aerials aid reception by combining maximum surface with minimum resistance. FORREST, eminent inventor, says, "I get best results by twisting Ribbon Aerial, 2 twists per 50 feet." Complete with snap hooks soldered to ends for instant attachment to insulators.

Transcontinental RIBBON COPPER AERIAL	50-Foot \$1.50 75-Ft. \$2.25 100-Ft. \$3.00 150-Ft. \$4.50
--	--

Clearer tone, greater volume, increased distance and selectivity guaranteed or your money refunded! Improves any set, tube or crystal. A laboratory product, with capacity, resistance and strength calculated to give better results.

Try It Without Risk! If your dealers cannot supply you, order direct from manufacturer, enclosing price. 100-foot length most generally used. Money-back guarantee protects you.

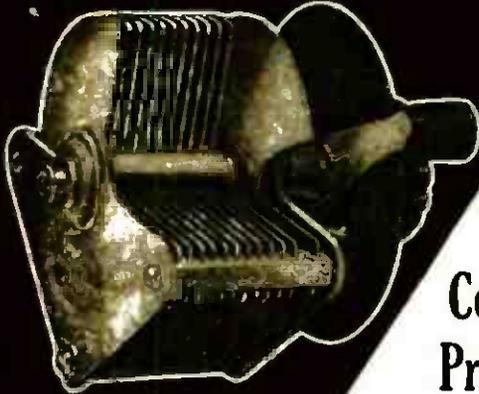
307 W. Lake St.
Dept. 308
CHICAGO

Acorn Radio Mfg. Co.

TRANSCONTINENTAL RIBBON AERIAL

DEALERS! Write for Special Offer!

DUPLEX



PATS. PEND.

TRADE MARK
NONE OTHER

Compact Precision Condenser

A highly efficient product at an extremely low price.

Die-Cast Rotor. Milled End Posts, Novel and effective vernier.

Be sure to write for Bulletin "Taking the 'Con' out of Condensers."

Who's your Dealer or Jobber?

The DUPLEX ENGINE GOVERNOR CO., Inc.
50 Flatbush Ave. Extension
BROOKLYN, N. Y.

S. HAMMER RADIO CO. 303 Atkins Ave. Brooklyn, New York

COCKADAY 4-CIRCUIT TUNER

Item	List Price	Item	List Price
1 Bakelite Panel 7x24.	\$3.90	2 Pacent Doub. Jacks.	\$1.60
1 Precision Cockaday Coil	.50	1 Pacent Single Jack	.60
2 Amsco 26 Pl. Cond. 4" Dial	11.00	2 Amertran Transformers	14.00
5 Melco Tube Sockets	5.00	2 Amsco Switch Levers	.60
1 Amsco 6 Ohm Rheostat	1.00	3 48,000 Ohms Lavite Resistances	3.75
3 Amsco 20 Ohm Rheostats	3.75	1 .00025 Dubilier	.45
2 Amplex Grid Densers	2.50	1 .0005 Dubilier	.45
1 Durham Var. Grid Leak	.75	1 Pr. Como Dup. P. P. Transformers	12.50
1 Amsco 400 Ohm Potentiometer	1.50	1 Panel 1x12	.40
1 Bradley Leak	1.85		

GENUINE COMPLETE PARTS as listed above for the Improved Cockaday 4-Circuit Tuner. Exactly as specified by Mr. Cockaday. List price \$69.00. SPECIAL KIT PRICE **\$55.00**

The above parts may be bought separately. Write for our catalogue

Orders over \$5.00 Shipped Prepaid. Money Orders or C. O. D. One-third must accompany all C. O. D. orders. Not insured unless insurance charges included.

CARTER Vernier Rheostat



6 ohms. \$1.50
20 or 30 ohms.
\$1.75

New original construction.
Only one hole to drill, mounts like a jack.
Only one control.
No scraping or scratching.
Vernier control all the way.
Send for Illustrated Catalog.

Carter Radio Co.
1807 REPUBLIC BUILDING
CHICAGO



The BELL Dial

For Your Protection

BELL molded bakelite Sockets and Dials are sold in individual blue boxes, branded with the BELL trade mark. Every socket or dial reaches you smooth and clean, without a nick or scratch. Use BELL Dials and Sockets for your pet hook-up.

The BELL Dial

Highly polished molded bakelite (not composition). Clean white engraving. Accurate brass bushings that will not wobble on the shaft. Being bakelite, these dials are strong mechanically, are unaffected by moisture and temperature, and are fast color. In 2, 3, 3½ and 4 inch sizes. Made also with hole through knob for vernier attachment. Vernier knob to match can be supplied.

The BELL Square Socket

One-piece molded bakelite, for base or panel mounting. Its unusual double-wipe spring contact makes firm sure contact with tube prongs, even after constant use. Gets the best results from your tubes.

Dealers: If your jobber does not carry BELL Radio Products, write us for circular on molded sockets and dials.

Bell Manufacturing Co.
12 Elkins St. Boston 27, Mass.



The BELL Square Socket



“SPIKE”

The Stations You Receive in a Kasper Radio Record Book

Then you will know where to set the Dials, Switches and Rheostats to bring them back. This book is indorsed by thousands of professional Radio Fans in all parts of the country because it covers everything on the panel. (Copyrighted.) Can be used with any set. Contains up-to-date list of 1,100 Broadcasting Stations. Time of Principal Cities and instructions HOW TO RECORD STATIONS. 24 pages, valuable information. No set complete without one. 50c a copy, Postpaid. For your

convenience enclose a \$1.00 bill for 2 copies, otherwise send a money order for 1 or more. No checks nor stamps.

We also furnish Kasper's "APPLAUSE CARDS" printed on stamped postal cards. 25 mailed anywhere upon receipt of 50c.

KASPER BROTHERS COMPANY

317 Lorain Street Bank Bldg., Cleveland, Ohio, U. S. A.



TYPE
A1
\$25.00
21" Fibre
Horn

The TRINITY LOUD SPEAKER

The Trinity Loud Speaker is an instrument that combines the best qualities of a phonograph reproducer in combination with electro-magnetic principles best fitted for radio amplification.

Perfect reproduction of all music and speech without distortion. No storage batteries required. The instrument is of a heavy duty type and is guaranteed fully by the manufacturers.

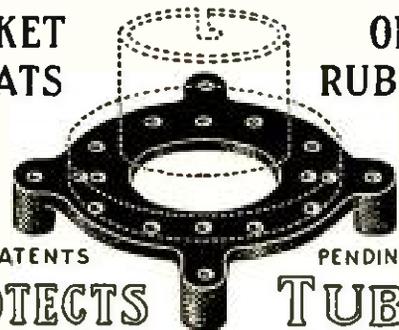
For sale by good dealers
Literature upon request

TRINITY RADIO CORPORATION
446 1/2 Tremont Street, Boston, Mass.

ILLINOIS SOCKET CUSHION

SOCKET
FLOATS

ON
RUBBER



PATENTS

PENDING

PROTECTS

TUBES

Cushion is moulded of pure gum rubber that absorbs all vibrations that would otherwise reach Tube. It is not a mere pad or washer. It is held to socket separately by 2 small screws and nuts and will fit any socket, round or square, for large or small Tubes. Just the mounting for portable camp sets and Super-heterodyne.

Price, 35c. Each—3 for \$1.00, Post Paid

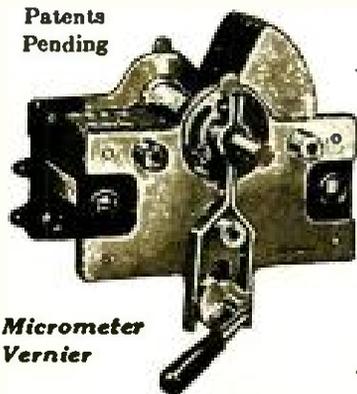
At your retail store. If your
dealer doesn't have them,
order direct.

ILLINOIS RADIO CO.
Springfield, Ill.

NEW MODEL "B" HAMMARLUND

Patents
Pending

Grounded-Rotor Precision Condenser A Laboratory Product



Micrometer
Vernier

PRICES for Panel Mounting

43	Plate .001	Mfd.	\$7.00
23	" .0005	"	6.00
17	" .00007	"	5.75
13	" .00025	"	5.50
	3-1/4" pure Bakelite Dial		.75
	4" pure Bakelite Dial		1.00

At your dealer's otherwise send purchase price and you
will be supplied postpaid.

The advanced design represented by the new Model "B" Hammarlund gives every essential the well informed radio builder demands—

- (1) Lowest loss (too small to measure).
- (2) Micrometer Vernier control.
- (3) Soldered Brass plates to reduce series resistance.
- (4) Rotor grounded-to-frame
- (5) Heavy, large face contact bearings to rotor.
- (6) Adjustable cone bearings.
- (7) Brass plates for rigid construction add electrical efficiency.

“The Condenser of Super-Qualities.”

WRITE FOR DESCRIPTIVE CIRCULAR

HAMMARLUND MFG. CO. 144 W. 18th St. NEW YORK

TRADE MARK



RADIO PANELS

Cost 25 to 50% Less

Recently introduced by The PANTASOTE COMPANY, Inc. Electrasote has highly desirable radio-electric properties—greater volume and surface resistivity than any other panel, therefore less surface-leakage and power-loss in the set.

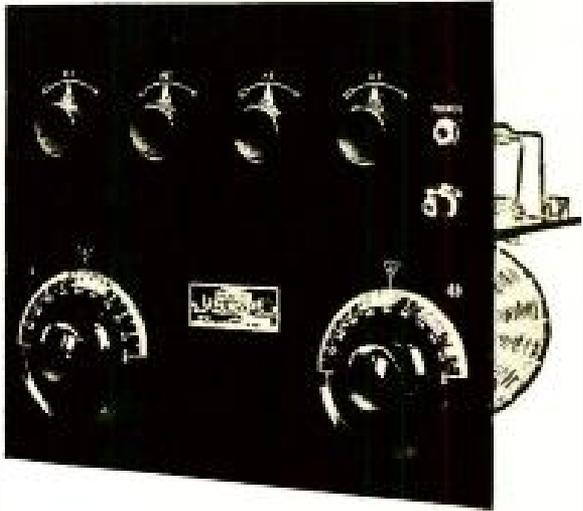
Remember—a good panel deserves proper handling: Use a new *sharp* drill with *slight* pressure.

All Standard Sizes at good Radio Dealers

JOBBERS AND DEALERS:
Write for our interesting proposition.

M. M. FLERON & SON, INC.
Exclusive Sales Agents for Electrasote Radio Panels
Trenton, New Jersey

Introducing—
the Greatest Achievement of a Broadcast Receiver





UNIDYNE Pat. Pend.
RECEIVER

Reg. U.S. Pat. Off.

Again the vast resources of *United* have made possible another brilliant triumph—the “UNIDYNE” RECEIVER.

We have produced a four-tube radio receiving instrument embodying every desirable feature:—Simple in operation, will not oscillate or reradiate, has super selectivity, receiving efficiency and purity of tone.

There are but two tuning dials which, with surprising sharpness, cover the entire range of broadcasting wavelengths. No need to wait until a local “silent night” to enjoy programs from distant stations.

The United “UNIDYNE” will equal the performance of any five-tube set. It will always bring in stations at the same recorded setting of the two dials.

The United “UNIDYNE” Receiver will make readily available to you everything necessary to the fullest enjoyment of all there is in Radio.

The pleasing design of the cabinet, either solid mahogany or walnut, and its beautiful finish make it an ornament to any home.

Ask a United dealer to demonstrate the “UNIDYNE” or write us for literature and prices.

Distributors will find an interesting proposition awaiting them.

UNITED MFG. & DISTG CO.
9705 Cottage Grove Ave.
Chicago, Ill.



14" Fibertone, \$12.50

A phone plus a FIBERTONE makes a beautiful musical instrument



Beautiful Tonal Reproduction

The reproduction of radio music and speech in the home through the Fibertone, is an example of the true tonal quality given by a horn of fiber. One phone from any good head set, when coupled with the Fibertone, renders the broadcast program with wonderful clearness, free from metallic noises. The attractive outward appearance of the Fibertone is significant of the inward beauty that permits such supremacy of reproduction.

If your dealer cannot supply you write direct.

FIBER PRODUCTS COMPANY
34 Orange St. Bloomfield, N. J.



RADIO HORN

ACCURATUNE

MICROMETER CONTROLS

"There's that Station"

"I have just tuned in on my Accuratune-equipped set, and with the ease of an amateur. For hours I've worked over that station with the old fashioned dials, and even vernier plate condensers. Now, with the slightest twist of the knob I pull in stations I never heard of.

"The Accuratune is not a mere dial but an actual Micrometer Control more efficient than vernier condensers or any tuning device, and far more simple to operate."

Designed for either coarse or precise tuning and to fit all standard condenser shafts. Price \$3.50.

The Mydar Radio Company

9-B Campbell Street :: Newark, N. J.

Radio Ltd., Montreal, Canada
Canadian Representatives

For the Phonograph

The Accuratune Phonograph Attachment is applied instantly to the reproducing arm and converts your phonograph into a loud speaker. Permits the whole family to enjoy broadcast music.

\$10.00



A 2c Stamp Brings this Loop on Trial

COMPARE reception on your present aerial with reception on this new IMPROVED Loop—at our expense! Put our claims of selectivity, directional capacity and sensitivity to the test, on your set, in your own home. 10 days in which to make every conceivable experiment. 10 days to find out all about this loop before you buy it. Unless it entirely satisfies, you may return it or have your money promptly refunded. Select your type and send C. O. D. order NOW!



Type A-737 (300-700 meters) 6 inches square—non-directional.....\$10
Type A-7236 (175-1000 meters) 6 inches square—non-directional.....\$12
Type B-2537 (300-700 meters) 18 inches square—directional.....\$20
Type BL-2520 (200-18,000 meters) with honeycomb coil mounting.
18 inches square—directional.....\$25

Send for Bulletin I-102

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



The Copper Giant "A" Battery

For UV199 and WD11 tubes

FIVE TIMES THE LIFE OF A DRY CELL
No deterioration when idle

At your dealer's or postpaid for \$1.35 each.
Renewals 50 cents each. Write for circular

THE COPPER GIANT BATTERY CO., Landsdowne, Pa.

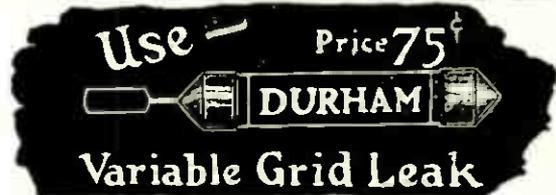
LOUD SPEAKING CRYSTAL SET

Stations brought in from over 1000 miles and music heard all over the room right from your present crystal set with the STEINMETZ AMPLIFYER. Get our complete catalog.

STEINMETZ WIRELESS MFG. CO.
5703 Penn Ave., Pittsburg, Pa.

YOU to hear programs from
stations 400 to 1000
DON'T NEED Miles Away. I can show
you how to get them
TUBES on YOUR CRYSTAL
SET. Changes often
cost Less Than One
Dollar. Send self-ad-
dressed envelope for picture of my set.

LEON LAMBERT
540 So. Volusia, Wichita, Kansas



At dealers, or postpaid
Durham & Co., 1936 Market St., Phila.

KING QUALITY
ALL THE NAME IMPLIES
RADIO APPARATUS



Detector
Vernier
Rheostat

Genuine
Bakelite
Knob and Base

THE KING QUALITY LINE COMPRISES:

Adapters	Dials	Rheostats
Bakelite Knobs	Inductance-	Switch Levers
Binding Posts	Switches	Vacuum Tube-
Contact Points	Panel Mountings	Sockets

RADIO DIVISION
KING SEWING MACHINE CO.
BUFFALO NEW YORK



SICKLES
DIAMOND
WEAVE
INDUCTANCE
COILS

VARIOMETER and
VARIOCOUPLER

Variometer - \$4.50
Variocoupler - \$4.50

THE F. W. SICKLES CO.

Successors to
RADIO MANUFACTURING CO.
Dept. B. 337 WORTHINGTON ST., SPRINGFIELD, MASS.

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 3 1/4" sizes.

Alden Manufacturing Company
Largest makers of Radio sockets and dials in the world
Dept. C 52 Willow St.
Springfield, Mass.



No. 3003-4
3 Inch
35c, 3 for \$1.00

SHAMROCK
FOR SELECTIVE TUNING



LIST
\$20

*You'll be neighbor
to Havana*

WITH the new Shamrock Kit you can build a set that pulls in stations 3000 miles away. You can get distant stations while the local stations are going full blast—due to the wonderful selective capacity of sets built with this kit. The kit is equipped with two wonder working Shamrock balancing condensers—also three Shamrock air core transformers mounted and properly balanced on U. S. Tool condensers—made expressly for Shamrock.

Inspect this kit at your dealer's today. You will be impressed by the high quality and finish of each instrument in it. If your dealer hasn't the kit in stock, send us the coupon below.

SHAMROCK
MANUFACTURING COMPANY

Dept. 90, Market St., Newark, N. J.

CLIP THIS COUPON

SHAMROCK MFG. CO.,
Dept. 90, Market St., Newark, N. J.

Gentlemen:
Send me information on your Shamrock Kit.

Name

Address

Dealer's Name

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 varlocoupler.

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 22 cents.)

February, 1923 (Out of stock)

March, 1923 (Out of stock.)

April, 1923

- Regeneration without Radiation.
- How to make a simple single tube Receiving Set.
- Circuit diagram of the Cockaday DX-3 Circuit Tuner, with instructions on how to add three stages of radio frequency.

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 page 108.)

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 page 108.)

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

- How to build the "Improved" Cockaday 4-Circuit Tuner.
- The 100 Best Hook-ups (Part 3.)
- How to Read a Diagram (Part 2.)
- List of U. S. Broadcasting Stations.
- How to build the coupler, oscillator coupler and r. f. transformers for the Super-heterodyne.

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.

POPULAR RADIO, INC.

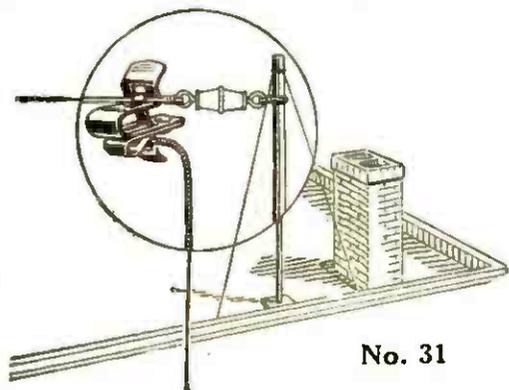
627 West 43d Street

Dept. 58

New York City

Please refer to POPULAR RADIO when answering advertisements.

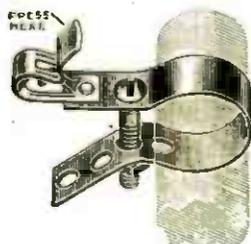
FAHNESTOCK'S RADIO PRODUCTS



No. 31

The Antenna Connector

Snap larger connector over Antenna Wire; insert Lead-in Wire into smaller clip and a perfect connection is the result.



Improved Ground Clamp

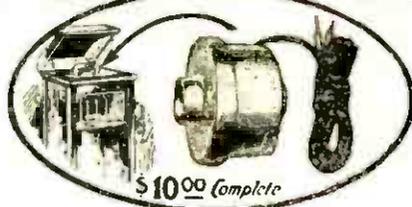
Equipped with Fahnestock Patent Wire Connectors Easily Attached.

No Soldering—For Radio Use Only.
Our name is stamped on all our products. None genuine without it.

At Your Dealers

FAHNESTOCK ELEC. CO.
Long Island City, New York

Morrison



Loud Speaker

To hear a radio concert reproduced by Morrison creates an instant desire to own one of these faithful Loud Speaking Units. For it seems like magic to hear so truly the singing quartet and the sweet-toned violin. Even with full volume no harshness nor vibration creeps in.

Then too Morrison is adjustable — turn a little dial and regulate the volume to your taste. It isn't surprising that once you own a Morrison you cannot be satisfied with less. Distant stations are unbelievably loud and clear and you can soften the tone if you wish.

Every Morrison carries a "money-back" guarantee.

Handsomely Nickel Plated

\$10.00

Complete with 5 foot cord

Free two color catalog on request

JOBBERS—DEALERS

The market on Morrison is active. Our merchandising plan will interest you. Write immediately for details and discounts.

Morrison Laboratories, Inc.
345 East Jefferson Ave., Detroit, Mich.

Price 50 cents everywhere

Never sold at cut prices

B-METAL
LOUD TALKING CRYSTAL

Sold only by reliable dealers and at full price.
The Premier Crystal of the Radio world today.
Ideal for REFLEX or CRYSTAL sets.

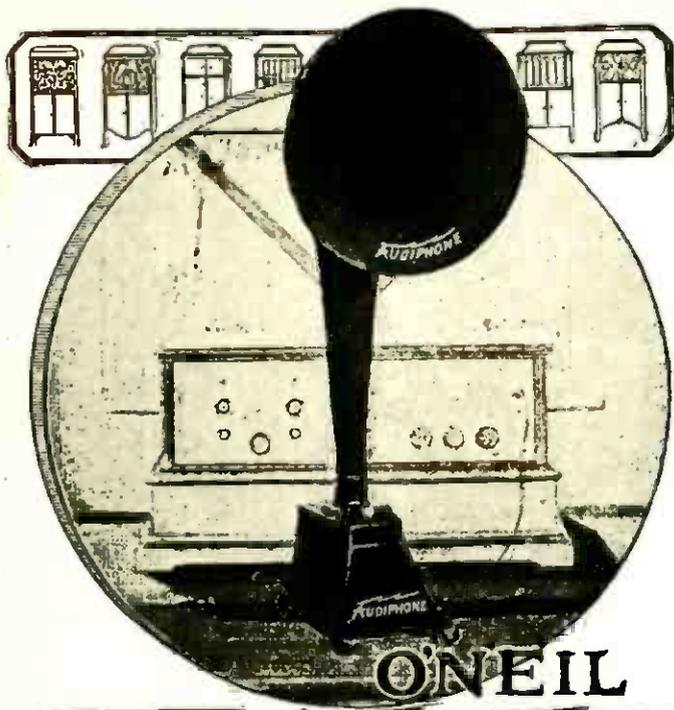
Order if possible from your dealer. If he does not have it send to us for one—price 50 cents post paid.

New Jobbers and Distributors plan now ready

B-METAL REFINING COMPANY
525 Woodward Ave. Suite 12
DETROIT, MICH.

GENUINE
B-METAL

Chicago Branch 55 West Jackson Street
New York Branch 212 Fulton Street



O'NEIL AUDIPHONE

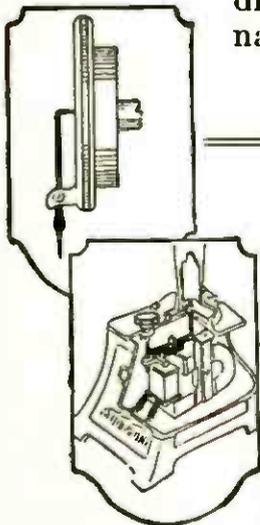
THE Audiphone began beyond the limits of the average "loud speaker." Radio acoustic engineers and phonograph craftsmen coordinated the tone principles of the finest phonographs with those of radio. The result is a NEW naturalness. Sensitive enough to perfectly amplify the weaker signals, and flexible enough to reproduce on a neutrodyne, superheterodyne or other multiple sets without rattle or chatter. Satisfaction or your money refunded. At most good dealers, or you can order direct, giving your dealer's name.

ART MODEL

Beautiful Antique Bronze Finish. No extra batteries needed. Complete, with connecting cord.

\$30

14 Inch Horn
\$5 additional



Note the similarity of construction between the phonograph reproducer (illustrated in the upper panel) and the reproducer of the O'Neil AUDIPHONE (below): both have a mica diaphragm set in a sound-box chamber actuated by an elbow stylus bar.

O'Neil Mfg. Co.

714 Palisade Avenue
West New York, New Jersey

\$200
SELECTIVITY
for \$8.50!

Make Every Night Silent Night!

TRAP OUT THE INTERFERENCE

Selectivity—which is merely the ability to cut out interference—is the dominating difference between the very expensive sets and the moderately priced ones. Why pay \$50.00 to \$200.00 extra for increased selectivity, when for \$8.50 you can get a **FERBEND WAVE TRAP** which will absolutely cut out any interfering station, no matter how loud, how close by or how troublesome.

Add a Ferbend Wave Trap to Your Set

You will find it a valuable addition. It is designed and manufactured complete by us, after years of careful experimenting. It is not to be confused with imitations hastily assembled from ordinary parts. The price is \$8.50. Shipment is made parcel post C. O. D. plus a few cents postage. If you prefer, you can send cash in full with order and we will ship postage prepaid. Send us your order today.

We guarantee that the Ferbend Wave Trap, when properly connected to any workable receiving set, will tune out any interfering station.



FERBEND ELECTRIC COMPANY
21 E. South Water St.
CHICAGO
Descriptive Folder on Request
FERBEND Wave Trap

RADIO PIN-MAP

of United States, Canada and West Indies with indexed booklet Broadcasting guide.

Spot Stations You Hear with Colored Map Pins

Map size, 22x14 in., mounted on map-pin board. Shows all broadcasting cities, distance scale, relay and time divisions. Guide gives all call signals, locations, stations, wave lengths, etc. Price complete, 85c. Map-pins, 10c per doz. Any color. Above booklet with folded paper map, 35c. At your dealer or direct.

AMERICAN MAP CO.

MAP MAKERS PUBLISHERS
7 WEST 42nd ST. Dept. L. NEW YORK
Dealers and Representatives wanted

SUPERHETERODYNE that gets results

Here is one Superheterodyne that is not a "silver." Successful in transatlantic test. Operates on loop only. All complications removed without impairing its efficiency. Low in cost, high in performance. Acquaint yourself with the details of this real receiver. Blue prints and data mailed post paid for

50c.

Jobbers and Dealers correspondence invited

RADIO INSTRUMENTS CO.

17 N. WABASH AVE. CHICAGO - U. S. A.

Use **INDIVIDUAL** Call Cards and Radiograms with **YOUR OWN** Name, Address and Station



ARRL Emblem Added if Requested
MONEY REFUNDED if Not Satisfied
Cards: Red call, black printing.
High quality, 100—\$1.75; 200—\$2.75;
500—\$3.60, postpaid. Gov. post cards 1 cent extra per card.
Radiograms: Same prices.

Write for **INDIVIDUAL** Radio Stationery and log samples and prices
Send order with check or money order Today—**NOW.**
RADIO PRINTERS, Dept. 35 Mendota, Illinois

All the Rage
Get Yours NOW



ADD SELECTIVITY

to your Present Set
with a

CONTROL-O-METER

The Control-O-Meter is available from good dealers in most sections of the country—if, however, you have any difficulty in securing one, we will ship direct, post-paid on receipt of price—\$12.50.

You don't need a new set to hear radio programs one at a time. Add a Malone-Lemmon Control-O-Meter to your present set and you immediately add the power of selectivity. Selectivity which will allow you to hear any station within the range of your set without interference from another.

The Malone-Lemmon Control-O-Meter works equally well with any type of set regardless of your location or antenna.

Send for literature describing the Control-O-Meter and other Malone-Lemmon Products.



MALONE-LEMMON PRODUCTS

Made by STEPHENSON LABORATORIES

342 MADISON AVENUE
NEW YORK CITY



They're Perfect!

EVERY condenser bearing the United Scientific Laboratory stamp is a precision product! Bakelite ends! Pure Aluminum Plates. Accurate spacing! Extra rugged bearings. A condenser that has such low losses it will double the efficiency of your set.

Plates	Vern. List	Plain List	App. Cap.
13	\$4.50	\$2.10	.00025
17	4.60	2.20	.00035
23	5.00	2.40	.0005
43	5.60	3.10	.001

At your dealer or direct on receipt of purchase price.

UNITED SCIENTIFIC
LABORATORY INC.



92 E. 10th Street

New York, N. Y.

The "EZTOON" (Easy Tune)

Radio Dial

is two dials in one with a 40 to 1 ratio.

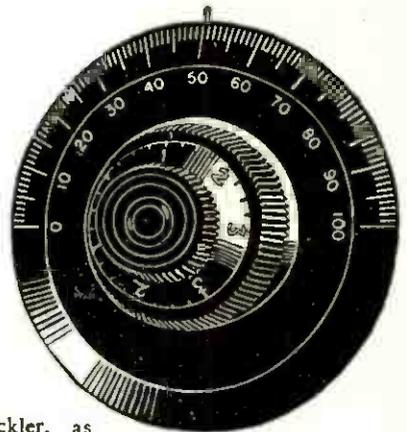
"EZTOON" dials make possible vernier adjustment of vario-coupler, vario-meter rheostat, potentiometer, or tickler, as well as saving the expense of a second set of adjustable plates on condensers.

The "EZTOON" gives unusual close tuning so essential in Heterodyne, Acmedyne, Neutrodyne and tuned radio frequency circuits.

No panel holes to drill. Just take off old dial, slip on "EZTOON" dial and tighten set screw.

Sold under positive money-back guarantee.

Ask your dealer. If he cannot supply you, we ship parcel post 3" dial, \$2.00; 4" dial, \$2.25. Jobbers—Dealers—Manufacturers: Write for discounts.



With "EZTOON" (Easy Tune) RADIO DIAL

You Can

bring in stations that heretofore you have passed up as impossible.

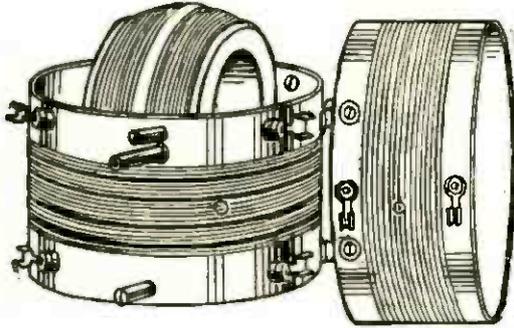
Get and hold stations. Use it on any and all types of receiving sets to obtain vernier adjustment unobtainable before.

Tune in DX stations you never heard before.

Obtain vernier adjustment of all tuning instruments within your set.

BUTLER MANUFACTURING CO.
3236 W. Washington St., Indianapolis, Ind.

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.**

Eastern Coil Sets
 FOR THE COCKADAY CIRCUIT

are the Standard, and in Universal use due to their Proved Efficiency in this wonder circuit.

Made as per specifications of Mr. Cockaday, "D" Coil bank-wound.
 Complete assembled set of B, C and D Coils on GENUINE BAKELITE TUBING, wound with No. 18 double silk covered wire. **\$4.25**
 Original and new hook-ups with material lists FREE with each set of coils.



4 Circuit Tuner

GENUINE LAVITE RESISTANCE



48,000 ohm Price \$1.50

These resistances control the tone of the Cockaday Circuit and eliminate all transformer distortion; modulating the tone after the fashion of the best of phonographs.

Mail Orders Filled. Dealers Communicate.
EASTERN RADIO MFG. CO.
 22 Warren Street Dept. P. R. NEW YORK, N. Y.

Regal

Radio Products are built by engineers who actually Know Radio. They are mechanically perfect, scientifically accurate and built for unusual durability.

Perfect Contact Vernier Rheostat

For fine filament control of tubes and superfine tuning, the Regal Vernier stands alone. Nothing just like it on the market.

Complete with Knob

- 6-Ohms.....\$1.25
- 30-Ohms.....1.25



Fifteen Taps But Only One Drill Hole Required!

A 15 Point Switch complete in one unit. No more messy soldering. No more drilling of holes. No more chipped panels. Complete with hard rubber Knob and Dial. Type No. 162. \$1.50



Broadcast Tested High Quality Audio Transformer

For clearness of tone amplification of voice and music from nearby and distant broadcasting stations, Regals are unequaled by any Transformers on the market.

- 3 1/2 to 1 Ratio.....\$4.25
- 5 to 1 Ratio.....4.50



At all good dealers—otherwise write direct for complete descriptive folder No. 24, sending dealer's name.

AMERICAN SPECIALTY CO.
 Bridgeport, Connecticut, U. S. A.

AMPLION

The World's Standard Loud Speaker

Campbell

RADIO CABINETS

(set up or knocked down)
 "from the lumber to you"



Campbell Radio Cabinets, designed by expert Cabinet Makers, are made absolutely accurate in size, and will fit standard panels perfectly.

Made of extra dry high-grade lumber. In solid Mahogany or Walnut, also, Mahogany or Walnut high piano rubbed or bright finishes.

WILL NOT WARP OR CRACK

PRICES

Cash with order, prepaid east of Missouri River, west add 15 cents to quoted price.

Send Post Office Money or Express Order or Bank Draft.

Panel Sizes	Walnut or Mahogany Finish	Genuine Walnut or Mahogany
7 x 7	\$2.94	\$5.52
7 x 10 1/2	3.54	6.28
7 x 12	3.68	6.38
7 x 14	3.84	7.12
7 x 18	4.24	7.30
7 x 21	5.50	10.06
7 x 24	6.52	11.48
7 x 26	8.78	14.50
7 x 28	9.00	15.00

SPECIAL SIZES TO ORDER

We make a specialty of cabinets for Cockaday "hook-ups." Price of cabinet for new 1924 circuit \$8.89.

Manufacturers' and Distributors' inquiries solicited

THE PERKINS-CAMPBELL CO. (Established 1879)
 410-440 New St., Cincinnati, O. Reference Dun or Bradstreet's

DISTANCE!

\$5.50



**The Only
Authorized Cockaday Coil**

Gets distant stations easily and clearly. Hundreds have substituted this quality coil for those of inferior make, and are amazed at the improved reception, selectivity and general D-X results.

Y. M. C. A. Secretary, Wilmerding, Pa., says, "We've been getting KHJ in Los Angeles on three tubes (WD-1) but since installing your coils we now get KHJ on the detector alone, a distance of 2300 miles, and much clearer."

The Authorized Cockaday Coil is made in strict accordance with specifications of Laurence M. Cockaday, inventor of the famous Cockaday Four Circuit Tuner. Wound on hard rubber tubing, 1/2 inch wall, with No. 18 D.S.C. copper wire which insures selectivity, greater volume, sharp tuning and maximum sensitivity. Guaranteed.

At your dealers, otherwise send purchase price and you will be supplied postpaid.

PRECISION COIL CO., Inc.
209-B Centre St., New York

*This may be the trouble
with YOUR set—*

You can probably change
your grid leak for higher
Detecting Efficiency

The highest efficiency can
only be obtained by changing
both resistor and condenser

Can You Do This?



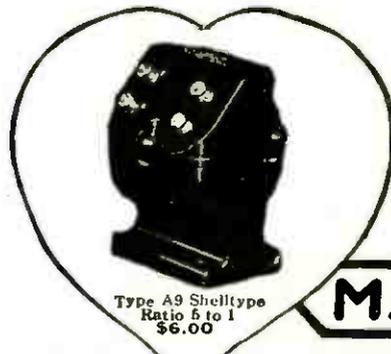
THE DAVEN COMBINED RESISTOR-
CONDENSER MOUNTING DOES BOTH

If your dealer cannot supply you
write

Daven Radio Company

Resistor Specialists

9 Campbell Street Newark, N. J.



Type A9 Shelltype
Ratio 5 to 1
\$6.00



**Radio & Audio Frequency
TRANSFORMERS**

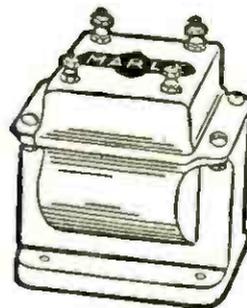
*"The Heart of a
Good Receiver"*

EQUAL to the widest range of recep-
tion requirements. Marle Trans-
formers amplify the weakest
broadcasting, over frequencies all the way
up to 3500 cycles without variation.
Perfect tone quality. Utter absence of
howling or distortion. To get the most out
of radio—use Marle Transformers.

Specially adapted to the latest circuits, the
SUPERDYNE, SUPERHETERODYNE,
FOUR-CIRCUIT TUNER, NEUTRO-
DYNE, INVERSE DUPLEX and any
circuit that makes high requirements of
a transformer.

Type A4
Ratio 3 3/4 to 1
\$3.75

Type A6 Audio F
Ratio 5 to 1
\$4.25



**MARLE
Engineering
Company**

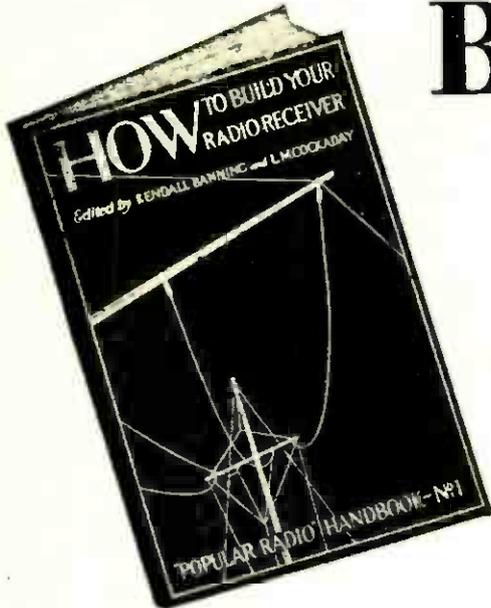
Orange
New Jersey

Audio F
Shelltype
Type A7
Ratio
3 3/4 to 1
\$4.50



Radio F
Types
R1
and R2
\$4.00

Last Chance to Get This Big Book FREE



—but free distribution will be limited to stock on hand!

100 PAGES
Size $7\frac{3}{4} \times 11\frac{1}{4}$
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.

THE Popular Radio Handbook has been the sensation of the season. Eager fans exhausted the first edition almost before it was off the presses.

This is a signal tribute to Kendall Banning and Lawrence M. Cockaday. It demonstrates that you will find in their contributions diagrams and instructions so clear and concise that *with or without previous technical knowledge or training* you can build a radio receiving set that will operate beyond your expectations.

"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.

Scores of Helpful Hints

In this new book edited by Mr. Banning and Mr. Cockaday, you will also find scores of valuable suggestions about aeri-als, 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.

“Far Superior to anything thus far attempted”—says Waldemar Kaempffert

EACH of the sets described in POPULAR RADIO'S new handbook has been selected as the most *ideal* of its kind—for distance, selectivity, tone, volume, simplicity of construction, ease in tuning, reliability and general all-around satisfaction.

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.

Money Back Guarantee

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.”

WALDEMAR KAEMPPFERT,
Formerly Editor of ‘Scientific American’ and ‘Popular Science Monthly.’

“Any radio bookshelf has a decided place for your new contribution of HOW articles in book form.”

PAUL MCGINNIS, Radio Editor,
New York Evening Journal.

“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.”

CUSTOMER NO. 7347.

“In one evening I built a set following the easy instructions in your book, and my friends are all jealous of me now.”

CUSTOMER NO. 4260.

Mail this Coupon Today for a Free Copy

POPULAR RADIO, Dept. 55,
627 West 43d Street, New York City.

Please send me, postage prepaid, a FREE copy of POPULAR RADIO'S new handbook, “How to Build Your Radio Receiver,” edited by Kendall Banning and L. M. Cockaday. I enclose \$3 for a year's subscription to POPULAR RADIO which entitles me to this big cloth-bound book (size 7 3/4 x 11 1/4 inches) absolutely free of charge. If not fully satisfied I will return the book within 10 days and you will cancel my subscription, refunding my \$3 without question.

NAME.....

STREET & NO.....

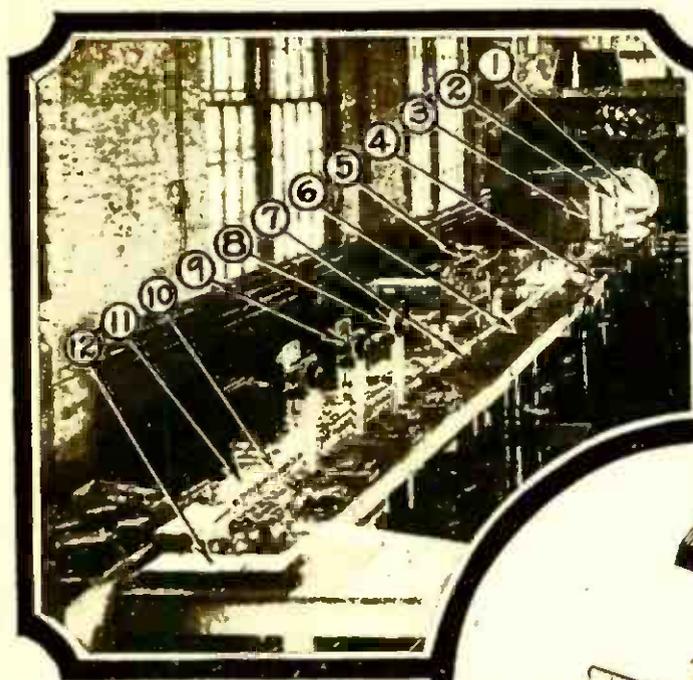
CITY & STATE.....

(No extra for Canada. Foreign countries 50 cents postage extra).

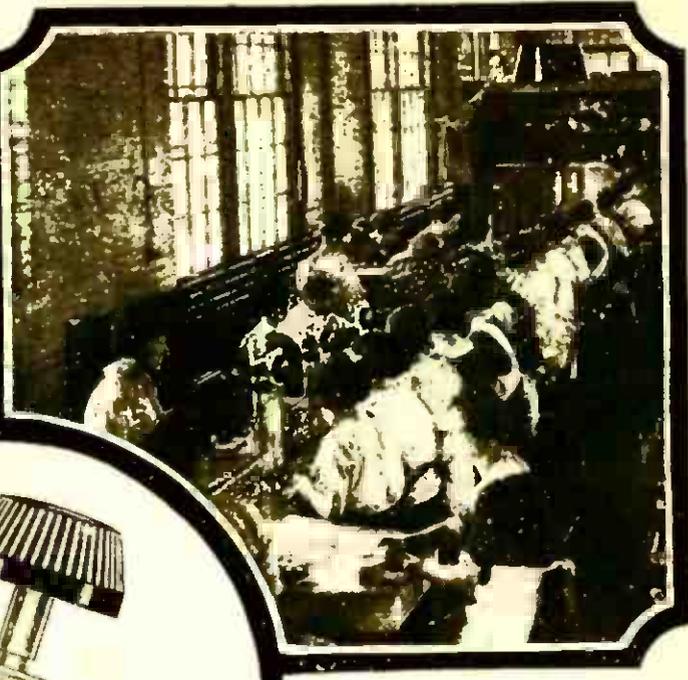
Please mark here

Indicate by a circle whether your subscription is new (N), renewal (R), or an extension of your present subscription (E).

N R E



View of one production line in Bradleystat assembling department. The conveyor assembly process was developed to keep up with the increasing demand for Bradleystats and Bradleyleaks. See explanation below.



View of one production line, showing operators assembling Bradleystats and packing them in cartons for shipment. All parts are fabricated in other departments. The electric furnaces are in a separate building.



How the Bradleystat is made

FOR over twenty years the Allen-Bradley Co. has made graphite disc rheostats for battery chargers and motor starters. The experience gained during these twenty years is embodied in the most perfect filament rheostat used in radio, the Bradleystat.

Today, the Universal Bradleystat, with its two columns of graphite discs under adjustable pressure, provides unequalled control for radio tubes. Its control is absolutely noiseless, stepless and of exceedingly wide range.

Bradleystats are assembled by the most modern methods and tested rigidly before they are shipped.

The illustration above depicts the assembly process that guarantees a uniform product for the radio fan.

- | | |
|------------------------------|-----------------------------|
| 1—Cleaning porcelains | 7—Installing cover plates |
| 2—Riveting terminals | 8—Inserting adjusting knobs |
| 3—Threading terminals | 9—Six testing machines |
| 4—Inserting terminal screws | 10—Conveying Bradleystats |
| 5—Disc-filling machine | 11—Inspecting Bradleystats |
| 6—Inserting pressure springs | 12—Packing Bradleystats |

Bradleyleaks follow the same process, except for the use of different discs and the installation of condensers.

Install Bradleystats in your radio set, if you want the finest filament control obtainable. Try one, and experience new delights in radio reception.

Allen-Bradley Co.
Electric Controlling Apparatus

276 Greenfield
Avenue



MILWAUKEE,
Wisconsin.

For Sale at All Dealers
BRADLEYSTAT \$1.85
BRADLEYLEAK 1.85
CONDENSER (.00025 mf.)35

THE ALLEN-BRADLEY CO. HAS BUILT GRAPHITE DISC RHEOSTATS FOR OVER TWENTY YEARS

Please refer to POPULAR RADIO when answering advertisements.