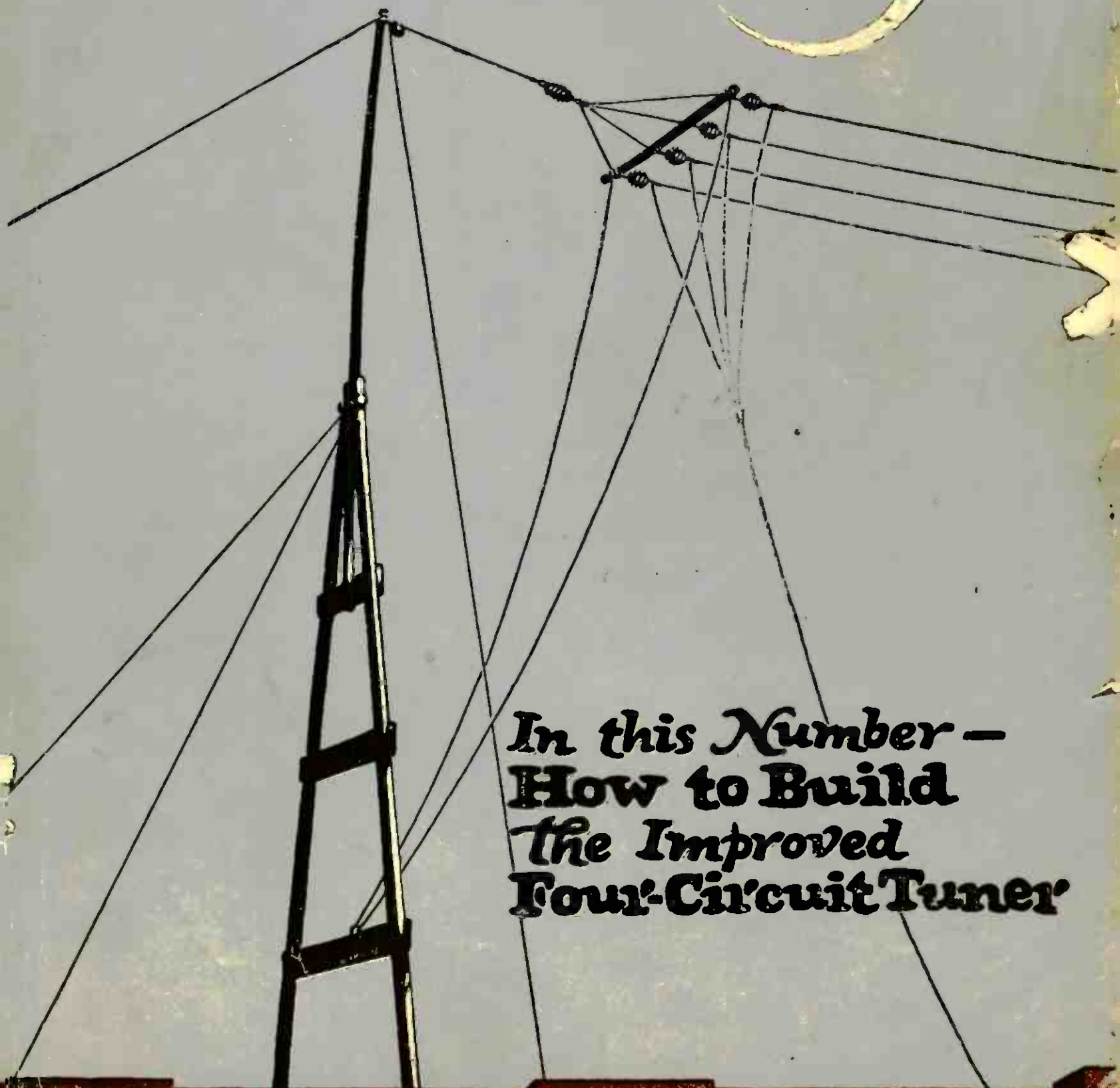


82.00

# Popular Radio

Edited by **KENDALL BANNING**  
**JANUARY, 1924**

**25¢**



*In this Number —  
How to Build  
The Improved  
Four-Circuit Tuner*

---

---

# Clear as Your Headphones

**C**ALL in the crowd, now. Everyone can listen in with as much joy as one man at the headphones. Here is a loudspeaker with a reproducing range so wide that it gets all the tones—the high notes—and the low ones—with all their overtones and partials—full and rich. With a horn so perfect that it causes no distortion—adds no vibration of its own. And a one-finger adjustment that controls the volume, at your pleasure. Everything—music, speech, sports news—*clear for the crowd!* No more one-man radio sets. Everybody gets it—all!



This symbol  
of quality  
is your pro-  
tection.



Radiola Loudspeaker  
Model U. Z.—1320  
Price \$36.50

Radio Corporation of America

Sales Offices: Dept. 41

433 Broadway, New York

433 California St., San Francisco, Cal.

# Radiola

## LOUDSPEAKER

---

---

Please mention POPULAR RADIO when answering advertisements.

# Brandes

## Table-Talker

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

## Everybody- listen in!

"Tune" with your *Matched Tone* Headset. Then let the family listen with a Brandes *Table-Talker*! The perfect combination for *real* radio fun.

The new *Table-Talker* does for group-listening what the *Matched Tone* Headset does for the individual.

It provides true tone—mellow and strong. It reproduces the program faithfully—from the deepest speaking voice to the highest instrumental music. And it's a good-looking addition to any set—with its simple lines and neutral brown finish. A *remarkable* loud-speaker!

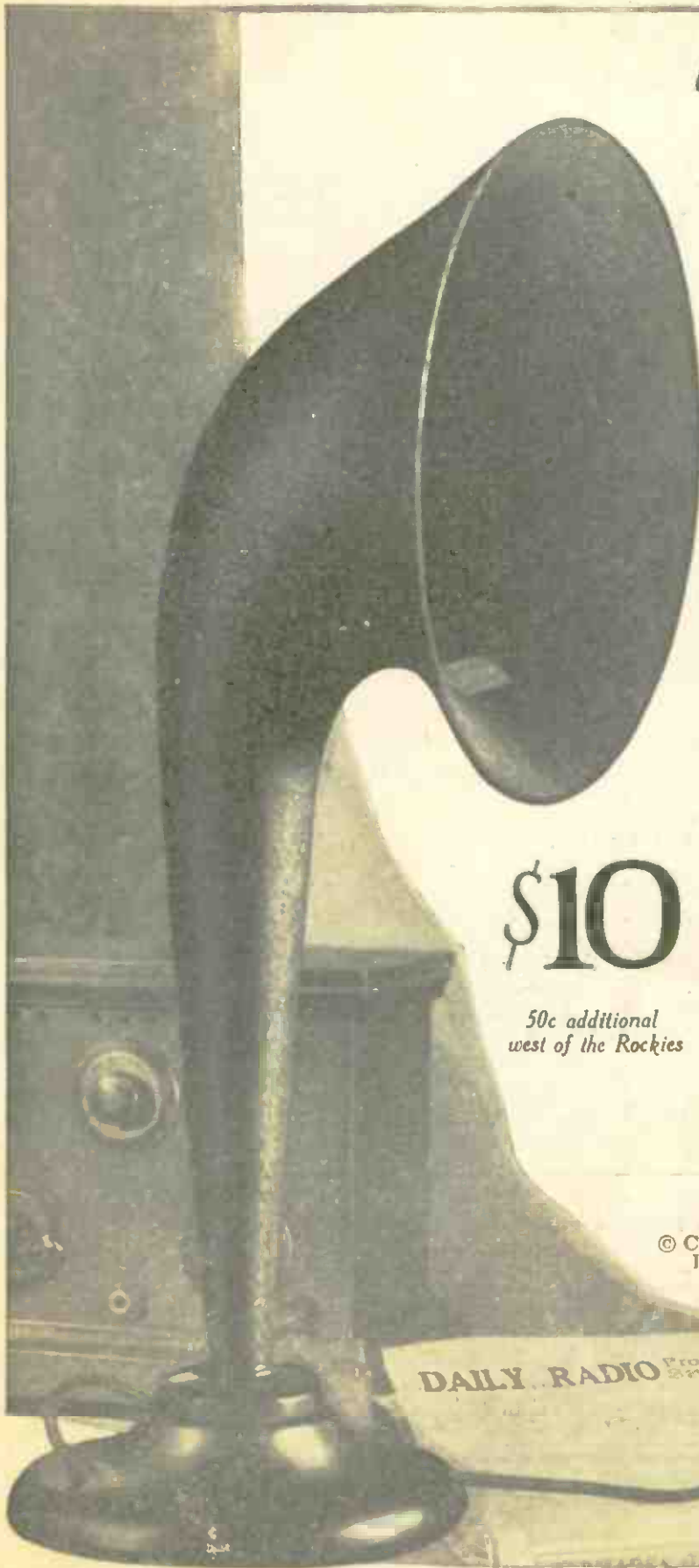
All Brandes Products are sold under a money-back guarantee.

C. BRANDES, Inc., New York

## Matched Tone

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

© C. Brandes, Inc., 1923 **Radio Headsets**



# \$10

50c additional west of the Rockies

DAILY RADIO Program and Song Day



# POPULAR RADIO

EDITED by KENDALL BANNING



## CONTENTS for JANUARY, 1924

(Cover design by Frank B. Masters)

VOLUME V

NUMBER 1

Radio Joins the College Faculty.....	FRONTISPIECE
Avoiding Train Wrecks by Radio.....	<i>Robert G. Skerrett</i> ..... Page 3
Where Fortunes Await.....	<i>Henry Woodhouse</i> ..... 12
How to Build the Improved Four-circuit Tuner....	<i>Laurence M. Cockaday</i> ..... 23
Motorized Radio Station for Police Work.....	36
The University of the Ether.....	<i>Percy Mackaye</i> ..... 37
700,000,000,000,000,000,000 Electrons for a Cent.....	<i>E. E. Free</i> ..... 41
100 Best Hook-ups.....	<i>The Technical Editor</i> ..... 49
Installment No. 3	
How to Make a Chopping Bowl Loudspeaker.....	<i>Spencer Boyd</i> ..... 54
How to Read a Diagram.....	<i>Albert G. Craig</i> ..... 57
Part II	
Amplification without Distortion.....	<i>Dorman D. Israel</i> ..... 68

### DEPARTMENTS

What Readers Ask.....	76
Broadcasts.....	82
In the World's Laboratories.....	87
Hints for Amateurs.....	95
Listening In.....	97
Facts You Hunt For.....	101
"Stations I Have Heard".....	103
Adventure in the Air.....	105

VOLUME V

JANUARY, 1924

NUMBER 1

Published monthly by Popular Radio, Inc., 9 East 40th Street, New York, N. Y., telephone number Vanderbilt 9985; H. B. Emerson, President; Paul O. Batch, Secretary; F. C. Hemberger, Treasurer. Price, 25 cents a copy; subscription \$2.00 a year (prior to Dec. 15, 1923) in the U. S., Canada and all countries within the domestic postal zone; after Dec. 15, \$3.00 a year; 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, 1923, 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 & Co.  
New York: 9 East 40th St. Chicago: 225 North Michigan Ave.

Please mention POPULAR RADIO when answering advertisements.

“Live in harmony with your age.  
Lao Tzu —”

To be in harmony with the  
present age, you must own  
a

**GREBE**

BROADCAST RECEIVER

*Doctor My.*

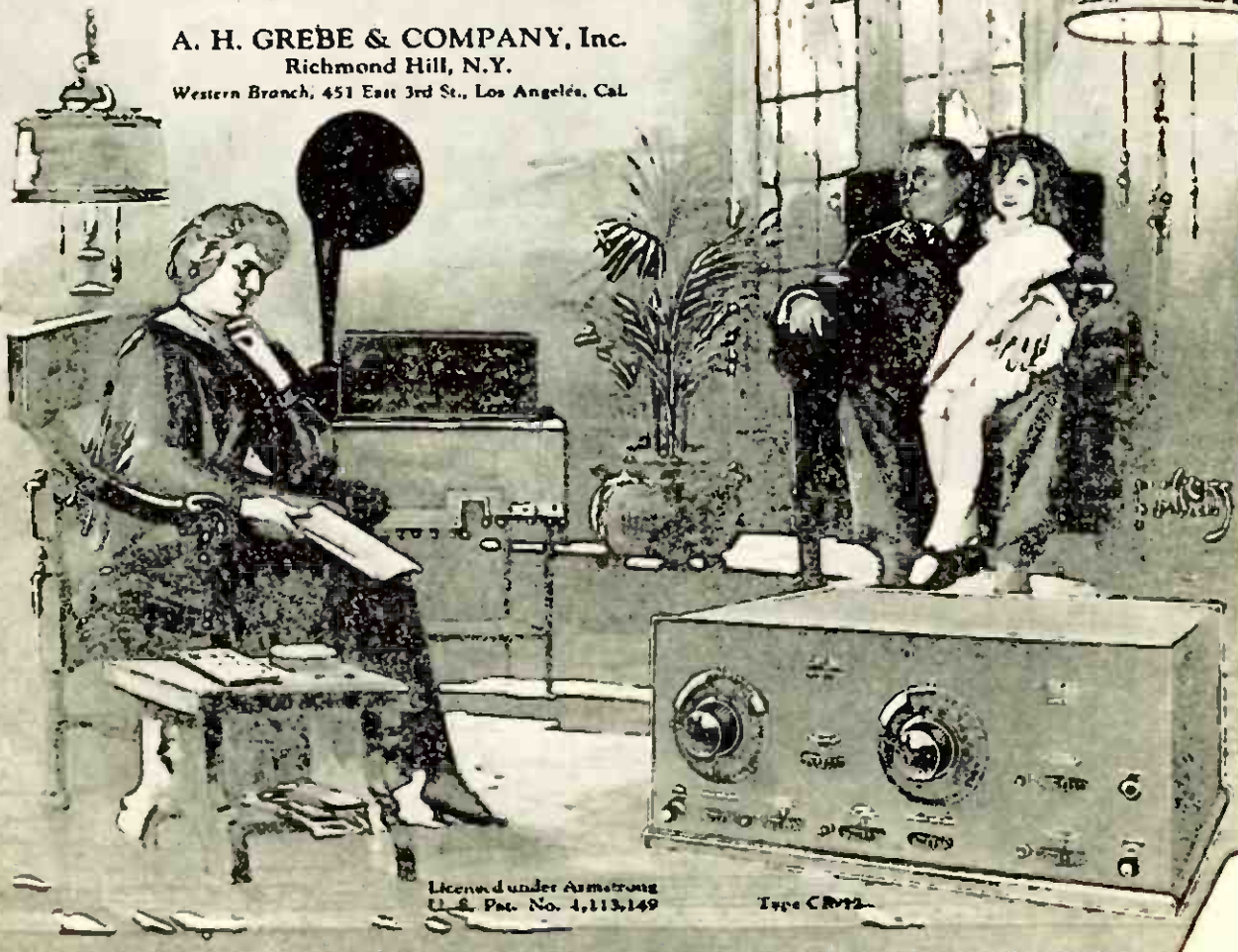


**T**HE 20-foot silk-covered wire, supplied with this Receiver, is the only antenna required. This wire may be concealed behind the picture moulding or run along the baseboard in your library or living room.

The beautiful walnut cabinet has compartments for all necessary batteries.

Write for "Grebe Radio in the Well-Appointed Home"

**A. H. GREBE & COMPANY, Inc.**  
Richmond Hill, N.Y.  
Western Branch, 451 East 3rd St., Los Angeles, Cal.



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

Type CR12

# PAGES WITH THE EDITOR

BEGINNING with this number the regular publication date of POPULAR RADIO is the 20th of each month preceding the date of publication.

\* \* \*

WHEN POPULAR RADIO inaugurated the policy of mentioning specifically by name the exact parts that are required for the most successful operation of the circuits described in its pages, it did so with just one purpose in view: *to help the experimenter build and use his set to the best possible advantage.*

\* \* \*

THE Editor was fully aware of the dangers that lurked in such a policy—a policy that was unique in the radio field where the editorial methods of the trade journal and of the house organ so largely prevail.

\* \* \*

IN the first place, several manufacturers of radio apparatus (and some of the more skeptical of our readers as well) assumed that editorial mention of these parts was inspired by our advertisers.

This was not, is not and will not be the case.

Such radio parts as are mentioned in our reading pages are specified by our technical staff as the result of long and careful experimentation in the laboratory, and these parts are recommended for use *only for the specific set that is under consideration.*

\* \* \*

No pressure from the business office has influenced, nor will it influence, the unbiased judgment of our technical staff.

\* \* \*

THE Editor believes that our readers are entitled to the most helpful, practical, specific and authoritative data that our staff can give them. And he believes that the mention by name of such parts as are necessary to the most successful operation of their sets is not only exceedingly valuable but, in fact, essential.

\* \* \*

APPARENTLY this policy is receiving the substantial endorsement of the great army of radio fans—if the remarkable growth of POPULAR RADIO in circulation is any criterion. Apparently, too, our readers are quick to express their approval in personal letters. Out of the mail bag the Editor picks at random the following endorsement that comes from Fort A. A. Humphreys, in Virginia:

\* \* \*

"I AM sorry that any question of business ethics has come up in the matter of your publishing the name of the parts necessary to make a working receiver. It is knowledge. It is what I have been craving since the hook-ups have first been published. For the average tinkerers with radio to go into a large store to pick out parts is nothing but a gamble pure and simple. There are, say, twenty different kinds of each and every part he may desire,

and it takes no mathematician to figure the number of permutations and combinations he may form or the chance he has of picking out the right combination. Here is one reader who most heartily endorses your policy. Personally, I have ordered the parts for the tuner and oscillator through my Washington dealer, and if there is any violation of business ethics in that, then let us change our ethical viewpoint."

—GEORGE A. BROWN

\* \* \*

EVEN from abroad come letters that endorse this policy. From an engineer in Nancy, France, for instance, comes this word of approval:

\* \* \*

"I appreciate very much the fact that when describing new sets you give all the data and the names of the furnishers of spare parts. This is very useful, especially for foreigners who have no connections with the dealers of your country."

—EMILE F. LANORD

\* \* \*

AGAIN POPULAR RADIO has had another feather stuck in its editorial cap! The first prize awarded to amateur sets at the New York radio show in October fell to Oliver B. Parker of Brooklyn, N. Y., whose receiver was unanimously proclaimed the best for "originality, craftsmanship, workability and all-around excellence." And the set was a Cockaday four-circuit tuner—the set that was first announced in POPULAR RADIO for May, 1923—arranged in a portable cabinet that included an aerial. This clever adaptation of the famous Cockaday circuit will be described in this magazine by Mr. Parker himself.

\* \* \*

THE four-circuit tuner—popularly known as the "Cockaday Circuit" in honor of the inventor, who is the Technical Editor of POPULAR RADIO—is hitting the middle west with a bang. Reports indicate that the fans of the district between Buffalo and Kansas are beginning to get acquainted with this new and wonderfully efficient receiver.

\* \* \*

ONE fan out in Chicago, H. W. Bond, for instance, wrote recently to a friend in Memphis, Tennessee:

"Tell the boys that if they want a real receiver that *tunes*, to junk their standards, reflexes and singles and build a Cockaday four-circuit, stick in two new-type, low-ratio Thor-darsons and lean back and listen to everything from Hell, Hull and Byhalia. It is the only medium priced receiver that, from Chicago, will tune out WDAP and KYW and pick up outside stations so that they can be put on the loudspeaker."

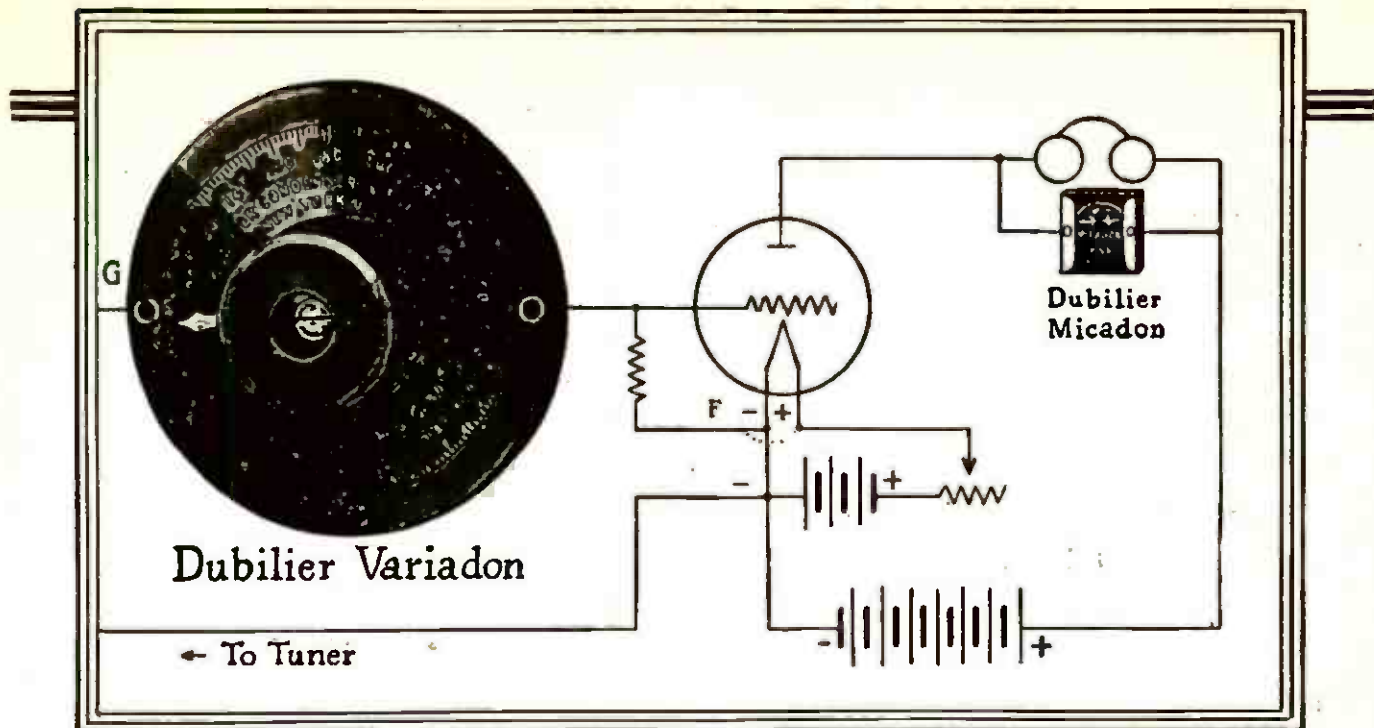
\* \* \*

It is estimated that about 500,000 radio fans in this country alone have built the Cockaday

(Continued on page 6)

Please mention POPULAR RADIO when answering advertisements.

**A**T F, the filament terminal of the grid leak is shown connected to the negative side of the tube. Occasionally better results are obtained by connecting the grid leak terminal to the positive side of the tube.



## The Variadon—a Variable Grid Control

**B**BETTER than the average variable grid-leak and a fixed condenser in a grid-circuit are the Variadon (the Dubilier variable mica condenser) and a fixed resistance.

Better because it is difficult to control the resistance with the average variable grid-leak *but certain and easy to control the capacity* of the grid-circuit with the Dubilier Variadon.

Used with a fixed resistance the Dubilier Variadon greatly increases both the selectivity of the set and the volume of the signals. Thus disappear the difficulties experienced when poor variable grid-leaks are used.

Because of its compactness the Dubilier Variadon readily finds a place in the average cabinet. It is no larger than an ordinary dial.

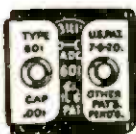
Price \$2.50. At all good dealers.

Write for further information to department 125.

**DUBILIER CONDENSER & RADIO CORPORATION**  
48-50 West Fourth Street  
New York



**DUBILIER DUCON**  
The Standard Socket Plug



**DUBILIER MICADON**  
The Standard Fixed Condenser



**DUBILIER DURATRAN**  
Radio-Frequency Transformer

# DUBILIER DEVICES

## PAGES WITH THE EDITOR

(Continued from page 4)

four-circuit tuner. And now the Editor is beginning to get reports about its steadily growing popularity in England, Europe and South America.

\* \* \*

TYPICAL of the hundreds of letters that have reached the Editor from enthusiastic fans, is the following from Douglas Henderson of New York; he writes:

"Since 1922, when radio broke out in good shape, I had used the conventional regenerative tuner with a variometer in the plate circuit; the results were satisfactory. But—about the 15th of last May when the wavelengths changed according to the new government regulations, I moved from the Bronx out to Richmond Hill. The former location was such that I had a small outdoor aerial but out where I am now it is out of the question. Hence I resorted to an indoor arrangement whereby a small wire was run around the rooms, concealed. The moving and change of wavelengths was too much for the old set and talk about interference . . . WOW!

\* \* \*

"THEN came POPULAR RADIO with your new circuit and I was just in the right frame of mind to put it into effect. The results were immediate. With that little farce of an antenna, using WD-11 tubes throughout with 45 volts on the plate, I have been literally astounded at the stations I hear. The aerial violates every known rule, being a piece of single cotton-covered magnet wire salvaged from an old variometer; in many places the insulation has been destroyed, and is tacked around the baseboard of the rooms with ordinary carpet tacks, without insulation. The far end terminates on a bedspring.

"Everything as far west as Chicago arrives in a satisfactory manner."

\* \* \*

AGAIN the Editor feels constrained to utter a friendly word of warning to our readers against manufacturers of and dealers in "outlaw" radio apparatus that is made by radio bootleggers in violation of patent rights. And also against apparatus that is unsound scientifically or cheaply made or otherwise inefficient and unsuitable for use. And against unscrupulous promoters who aim to sell stock in such enterprises.

\* \* \*

SOME of these promoters have issued advertising circulars that quote from articles that have appeared in POPULAR RADIO, and quoted them in a way that might be construed as indicative of this magazine's endorsement. These quotations have been made without the Editor's knowledge or approval. In order to counteract the impression that these quotations may create, the Editor especially warns our readers against those stock dealers who quote POPULAR RADIO in their advertising circulars.

THE success of the Haynes DX receiver—described in our September number—was instant and nation-wide. One fan out in Winfield, Kansas, has written in such an interesting report of it that the Editor is sharing it with our readers.

Here it is:

\* \* \*

"I built the Haynes DX receiver as described in POPULAR RADIO and added two stages of audio amplification. In one evening I heard the following stations, all on a loudspeaker: WHAS Louisville, Ky., WOS Jefferson City, Mo., WSB Atlanta, Georgia, WOC Davenport, Iowa, WJAZ Chicago, Ill., KYW Chicago, Ill., WDAP Chicago, Ill., WOAF Omaha, Neb., KSD St. Louis, Mo., WGY Schenectady, N. Y., WLAG Minneapolis, Minn., and the next evening KFI Los Angeles, Calif., and KHJ Los Angeles, Calif.

\* \* \*

"THE complete set (including the two stages of audio amplification) is in a cabinet 10½ by 7½ by 6 inches, the variable condenser which is in the grid circuit is a .0005 with vernier, a .00025 which I first used worked fine but it would not allow me to tune above 411 meters; the fixed condenser across the primary of the first audio transformer is a .0005; a .002 worked but the .0005 was much better; this I believe is due to the transformer which is an All American ratio 10-1.

\* \* \*

"THIS set is a real DX receiver, the tuning would probably be difficult with rough tuning devices but I considered this in selecting the parts, which are a Bradleystat for the detector, an A. C. Hayden sharp-tuner dial for the tickler and the .0005 variable condenser with vernier for the grid circuit."

—BERT DECK

\* \* \*

SPECULATION about "the receiving set of the future" is beginning to focus upon a type that is aptly referred to, in an Esteemed Contemporary, as follows:

"To do away with the tinkering—simply to turn one handle to a definite, marked point and get the station wanted, if it is transmitting; that is the kind of set which will probably find a good deal of favor in the future."

The prophecy is signed "J. H. M.," whom the Editor suspects is no other than the eminent physicist, Prof. J. H. Morecroft. It is with particular gratification, therefore, that the Editor is able to refer our readers to a detailed description of just such a set—beginning on page 23 of this issue of POPULAR RADIO!

  
Kendall Banning

Editor, POPULAR RADIO





# The World's Most Popular Battery Charger

Nothing speaks so eloquently of HOMCHARGER satisfaction as the fact that thru sheer merit alone it has become the *standard* by which all other battery chargers are judged. Over 125,000 HOMCHARGERS already in use offer the most convincing proof that it is the most efficient, economical and fool-proof battery charger at any price.

## A NEW TRADE-MARK FOR A TRIED AND PROVEN PRODUCT

Its phenomenal success has led to the introduction of many inferior and make-shift imitations. To insure our reputation and protect the buying public against substitution, the Radio De Luxe HOMCHARGER henceforth will be sold under a new Trade-Mark, viz:



Retaining the same fundamentally correct operating principle and beautiful appearance of our Radio De Luxe model, it is a step nearer ultimate perfection through adoption of several construction refinements dictated by the policy of Progress.

### HOMCHARGER'S 10 POINTS OF SUPERIORITY

1. **Simple**—Only one moving and wearing part, replaceable after thousands of hours use for \$1.00. Will last a lifetime.
2. **Efficient**—Uses less than one-half the current of any bulb or liquid type rectifier. Will charge any radio or automobile battery for a nickel.

3. **Quick**—Its high charging rate of 7 amperes eliminates long waiting for battery to become charged. Will charge any "A" or "B" battery over night, or three times as fast as a 2-ampere machine.
4. **Clean**—No expensive bulbs to break or acids to spill or replace. No acid fumes. Charges without muss fuss or bother.
5. **Dependable**—Tungsten contacts insure continuous operation—prevent sticking and stopping.
6. **Fool-Proof**—Can be operated by anyone. Attach to lamp socket and connect battery either way, it will always charge. High-grade ammeter eliminates guess work.
7. **Safe**—No danger of shock or fire. Tested and approved by Fire Insurance Underwriters everywhere. Gives tapering charge—will not overheat or injure battery.
8. **Beautiful**—Mahogany and Gold Finish
9. **Unqualifiedly Guaranteed.**
10. **Popularly Priced**—Retail at \$18.50 complete (\$23.00 Canada). No extras to buy. Sold by all dealers.

**FREE BROADCASTING LIST.** Send to-day for Free List of Broadcasting Stations, and Circular Describing the Gold Seal Homcharger.

**DEALERS!**

**JOBBER!**

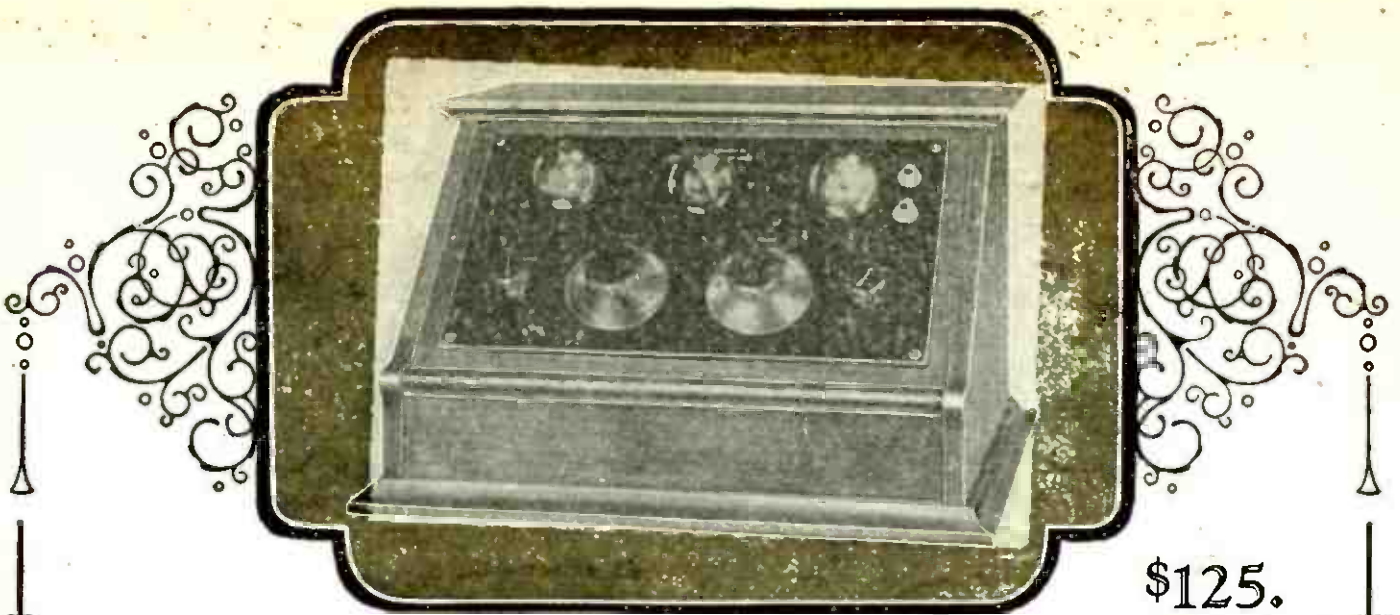
GOLD SEAL HOMCHARGERS will outsell any other radio device this season. "GOLD SEAL Business Builders" illustrates many attractive sales helps and explains how we are prepared to co-operate with the Trade in making this "HOMCHARGER Year." Send for your copy and Trade Discounts TODAY.

**Insist** *LOOK FOR IT*  
**on the GOLD SEAL**

It is your protection against substitution. When buying order by name and verify by the GOLD SEAL, which appears on the carton as well as the nameplate.



**The Automatic Electrical Devices Co., 132 West Third St., Cincinnati**  
*Largest Manufacturers of Vibrating Rectifiers in the W*



MODEL V

\$125.  
fully equipped

## A New and Radical Radio Achievement

This new Kennedy Model V is one of the foremost contributions ever made to the radio art. It was developed by the Kennedy Engineering Staff to meet a definite demand for a receiver with greatly simplified control—but with the same high standards of selectivity and mechanical excellence that have always distinguished Kennedy radio equipment.

The most striking individual feature of this new Kennedy Model V is its utter simplicity of operation. After a single initial setting is made, only one dial is used to control all tuning. And with this simplicity of tuning comes the positive assurance that, night after night, a given station will "come in" at its own particular setting—even though the receiver is tuned on different antennae.

Model V is very selective. For instance, in New York one of these receivers located in the Belmont Hotel "tuned out" station WEAJ, only two blocks away, and "brought in" out-of-town stations. It is stable in operation, reproduces music and voice with unusual fidelity and is credited with remarkable distance records. "Re-radiation" is practically eliminated. Responds to all broadcast wave-lengths—operates on any ordinary antenna, outside type preferred.

The cabinet is built of mahogany and follows dignified, harmonious lines that give it a pleasing appearance and make it an attractive addition to any home. The arrangement of the panel is the result of considerable study—it is placed at a height and angle that are new and provide an unusual degree of ease, comfort and precision in tuning. Dials, knobs and tubes are symmetrically arranged and tend to enhance the already attractive appearance of the receiver as a whole.

Model V is an entirely new development in radio science—it is unusually simple to operate, very selective, has high electrical efficiency, presents a pleasing appearance and sells for only \$125.00, completely equipped with all tubes, dry batteries, Kennedy 3,000-ohm phones, with plug. This unquestionably stamps it as the one striking value in the radio field.

*Ask your dealer to show you the new Kennedy Radio Model V—or write us direct for fully illustrated literature. Other Kennedy models in period furniture designs range up to \$825.00 fully equipped, including built-in loud speaker.*

**THE COLIN B. KENNEDY COMPANY**  
SAINT LOUIS                                      SAN FRANCISCO

*All Kennedy receiving sets are regenerative.  
Licensed under Armstrong U. S. Patent No. 1,113,149*

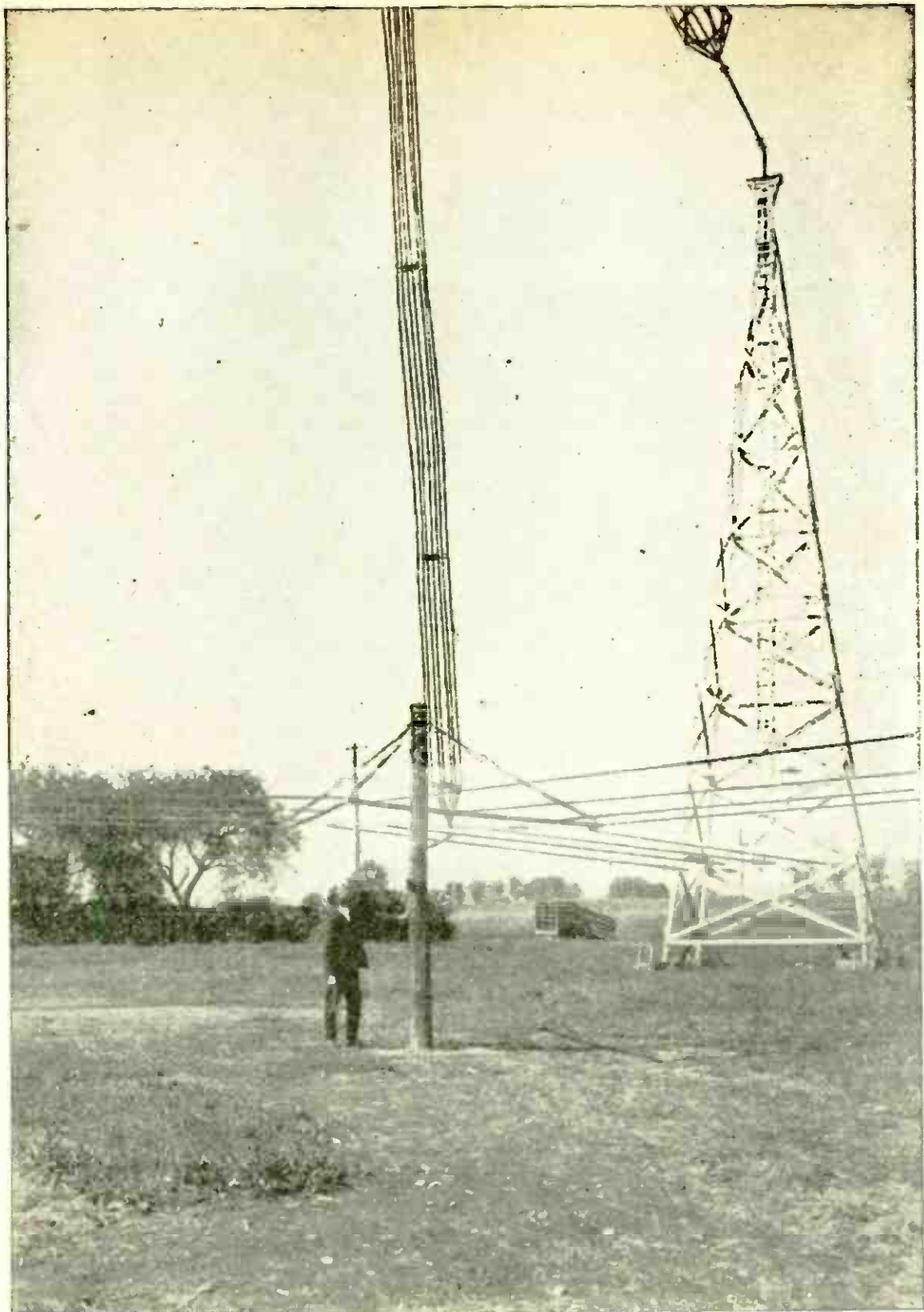
# K E N N E D Y

The Royalty  of Radio



### Is Radio Changing Our Mental Habits?

*Dr. Willis R. Whitney, one of the world's foremost scientists, thinks it is; he will tell his reasons in a coming issue of POPULAR RADIO.*



Armstrong Perry

## Radio Joins the College Faculty

*Some of the more progressive of American educators are beginning to realize the tremendous possibilities of radio as a means of disseminating education, not merely to small groups of students, but to all the residents of large areas. Here is shown the antenna of the broadcasting station WPAB of Pennsylvania State College, which is developing "extension courses" that may reach the peoples of an entire state. (See "THE UNIVERSITY OF THE ETHER," page 37.)*

# Popular Radio

VOLUME V

JANUARY, 1924

NUMBER 1



## Avoiding Train Wrecks by Radio

The chief cause of railway accidents is the "human factor." Some one forgets, some one dozes off for a brief moment—and the damage is done. The most careful of men are fallible once in a while; the remedy is to make human error impossible by using automatic apparatus. This article describes how radio devices are contributing to this end.

By ROBERT G. SKERRETT

ONE of the most frequent causes of railway accidents is the uncertain human factor. Despite all that has been done to safeguard traffic, the fact remains that block signals, no matter how operated, do not always impress their warnings upon the man at the throttle. Time and again in the course of each year trains go speeding by these cautioning sentinels, sometimes because the semaphore or the light is obscured by fog or smoke, but once in a while because of some mental lapse or physical disability of the engineer.

The consequence may be a collision or a derailment entailing serious damage to property, or even the sacrifice of life. Be the outcome what it may, the annual toll is a heavy one.

Recognizing the fallibility of human nature and the hampering conditions of fog, smoke or snow in the air, the Interstate Commerce Commission decided several months ago upon a momentous

step in the direction of increased safety of railroad operation. It has ordered that no fewer than forty-nine of our great railways shall either equip their lines with some type of automatic train-control apparatus by July, 1924, or shall give satisfactory reasons for not doing so.

This attitude on the part of the Commission was based upon the knowledge that some of our inventors have brought such train-control devices to an acceptable stage of dependability. The systems devised have taken various forms, but all of them are designed not only to arouse the engineer to a state of alertness but automatically to slow up his train and bring it to a stop if, for any reason, he neglects to heed the visual signals of the semaphore or those other signals transmitted to him by the system of automatic control.

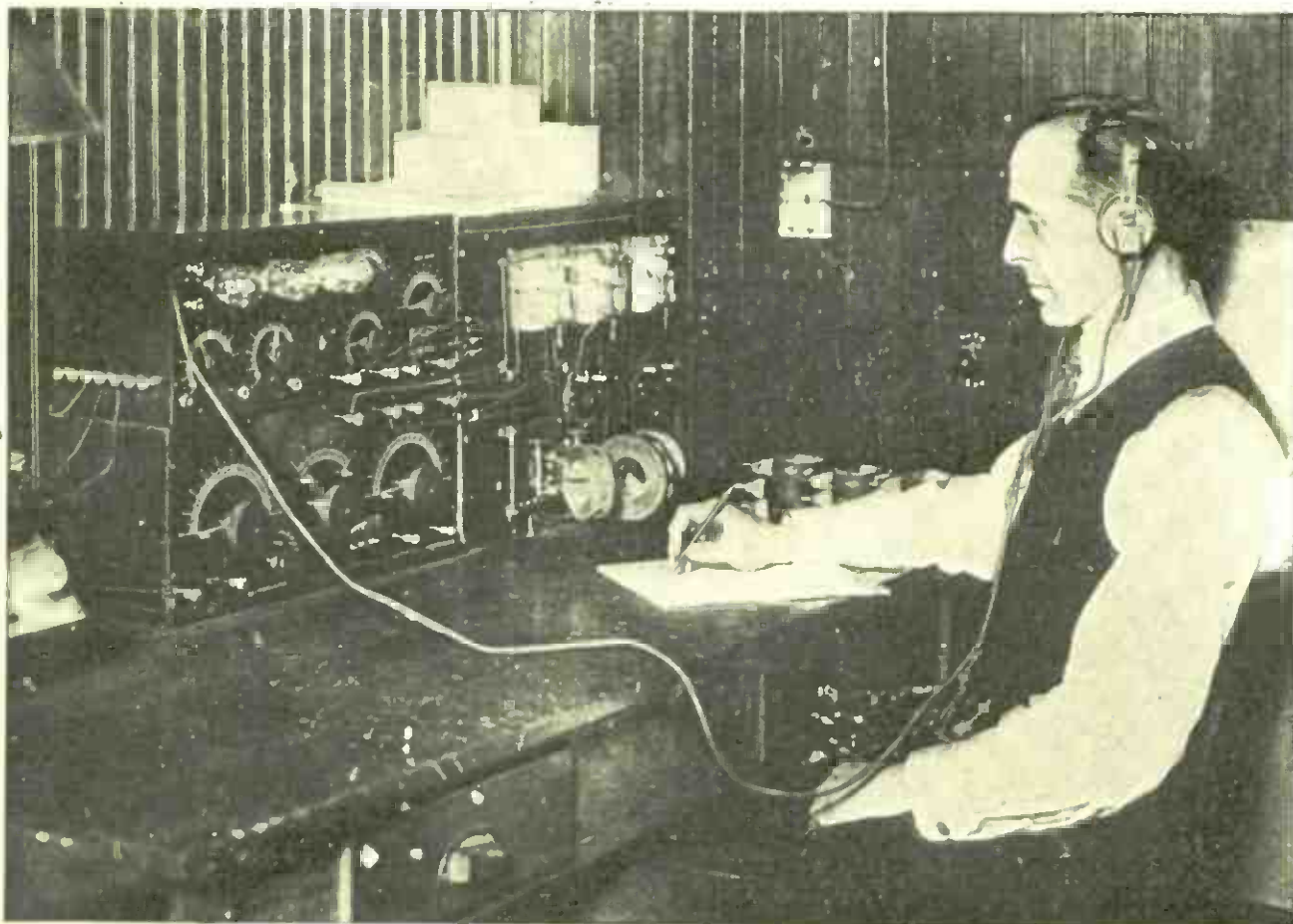
One of the simplest methods of train control depends on the growing ap

cation of radio telephony to the problem of communicating with the moving train. All radio engineers are familiar with the fact that radio impulses from wires strung along the track can be communicated to parallel wires fixed to the train, as in the usual systems of carrier-current radio or "wired wireless." Of course, a transmitting device on the train can operate such a system in a reverse direction so that signals from the train can be sent to the wires along the track and thence to a central control station anywhere.

By this method it is possible for the dispatcher at a railway division point to be in constant touch by telephone with the engineer of a moving train and thus to control its operation almost as perfectly as though he himself held the

throttle. And if the engineer is ill or inattentive and thus runs by a signal set against him the dispatcher can communicate at once with the conductor or any other official on the train so that assistance can be sent instantly to the cab of the locomotive.

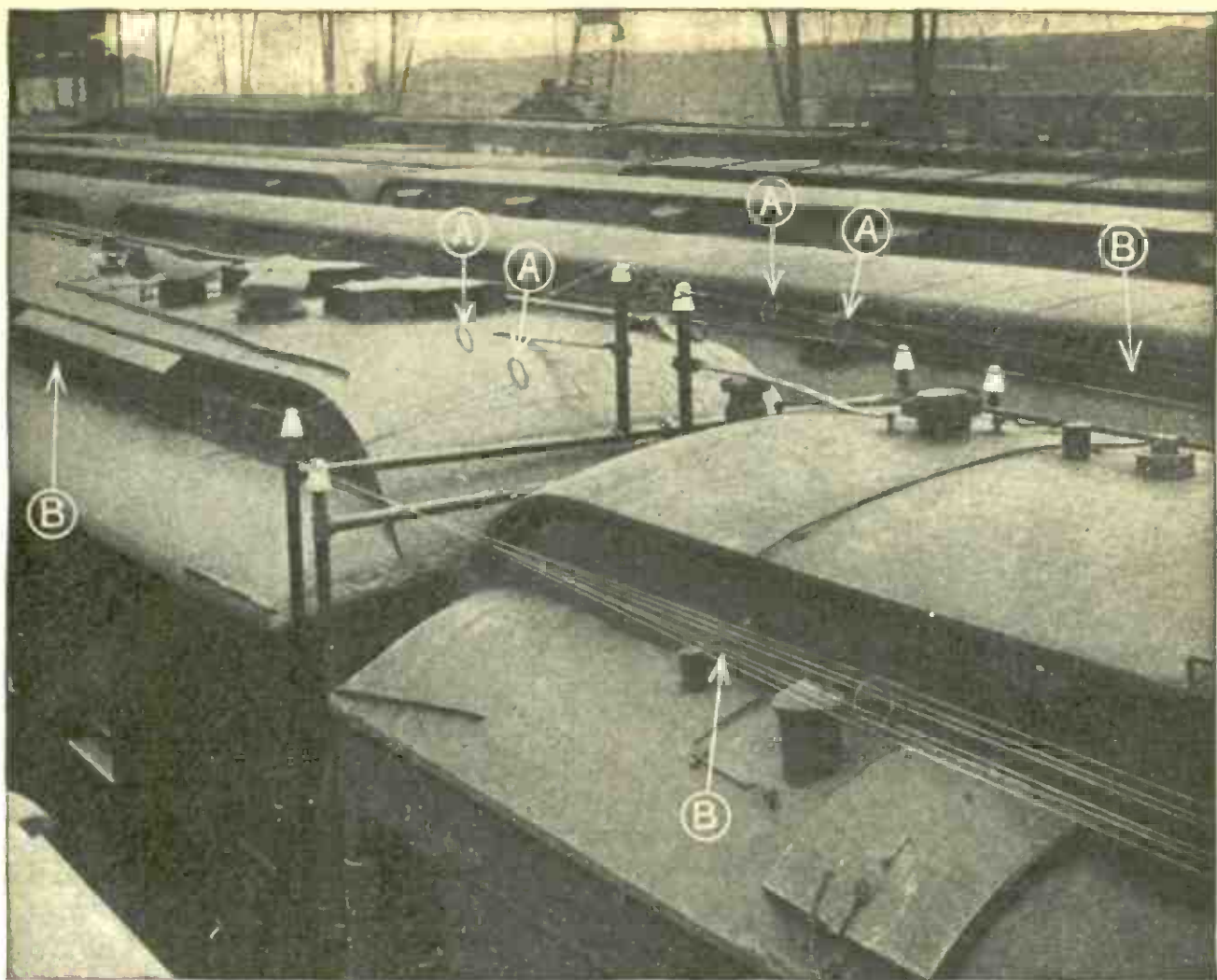
It is simple enough to equip these systems with call-bell devices controllable from the dispatcher's office so that the instant attention of the engineer or the trainmen can be secured whenever necessary. It is possible, even, to install on the train a system of relays actuated by radio signals, like the relays used in the automatic radio control of unmanned battleships and airplanes. These relays, adjusted to be sensitive only to special sets of signals, can be used by the dispatcher to stop the train at any



Keystone View Co.

#### THE RADIO TRAIN DISPATCHER

*Using ordinary transmitting apparatus connected with wires strung along the track parallel with the moving train, the dispatcher can communicate at any instant with the conductor on the train. The train movement is thus under constant control from the central office. The set shown was used in the dispatcher's office at Nashville, Tennessee, during trials on the Nashville, Chattanooga and St. Louis Railway.*



Keystone View Co.

#### HOW ANTENNAS ARE ATTACHED TO RAILWAY CARS

*The antennas of each car are separate; they are indicated in the illustration above by B. These antennas are connected together by the leads A, so that there is practically one long antenna that covers the entire length of the train.*

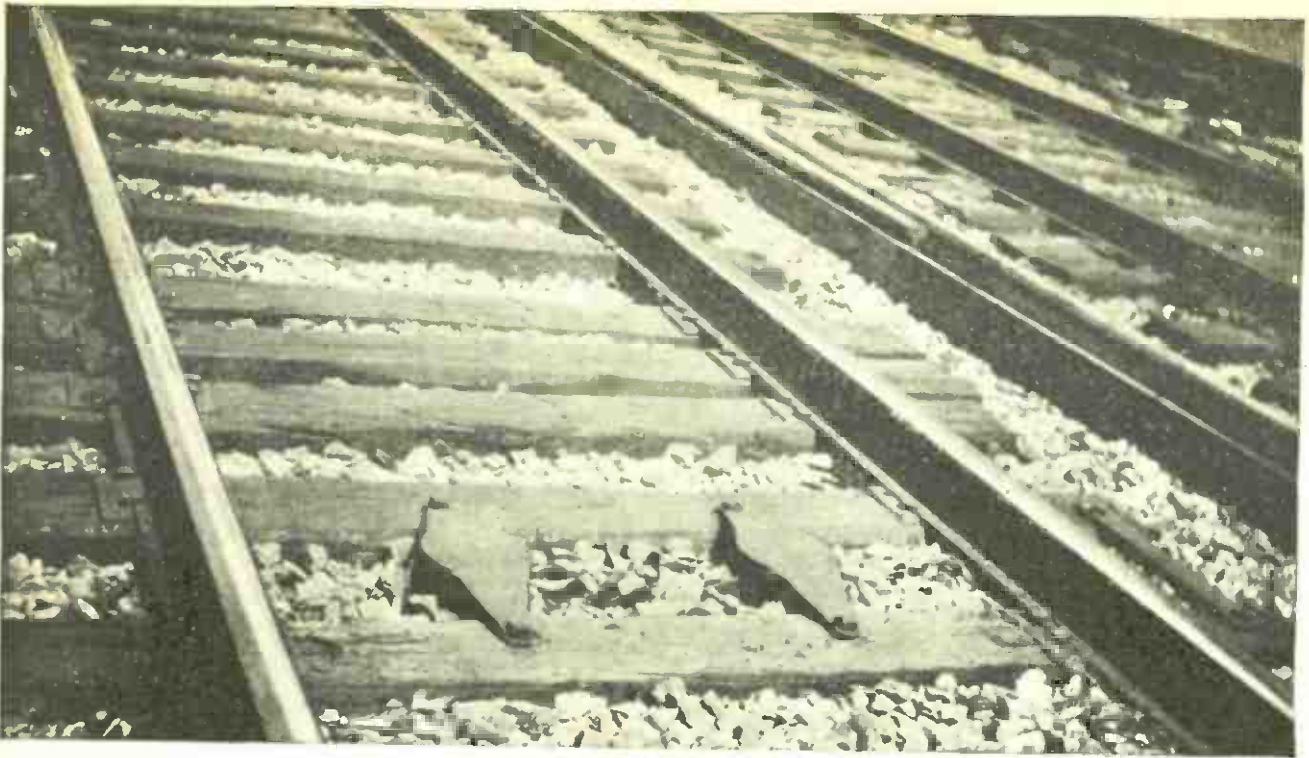
instant without reference to the engineer at all.

Indeed, so extensive are the present resources of the experts in the remote control of machinery by radio that it would be perfectly possible to dispense altogether with the engineer and to direct unmanned locomotives from a central office; stopping and starting them, increasing or reducing speed when necessary, and performing all other operations by radio signals exactly as ships, airplanes and motor cars have actually been controlled on many occasions.

But while all such systems that depend upon radio signals from the dispatcher do eliminate the dangers arising from a failure of the visual signal system or from an error of the engineer,

they still contain an element of human fallibility. They remain dependent upon the dispatcher, who must send the proper radio signal at the proper instant, and they also depend upon this signal getting through to the train with sufficient strength and accuracy to actuate the proper relay. A really perfect system of train control must eliminate even this source of failures and mistakes. It must be completely automatic, not dependent upon the action of any man, either the train or elsewhere. And it is desirable that this perfect system involve the simplest possible and electrical apparatus, so that accidents (as for example, a storm) will not put business.

The  
ise for the  
to have reach  
and



#### THE MAGNET THAT SAYS "STOP!"

*If the engineer runs past a block when he should not do so, this brake-application magnet (one of which is situated at the entrance end of each block) operates automatically to set the brakes.*

A number of such purely automatic and accident-proof systems have been devised. Some depend upon radio waves sent along the rails and effective within the train to signal the engineer or to operate relays, just as the usual electric currents in the rails are effective now to operate the signals of the block-signal systems. Others depend upon radio-transmitting antennas of small range, or upon magnets, placed from point to point along the track and adjusted to stop the train if it runs past them too rapidly or if it passes them at all when the signal says that it should halt.

The radio transmitters that are useful for this purpose are merely loops or condensers supplied with high-frequency current. They operate just as all radio devices operate, the closest analogy to them in familiar radio science being the short-wave directed radio now being experimented with so actively both here and abroad.

These radio methods have much promise for the future, but they do not seem to be as yet, so complete a

perfection as has been attained by the magnetic devices. Most of the systems actually installed and tried out under service conditions, if not all of them, depend upon the use of magnets. Permanent magnets or electromagnets are placed at proper points along the track and these influence, by electromagnetic induction, other magnetic or electric devices placed on the trains that pass over them.

One of the most complete of these magnetic systems is the achievement of an eminent electrical engineer, Mr. Frank J. Sprague, who was assisted in this work by his son, Mr. F. Desmond Sprague. The system is the outcome of nearly a decade of research costing more than \$500,000.

Most of us are familiar with the block signals spaced at suitable intervals along the right of way of a railroad. We know that they are placed there to inform the engineer whether he can proceed at full speed or at a slackened pace. If danger is near the semaphore or light will bid him halt. Now the purpose of the Sprague automatic train con-





#### THE MAGNET THAT SAYS "GO AHEAD"

*At the entrance end of each block is one of these magnets.. When the block is clear the magnet resets the apparatus on the engine so that the train can proceed.*

trol is to repeat the indications of these block signals and, furthermore, to subdivide each block into smaller regulatory zones. This subdivision of the blocks not only adds to safety of traffic but it also keeps the transportation stream in motion with as few stops as possible. The average person does not realize how much time is lost in getting a train under way after it has come to a standstill or how much this costs in fuel wastefully consumed.

The Sprague system locates between the tracks in each signal block three independent magnets. The first is situated a short distance from the entrance to the block. The second is stationed at the critical point of the block, that is, a little beyond the middle of it. The third is not far from the exit of the block.

Magnets number one and number two are permanent magnets so constructed that they act to start the application of the train's brakes. Magnet number three is a reset apparatus which restores the control mechanism on the locomotive to its original state so that it is ready to

function anew when it gets into the next block. All three magnets are linked electrically with the block-signal system, and the manner in which they perform is determined entirely by the orders transmitted through that system. Magnet number one is controlled by the signal at the entrance of the block, while magnets number two and number three respond to the warning of the signal at the exit of the block.

The magnets are sunk in the road-bed, between the rails, so that their upper surfaces are nearly flush with the wooden ties, where they are out of harm's way. Each of the first two or brake-application magnets is really an aggregation of several independent bar magnets, tucked away inside a water-tight metal casing and surmounted by two short, upright projections, called pole pieces. These pole pieces carry coils of wire which are connected with the regular block-signal system. When the track is clear current is fed to the coils in such a direction that the magnet and suppresses i

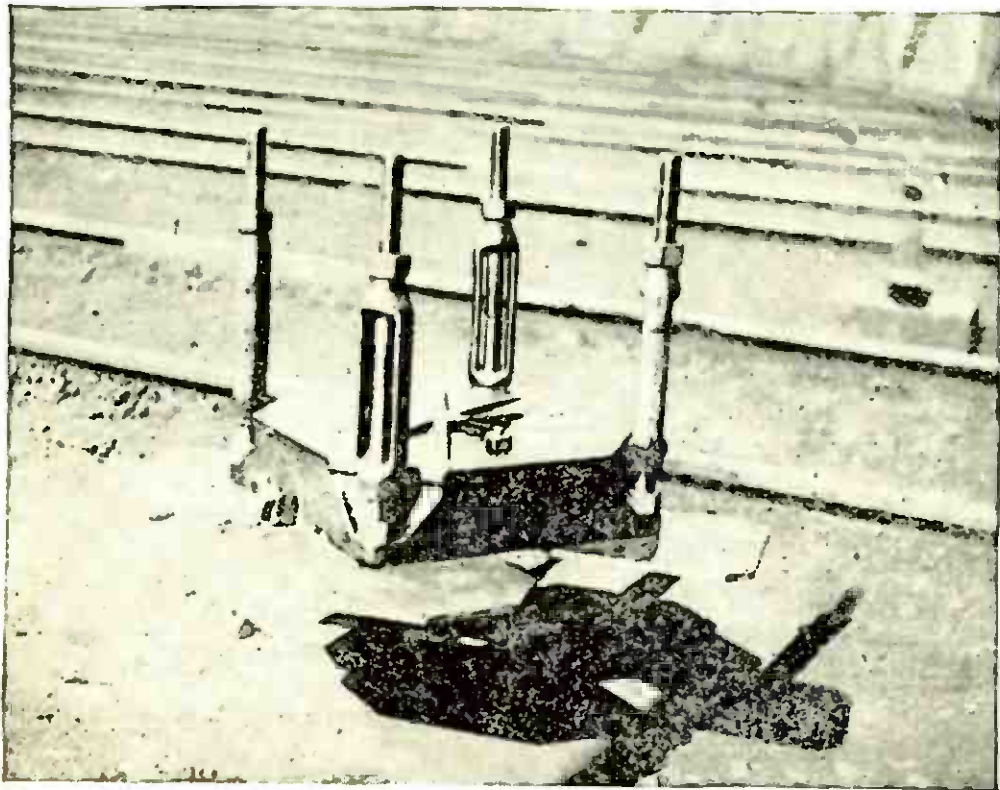
When the magnet is in this condition it is inactive and the sensitive element on the locomotive will pass through this "dead" field without being affected. That is, there is no automatic application of the brakes and the train is free to run on unchecked. The object of making the brake-application magnets normally active rather than normally inactive is a safety-first measure. Should any of the magnets cause the brakes to be set when the block really is clear this gives notices that the electric circuits are out of order and must be attended to.

The third or reset magnet placed near the exit of each block is not a permanent magnet at all. It is an electromagnet, and is energized from the signal just beyond it. If this signal is at "danger" no electricity reaches the magnet's coil and the magnet is powerless to reset the train apparatus as it would do if the succeeding block were clear.

The first two or brake-application magnets are fixed in the road-bed so

that their magnetic fields are exerted vertically. On the other hand, the reset magnets are arranged so that their fields are parallel with the rails. Keep this difference in mind. Suspended beneath the forward end of the locomotive is a box from the bottom of which project two crosswise iron plates and two lengthwise ones. These plates are from three to four inches above the rails. The gap between them and the road-bed magnets is seven or eight inches. The crosswise plates collect magnetism only from the brake-application magnets, while the lengthwise plates respond only to the flux of the brake-application magnets.

Inside the box, which is water-proof, dust-proof and not itself magnetic, are two small metal armatures which are exquisitely sensitive to magnetic impulses and yet are so mounted that the jarring of the train does not disturb them. Depending upon whether the magnetic impulse to these armatures comes from the crosswise iron plates or the lengthwise ones, the armatures



THE MAGNETIC BRAIN ON THE LOCOMOTIVE

*The projecting iron plates on this box pick up the magnetic impulses from the track magnets and thus supply the necessary signals to the engineer and to the automatic controls.*



Lackawanna Railroad

## TELEPHONING FROM A MOVING TRAIN

*As long ago as 1915 this apparatus was used in experimental tests of the possibility of communicating with moving trains by radio waves passing from wires stretched along the track to other wires carried on the train. The development of this system, interrupted by the war, is now active again.*

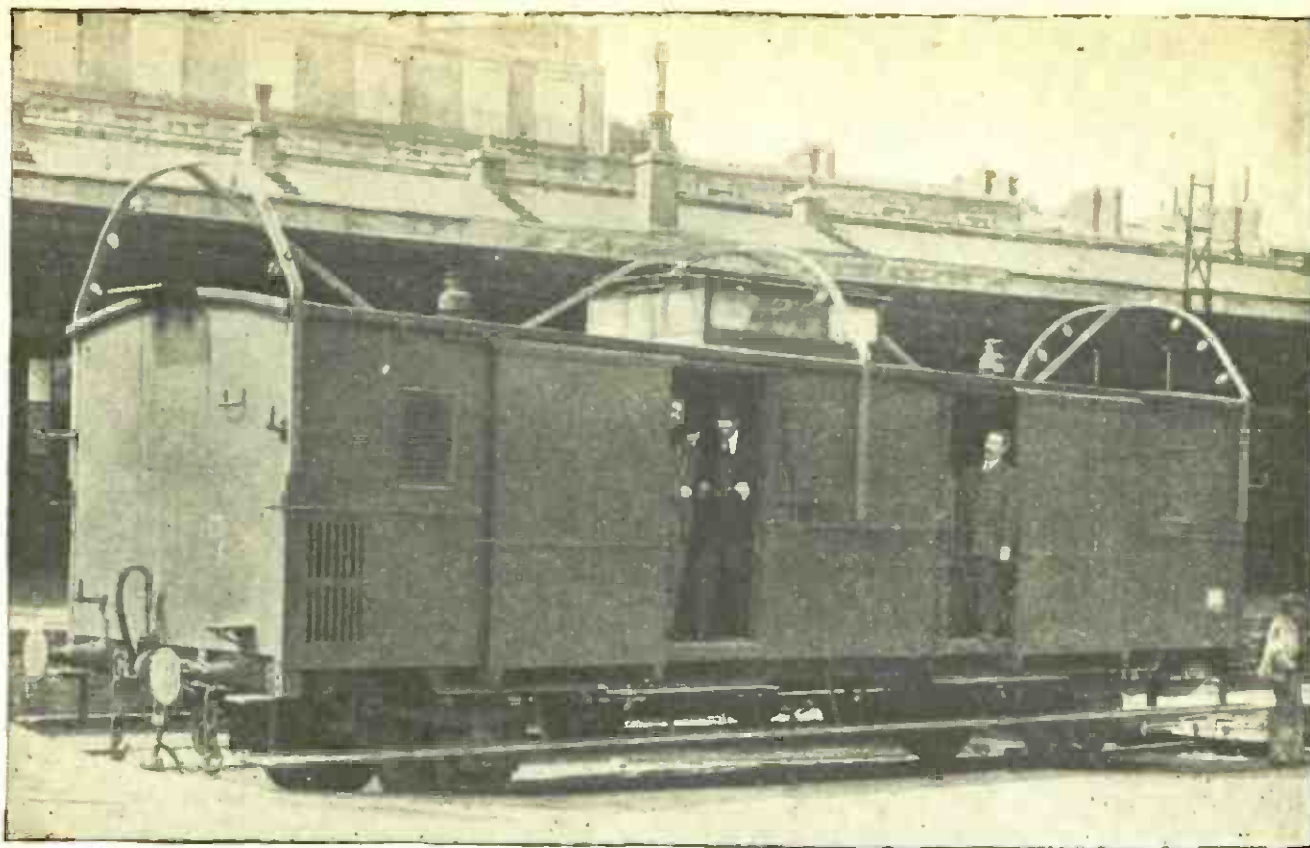
make or break one or the other of two electric circuits. By this means they call into play the control apparatus on the train. Even though a train may rush past any of the magnets in a small fraction of a second, the iron plates that serve as magnetic collectors are sufficiently receptive to catch and transmit the magnetic flux to the proper armature.

We might liken the collector plates and the receiver armatures to our senses and the linking circuits to the corresponding nerves. These nerverlike circuits converge in their turn, upon a metal box on the running board of the locomotive. In this sealed case, or brain, are the nerve centers, a group of three delicate relays capable of responding to electric impulses lasting only one-

thousandth of a second. In complete correspondence with the magnetic signals from the road-bed these relays send electric orders to the proper valves and other mechanisms.

For example, the relays actuate two air valves which automatically move the engineer's brake valve by way of warning to him and also to discharge air to apply the brakes, either partially or completely, as circumstances may demand. These valves can be set to produce different braking actions to meet the special traffic needs of any railroad. Herein lies one of the admirable features of the equipment. It is thoroughly flexible.

There is also an automatic speed-control mechanism which is connected with an axle of the locomotive. The apparatus, likewise, can be set to



Boyer, Paris

#### RADIO TRAIN CONTROL IN FRANCE

*This railway car of the French State Railways will have memories for members of the A. E. F. Fixed to the top of the car are the antennas used in the experiments now being carried out on train control by radio telephony between the dispatcher's office and the train crew.*

train whenever its speed exceeds that prescribed in a "caution" block. Should the engineer be unmindful of the warnings given him, and release the automatically applied brakes with the intention of defying the control system, matters are taken out of his hands and the train is slowed up or brought to a halt.

Now let us see just how this system works. Assume that the train is about to enter a protected block and that it is speeding along at sixty miles an hour. You are standing on the floor plate of the locomotive where you can observe what goes on in the cab as well as the semaphores by the roadside. The last semaphore has been at "clear," and repeating this signal a little green light shines in the cab in front of the engineer. A duplicate green light glows on the opposite side of the cab before the fireman. All is well.

But the next semaphore is at "caution," and when the locomotive arrives

at the first magnet beyond this semaphore the brakes are automatically applied, unless the engineer has already seen the semaphore and applied them. The brakes continue to retard the train until it has reached the prescribed safety speed, say forty miles an hour. Simultaneously with this automatic application of the brakes two yellow lights, meaning caution, takes the place of the two green ones in the cab.

Simultaneously, whenever the brakes are called into play by the impulse from the road-bed magnet, the lever of the engineer's brake valve moves under his hand. This movement is counted upon to arouse him if he has not noticed the signal just passed. He may be further warned by a whistle or horn in the cab.

The automatic equipment does not immediately take the control out of the hands of the engineer. He can return the valve lever to the brake-releasing position by exercising a vigorous effort.

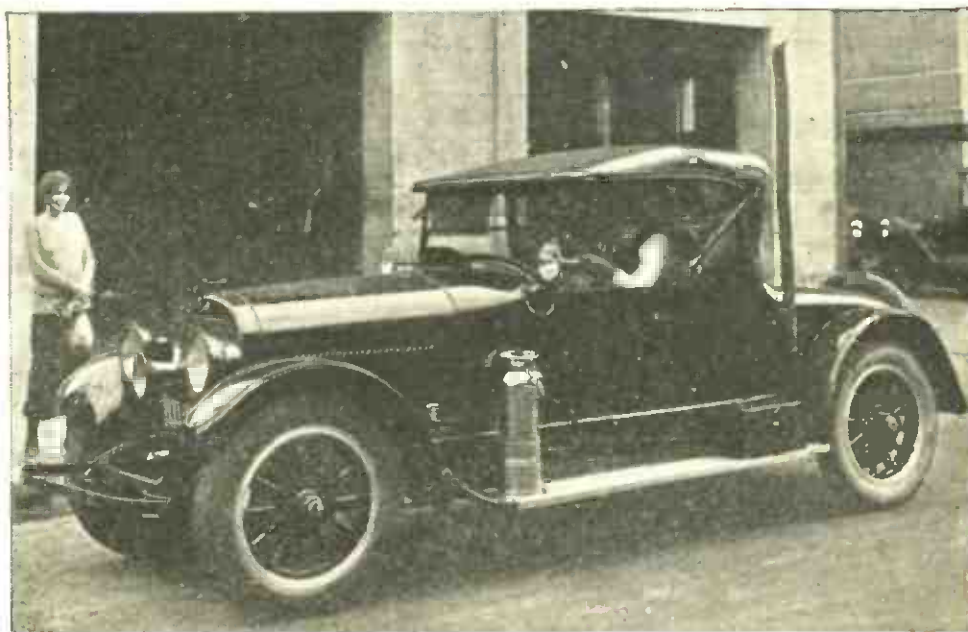
But if he tries to run his train above the prescribed "caution" speed he is forced to surrender control the moment the train reaches the second brake-application magnet. If the speed is then still excessive the brakes grip the wheels again and hold on until the train is slowed to the predetermined caution speed of forty miles an hour. At the second magnet the audible signal is once more announced in the cab and the yellow lights again blink their admonition.

Let us suppose that the engineer is perverse. Having left the first and the second magnets behind, he believes that he can beat the system from there into the nearing block. He forcibly releases the brakes and opens up the throttle. The train gathers prohibitive headway. But upon arriving at the third or reset magnet the engineer is in trouble again. This magnet, instead of restoring the train-control mechanism to normal, steps in and dominates the situation. It causes an emergency application of the brakes which stops the train abruptly. Before the train can start again the engineer must descend to the ground and press a releasing button located below the cab. This final functioning of the

reset magnet effectually prevents the train being wilfully driven past a semaphore that demands a halt.

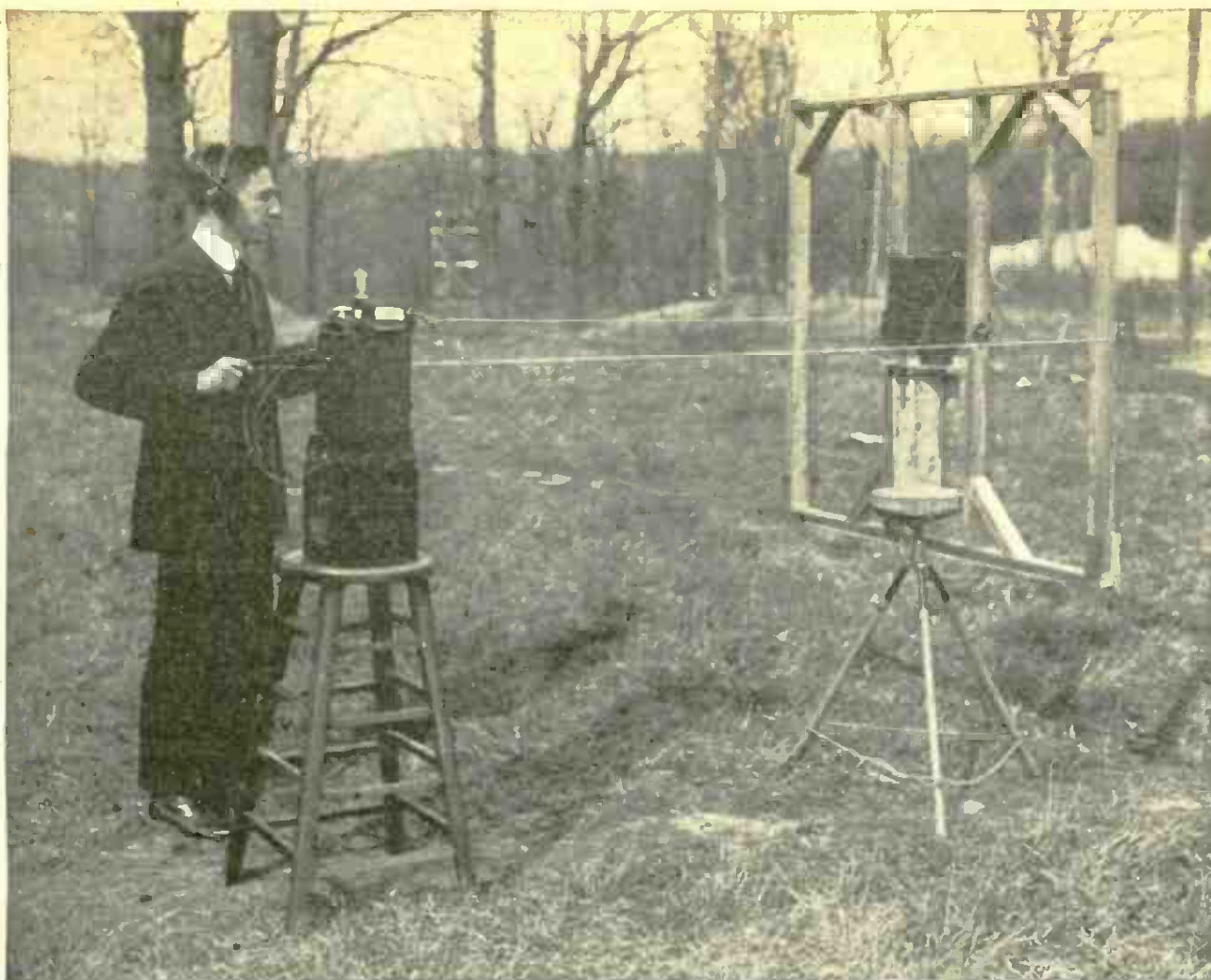
It should be understood, of course, that if the man at the throttle is careful and does of his own volition whatever the wayside signals bid him do, then he anticipates the road-bed magnets and his train is at all times subject to his own control. The object of the Sprague system is to serve merely as an auxiliary to the block-signal system. It is not designed to stop a train so long as that train is moving in accordance with the traffic regulations.

The system is actually in use on a five-mile stretch of track between Ossining and Tarrytown, New York. Months of daily testing have shown that the magnetic impulses can be relied upon to command the situation whenever it is necessary that they do so. With uncanny certainty they reach across the eight-inch gap under the train and instantly set in motion the series of corrective mechanisms. The flow of traffic is restrained only so far as may be necessary to insure safety, but no train can move when further progress would invite disaster.



**THE RADIO-EQUIPPED CAR OF A FIRE CHIEF**

*In order to keep in constant touch with headquarters, the head of the Dallas, Texas, fire department has equipped his official auto with a receiving set, on which he picks up all fire signals broadcast from station WRR.*



Bureau of Standards

#### EXPLORING THE MYSTERIES OF RADIO TRANSMISSION

*With this movable loop connected to delicate receiving and recording apparatus the scientists of the Bureau of Standards are investigating the distortion of radio waves during transmission, one of the radio mysteries that will bring rich rewards to the experimenter who succeeds in solving it.*

## WHERE FORTUNES AWAIT

Unlimited opportunities lie before the radio amateur, the radio fan and the scientist for solving the mysteries of radio phenomena. This article points out what some of these mysteries are.

By HENRY WOODHOUSE

**A**N eminent doctor recently called on me to ask how he could get a transmitting and receiving radio station.

"Where do you want to transmit to?" I asked.

"Any part of the world," he answered. "Two of my patients are in

Paris, one in London, one in Egypt, several at various summer resorts, and two on the Pacific Ocean *en route* to China and Japan. With a radio I can keep in touch with them daily and advise them instantly regarding their health. If I don't prepare for it they'll soon find a more progressive physician."

I had to admit that the argument was convincing, although I advised him that the matter of transmitting would be too complex for a physician and he should make arrangements with one of the large corporations.

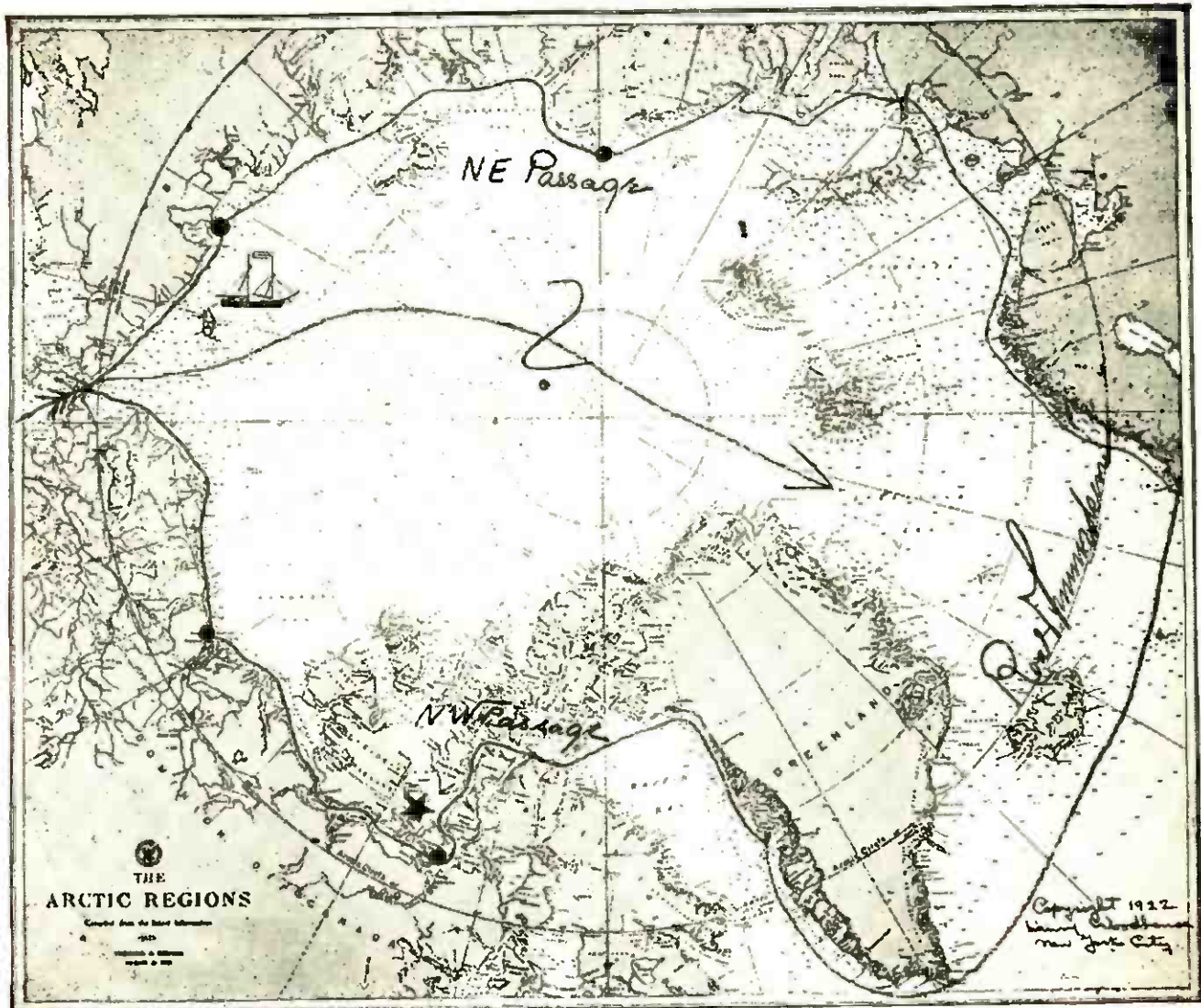
"How many physicians are there in the United States?" I inquired.

"Over one hundred thousand," he answered.

It may seem visionary to state that it will not be long before every physician will have to have a radio telephone. But it is not more visionary than it appeared twenty-five years ago to say that physicians would soon have to have the

telephone. Alexander Graham Bell, the inventor of the telephone, told me that even in his wildest dreams he never dared to think that doctors would ever find it necessary to have telephones in their offices. What would you think now of a physician who did not have a telephone in his office?

The incident is significant. The stupendous spread of interest in radio, by bringing into being a corps of hundreds of thousands of radio experts, professionals and amateurs, has created a world-wide organization, large enough and equipped with the means necessary to attack the most profound



#### DOES THE MAGNETIC POLE AFFECT RADIO TRANSMISSION?

Captain Amundsen's ship MAUD is now frozen in the ice in approximately the place shown on this map. It is planned to drift across the pole, locked in the ice fields. The MAUD is sending out daily radio messages; if radio amateurs will listen for these messages and record the facts about them they may help to solve the great mystery of the effect of the North Magnetic Pole (shown by the black star) on radio transmission.

problems that have heretofore baffled science, the solving of which will, coincidentally, solve the basic problems that stand in the way of further progress in radio transmission and the fundamental progress of electric art and science.

If we can solve these problems radio will become a five-billion-dollar industry; the electrical industries will advance until they equal twice as much more. For it is the same group of fundamental mysteries that underlies both radio and all the other uses of electricity and magnetism.

The future of radio—to take only this one among the possibilities of electricity—is so immense that it is beyond our power to grasp. The world is ready to adopt radio in every branch of human endeavor, and will do so as soon as ways are found to so control radio waves that a million or more messages can be sent and received simultaneously from as many stations, without mutual interference, and as soon as natural electric, magnetic and atmospheric interferences are eliminated or controlled.

To get an idea of the developments to be expected—you must ask yourself what radio can do in co-operation with the hundred or so gigantic industries like the shipping industry, the railroad industry, the automobile industry, the telegraph, telephone and cable industries, the oil industry; in every branch of the commercial world, such as banking, buying, selling, negotiating contracts and concessions; in the transmission of news, photographs and images of events; in the various professions, and at home and in every phase of daily life.

For instance, in the near future it may be a legal requirement to equip automobiles with radio-telephone receiving instruments, to facilitate the control of interstate traffic. Then there will be a sudden demand for over 13,000,000 receiving instruments, one for each registered auto. This develop-

ment is dependent upon better control of transmitting and receiving and on the neutralizing of local magnetic and other natural or artificial phenomena created by railway and electric systems, steel buildings and other local conditions.

The better control of radio will make it possible for millions of firms and individuals to communicate with their correspondents by radio messages, received on typing machines at the receiving end as fast as they are typed at the sending end.

The solution of these pressing radio problems may make it possible, also, to realize the task of supplying to air craft, water craft or land craft, as well as to machinery, power from central radio stations—as proposed by Nikola Tesla to me ten years ago.

In the not distant future we may expect that audible broadcasting will be supplemented by visible broadcasting of what we may call radioscaping, through systems that will make it possible to project the pictures of ships and trains in transit and of other events on a screen in any part of the world.

A baseball game in New Zealand will be projected on a screen in a theater or private home in New York or on ships at sea; an opera performance in New York will be seen as well as heard, all over the world; the progress of ships at sea will be shown on the screen at the offices of the shipping companies, or in the homes of friends of persons traveling on the ships; it will be possible to see actions of congressmen and members of legislatures as well as to hear their addresses, and civic associations will no doubt maintain auditoriums in cities and communities where people may go daily to follow the acts of their legislators; the maneuvers of warships will be projected on screens in Washington where the naval authorities may follow them; and so on with every public branch of human endeavor.

Radio has always had a keen scientific appeal. But now it is becoming an





From a photograph made for POPULAR RADIO

### RICHES WAIT FOR THE MAN WHO SOLVES THIS MYSTERY ABOUT THE NATURE OF MAGNETISM

*No one knows, the author says, the nature of the forces that hold the string of little steel balls suspended from the pole of the magnet. Whoever finds out will rank among the immortals in science.*

essential of everyday life, just as has the telephone, which now has over 15,000,000 subscribers in American territory. There are even greater prospects for radio provided we solve the problems that restrict the volume of radio traffic.

"How can we solve these problems," asks every radio worker who is ambitious to win fame or fortune from his art. So also asks every person who sees

a possibility of using radio or electricity to solve some problem of business or of everyday life.

The first step is to see what the problems are.

As a result of twelve years of investigation and contact with leading scientists, who accorded to the writer the rare privilege of stating frankly what we know and what we do not know about fundamentals, the

has listed over one hundred unsolved radio, electric and magnetic mysteries that await solution. The following are a few of them.

1. What are the sources of terrestrial magnetism? If these sources are inherent in the earth can they be so vast as to supply so enormous an amount of magnetic force for thousands of years without being capable of being tapped for power to drive our machinery, ships and automobiles?

2. Why is it that both radio and terrestrial magnetism diminish and fade away at the equator? Is it that radio is less strong there because it is unsupported by terrestrial magnetism or is it that both are diminished by some third mysterious phenomenon about which we do not know anything?

3. Why does the Aurora or polar lights, while disturbing telephone and telegraph service and creating radio disturbance in some regions, improve radio transmission in other regions?

4. By adopting the new theory that ether is a magnetic (or electromagnetic) flux can we explain the kinetics of the universe, providing a mechanical basis for computations which were limited, heretofore, to mathematical deductions and philosophic conceptions?

5. Do the radio signals from surface vessels, that are picked up by submerged submarines, travel over the surface of the water and then ground where the

submarine is? Or do they ground immediately they are transmitted and follow or "hug" the bottom of the ocean? Or do they traverse the whole vertical depth of the water?

6. Are the phenomena of "static" and "atmospherics" the same below, on and beneath the surface of the earth? Or, to phrase it differently, is ground static the same as atmospheric static or are they entirely different, each requiring different means for its elimination or utilization?

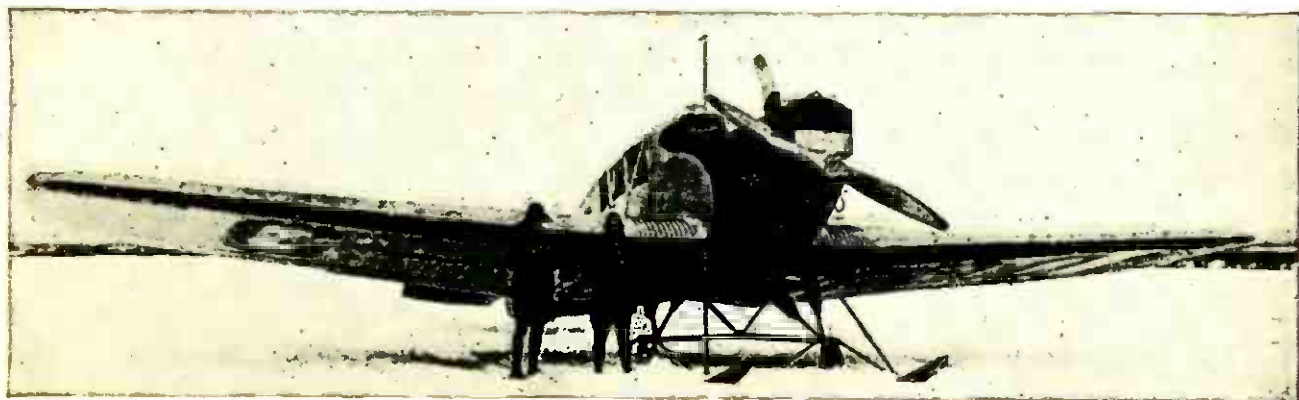
7. Why is it that static disturbances are directional and come mainly from areas located at the magnetic equators, these areas being also the areas of maximum frequency of thunder storms?

8. Are sun spots, magnetic storms, polar lights, magnetic variations and static conditions simultaneous occurrences, interrelated causes and effects all originating from the same source?

9. What is the cause of the mysterious "dead spots" for radio transmission which have been found in the Eastern United States, in Alaska, in Europe, on the oceans, and elsewhere?

10. What forces associated with, or resulting from, the motion of the earth increase or decrease radio conductivity?

11. Is the electron responsible for magnetism, or magnetism for the electron, or neither? Is there an ultimate magnetic particle and what is its relation to the ultimate electric particle?



#### HOW RADIO MAY GO TO THE POLE

*This airplane with which Captain Amundsen will try to fly across the ice-covered polar regions is equipped with radio so that communication with civilisation may be maintained. Note the ski-like runners.*



From a photograph made for POPULAR RADIO

#### IS THIS WHAT BLOCKS THE POLAR RADIO?

*With this small globe the author illustrates the magnetism of the earth. The point of the pencil indicates the end of a small bar magnet thrust through the globe to reproduce the magnetic axis of the earth.*

12. What are the effects on the earth of the action of the sun in charging space with electric energy amounting to millions of billions of volts and with light amounting to innumerable billions of candle power?

When these questions, and the scores of others like them, have been answered we shall have gone a long way toward solving the practical problems of radio and of electrical engineering. Practically every one of these problems affords a stupendous opportunity for fame, rewards and distinction to whoever succeeds in finding the answer to it.

An experimenter, a radio amateur provided only with the simplest equipment, may in seeking the answer to one of these questions discover some new principle or some new method of ap-

plication of old principles, some utilization of forces and elements now ignored, just as Edison discovered many new principles while experimenting to obtain entirely different results, just as Roentgen discovered the X rays by accident, just as De Forest evolved the revolutionary audion lamp from observing, while experimenting, that the discharge produced by a spark coil affected the intensity of the gas burner in his lodging room, and just as Ampere discovered the principles that brought him fame while working as a village locksmith.

"Why do we not know these things?" and "Tell me where to begin?" are the two questions I have asked the world's leading scientists—and in turn I have been asked by hundreds who have heard

my lectures and read my statements on some of these subjects.

I have space here to mention only a very few of these problems. One of the most alluring of them is that of the nature of magnetism. It is a subject about which we know almost nothing but which probably, nevertheless, is the most important of all to the future of radio and of electricity.

What *is* this mysterious something that we call magnetism, that penetrates everything and is to be found everywhere? Where does it come from? Why is the earth magnetic? What are the magnetic poles? How has it been possible for the magnetic poles to magnetize everything in the earth and, undoubtedly, in the surrounding atmosphere without the source becoming exhausted?

The world cannot answer these questions. Captain Roald Amundsen, who studied magnetism since boyhood and who actually lived over a year in the region of the north magnetic pole in order to study the phenomena there, told me:

"Magnetism is more fundamental and more wonderful than electricity. We know only very little about it."

A small compass, a piece of lodestone, a magnet, a half ounce of iron filings and a dozen needles, the whole costing about \$3.00, will demonstrate more mysterious phenomena than the collective knowledge of mankind can explain today.

It is a curious commentary upon man's proverbial enterprise that although billions of persons—or an average of two billion every fifty years—have lived and died since the Chinese began using the magnetic compass, about two thousand years ago, only half a dozen men ever tried to follow the compass to the earth's magnetic poles to find out what the source of this phenomenon is; and of this half dozen, only one, Captain Amundsen, stayed in the magnetic polar regions a number of months to

study the phenomena that occur there.

A number of the most pressing practical problems of radio are related, presumably, to this matter of the earth's magnetism. One example is the frequent phenomenon of variable path of waves in radio transmission. We are reminded by Marconi and other authorities who have opportunity of obtaining continual data of such variations that signals from stations at great distances do not always retain their direction along one great circle, but reach the receiver from either way or various ways round the earth. Marconi reports:

"The observers noted American signals from Radio Central and from Tuckerton coming from a direction which indicated that they preferred to travel a distance of three-quarters of the way round the earth, rather than come by the shortest way round."

Another interesting and extraordinary result was noted on several occasions, according to the report of Mr. Tremallen from Rocky Point, New Zealand, where during last March the signals from Nauen appeared to travel to him *via* the South Pole, whilst those from Hanover, also situated in Germany, and not very far from Nauen, appeared to prefer to travel *via* the North Pole.

Why? Nobody knows, but we may explain the phenomena if fifty thousand radio experimenters report for six months what they hear at different times of the day and night, because when such reports are tabulated they may make evident facts which we do not even suspect at present.

The *Maud*, the ship of the Amundsen Arctic Relief Expedition, frozen in the slowly drifting polar ice, is sending two radio weather reports each day from its powerful plant. These are received across the North Pole, at European stations, but, as far as has been ascertained, are not received in Alaska, Canada and the United States.

What is it that prevents the *Maud's* daily radios from reaching the stations



From a photograph by William Henry

#### WHAT EFFECT HAS THE NORTHERN LIGHTS ON RADIO?

*The radio fans may be able to answer this question, the author believes, if they will co-operate in collecting information about it. This unusual photograph of the Northern Lights (or Aurora Borealis) was made from the top of the old Herald Building in New York, March 11, 1914.*

on the American continent? It cannot be the ice fields, the frigid air, the arctic storms, because there are more of these north of the *Maud* than south and west of her. The North Magnetic Pole, the center of the earth's magnetic attraction may be the cause, but nobody knows.

It is one of the mysteries that may be solved by the world's radio amateurs if they will listen for the *Maud's* daily radio signals and report whether they hear them or not. And any amateur who succeeds in solving this mystery, or any other one of the basic radio problems still unsolved, may find that it puts into his hands the key to wealth as well as to scientific distinction.

In May, 1916, when I delivered an address to the New York Electrical Society, I reported my experiences in testing the compass at high altitudes and the possibility of aerial torpedoes and torpedoes mounted on airplanes, directed through the air by radio, and pointed out that the mechanical problems of launching a five-ton load of T. N. T. through the air by radio would be solved before we could solve the problems of directing that load safely.

This is the case today. The Hammond system has demonstrated that even a battleship can be operated by radio, but we dare not venture a full size airplane, because of the many unsolved problems of radio transmission.

Directing military airplanes by radio cannot be undertaken so long as there is a possibility of interference. While the airplane would carry the load of explosive past a dead spot, which the airplane could easily negotiate, the radio could not cross that spot and the airplane would from that point on be adrift, guideless, a menace to communities below!

This gives an idea of the importance of some of these problems from a military standpoint. Many of them are equally important commercially.

Another one, which may or may not have a magnetic element, is the mystery

of the disturbances known popularly as "static" or "atmospherics." Very little is known of these disturbances beyond the fact that they occur. The phenomena may be at times electric, at times magnetic, at times atmospheric. One of the important needs at present is to analyze the disturbances into these or other divisions. Only by learning their nature will we be able to screen them off or to utilize them, the latter being the most likely result because it is not natural with human beings to let power go unharnessed.

The genius of Tesla, in noticing that the stationary waves caused by a distant storm could be reproduced in the conducting layer of the earth by means of two synchronized oscillators, and utilized to explode submarine mines is an example of how we may utilize all "static" phenomena.

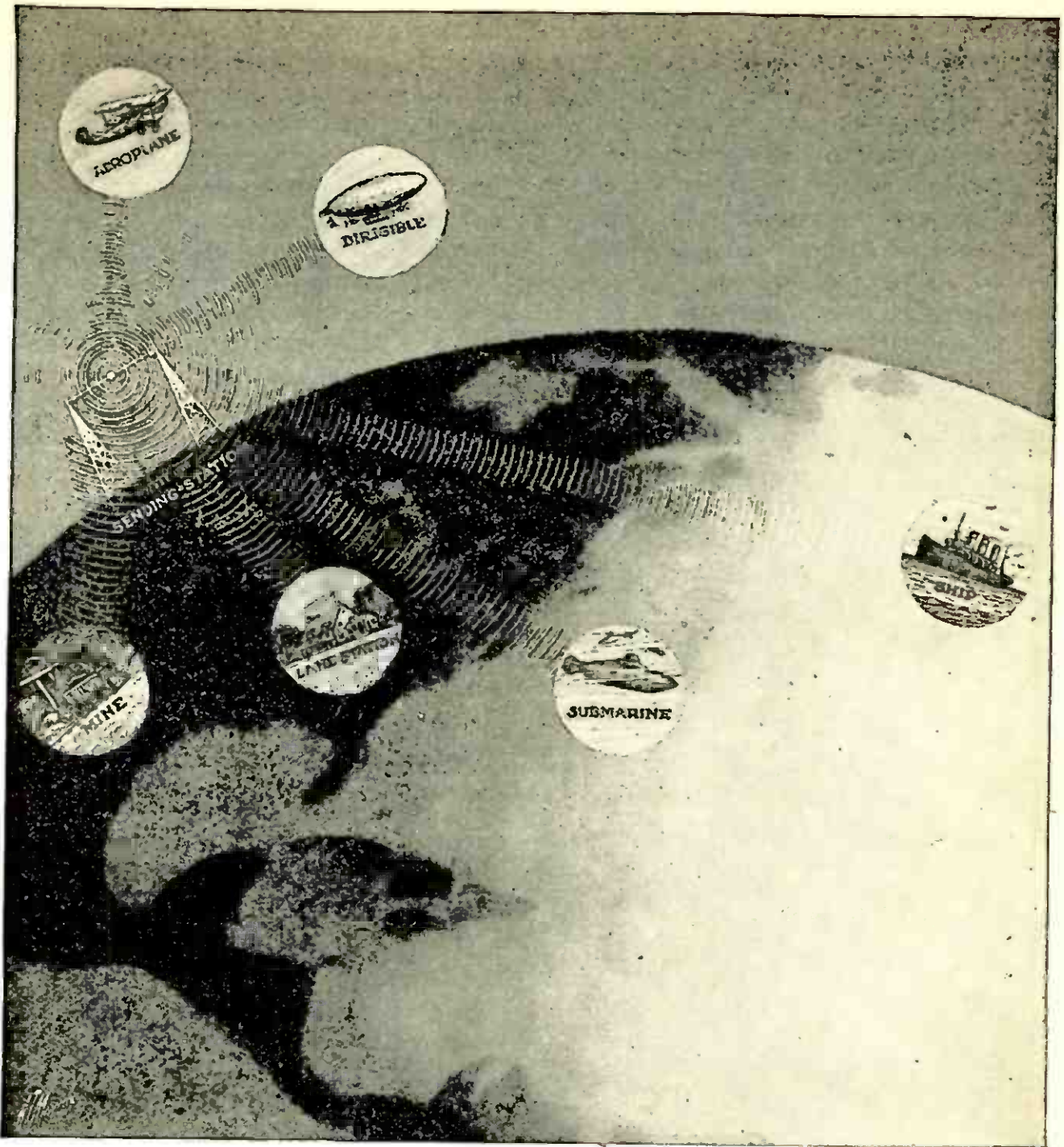
But first we must find out what the disturbances are. Do they originate in the crust of the earth, or in the atmosphere which wraps the earth, or from cosmic sources altogether outside the earth, or from all of these in combination?

This is one of the cardinal questions to be solved.

We must not forget that whatever the nature of these disturbing factors, they use the same conductive media as radio signals, therefore we may learn about both in studying either.

Were it possible for a radio experimenter to view the whole earth whenever his receiving instruments register the clicks and rattlings of static he would find, probably, that polar lights are flashing their dazzling streamers from points ranging from sixty to one hundred miles above the north and south polar regions and extending skyward, several hundred miles up.

Why? No one knows. It is one of the many unexplained phenomena which the radio experimenters may help to define, benefiting the art of radio transmission in so doing.



### WHY DO RADIO WAVES GO EVERYWHERE?

*The airship and airplane high in the air, the submarine under the sea, the miner deep in the earth all receive radio waves, yet the nature of these waves and the medium that carries them is still a mystery that demands solution and that will hugely reward the experimenter who solves it.*

By adding to their radio sets the simplest equipment used for determining magnetic variations, the world's radio experimenters could supply in the course of a year data that might make it possible to establish the connection of the so-called "static" and "atmospheric" disturbances with the polar lights, the connection between polar

lights and magnetic storms, the direction and geography of magnetic disturbances and other basic facts.

Radio engineers have been as prodigal with the natural resources available to them as other pioneers have been. Their attitude toward static and atmospheric disturbances is similar to that of the salt miners a century

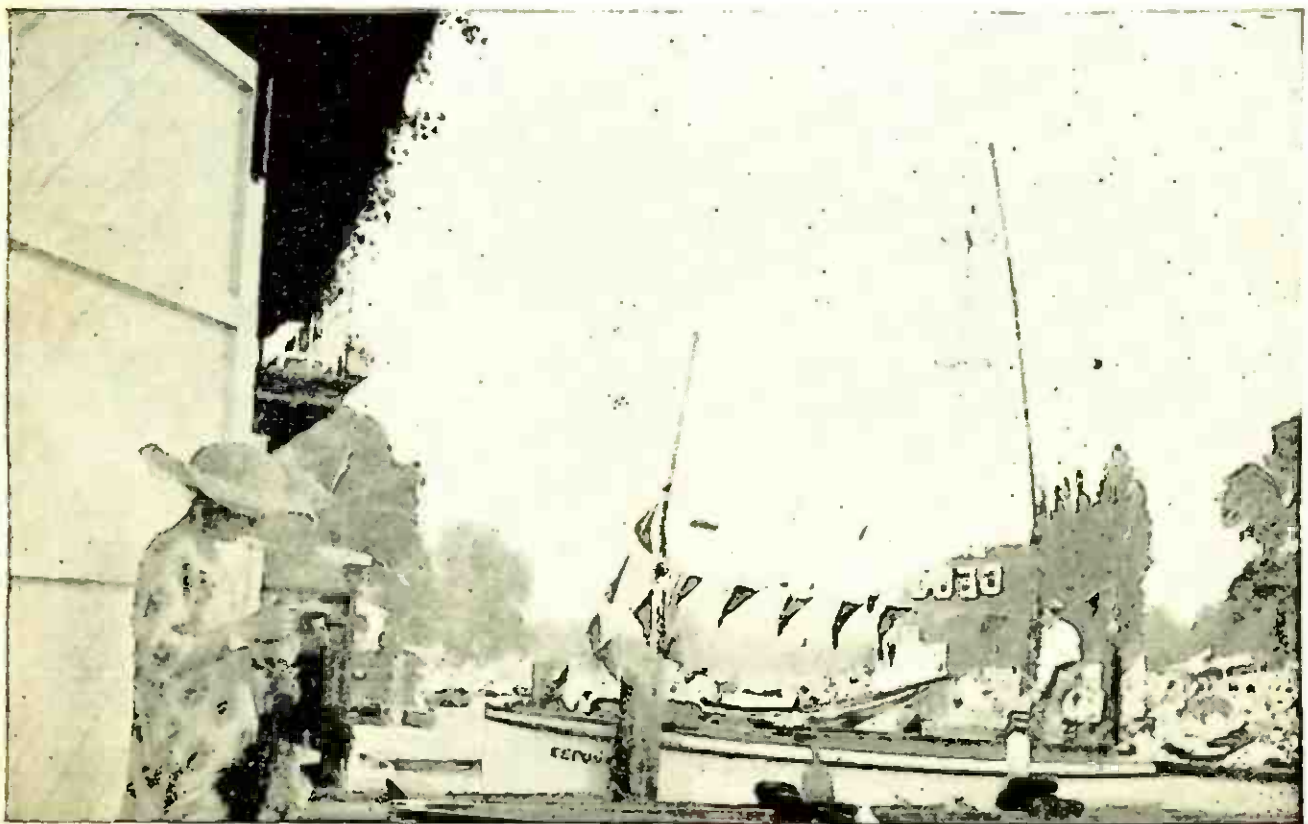
who cussed when they struck some stuff called petroleum while mining salt. They are just as wasteful as the railroad people who spent thousands of dollars wearing out brakes in slowing up electric trains going down hill. Now the salt miners who strike oil abandon the salt to take care of the oil, and the railroads use the downward journeys of trains to generate electricity to use to take the same train up the next hill.

The time is coming when what is now grouped under "static" disturbance and cussed by the radio experimenter, will be divided into categories, such as electrics to designate electric phenomena, magnetics to designate magnetic phenomena and atmospheric to designate phenomena caused by atmospheric conditions. Each will be utilized and used not only to advance the cause of radio and electric transmission but also to advance other industries, arts and branches of science.

We may obtain benefits of material value in everyday life, such as means of tapping the natural electric fields for cheaper power to drive machinery and to light the streets and homes of the most isolated communities.

It may come to pass that static and the polar lights, instead of being regarded purely as vagaries of nature that often disrupt the radio and telephone and telegraph service, may become signals that conditions are favorable for tapping the natural electric fields and for storing away electricity to drive our machinery for months to come.

Imagine the world-wide and lasting fame, to say nothing of more tangible rewards, that awaits the man who first succeeds in doing this. Every radio experimenter has unparalleled opportunities of winning fame and wealth by solving one or more of these basic scientific mysteries. There are opportunities for thousands.



Armstrong Perry

#### RADIO ENTERTAINS THE CROWD AT THE HENLEY REGATTA

*The classic rowing event of England was marked this past season by pleasure craft equipped with receiving sets that kept the spectators interested, between the races, with broadcasts from London.*





From a photograph made for POPULAR RADIO

### THE COMPLETED SET

The inventor, Mr. Cockaday, is here shown demonstrating his experimental receiver to Dr. E. E. Free and Raymond F. Yates.

## HOW TO BUILD THE IMPROVED 4-CIRCUIT TUNER

By LAURENCE M. COCKADAY, R.E.

It is estimated that there are now in use about 500,000 four-circuit tuners—first announced in POPULAR RADIO for May, 1923. This article describes a remarkable development of this set—a development that provides for AUTOMATIC TUNING, practically unlimited distance range, maximum volume of sound, excellent reproduction and no interference. This set is probably the most important contribution that has yet been made to the equipment of the radio fan.

—EDITOR

COSTS OF PARTS: *About \$95.00*

RECEIVING RANGE: *Over 3,400 miles*

#### HERE ARE THE ITEMS YOU WILL NEED

*Four-circuit coil set, units A, B, C, D;*

A—primary winding, consisting of a single turn of tinned-copper, bus-wire 1/16-inch square;

B—secondary winding, consisting of 65 turns of No. 18 DSC copper wire;

C—stabilizer winding, consisting of 34 turns of No. 18 DSC copper wire; (coils A, B and C are wound on a hard-rubber tube, 3 1/4 inches in diameter and 5 9/16 inches long);

D—antenna tuning coil, consisting of 43 turns of No. 18 DSC copper wire double bank wound and tapped on hard-rubber tube, 3 1/4 inches in diameter and 1 5/8 inches long.

E and F—Amsco vernier variable condensers,

26 plates, .00046 (.0005) mfd. (with 4-inch knob-and-dial and vernier knob);

G and H—Amplex grid-densers (small variable condensers);

I—Bradley-leak, variable 1/4 to 10 megohms;

J1, J2, J3, J4 and J5—Melco vacuum-tube sockets;

K—Amsco filament rheostat, 6 ohms;

L1, L2, L3—Amsco filament rheostats, 2

M1, M2, and M3—Pacent jacks, 2 circuits and one single-circuit

N1 and N2—Amertran audio-frequency transformers;

O—Como input "push and

P—Como output "push and

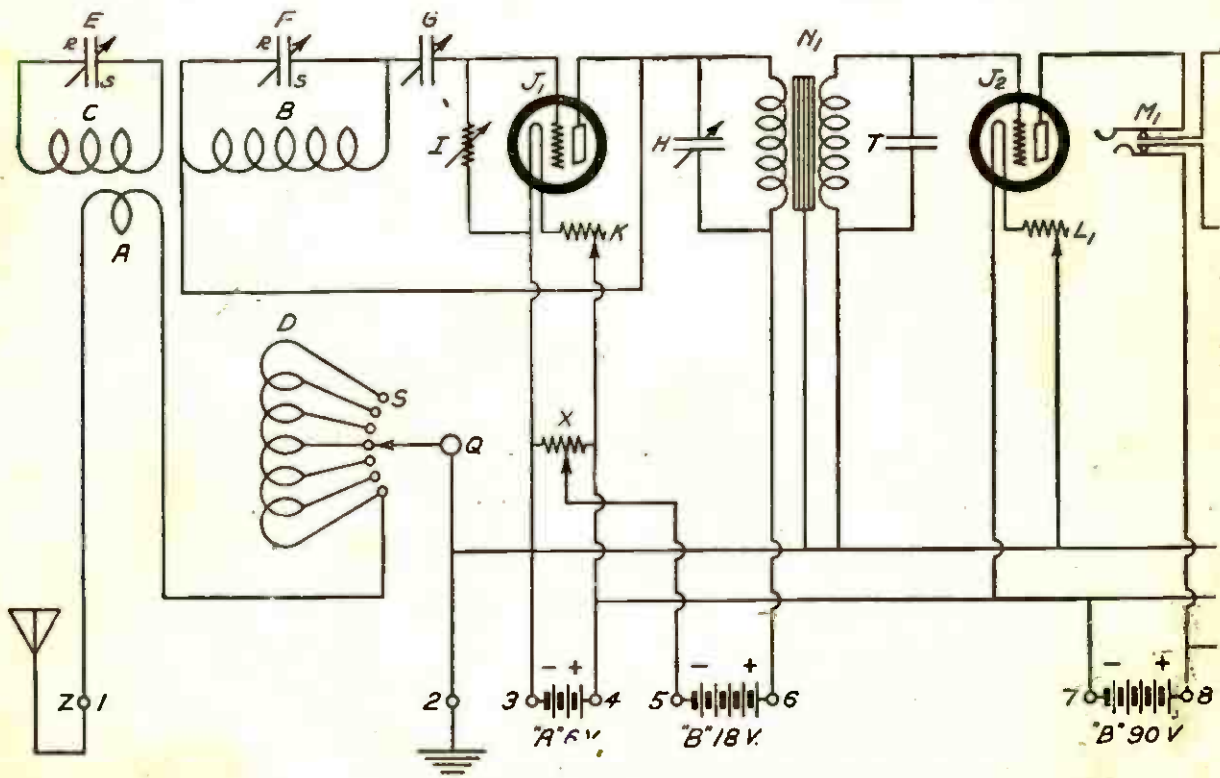
Q and R—switch levers and knobs;  
 S—switch points;  
 T—Dubilier mica fixed condenser .0005 mfd. (with lugs for transformer mounting);  
 U—Dubilier mica fixed condenser .00025 (with clips for grid-leak);  
 V—Durham variable grid-leak;  
 W1, W2 and W3—Lavite resistances, 48,000 ohms;  
 X—Amsco potentiometer, 400 ohms;

Y1, Y2, Y3—composition panels (7x24 inches), (3x2¼ inches), (and 1 foot x 12 inches). See Figures 7 and 9;  
 Z—binding posts;  
 AA—base;  
 AB—cabinet. (See Figure 8);  
 AC, AD and AE—brass brackets. See Figure 9;  
 varnished cambric tubing;  
 solder, etc.

THE letters telling of the radio enthusiasts' experiments and success with the four-circuit tuner have been pouring in so fast that the author has not had time even to try all the suggestions that they contain. Nevertheless he has managed to investigate every suggestion for improvement of seemingly worthwhile value that has come in and has picked out the good ones received and applied them to the set. Along with this have come letters from fans who have built the set described in the May issue of POPULAR RADIO and have for some reason or other not had the success with it that they should have had. Some have found the set ideal on local recep-

tion but poor on DX; some have found it wonderful for DX reception but not of enough volume on local stuff. Some write in that their set does not oscillate freely; some say that their set oscillates too much.

In every case, the trouble can be run down and it is almost always found to be due to a *mistake in connections* or to *apparatus of poor design or poor quality* that has been incorporated in the set. It should be remembered that a set is no better than its poorest part, and if one such part is used in the set, the whole set will be dragged down to this level. A poorly designed instrument can never be boosted up to the level of a good one by



THE COMPLETE WIRING DIAGRAM THAT INCLUDES—

FIGURE 1: This diagram shows how to hook up the various instruments and parts in the circuit. It will be noticed that all the parts are given a designating letter

placing it in a circuit in company with good ones.

The improved circuit which is here described, besides having its recognized qualities of (A) unusual selectivity, (B) unlimited distance range, (C) ease of tuning, (D) truthful reproduction, also incorporates the following new features:

- E—wavelength range, 150 to 675 meters;
- F—wavelength calibration;
- G—automatic tuning;
- H—power amplification;
- I—simpler construction;
- J—adjustable circuit values.

The feature E makes the circuit suitable for amateur, broadcast, and commercial reception from CW, telephone, or spark transmitters.

Feature F allows the operator to set the dials for any particular wavelength he wishes to receive on, with the assurance that he will immediately pick up the station he is trying to get, without interference—providing the station is transmitting at the time.

Feature G allows of tuning by a

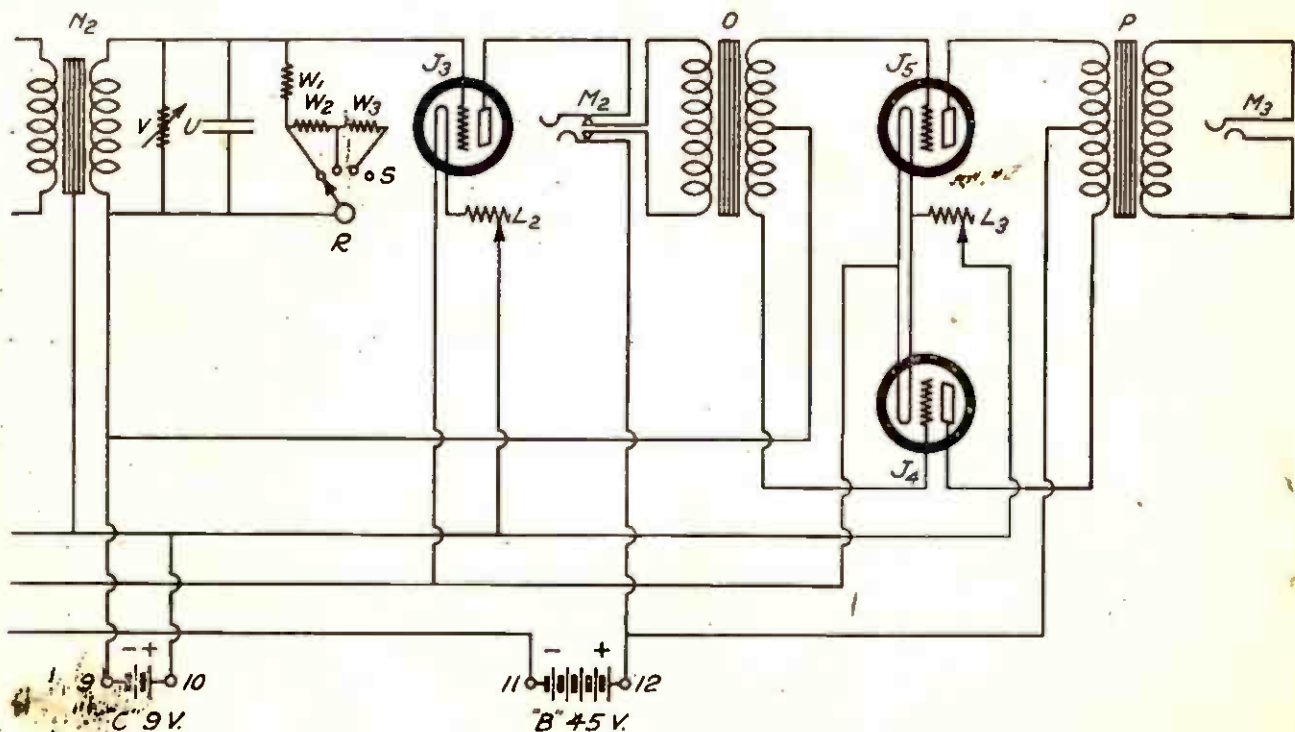
novice, even though he has no conception of what is happening when he adjusts the dials to the given settings.

Feature H allows of loudspeaker reception of DX\* within 3,000 miles, and on account of the quality assured by the "push and pull" amplifier system, the reproduction of music and voice signals will be pure and undistorted.

Feature I is important because in building the first four-circuit tuner it was necessary to make special brackets for mounting the instruments, which were almost beyond the scope of the amateur builder. The new set is a structure in which all the instruments, except those that are mounted directly upon the panel, are fixed to the base, which is made of hard walnut wood. By this construction all the instruments are easily accessible and may be wired up with little difficulty.

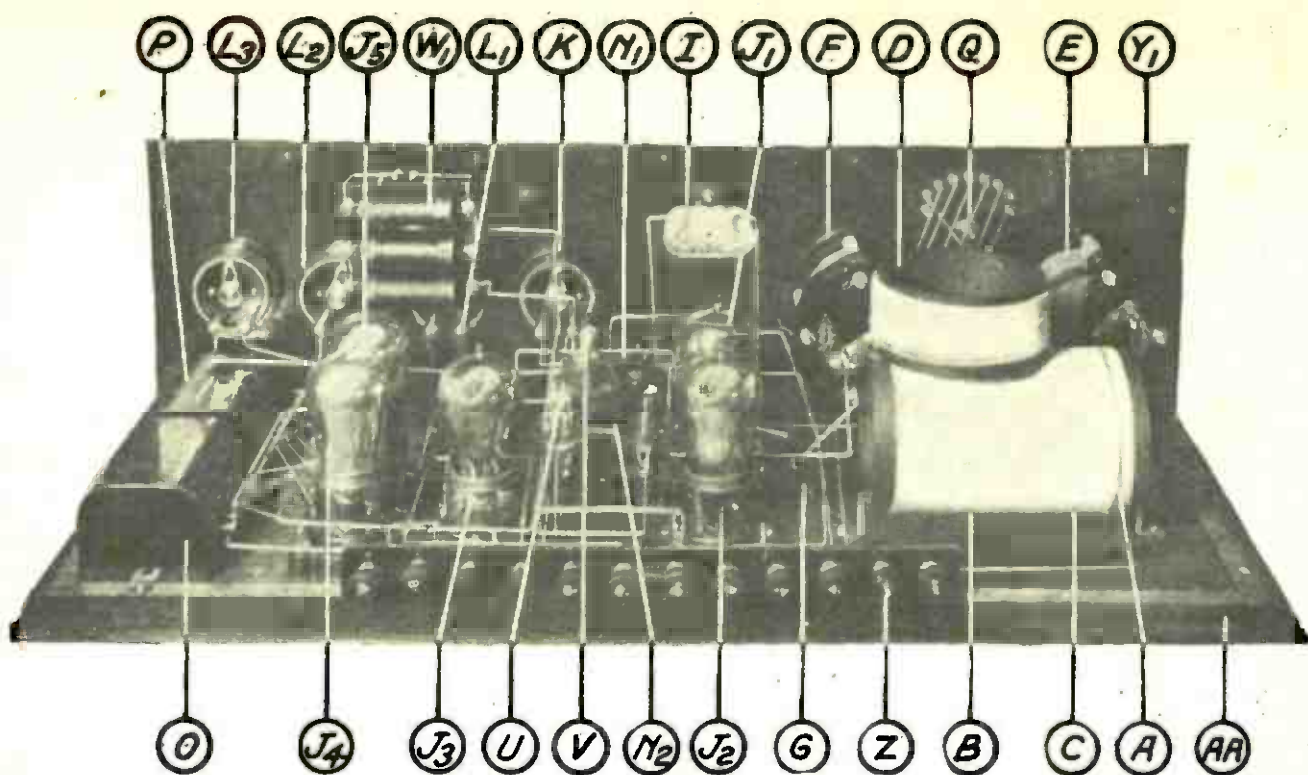
Feature J is important because the various people who build the set may find that their set may oscillate too freely

\*Amateur slogan for "long distance."



#### —THE TUNER, AUDIO AMPLIFIER AND POWER AMPLIFIER

which is the same as that given for the same units in the list of parts and the text. The binding posts are numbered. This eliminates the possibility of mistakes in wiring up.



THE REAR VIEW OF THE SET

FIGURE 2: This picture shows the general arrangement of all of the instruments fastened to the panel or the base. The exact locations for the instruments are shown in Figure 4.

or not enough and if the grid condenser, the by-pass condenser, and the grid leak are made variable, these difficulties can be overcome and the set put into critical, regenerative condition.

The cabinet for the set is of simple construction; it consists of three sides fastened together which may be fixed onto the base and the panel by screws running through the base and the panel. The receiver is built on a 7x24-inch panel which is a standard size and can be obtained from any dealer.

Of course, the receiver does not re-radiate; this is really important in these days when closely coupled regenerative receivers are the rule, and we have so much whistling and squeaking accompanying reception in a locality where a number of these re-radiating receivers are in use.

The set is not susceptible to body capacity and needs no shielding at all; this is taken care of by the wiring of the set itself.

The wiring diagram is shown in Figure 1.

#### The Parts Used in Building the Set

In all the diagrams in this article each part bears a designating letter. In this way the prospective builder of a receiver 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 the list of parts at the beginning of the article.

**T**he 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 spacing of the holes drilled in the panel and shelf for mounting them.

#### How to Construct the Set

After procuring all the instruments and materials for building the set, the amateur should set about preparing the panel Y1, (shown in Figures 2, 3, 4, 5, 6 and 7).

First of all the panel should be cut to the correct size, 7 by 24 inches.

Then the edges should be squared up smoothly with a file. The centers for boring the holes (which are necessary for mounting the instruments) should be laid out on the panel as shown in Figure 7.

The holes outlined here with a double circle should be countersunk so that the flat-head machine screws used for fastening the instru-

ments 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 mount the condensers, E and F on the main panel Y, by means of three screws each, and attach the knobs-and-dials. Be sure that the plates of the condensers are "all out" when the dial settings read zero. This is important if the calibration curve is to be used. Also be sure that the vernier plates of the condensers are "half in and half out" when the word "vernier" reads horizontally across the vernier knobs. Then mount the variable grid-leak I, on the panel with two screws, see Figures 2, 3 and 4.

Now mount the potentiometer X directly beneath the grid-leak by means of two screws.

Fasten the 6-ohm rheostat K directly above the hole for the first jack M1 by means of two more screws. The three 20-ohm rheostats L1, L2 and L3 should now be mounted in their

respective positions to the right of the 6-ohm rheostat K.

Then mount the two switch levers and knobs Q and R on the panel, and also the switch points S. (See Figures 2, 3, 4 and 6.)

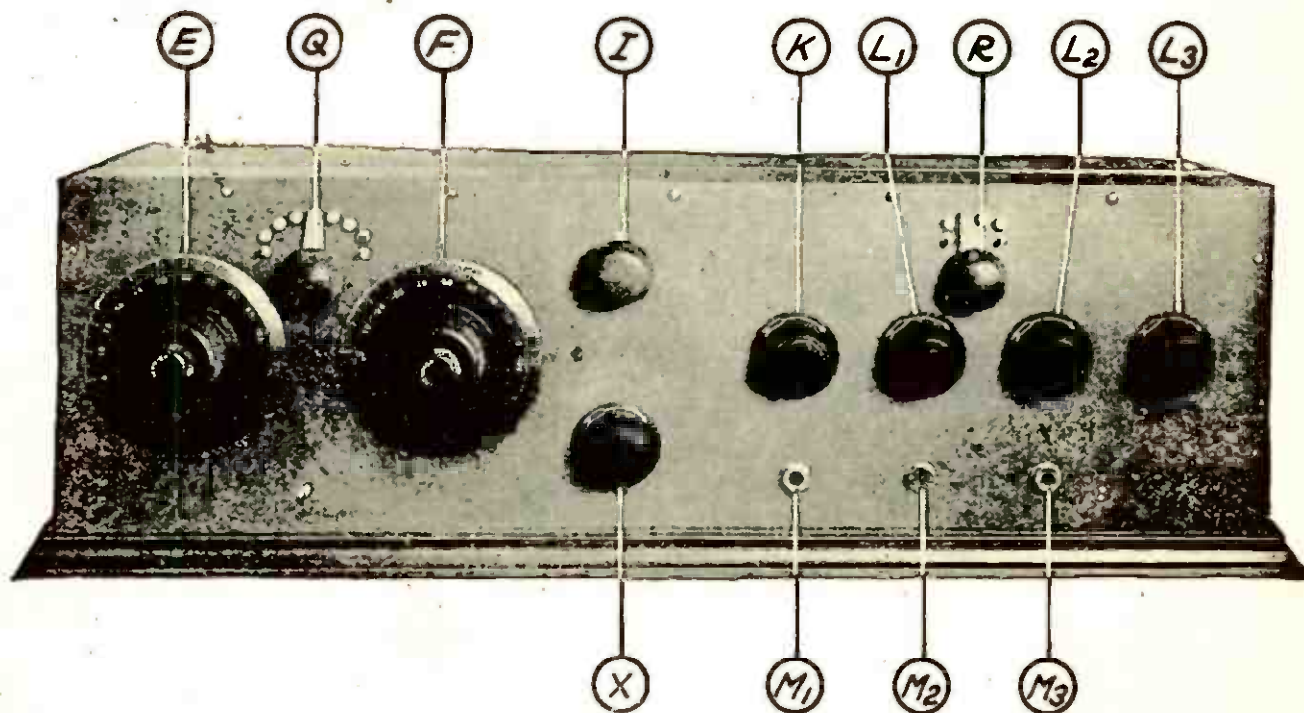
Next mount the three jacks M1, M2 and M3 in their respective places at the lower right end of the panel.

The correct positions on the panel for all these various instruments are shown in Figure 3, where all the knobs and parts are designated by the same letters as appear in the text.

The complete panel should now be attached to the wooden base by means of two small angle-brass brackets AC, see figures 2, 4, 5 and 9. The two holes for these brackets are shown in the drilling plan of the panel Y1 in Figure 7.

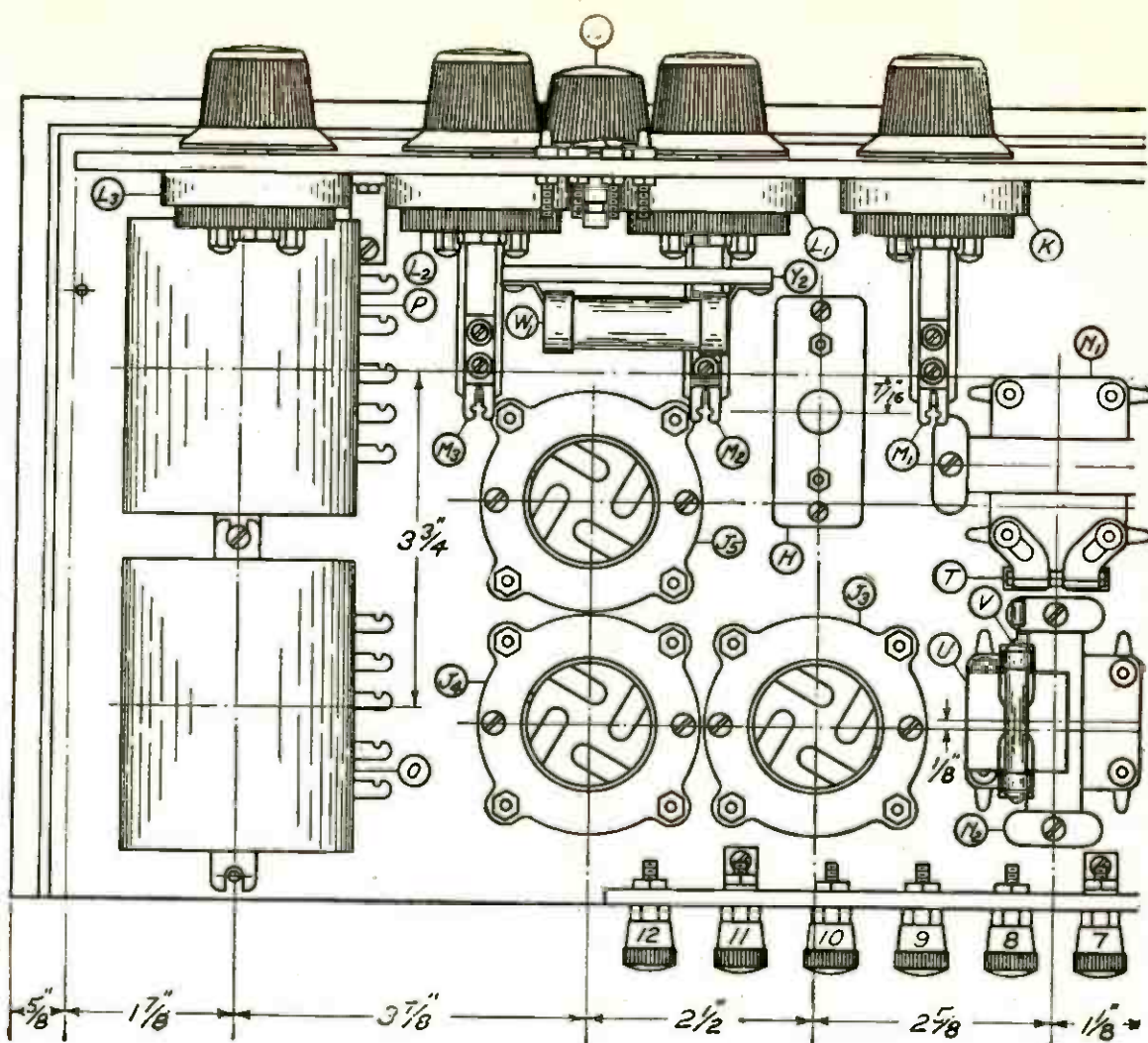
Now mount the coil set A, B, C and D with two screws fastened through the brackets AE as shown in Figure 4. Then fasten the five tube sockets J1, J2, J3, J4 and J5 in their respective places as shown in Figure 4.

Next fasten the two transformers N1 and N2 to the base, as shown in Figures 2 and 4. The first transformer N1 is attached to the base by slipping the small metal leg underneath the detector socket and fastening with the same screw as that used for one side of the detector socket. This gives close spacing. It will be noted that these two transformers are placed at right angles to each other. It should also be noted that the sockets are mounted with the slot facing a specific direction so that the grid terminals will be closest to their respective points of connection. (See



THE PANEL VIEW OF THE RECEIVER

FIGURE 3: This gives an idea of how the set looks from the front and as the dials and knobs are marked with letters which correspond to the instruments which they are attached, the prospective operator will have no trouble in locating the various tuning controls as they are explained in the instructions for use automatically.



#### THE WORKING DRAWING FOR CONSTRUCTION

FIGURE 4: Here are shown the correct positions for the various instruments. The positions are given, center to center, for all instruments.

Figure 4.) This makes for short leads.

The next job will be to mount the transformer O at the rear of the base, and the transformer P close to the panel Y1. These two transformers are fastened to the base by means of two screws, one through the leg of transformer P near the panel, and one through the remaining leg of this transformer and the adjacent leg of transformer O. The remaining leg of transformer O will be held by one of the screws which are inserted up through the base and which hold the cabinet to the base.

Now mount the condenser T across the secondary terminals of the first transformer N1 and mount the condenser U and the grid-leak V across the secondary terminals of the second transformer N2. This is clearly shown in Figure 4.

The next job is to screw the two small rectangular-shaped variable condensers G and H in their respective positions as shown in Figure 4. These two instruments are mounted by two screws for each condenser.

Now cut the small connection block Y3 out of composition panel material, to the size shown in Figure 9 and drill for the binding posts. This panel should then be mounted on the

base AA, by means of three small brass brackets AD constructed as shown in Figure 9. See Figures 2, 4 and 5 for mounting the connecting block.

The last job is to cut the small composition panel Y2 for mounting the three resistances W1, W2 and W3. This is done as shown in Figure 9, which gives the dimensions for drilling and shows the manner in which the units are mounted. As this panel is supported by the wiring of the set, the directions for mounting it will be left until later.

#### How to Wire the Set

The design of this set is such that the grid-circuit wiring of each of the five tubes may be made extremely short and isolated from the other circuits. In fact, all the tuning circuits and leads are so arranged that short connections may be used. As this is the case, the set may be wired with bus-bar with little loss in efficiency.

A tinned-copper wire is recommended. It should be about 1/16-inch square. All connections should first be shaped so that they will fit and then soldered in place. Start wiring the filament circuit as shown in the diagram in

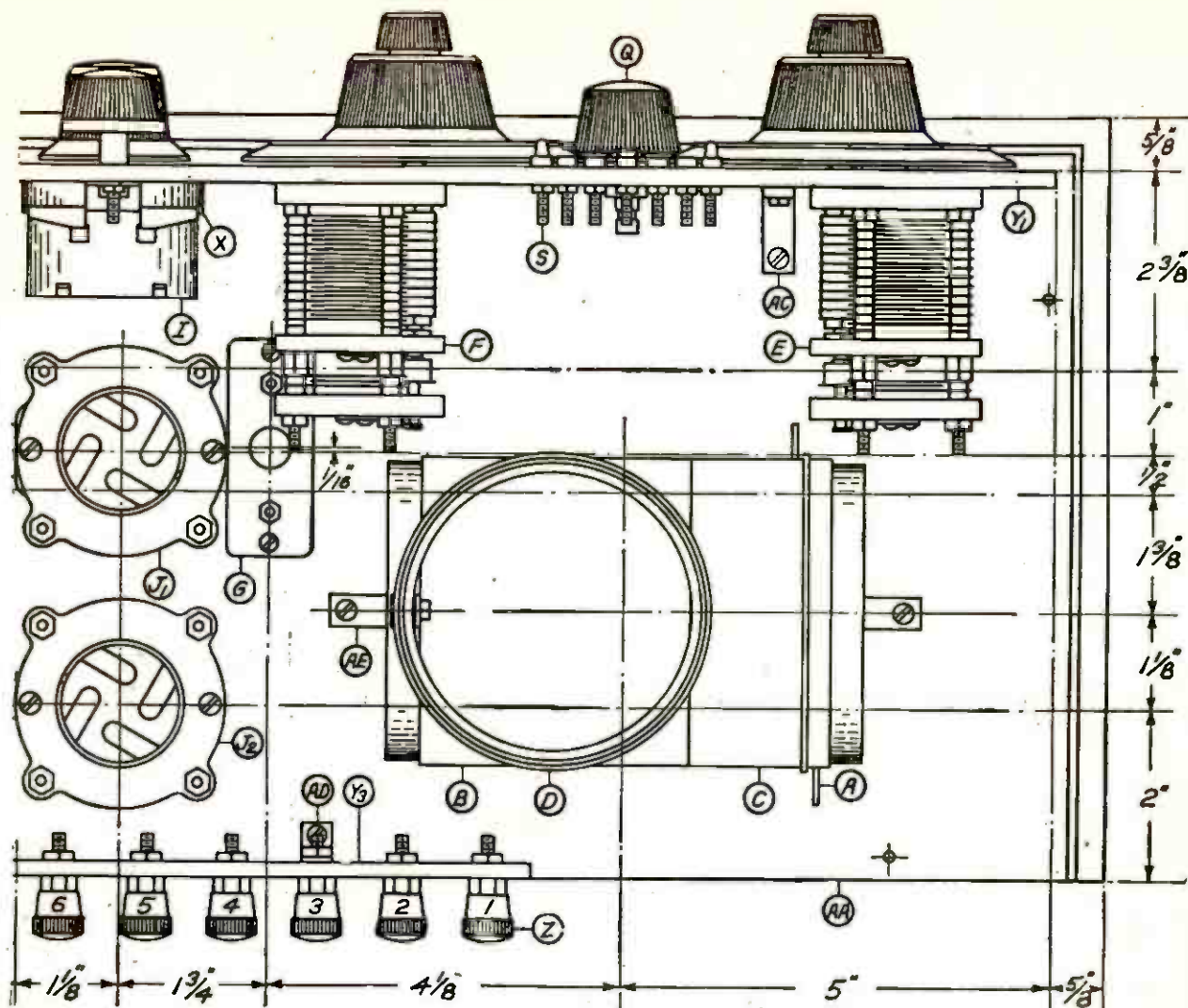


Figure 1. Be sure to include the rheostats in the correct side of the filament circuits. *This is important!*

In wiring up the potentiometer X be sure that the left-hand post of this instrument is connected to the negative "A" battery and the right-hand post is connected to the positive "A" battery.

Run a wire from the antenna post and loop it around coil C, one turn (forming winding A) spaced  $\frac{1}{4}$  inch in from the outer end of the winding as shown in Figure 4. Run the other end of this loop over to the top end of coil D and from there over to the first switch point on the panel Y1, then connect up the rest of the switch points to their respective taps on the coil D. The switch lever Q should now be connected to the ground binding post and the negative "A" battery post on the connection block Y2.

Now wire up the two condensers E and F as shown in Figure 1, with the rotor and stator plates connected as shown in the diagram. Then wire up the grid circuit of the detector tube which includes the condenser G and the grid-leak I.

Run a wire from the middle post on the potentiometer X to the detector negative "B" post on the connection block. This is the fifth post from the right (looking at the set from

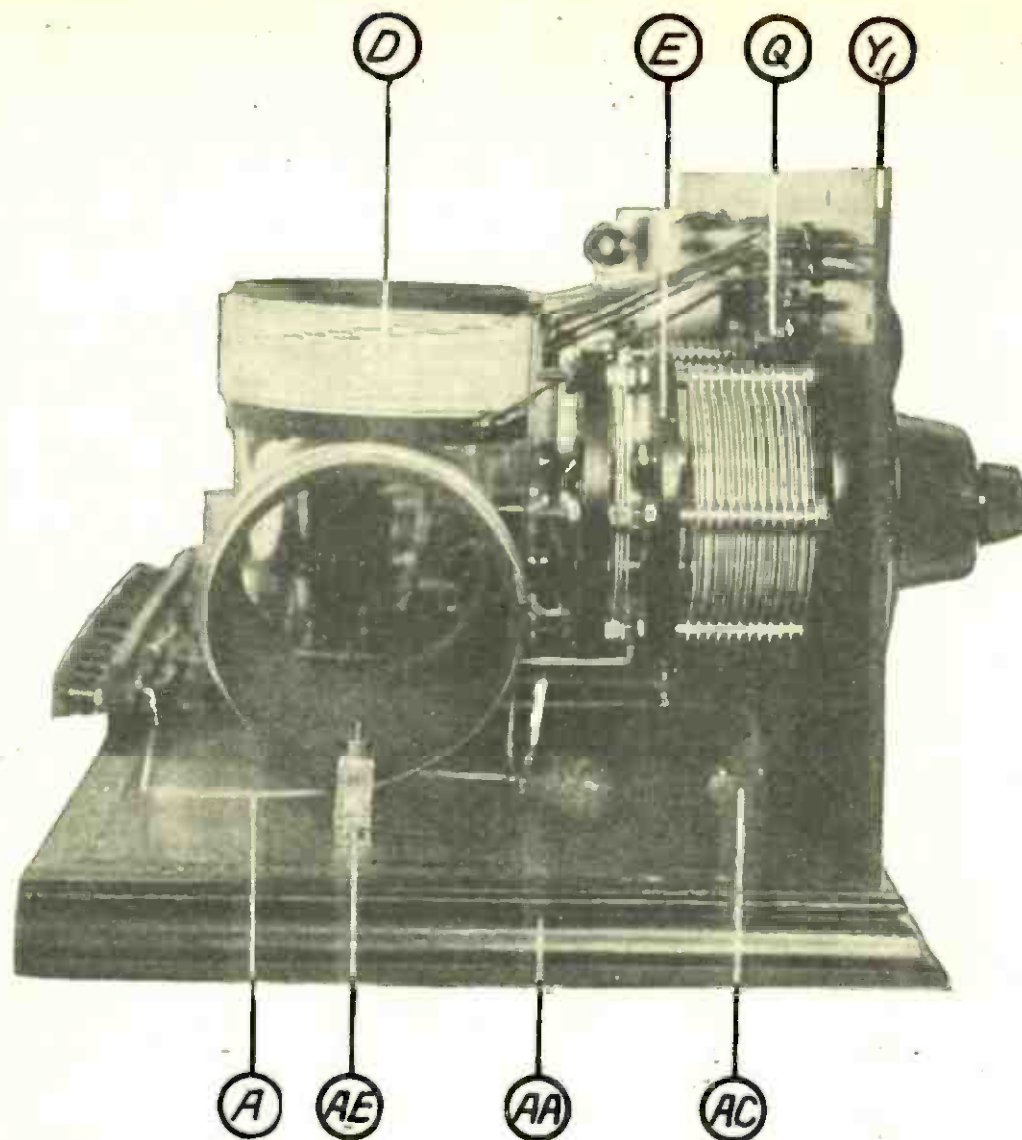
the rear). The sixth post should be connected with a wire over to the B+ terminal of the primary side of the first transformer N1 with the remaining terminal connected to the plate terminal of the first tube socket. Now connect the small variable condenser H, by two wires, across the primary of this same transformer N1.

Next connect up the secondary of transformer N1 to the correct terminals of the second tube socket.

Then wire up the plate circuit of the second tube which includes the primary of the second transformer N2 and the first jack M1. The seventh binding post on the connecting block is for the negative 90-volt amplifier "B" battery and the eighth post is for the positive 90-volt amplifier "B" battery, which is connected to the second-tube plate circuit.

Now connect up the secondary circuit of the second transformer N2 to the grid circuit of the third tube. The ninth binding post on the connecting block is for the negative "C" battery and the tenth binding post is for the positive "C" battery.

The resistances W1, W2 and W3 which are fastened to the small panel Y2 are now connected with bus-wire to the switch points S and switch lever R and also to the second terminals of the second transformer N2.



VIEW OF THE SET AS SEEN FROM THE LEFT

FIGURE 5: This photograph shows the way to mount the condensers and the coil set, and specifically the manner of attaching the single turn of bus bar for the coil A.

indicated in the wiring diagram and shown in Figures 1, 2, 4, and 6.

Now connect the plate circuit of the third tube which includes the second jack M2 and the proper connections on the input transformer O which are printed on the bottom of the transformer. The eleventh post is for the negative terminal of the extra 45-volt "B" battery used on the two last stages of amplification. This post should be connected by a wire to the eighth post. The twelfth post is the positive terminal of the extra forty-five volts of "B" battery. This should be connected to the plate circuit of the three last tubes as shown in the wiring diagram in Figure 1.

Now connect the remaining terminals of the input transformer O to the grid circuit of the last two tubes, including the "C" battery connection.

Connect up the plate circuit of the last two tubes which includes the primary connection to the output transformer P.

The last job in wiring is to connect the two secondary terminals of transformer P to the

two terminals of the last Jack—M3. This completes the wiring.

#### How to Install the Set

After the set has been completely wired, the cabinet may be attached by means of wood screws inserted up through the base into the bottom edges of the cabinet and by smaller wood screws (nickel plated) inserted through the panel into the edges of the cabinet.

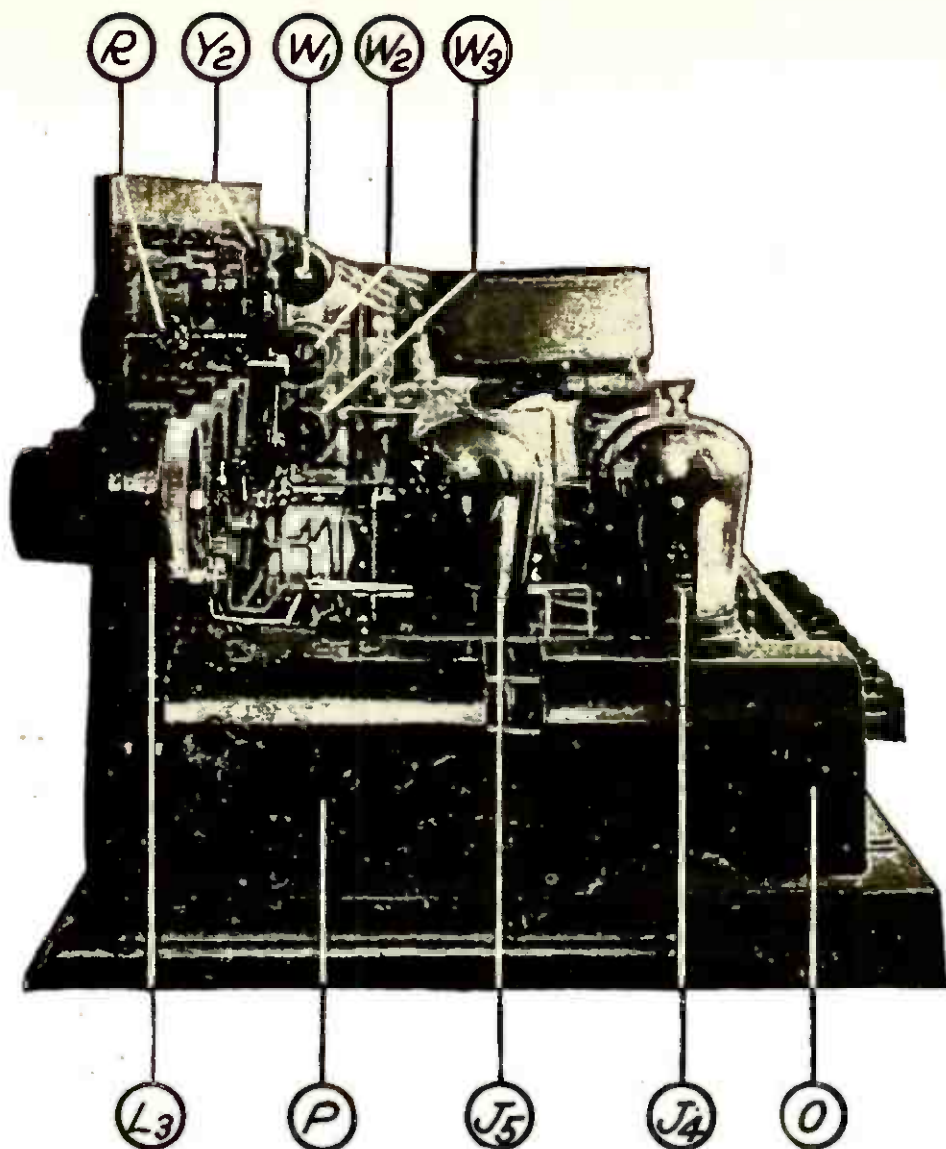
The binding posts Z on the connection block will now protrude through the slot cut for them in the back of the cabinet.

To connect the set, do the following:

Attach the antenna wire to the first binding post at the right (looking from the rear). Attach the ground wire to the second post from the right.

The third post from the right should be connected to the negative "A" battery, 6 volts. The fourth post from the right should be connected to the positive "A" battery, 6 volts. The fifth post from the right should be con-





VIEW OF THE SET AS SEEN FROM THE RIGHT

FIGURE 6: - This view gives a better idea of how to mount the two push-pull transformers and the rheostats and resistances.

nected to the detector negative "B" battery, 18 or 20 volts.

The sixth post from the right should be connected to the detector positive "B" battery, 18 or 20 volts.

The seventh post from the right should be connected to the amplifier negative "B" battery, 90 volts.

The eighth post from the right should be connected to the amplifier positive "B" battery, 90 volts.

The ninth post from the right should be connected to the negative "C" battery, 9 volts.

The tenth post from the right should be connected to the positive "C" battery, 9 volts.

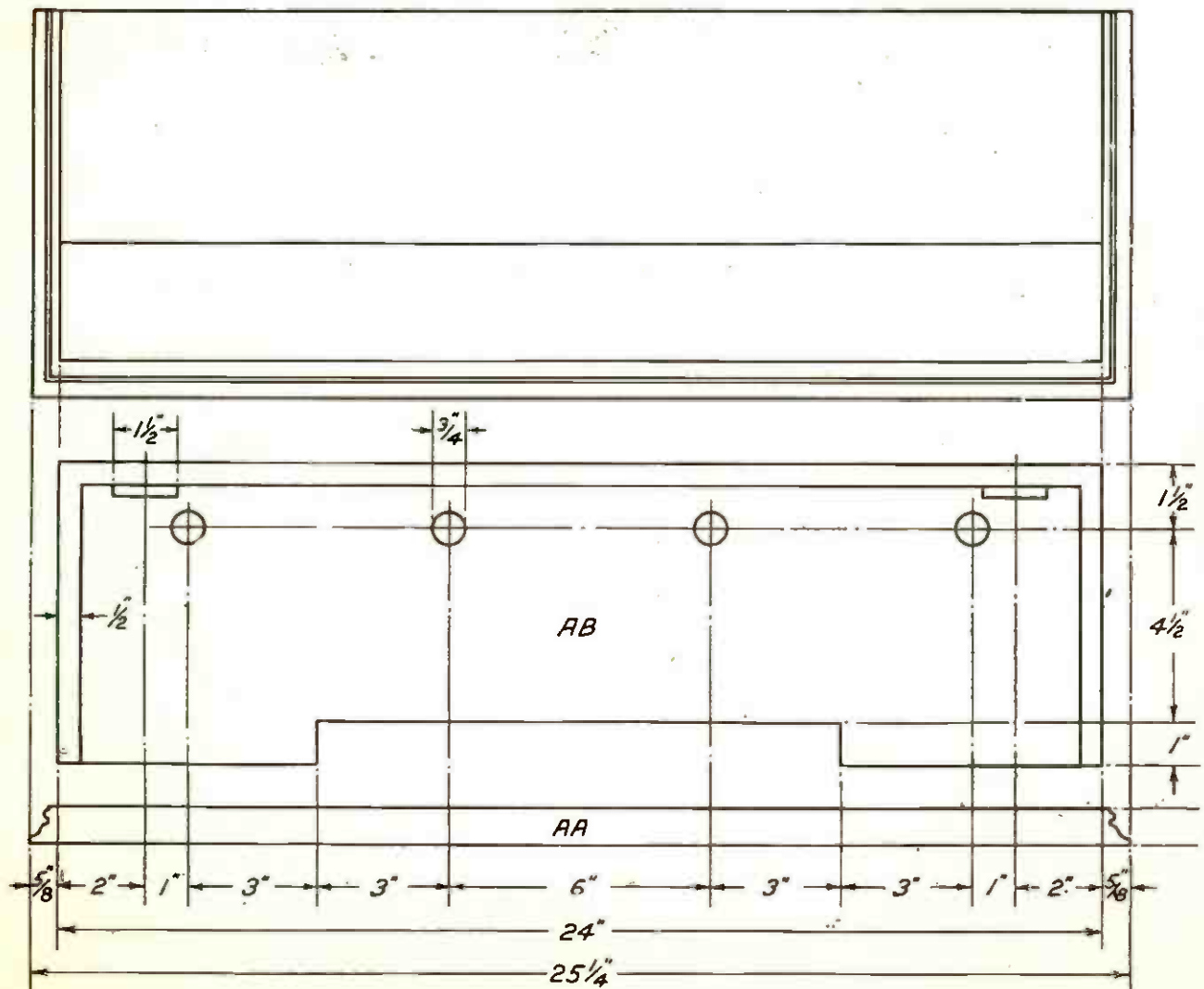
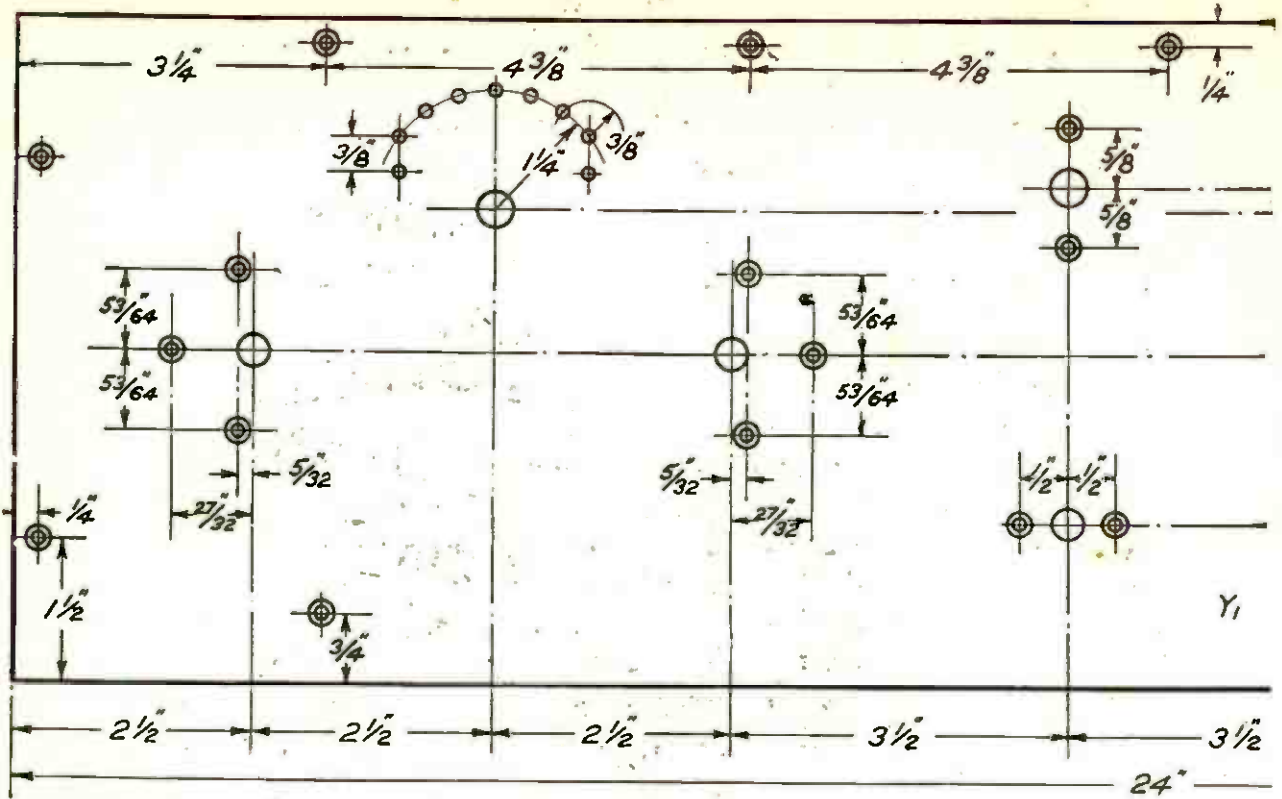
The eleventh post from the right should be connected to the extra amplifier negative "B" battery, 45 volts.

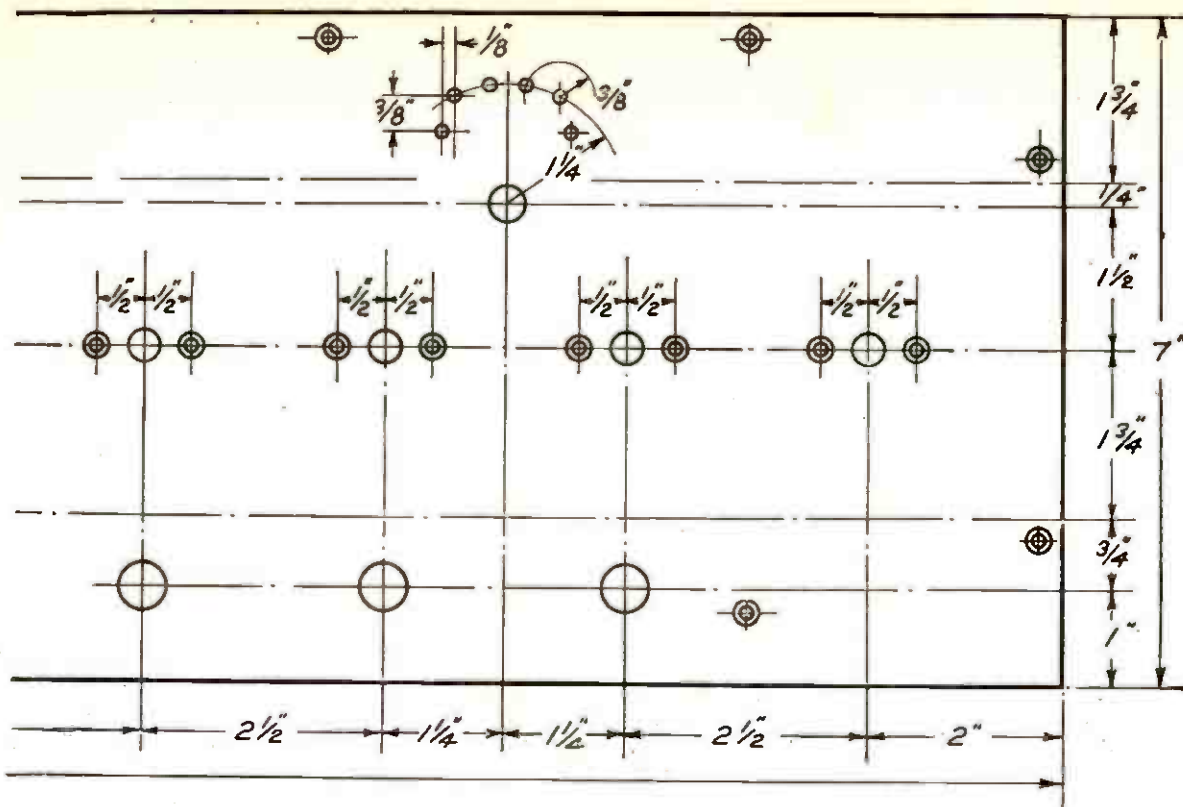
The left-hand post should be connected to the extra amplifier positive "B" battery, 45 volts.

For the detector, insert one UV-200 or one C-300 vacuum tube in the first socket J1.

Insert one UV-201-a or one C-301-a tube in each of the remaining sockets J2, J3, J4, and J5.

If the telephones are to be used, the plug should be inserted in the first jack M1, and the first two tubes lighted by turning the rheostat knobs K and L1. Turn rheostat K up about three-quarters of the way. Turn rheostat L1 up about the same distance. This will allow of reception from local and distant stations with the headphones. If the DX stations should be very far away and too weak on the first stage, take the plug out of the first jack and insert it into the second jack M2. Then turn up the rheostat L2 about three-quarters of the way, and the signals will now be amplified sufficiently to allow reception without trouble. If a loudspeaker is to be used, it may be plugged into this same second jack M2, which should give sufficient volume. However, if the DX signals are not quite loud enough in this jack, the loudspeaker plug should be withdrawn and inserted into the third jack M3 and the rheostat L3 turned up nearly all of the way. This will produce plenty of volume even on stations located on the other side of the continent.





**THE DRILLING PLAN FOR THE PANEL**

**FIGURE 7:** 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.

Be sure to use a loudspeaker which is capable of handling quite considerable amounts of power, otherwise it will chatter on account of the diaphragm or armature hitting the magnets.\*

Now to put the set into actual operation: First set the two grid-densers. These are two small semi-variable condensers in which the plates are pressed together or released by

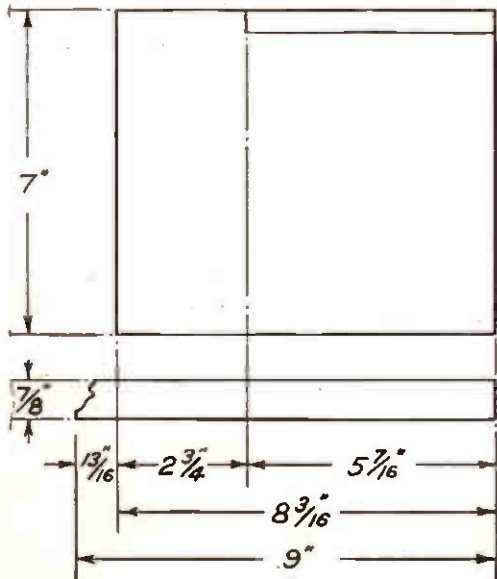
\* With the power amplifier in this set, and a 10-D Western Electric loudspeaker (with the transformer removed), signals can easily be heard from the author's laboratory window, over the valley to the next hill, which is about half a mile or so away.

a thumb-screw, increasing or decreasing the capacity. The condenser G should be set with the screw turned "all out" (counter-clockwise). The condenser H should be set the same way and generally it should be turned back about 1 1/2 complete turns (clockwise). However, this depends on how the set is wired and what the quality of the detector tube happens to be. If the set does not oscillate enough, turn it counter-clockwise until it does. If it oscillates too much, turn it clockwise. If screwed down too far it will broaden the tuning. The correct adjustment can be found when the set has been in operation a few days.

Now refer to the tuning chart given in Figure 10. This is something new in tuning. The curve in the diagram shows how to tune the receiver for the various wavelengths used in broadcasting.

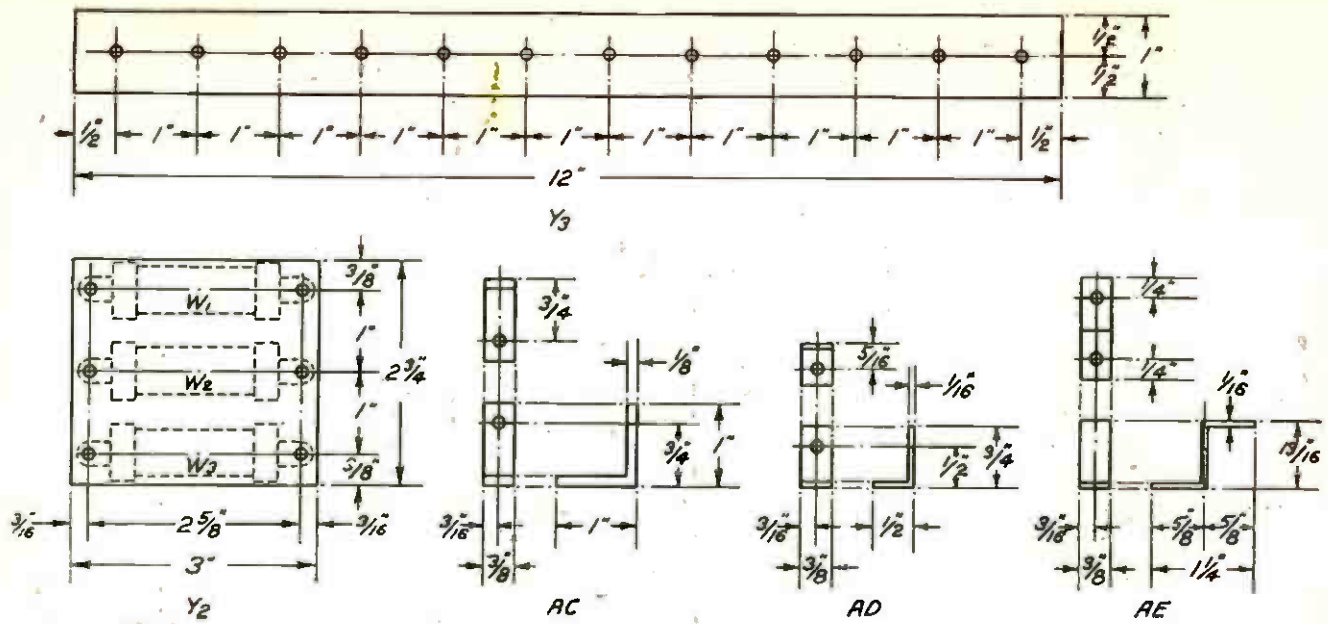
There are two scales on the chart, one, running up along the left side of the chart, is marked into degrees, 0 to 80, which corresponds to the two dial settings on the condensers E and F. The other, running across the lower side of the chart, is marked in wavelengths, 220 to 580 meters.

Pick out the wavelength of the local station



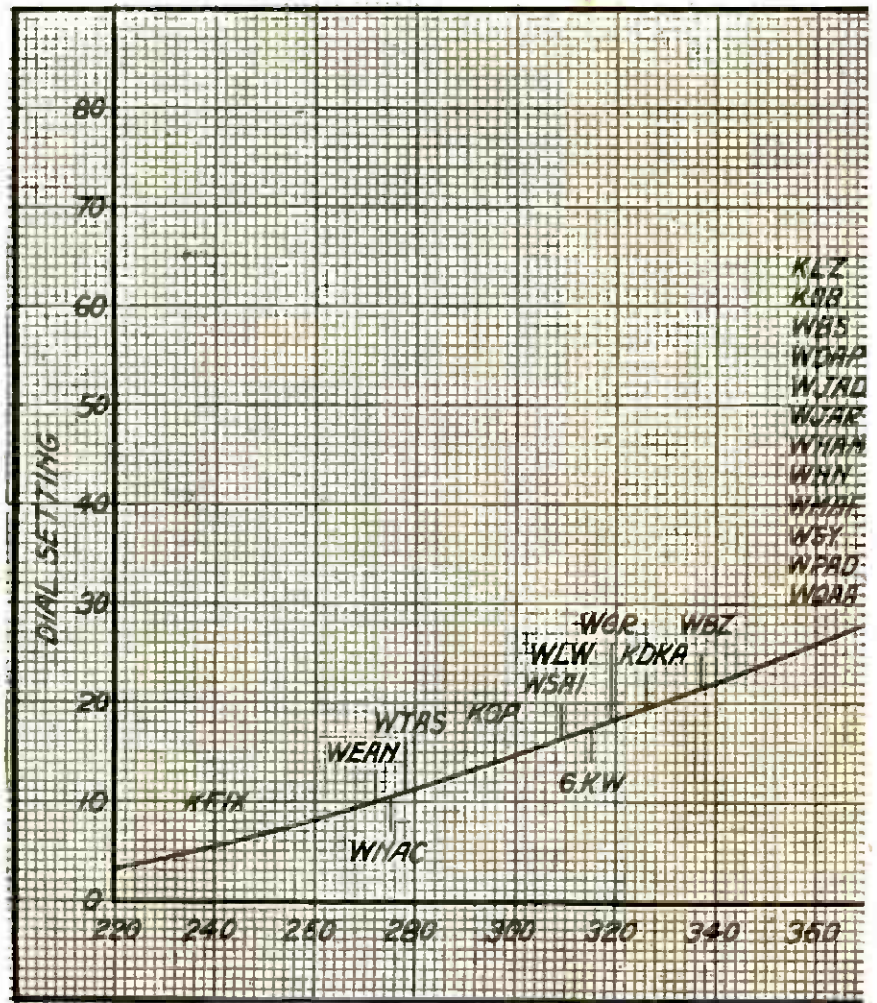
**THE DIMENSIONS FOR THE CABINET**

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



DETAILS OF THE SMALL PANELS AND BRACKETS

FIGURE 9: This drawing gives the necessary data for making the two small panels for the connecting block and the resistances, and for making the small brass brackets for mounting the main panel, the connecting block and the coil set.



THE AUTOMATIC TUNING CHART—

FIGURE 10: Paste this on the lid of the cabinet. It shows you how to tune the set for a given wavelength. Pick out the vertical line corresponding to the wavelength you want (on the lower scale) and follow it until it hits the curved line. At this point

on the chart and follow up the vertical line which runs through this point on the chart, until it crosses the curved black line. At this point, follow the horizontal line on the chart, which crosses the same spot, until it fetches up at the left side of the chart. This will give the proper dial settings for the two condensers E and F, for that particular wavelength.

First, in tuning in a station, see that the two small vernier knobs are set so that they read horizontally, then set the two large dials at the setting found on the chart for the given wavelength. *Immediately, the station desired should be heard* (provided it is transmitting at the time). Then swing the switch lever Q to the proper point for the antenna wavelength (loudest point). Now further increase the volume by adjusting the vernier of condenser F, and finish up with condenser E's vernier. In tuning in the first station received the proper settings for the grid-leak I should be made. This will be found to be with the knob rotated somewhere near all the way out (counter-clockwise). Then the proper setting of the detector rheostat K, and the potentiometer X should be made. The potentiometer should be set about half way. Rotating the potentiometer knob clockwise increases regeneration by vary-

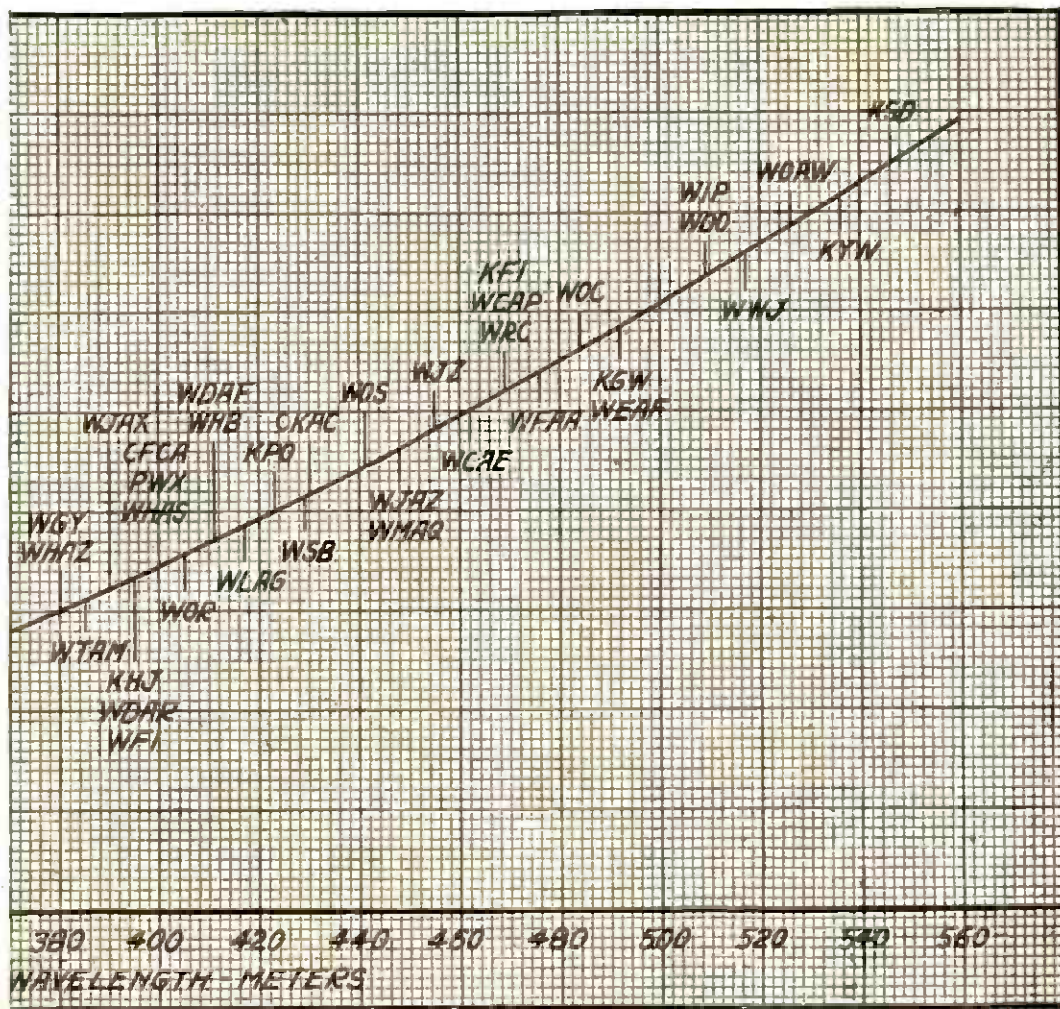
ing the resistance of the plate circuit and the "B" battery potential applied to the detector tube. Rotating this knob counter-clockwise decreases regeneration.

The switch R is used to control the volume output of the second and third stages of amplification; by placing the switch lever R on the first point (tap) the volume will be decreased and by swinging it to the right, point by point, the volume will be increased in steps. It is seldom necessary to use the last point to the right, even on DX.

The call letters on the chart include some of the larger broadcasting stations heard and logged by the author with this set, and probably do not include many stations that would be heard by listeners on the west coast. For these people, it would be a simple matter to write in, on the chart, some of their more familiar stations.

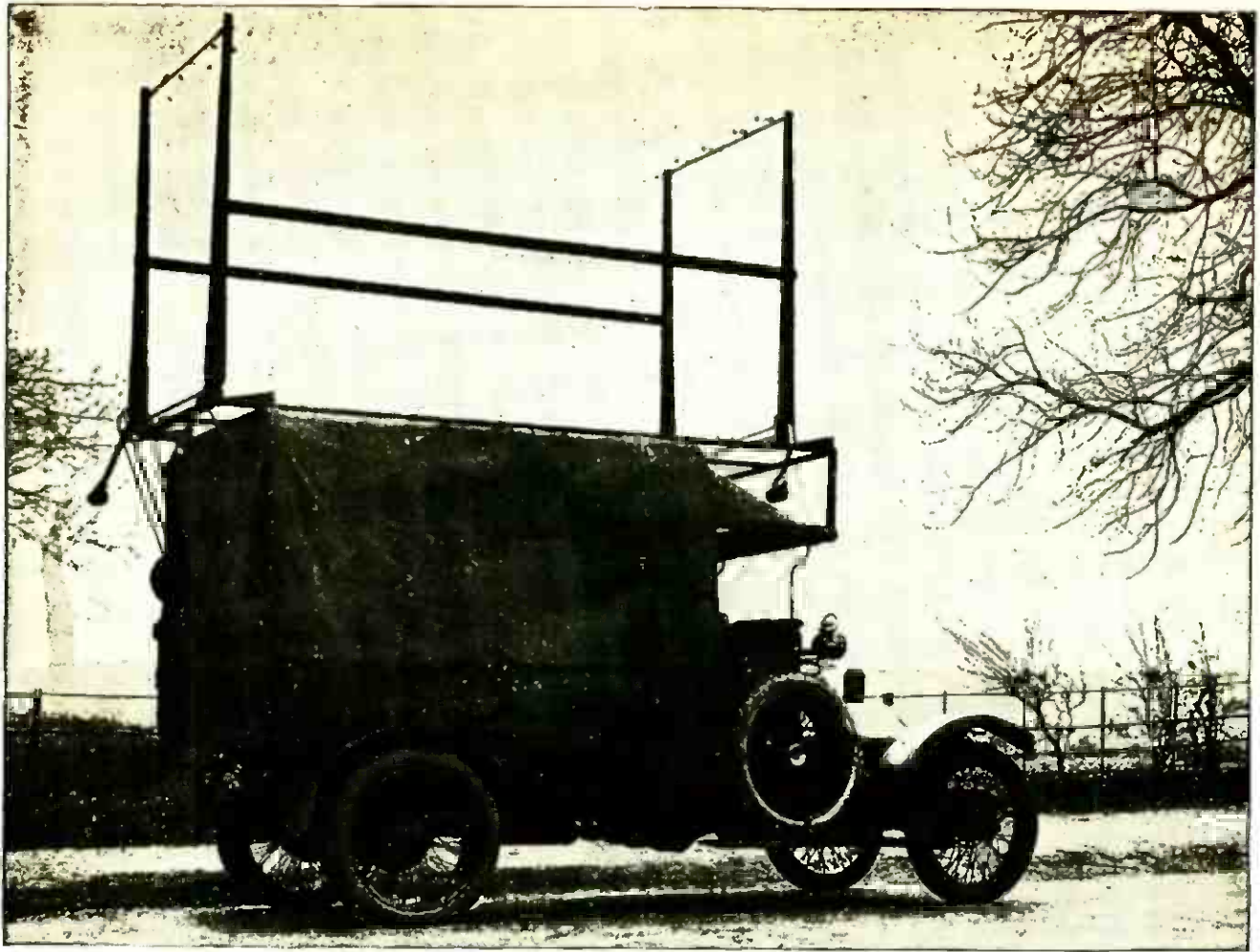
It is suggested that the builders of this set, cut out the chart in Figure 10 and paste it in the lid of the cabinet for ready reference. It works on all sets that use the condensers and coils specified; it works on any antenna, and it works for anybody who can read and set the dials.

The control is automatic.



—FOR PICKING UP BROADCASTING STATIONS

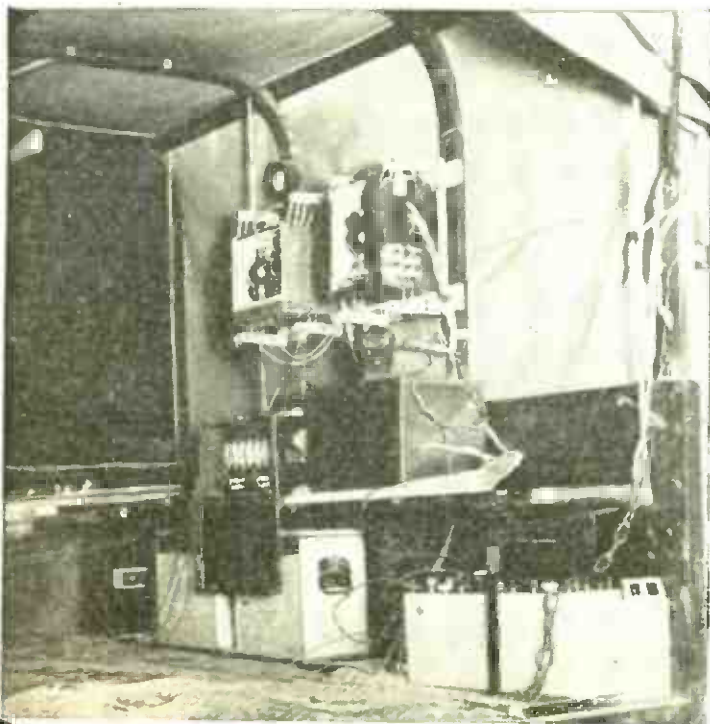
follow the horizontal line, intersecting the same point on the curve, and read the setting for both dials on the left-hand scale. Thus for station PWX the wave 400 meters and the correct dial setting for the condensers E and F is 34



Armstrong Perry

### A MOTORIZED RADIO STATION FOR POLICE WORK

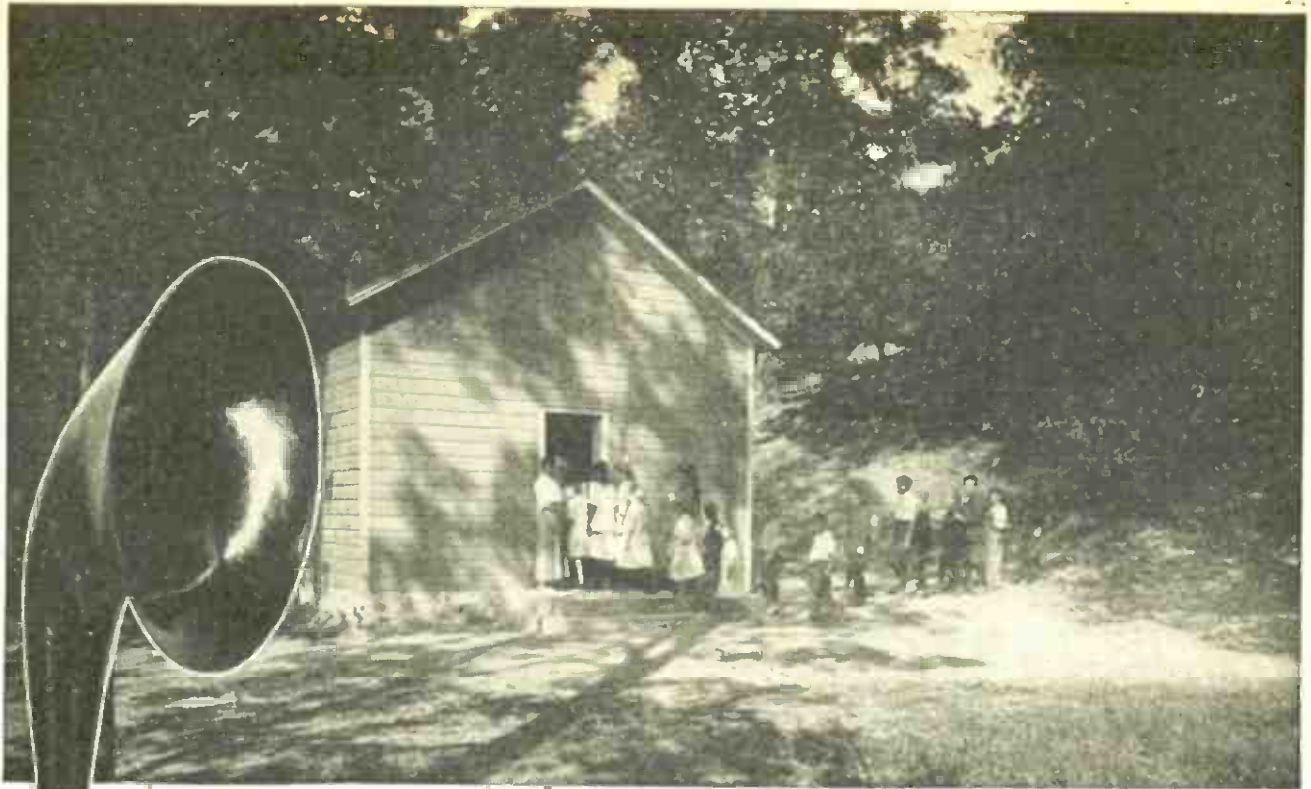
*This unique automobile, equipped with a powerful transmitting as well as receiving set and a collapsible antenna frame, has recently been put into service by the famous Scotland Yard officials in London. This portable radio station has been found of special value in directing crowds that assemble (for example) on such occasions as Derby Day, as it maintains a two-way communication with police headquarters.*



Armstrong Perry

### AN INTERIOR VIEW OF THE CAR

*The transmitting and receiving radio-  
phone apparatus is securely fastened to the side structure of the truck; it consists of two shockproof boxes, which hold the high-power, air-cooled transmitting tubes (shown here) and a small portable receiver that employs six tubes in a cabinet (at the left center); the cabinet containing the rest of the tuning apparatus for transmitting is seen at the right center and (below the shelf) is seen the high and low-tension batteries.*



Brown Bros.

#### A NEW TEACHER COMES TO TOWN

*The gradual extension of radio to our educational problems may literally "bring the world's greatest scientists and the world's greatest music" into the Little Red Schoolhouse sooner than the more conservative of our educators realize.*

## The University of the Ether

How will our educators, accustomed to plan courses of instruction in terms of the school or college only, solve the infinitely larger problem of reaching all the people of an entire state?

By PERCY MACKAYE

The author of this article is known throughout the world as a poet and dramatist of unusually vivid imaginative powers. His visualization of the future of radio in the field of education is so broad—(and so closely in accord with POPULAR RADIO'S own conception of it)—as to open up an entirely new conception of what "education" really is and of the methods of imparting it.—EDITOR.

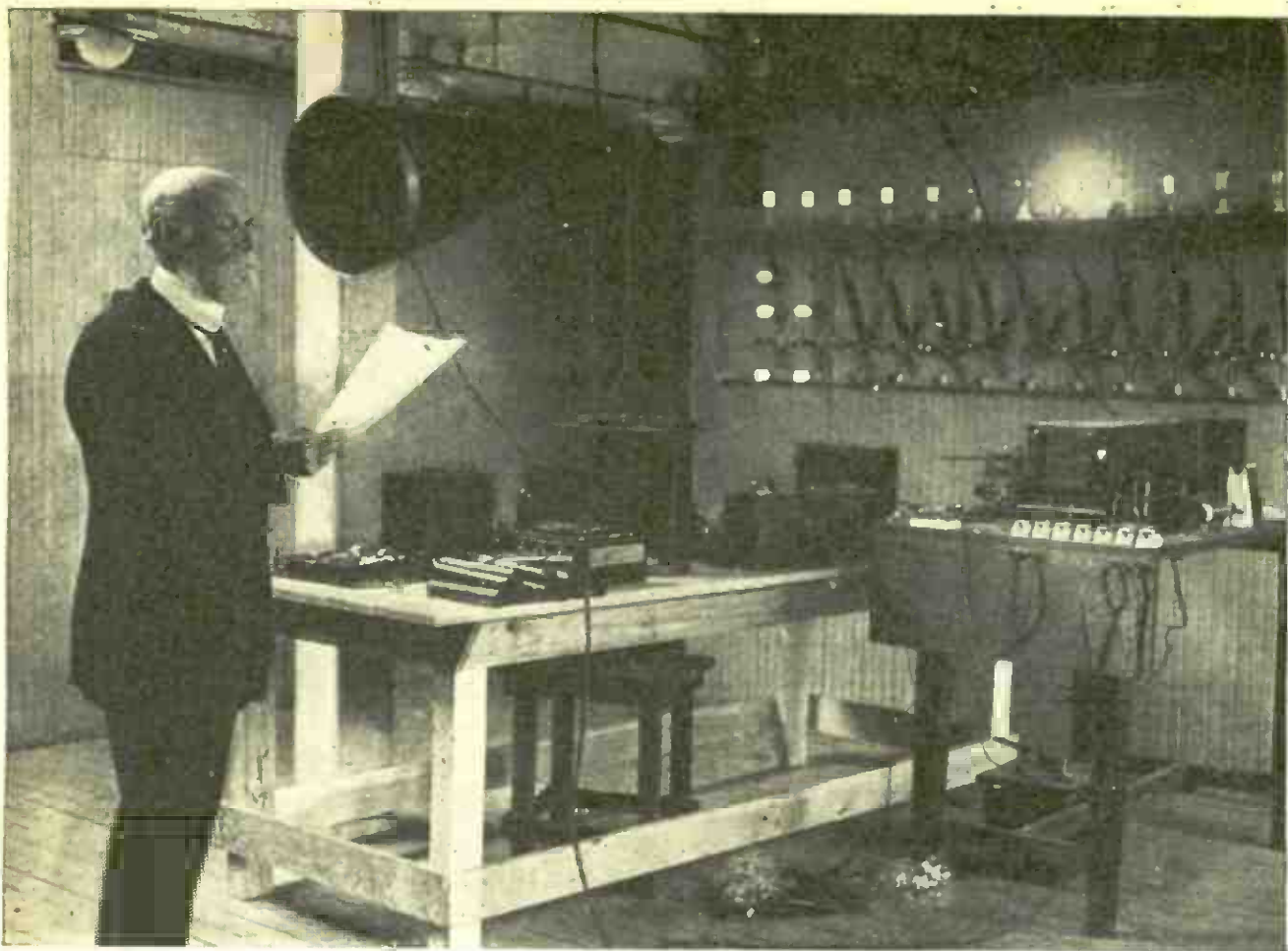
**T**HE discovery of the uses of the ether for human communication is as revolutionary as the discoveries of Copernicus, Columbus and Darwin.

Yet we are hardly half awake to its tremendous implications.

Radio, a godlike invention, calls upon man to be as godlike in his uses of it; yet he toys with it still, like a curious groping child, not yet realizing that he has found an instrument of Phœbus Apollo that may revolutionize civilization.

Radio indeed puts upon us a supreme test of imagination. Are we humanly capable of realizing the new universe that it opens upon us with such blinding suddenness?

Fresh, divinely potential for human



Underwood &amp; Underwood

### COLLEGE PROFESSORS WHOSE LECTURES GO INTO THE HOME

*While university authorities have been slow to realize the effect that radio is destined to have on educational methods, a few colleges have begun experimenting with extension courses that are designed not for mere undergraduate groups but for the residents of entire states.*

joy, communion and emancipation, is this quivering creature of the Apocalypse to be harnessed to the dreary, commercial humdrum of mediocrity which has subdued so many noble forerunners of invention to the paces of dullness and greed?

Are we to make of radio (or try to make of it) just another adjunct of the treadmill of organized education? Or will we make it the path to a regeneration of educational life—the gateway to a University of the Ether?

Hudson Maxim gives us a staggering sense of the fresh relationships and infinite magnitudes involved for us in the forces of the ether.\* Are such widening relationships and magnitudes to expand our own minds to larger conceptions of the nature of education

itself? Or are they to be ignored or minimized to fit the older notions of pedagogics which constitute our present entrenched and salaried system?

Fortunately for the breaking of precedents, those who are interested in radio are, from the start, an army of youthful-hearted enthusiasts, eagerly responsive to the growth of its human influences. "Faith and hope," says Coué, "are the creative forces." These enthusiasts already possess faith and hope in the powers of their new discovery—theirs by adoption, to make of it whatever they are capable of imagining.

Millions strong, they stand ready to be enlisted as charter members of a University of the Ether—provided that it meets their youthful forward-looking demands.

What are those demands?

\*See POPULAR RADIO for April, 1923





Radio Corporation of America

#### A PRACTICAL DEMONSTRATION OF RADIO IN THE CLASSROOM

*As evidence of the possible uses of radio in schools, the Haaren High School of New York has staged, in collaboration with the local station WJZ, a series of classroom problems. Such problems and lectures may be broadcast throughout all the schools of a large area.*

First of all, that the offerings of education (whatever forms of a new kind of *curricula* they may assume) shall be fascinating. Otherwise, by a mere twist of thumb and finger, pupils will dismiss their teachers to silence and the stellar spaces.

Does this conception of university discipline dismay the established conformist? Probably; and there are other conceptions more dismaying to educational precedent.

The University of the Ether will be devoid of all systems of outward discipline. It will need none, for it will be essentially a convocation of the disembodied. Each physically separate, each voluntarily self-disciplined, all of its millions of students will commune in the ether itself by virtue of the imagination of the educator.

Necessarily its doors must be open

to all ages, both sexes, and to all races—and necessarily no consequent social disharmony can result. For our new higher learning there is no racial problem involved; there is no age limitation to admission; there are no examinations; there are no compulsions of any sort whatever.

In brief, this new kind of university returns to that basic principle of self-teaching which pertains to all healthful childhood—the satisfying of curiosity, attained by voluntary self-discipline. What hardy endurances have been self-imposed by childhood in order to study an ant-hill or a bee-hive! How fascinating is the pursuit of all truth until it is diverted by substituting some symbol of blame or honor, failure or success, for the truth itself!

The University of the Ether deals with a new, myriad individualism:

by untold numbers it calls not the herd but the individual to self-culture. And it begins—as all valid education has always begun—with art.

Already radio subsists mainly through art—the art of music, the most elemental of the arts. The education of the ether must remain elemental if it is to enjoy its vast heritage of prophecy. Creative art, the enkindling element of all splendid civilization (almost totally ignored by our educational system) is necessarily the basic *sine qua non* of radio education.

It is, therefore, by no accident that radio stations have, from the first, sought their best publicity by broadcasting the works of the world's greatest composers, through performances of symphonies and operas. Closely related to these are the works of poets and dramatists, which also are coming into wide popular demand through the ether.

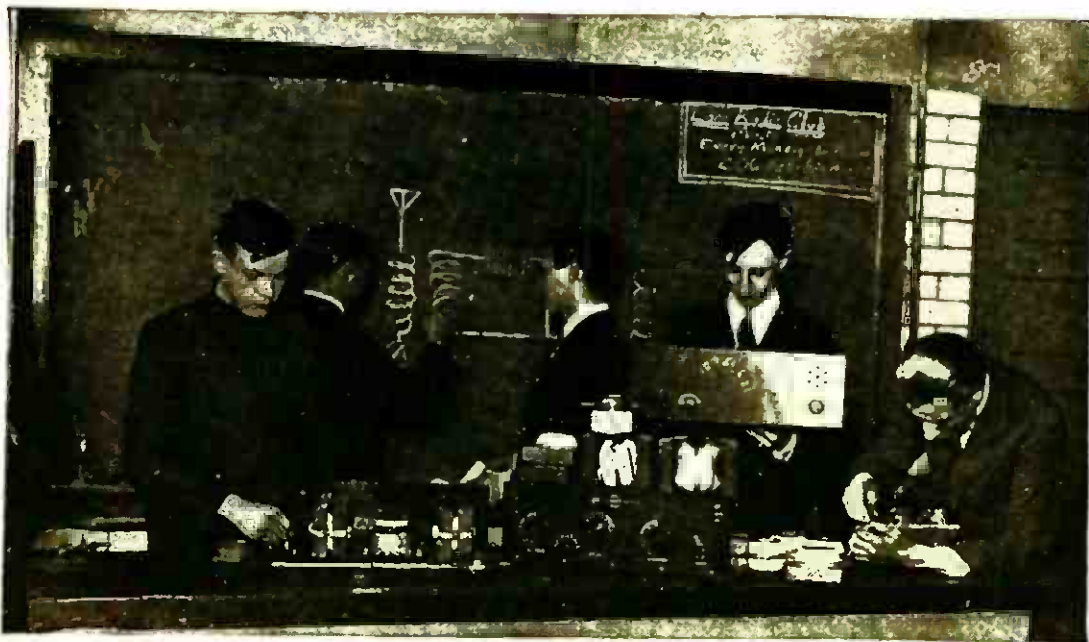
Obviously the creative genius of the world, scientific and artistic, should be focused upon this vast new problem of ethereal education through some non-commercial instrumentality dedicated to

the highest public service. Yet what is obvious is so seldom done that one wonders whether this shining opportunity of radio will be developed along obvious new paths unprecedented, or obstructed by blind alleys of conservatism.

The Government itself must soon recognize these new and mighty educational factors and problems. Will it place them under the static control of educational "experts," grown expert through years of experience with a system totally at variance with the ethereal principles involved? Or will it bring a fresh vision of creative art to seek a solution?

A University of the Ether! The still unfathomed powers of radio fling their challenge to the youth of the world for its noble foundation.

Some day there will rise in America some group of enthusiasts, having the requisite vision and necessary capital, who will create this education of a new order, and who will focus the creative imaginations of the world so that they may lead its millions in the fascinating pursuit of knowledge, beauty and delight.



Underwood & Underwood

#### SCHOOLBOYS ARE TAUGHT TO BUILD THEIR OWN SETS

*Not only does the educational value lie in the programs received by radio, but also in the manual training and technical instruction that is given in the design and construction of the apparatus. This picture shows a "radio class" in the Lane High School of Chicago.*

700,000,000,000,000,000,000,000

# Electrons for a Cent

The same electrons that run the vacuum tubes used in radio also fly about in even the most solid matter. They constitute nearly all that is known about electricity. This article will give you a picturesque conception of them that you can understand.

By E. E. FREE, Ph.D.

**I**N spite of all the talk nowadays about electrons, there are not many people who have any clear idea of just what an electron is. It is like the Ultimate Consumer or the Average American. We have been hearing about these individuals for years, but they don't mean anything to us. We wouldn't know either of them if we saw him.

No more would most of us know an electron. We have heard the scientists say that "electrons compose all kinds of matter," which means all substances, even the substance of the human body. We know, too, that electrons constitute electricity and that as such they light our lamps and run our street cars. We know that they work the vacuum tube, that without them there would be no radio. It is electrons that produce light. Food is electrons. Fire is electrons engaged among themselves in some rather spectacular separations and recombinations. Lightning is a crowd of electrons in a great hurry. Pretty much everything that goes on in the universe has these electrons, somehow, at the bottom of it.

But just what *is* an electron? How large is it? What would it look like if we could make it large enough (or ourselves small enough) so that we could see it? Where do the electrons stay when they are not at work? How much electricity is there in one of them? Are there a million electrons in the



© Leonard R. Crow

## TAKING A DOSE OF ELECTRONS

*Electricity enough to light a lamp can be passed through the human body safely—provided that high-frequency current is used.*

human body or a million millions or still more than this? How many electrons can you buy for a cent?

These questions are by no means unanswerable. The electron is just as definite a thing, really, as an apple or a locomotive. It is possible to form just as clear a mental picture of an electron as you have now of everyday things like these.

This article is an attempt to help you do it. If you are already on speaking terms with electrons, here is where you stop. But if you are not sure you would know one if you met it, read on.

Let us begin with the scientific



General Electric

### A VAST THOROUGHFARE FOR ELECTRONS

*When this lamp, the largest ever made, is lighted there pass through it every second 17,000,000,000,000,000,000 electrons. But vast as this number is it is still only about one-fortieth as many as are contained all the time inside a single copper penny.*

statement that electrons compose all kinds of matter. In front of me there lies an ordinary copper cent. It is composed, of course, of one kind of matter—copper. It contains, as the scientists say, atoms of copper. It is inside these copper atoms that we must look for the electrons.

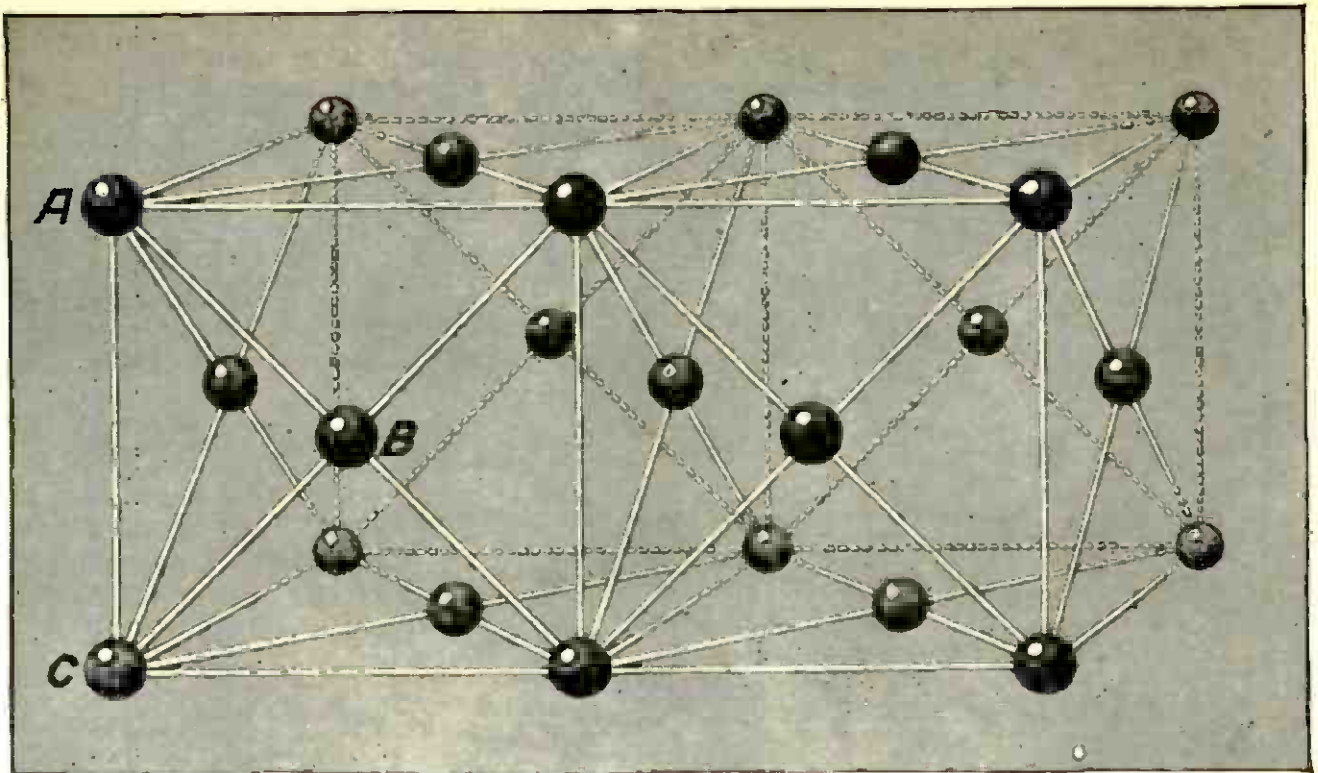
The human eye is far too coarse an instrument to see these atoms or electrons, or indeed to see inside the matter of the copper at all. But by using X rays and by various other scientific methods scientists have been able to "see" indirectly into the mass of copper, as well as into many other kinds of matter, and to explore the arrangement of the atoms and electrons.

To get an idea of what the scientists have found out, let us imagine that we possess that convenient ability of the magicians in the stories, and can make things larger or smaller just as we wish. Let us take this copper cent that I have in front of me and make it swell until it is a foot in diameter; then a mile, then a hundred miles, and so on until it is large enough to stretch all the way across the United States from New York to San Francisco. It would be, then, about 2,550 miles in diameter and the edges of it would tower 170 miles into the air, for we must imagine the cent to increase in thickness to the same degree that it increases in breadth.

If we stand now at the edge of this enlarged cent and look at it we will be able to see inside the mass of it. We would expect, of course, to see the atoms and electrons and to determine just how they are held together and arranged.

Here comes the surprise. If we really could enlarge a cent in this way, and if you and I stood side by side at the towering edge of it and peered into its interior, what we actually would see would be absolutely nothing!

By being stretched out so that it reached from New York to San Fran-



#### HOW THE ATOMS ARE PLACED IN METALLIC COPPER

*The round balls are the atomic nuclei. If a copper penny is enlarged to cover the earth's orbit, as described in this article, these nuclei would be eleven inches in diameter. The distance from A to B would be two and a half miles, and the distance from A to C three and a half miles.*

cisco the copper in a cent piece would become entirely invisible.

But if instead of using our unaided eyes we got a microscope and focussed it on the inside of our enlarged penny, just as a bacteriologist focusses his microscope on the tiny germs in a drop of water, we would see what we are looking for. Every two inches or so all through the space occupied by what had been the copper we would see a little floating speck, smaller even than a grain of dust. These specks would be relatively stationary, as though they were little balls strung on invisible wires, or like the grapes in a fruit jelly; a great deal of jelly, of course, and very few grapes.

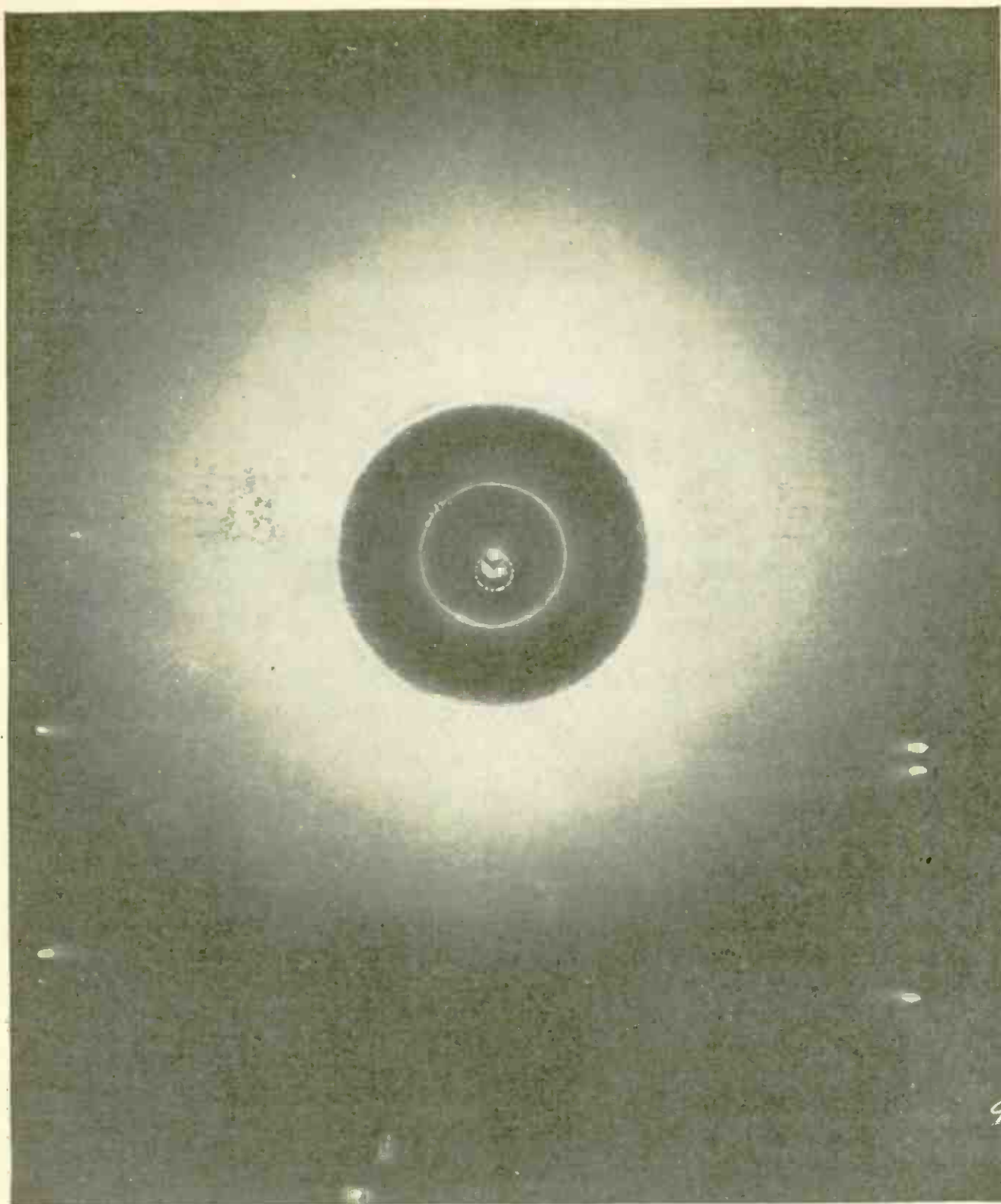
These specks are the central masses of the copper atoms, what scientists call the *atomic nuclei*. The electrons, which are still smaller, we would not be able to see at all.

In order to see them we must use our magical powers again and enlarge the cent some more. Suppose we let it

swell now until it is larger than the whole earth, larger than the sun, as large, finally, as the earth's orbit. It would be, then, a great copper disk 189,000,000 miles in diameter. The sun would be at its center and the earth would be rolling, once each year, around its edge. What would the atoms and electrons inside it look like now?

The little specks that we could just see before with the help of a microscope, the nuclei of the copper atoms, would show up now as roundish things about eleven inches in diameter, like old-fashioned cannon balls or small-sized goldfish globes. And now for the first time we would see the electrons too.

These would be roundish balls, also, each about three inches in diameter, but they would not be quite spherical. Instead they are flattened a little on two sides, like a ball of soft rubber when you squeeze it between the palms of your hands. In our enlarged, earth's-orbit-sized cent the electrons would be



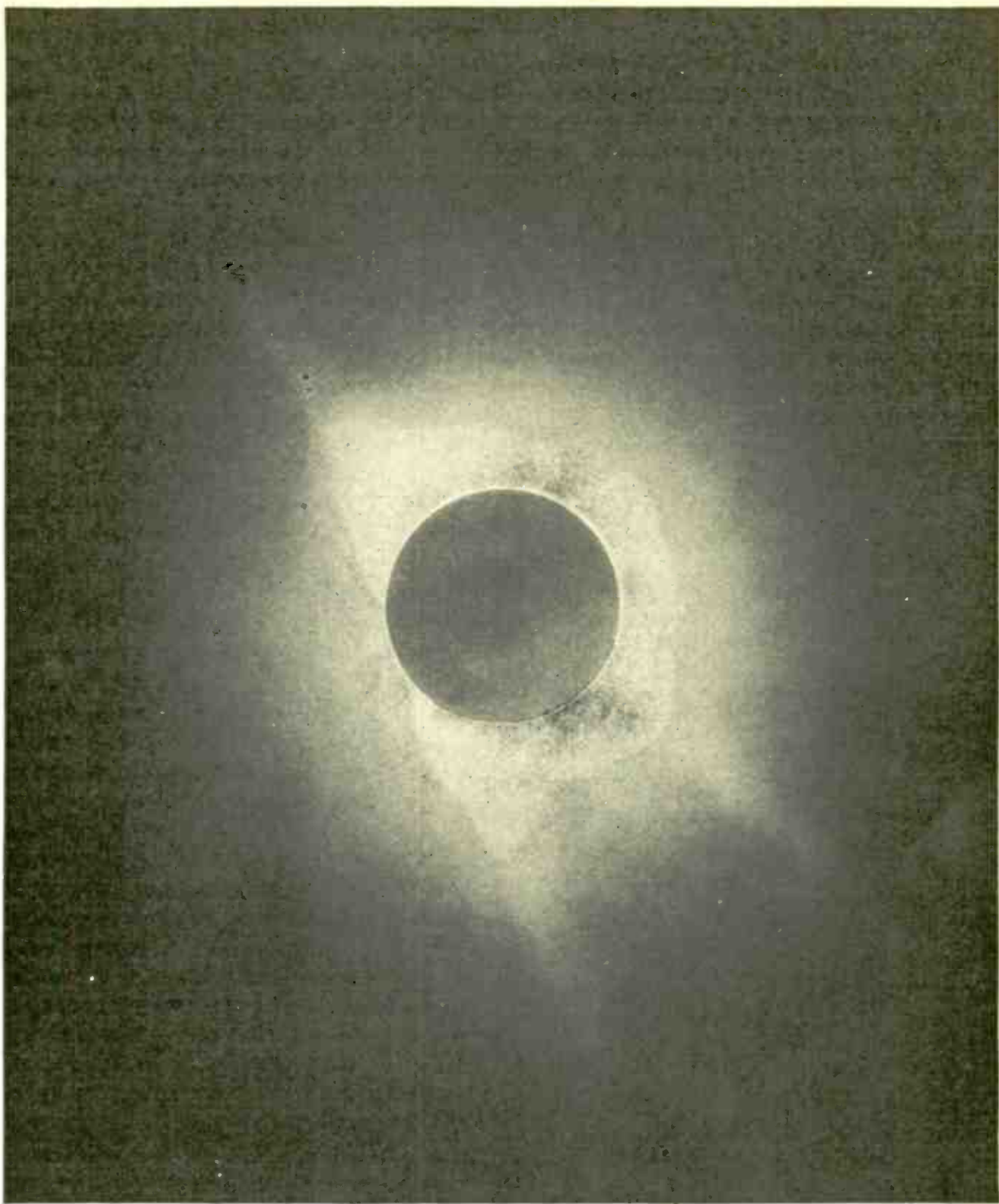
General Electric

#### ELECTRONS ESCAPING FROM A CHARGED WHEEL

*This photograph shows a three-foot pinwheel charged to a potential of 900,000 volts. There are so many electrons on it that they crowd each other off the edge, thus making the glow that appears all around the wheel.*

about the size and shape of a fairly large turnip. There would be 29 of them for each copper atom, corresponding, that is, to each one of the eleven-inch globes.

These electrons would not be still. Far from it. They would be flying about at tremendous speeds, each one in an orbit around its particular atomic nucleus much as the planets and comets



Courtesy Lick Observatory

#### ARE THERE ELECTRONS IN THE SUN'S CORONA?

*This is the glow around the sun as it becomes visible during a total eclipse. Compare it with the electron glow on the opposite page. It is possible that the solar corona is composed in part of electrons escaping from the sun.*

fly through space in their orbits around the sun.

I say that this is what we would see, but really we would need telescopic eyes in order to see all of it at once. For

in this vastly enlarged cent piece the eleven-inch globes, each of them the nucleus of a copper atom, would be over *two and a half miles apart*. If you and I (keeping, of course, our

ordinary size) were to step inside this enlarged model of a copper cent we would seem to ourselves to be in almost empty space. Close at hand we might see, perhaps, one of the globular eleven-inch nuclei. Off in the distance, two and a half miles away in each of eight directions, would be more of these eleven-inch globes. Still others would lie farther away, one after another all the way to the other side of the earth's orbit. But even the nearest ones would be quite invisible without a telescope.

In the space around us the electrons would be moving; some of them far

too rapidly to be visible at all, others slowly enough, perhaps, so that we could catch a momentary glimpse of them as they whizzed by. In the two and a half mile space surrounding us in all directions, between us, that is, and the eight nearest other nuclei, there would be about 150 electrons; 29 of them revolving around the nucleus near which we are standing, the others belonging to the other nuclei off in the distance.

This is not very many electrons for so much space. About 150 little balls the size of turnips do not go far toward filling up some sixty cubic miles of emptiness. They are about as little crowded, these electrons in matter, as three very small mosquitoes would be inside the dome of the Capitol at Washington.

This is one of the most astonishing things about matter, this great emptiness of it. A copper cent seems solid to us merely because of the grossness of our senses. Really it is the openest kind of a sieve. Just as you can see with a microscope the holes between the threads of what seems to be a close-woven cloth, so if you had a microscope powerful enough you could see the holes in matter. You would see, in fact, that matter is nearly all holes. Only about two one-hundred-trillionths of the space inside a piece of copper is occupied by anything solid, by the electrons and nuclei. All the rest of the space, so far as we know, is absolutely empty.

But we are talking about electrons. Let us get back to them.

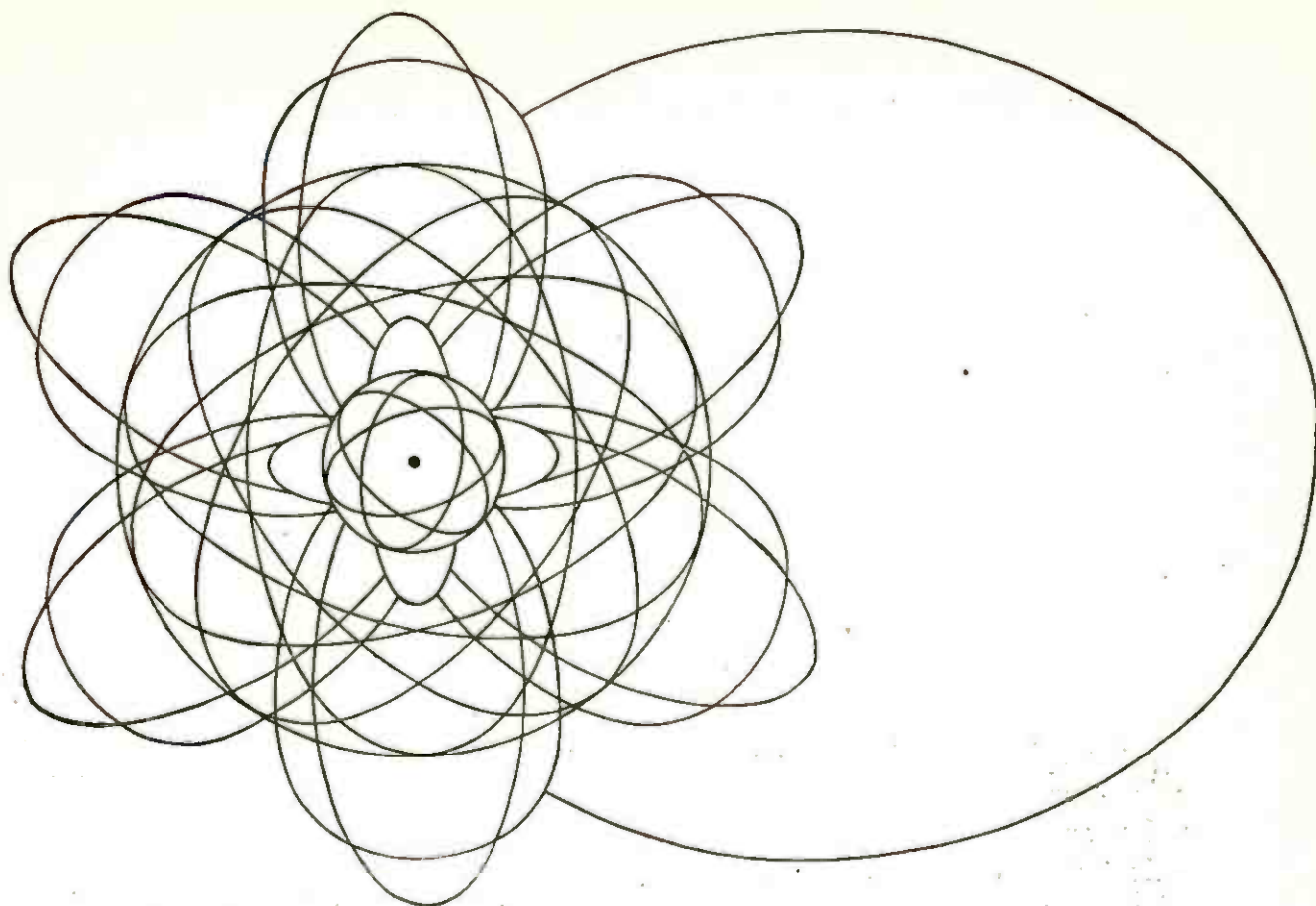
The movable electrons, the ones that fly about like planets in their orbits around the nucleus, are not the only electrons in the atom. There are some others inside the nucleus itself. The eleven-inch globe of our enlarged cent is made up in part of the three-inch turnip-shaped electrons. In the copper atom there are believed to be 15 of these internal electrons in each nucleus.



General Electric

**A VALUABLE USE FOR ELECTRONS**  
*In this X-ray tube it is a rapid stream of electrons impinging against the upper electrode that produces the X rays.*





#### THE ELECTRON ORBITS IN A COPPER ATOM

*These lines show a few of the orbits followed by the 29 electrons that revolve around the nucleus of a copper atom, as worked out by Prof. Nils Bohr of the University of Copenhagen, one of the world's greatest authorities on the structure of atoms.*

They stay inside it and are a permanent part of it.

There are, then, in each copper atom a total of 44 electrons; 15 of them in the atomic nucleus and the other 29 flying about in the planetary orbits outside it. In the whole of a copper cent there are about 700,000,000,000,000,000,000,000 electrons, which is a figure so vast that it doesn't mean anything to anybody.

But think of it this way. Suppose you had to count out one by one all these electrons that are in a cent. And suppose you got all the people in the United States to help you. And then suppose that every man, woman and child took a handful of electrons out of the cent and began to count them. And suppose that everybody kept on counting them at the rate of five a second (which is a lot faster than I can count anything), night and day, without stop-

ping for food or sleep. How long do you think it would take to get the job done?

Even with 120,000,000 people to help you it would take almost exactly *thirty-six million years*.

That is the number of electrons you can get, not only *for* a cent, but *in* a cent!

In larger things like a silver dollar, or a beefsteak or your own body, the number of electrons is correspondingly great. There are in the average man, for example, about 20,000 times as many electrons as there are in a copper cent. You can figure for yourself how long it would take to count them. In the ancient mythology the symbol of an impossible task was to carry a sieve. A much more impossible task would be to count the electrons in yourself.

The next question the

tackle is just what this excessively tiny and still more excessively numerous electron really is.

The answer is that it is electricity. It is a little, flattened, turnip-shaped ball of electricity. An electric current in a wire is merely a lot of these electrons, loose ones this time, rolling along in among the attached, planetary electrons of the metal. Or "flying along" is a better simile, for the loose electrons of an electric current fly about, really, in a good deal the same way as the attached electrons do, except that they are not held fast to individual atoms and do not move in regular orbits.

To take an illustration from astronomy, these loose electrons are like the strange comets that occasionally visit our solar system and then go off about their own business into space, never to be seen again by us. The attached electrons, on the other hand, are like the soberer, stay-at-home planets of our solar system, the earth and Mars and the rest.

An electric lamp gives light because of these wandering electrons. The filament in the lamp is really a very fine metal wire. It is made up, just as our copper cent is, of a lot of atomic nuclei which are relatively quite far apart and of some electrons that move

in orbits around them. Suppose, now, that you pass an electric current through this filament. This means that you drive in a lot of loose electrons at one end of the filament and that they hurry through it to get out at the other end and back again into the electric supply wires.

As they go they stir things up quite a lot. They jostle the atomic nuclei in the filament and the stay-at-home electrons that belong to them. The nuclei and electrons resent this. They get hot, not figuratively but literally. That is why the filament shines. The electrons passing through it have heated it. If you fire a lot of bullets very rapidly into a board from a machine gun the board will get warm. So does the filament wire when you fire a lot of electrons through it.

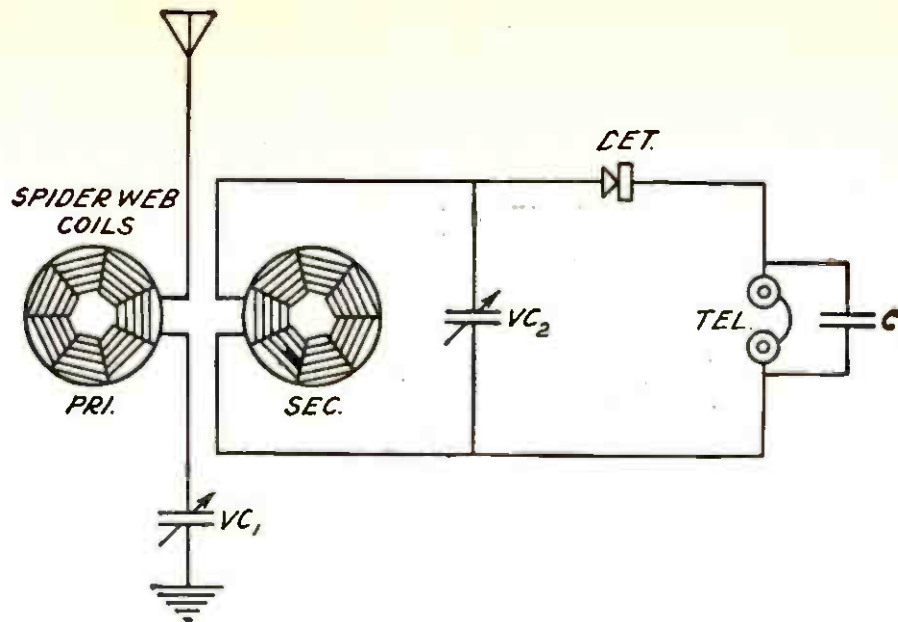
Like all figures that concern electrons, the number of them in an electric current is stupendous. Through the filament of the ordinary 60-watt electric lamp there pass each second about 3,500,000,000,000,000,000 of them. This is only about one two-hundred-thousandth as many as are held all the time inside a copper cent, but it is quite a lot just the same. It would take some time to count them even if you had help.

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### Keep Off the Ether During European Tests

*THE tests of transatlantic amateur communication will be held on the evenings of December 22 to January 10, inclusive. American amateurs are requested by the Amateur Radio Relay League not to transmit, but to confine their efforts to attempts to pick up the messages of their European colleagues. It asks that all American transmitters remain silent between 8.00 P.M. and 1.00 A.M., Eastern Standard Time, on the evenings mentioned; otherwise local interference may prevent the success of the tests. For Central, Mountain or Pacific Time, subtract one, two or three hours respectively from the times given. The tests will be on 180 to 220 meters. Broadcast listeners who can read code should be able to hear some of the messages.*

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### DOUBLE-CIRCUIT SPIDERWEB CRYSTAL CIRCUIT

*Cost of parts:* Not more than \$17.00.

*Selectivity:* Very good.

*Operation:* Fairly simple. The two circuits are tuned by means of variable condensers and the coupling between the circuits is easily adjusted by swinging the two spider-

web coils nearer together or farther apart.

*Ease of construction:* Not complicated.

*Approximate range:* 15 miles.

*Outstanding feature:* The tuning with this type of tuner is as sharp as it is possible to get with a crystal set.

# 100 BEST HOOK-UPS

## INSTALLMENT NO. 3

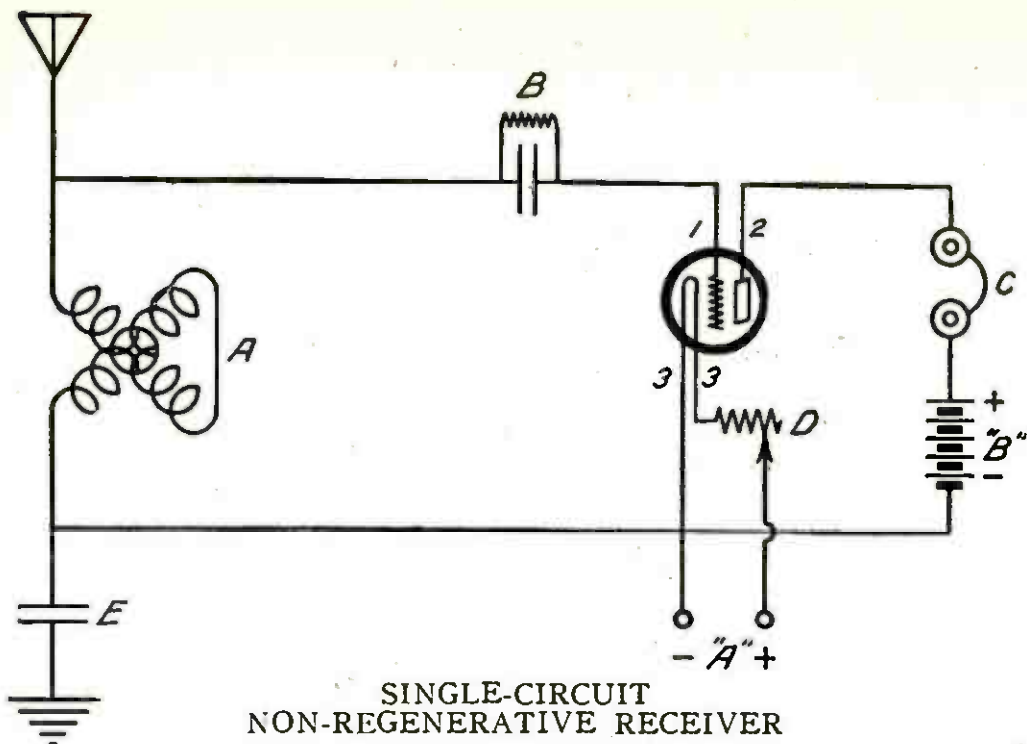
THIS feature of the magazine is designed to help the radio novice in the selection of the set best suited to his needs and to his purse. The ranges given are *averages* only; they will vary from 50 to 500 percent. The previous hook-ups of this series include:

### IN NOVEMBER, 1923

	Range		15 miles;	cost
The Conductively Coupled Crystal Circuit.....	"		\$10.00	
The Inductively Tuned Crystal Circuit.....	"	15 miles;	\$15.00	
The Combination Tuned-plate, Ultra-audion Circuit.....	"	500 miles;	\$25.00	
The Man-Day Single-control Regenerative Circuit.....	"	500 miles;	\$12.00	
Tuned Radio-frequency and Regenerative-detector Circuit.....	"	500 miles;	\$28.00	
The Squire Reflex Circuit.....	"	500 miles;	\$50.00	
The Reinartz Circuit, with Two Stages of Audio Amplification.....	"	1,500 miles;	\$35.00	
Triple-coil Honeycomb Regenerative Circuit with Two Stages of Amplification.....	"	1,000 miles;	\$35.00	
The Grimes Reflex Circuit.....	"	500 miles;	\$40.00	

### IN DECEMBER, 1923

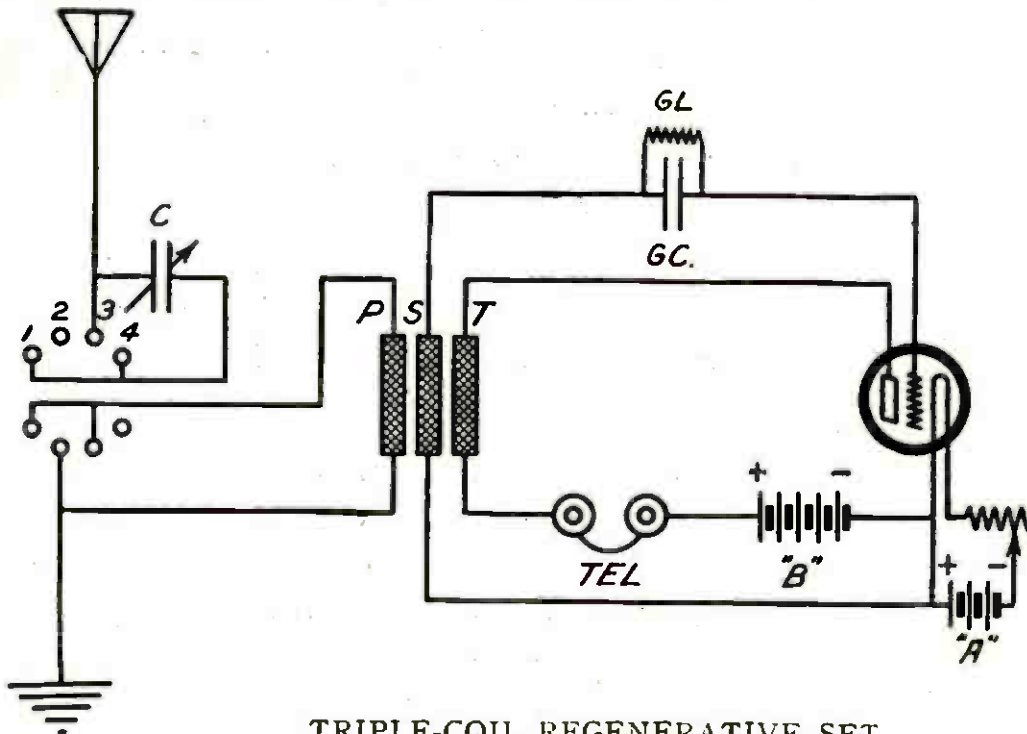
The Capacity-tuned Crystal Circuit.....	"	15 miles;	\$12.00
Special Ultra-audion Circuit.....	"	500 miles;	\$12.00
Single-tube and Crystal Reflex Circuit.....	"	1,000 miles;	\$28.00
The Twin-variometer, Variocoupler Circuit.....	"	500 miles;	\$30.00
The Triple-coil Honeycomb Regenerative Receiver with One Stage of Audio-frequency Amplification.....	"	800 miles;	\$30.00
Two-tube Super-regenerative Circuit.....	"	1,000 miles;	\$45.00
Modified DX Three-circuit Regenerative Receiver with Two Stages of Audio-frequency Amplification.....	"	1,500 miles;	\$35.00
Transformer-coupled Radio-frequency Circuit with Vacuum-tube Detector.....	"	1,000 miles;	\$35.00
Modified Acmedyne Circuit with Two Stages of Compensated Radio-frequency Amplification and Two Stages of Audio-frequency Amplification.....	"	2,500 miles;	\$60.00



SINGLE-CIRCUIT  
NON-REGENERATIVE RECEIVER

*Cost of parts:* Not more than \$12.00 (Note: The costs of tubes and batteries are considered "extras" and are not included in the costs given in these descriptions).  
*Selectivity:* Not especially selective.  
*Operation:* Most simple. The variometer is the only control for tuning. The rheostat

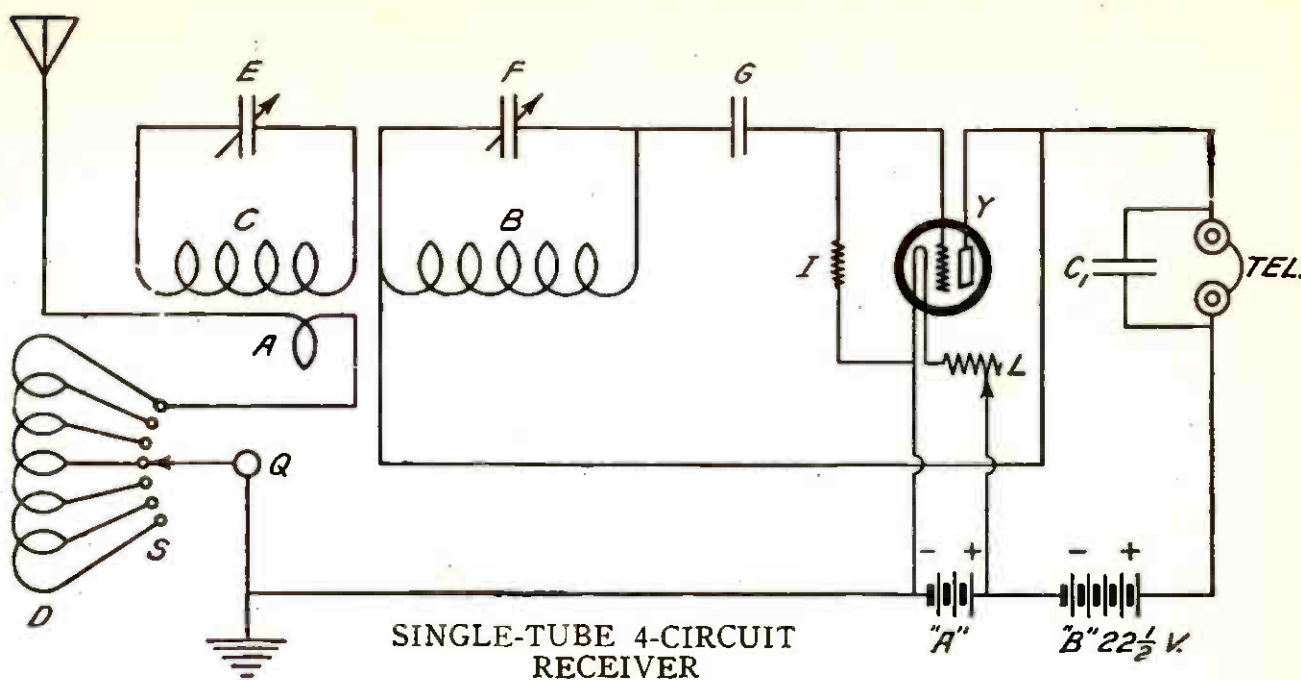
is set once for the correct filament brilliancy.  
*Ease of construction:* Most easy to make.  
*Approximate range:* 100 miles.  
*Outstanding features:* The simplest vacuum-tube set to build and one that will give utmost clarity of reception (though not very strong signals). It cannot re-radiate.



TRIPLE-COIL REGENERATIVE SET

*Cost of parts:* Not more than \$22.00.  
*Selectivity:* Good.  
*Operation:* Fairly simple. For more selective work, a variable condenser should be connected across the secondary coil. As shown above, the circuit is operated with coil P and coil S closely coupled together.  
*Ease of construction:* The building of such a set is a little more difficult than the single-circuit regenerative receiver but the better

results in tuning will be worth the extra trouble.  
*Approximate range:* 500 miles.  
*Outstanding features:* The set will tune more sharply than the single-circuit type and can be used for reception on all wavelengths by merely changing the coils; large ones are used for the higher waves and small ones for the lower wavelengths.



SINGLE-TUBE 4-CIRCUIT RECEIVER

*Cost of parts:* Not more than \$24.00.

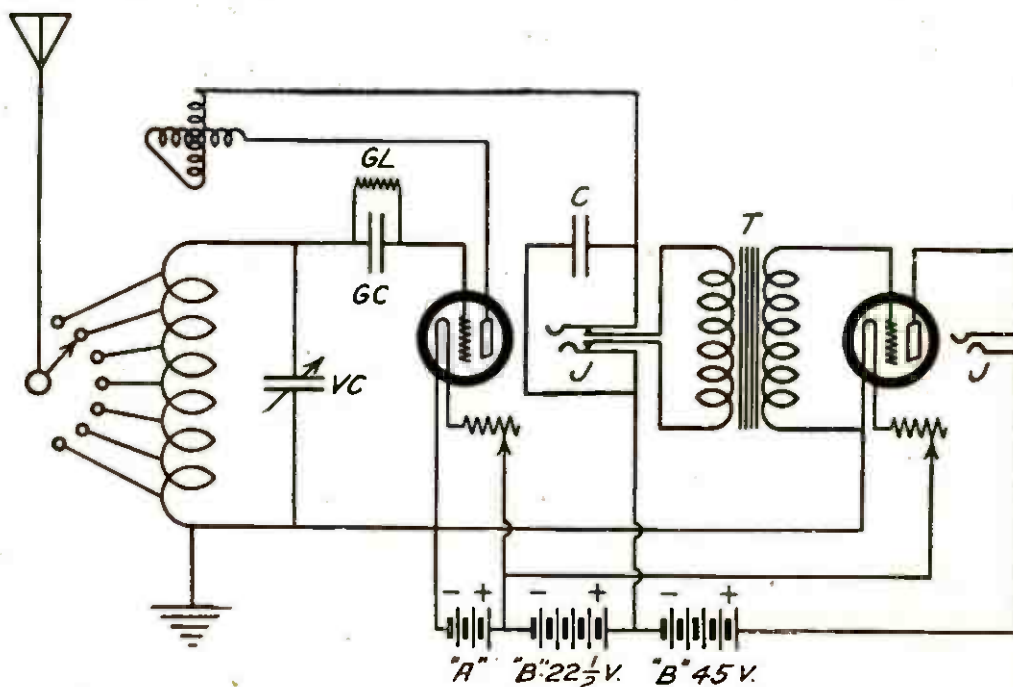
*Selectivity:* Excellent.

*Operation:* Simple. The condenser C1 should be of the correct value to put the set into stable condition and then the condenser E is adjusted so that the circuit is just on the highly regenerative point. All tuning is then accomplished with the condenser F and the antenna switch Q.

*Ease of construction:* Not complicated. Be sure that the best parts are obtained and the results will exceed expectations. Poor parts render the circuit useless.

*Approximate range:* 1,000 miles.

*Outstanding features:* The regeneration is independent of wavelength. The selectivity and sensitivity of this type of receiver are noteworthy.



THE CONDUCTIVELY-COUPLED, TUNED-PLATE REGENERATIVE CIRCUIT WITH ONE STAGE OF AUDIO-FREQUENCY AMPLIFICATION.

*Cost of parts:* Not more than \$30.00

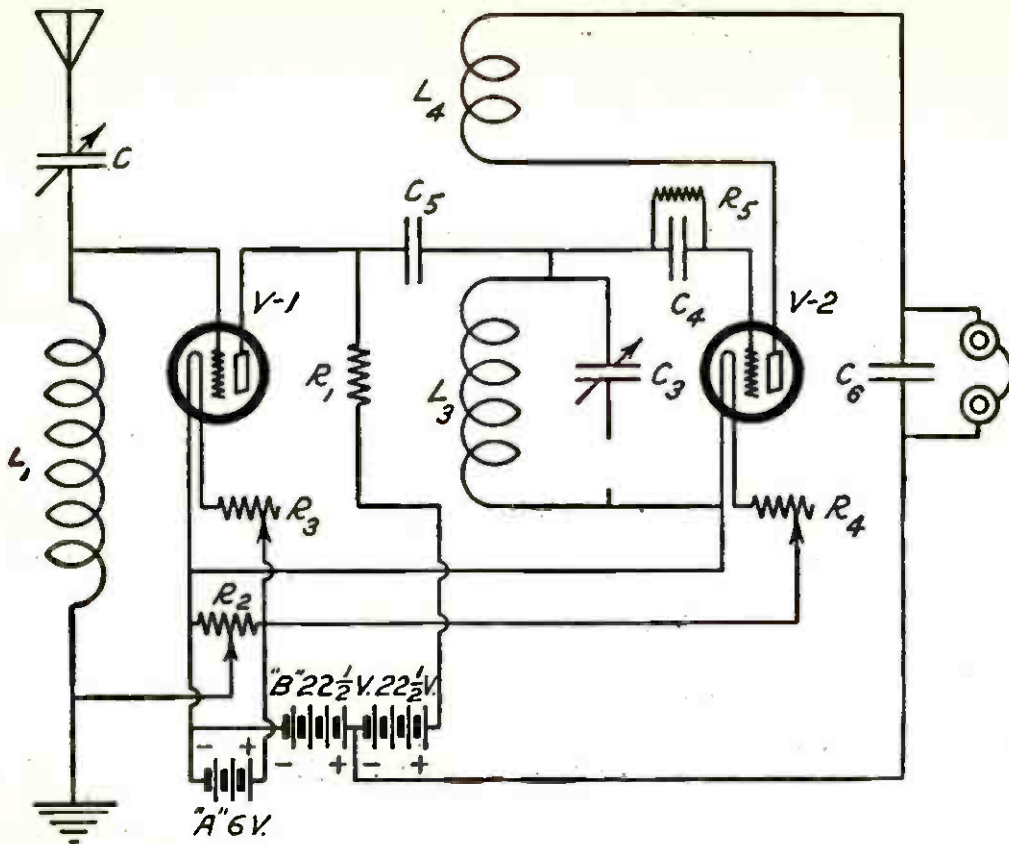
*Selectivity:* Fair.

*Operation:* Not very complicated. The antenna is tuned by means of a tapped switch, the secondary by means of a variable condenser and the regeneration is controlled by the variometer.

*Ease of construction:* Just an ordinary acquaintance with tools and some ability in wiring up the circuit is necessary.

*Approximate range:* 800 to 1,000 miles.

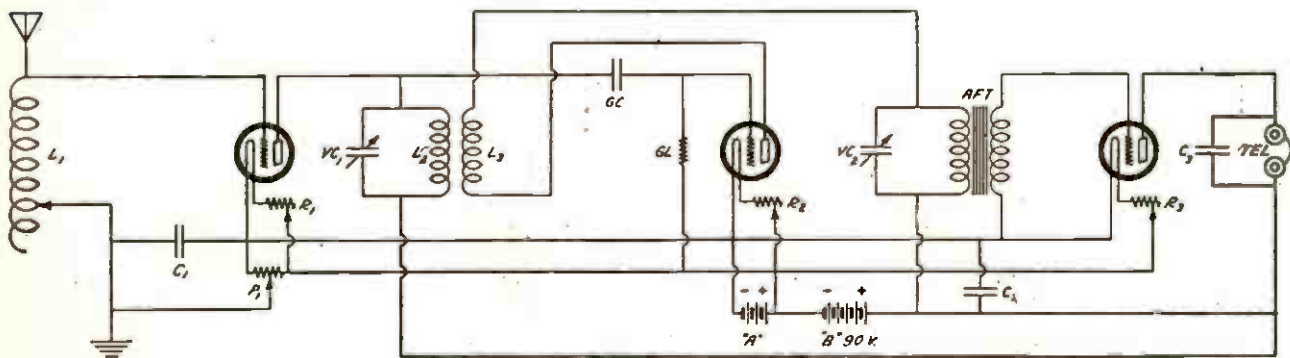
*Outstanding features:* Easy to operate and will bring in distance with good volume a pair of telephones. Good for am CW reception.



ONE STAGE OF RESISTANCE-COUPLED, RADIO-FREQUENCY AMPLIFICATION ADDED TO THE SINGLE-CIRCUIT REGENERATIVE RECEIVER

*Cost of parts:* Not more than \$30.00  
*Selectivity:* Good.  
*Operation:* Not too complicated. The antenna is tuned with a variable condenser. The grid circuit of the first tube is stabilized by means of a potentiometer to prevent oscillation. The grid circuit of the second tube is tuned by a second variable condenser, and regeneration in the detector circuit is con-

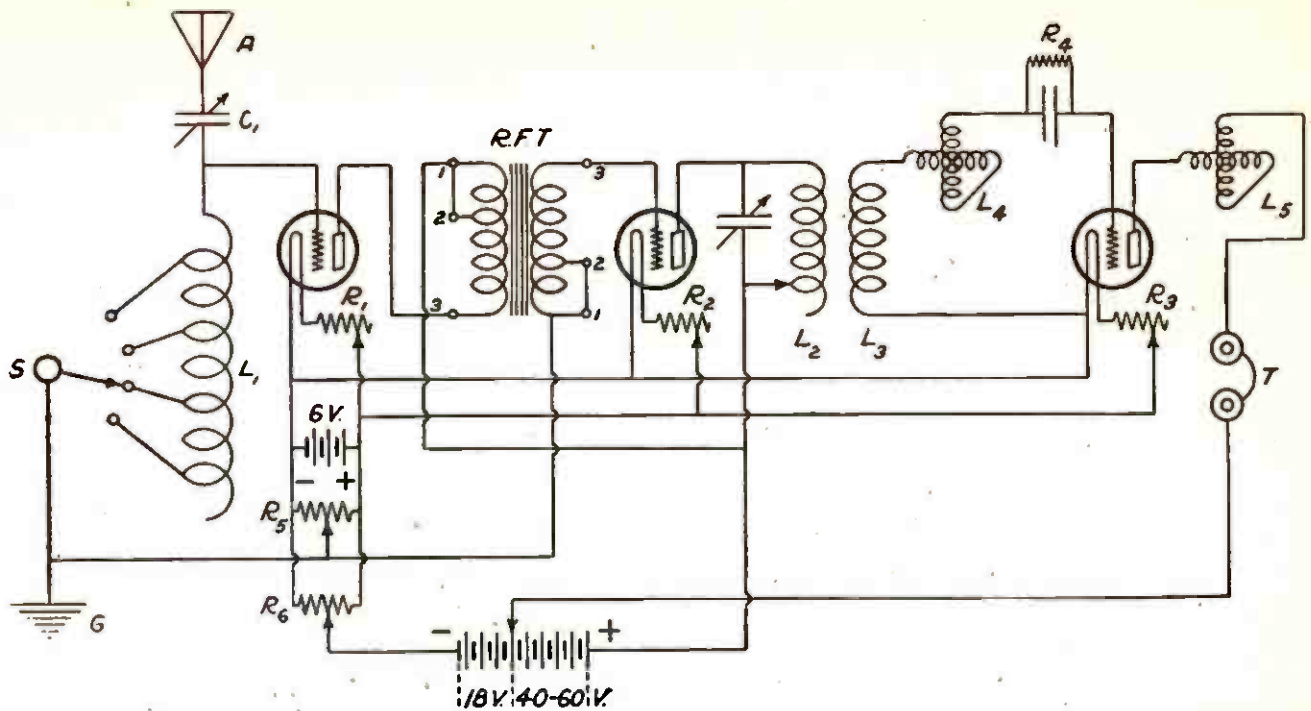
trolled by the feed-back honeycomb coil L4.  
*Ease of construction:* Fairly complicated.  
*Approximate range:* 800 to 1,000 miles.  
*Outstanding feature:* The use of this type of radio-frequency amplification added before the detector tube in the single-circuit regenerator prevents this circuit from re-radiating; at the same time it increases its sensitivity and selectivity.



ENGLISH TUNED-PLATE, RADIO-FREQUENCY AMPLIFIER WITH DETECTOR AND ONE STAGE OF AUDIO-FREQUENCY AMPLIFICATION

*Cost of parts:* Not more than \$35.00.  
*Selectivity:* Excellent.  
*Operation:* Rather complicated for a beginner.  
*Ease of construction:* This is a difficult circuit to get going properly—but the trouble is worth while, and good results can be at-

tained with a little patience and experimentation.  
*Approximate range:* 1,500 to 2,000 miles.  
*Outstanding feature:* Will not re-radiate if handled properly and is especially sensitive on weak distant signals.



TWO STAGES OF TRANSFORMER-COUPLED, RADIO-FREQUENCY AMPLIFICATION ADDED TO THE TWIN-VARIOMETER, VARIO-COUPLER, REGENERATIVE CIRCUIT

*Cost of parts:* Not more than \$50.00.

*Selectivity:* Good.

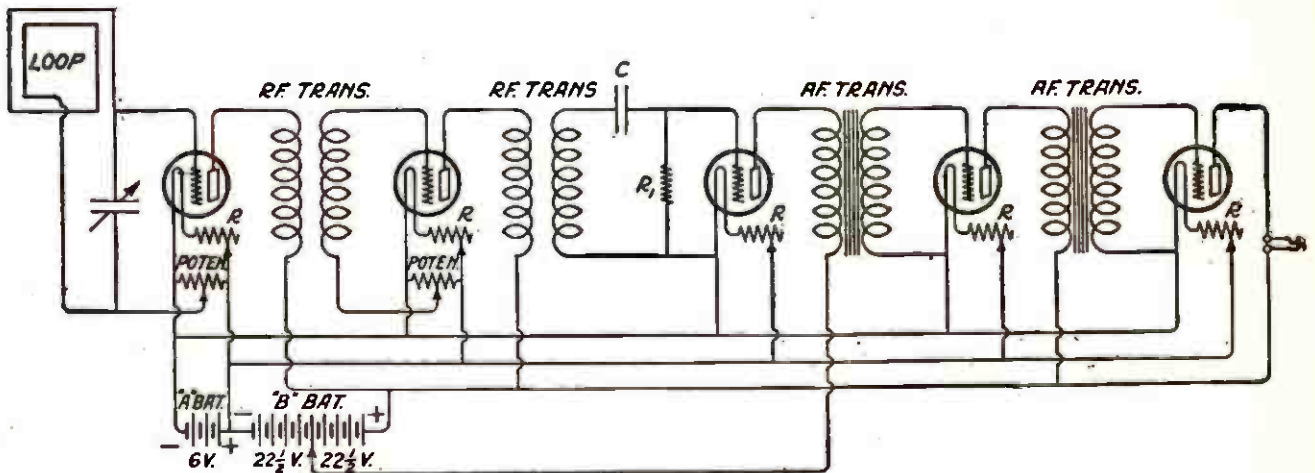
*Operation:* Complicated. The antenna must be tuned with the tapped switch and the variable condenser. There are two potentiometer adjustments, one for the stabilizer for the radio-frequency tubes and one for adjusting the plate potential of the detector tube. Then the output circuit of the second radio-frequency tube must be tuned with the variable condenser, and the regular tuning of the variometers in the grid and plate circuits

of the detector must be done before the signal is tuned in properly.

*Ease of construction:* Fairly complicated.

*Approximate range:* 1,500 miles.

*Outstanding features:* Is reliable for distance reception without the audio-frequency amplification that is usually used with this detector circuit. The radio-frequency amplification brings in the distance with much greater strength without appreciably increasing the local signals.



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

*Cost of parts:* Not more than \$50.00.

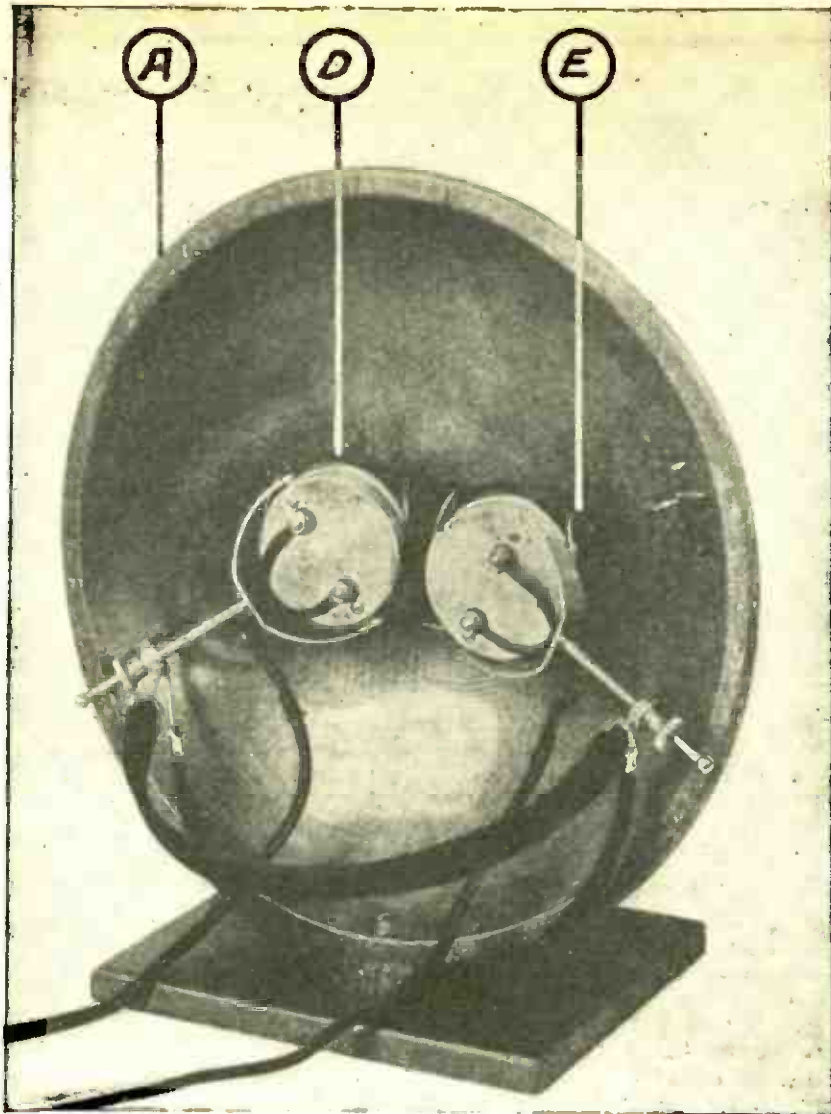
*Selectivity:* Good.

*Operation:* Simple. Only one control for tuning; the variable condenser. The two potentiometers are used as stabilizers for the control of regeneration in the radio-frequency stages.

*Ease of construction:* More or less complicated. There are a number of precautions that must be taken to get the circuit to function properly.

*Approximate range:* 500 miles (on a loop antenna).

*Outstanding features:* No outdoor antenna necessary and simplicity of tuning.



THE COMPLETED REFLECTOR

*It is composed of A, an ordinary wooden chopping bowl; D, the head telephones, and E, the spring wire clips for holding the telephones.*

## HOW TO MAKE A Chopping Bowl Loudspeaker

*—at a cost for parts not exceeding 25 cents*

By SPENCER BOYD

**T**HE device described in this article is a loudspeaker that does not *magnify* the total sound energy from the headphones; it merely concentrates it in one direction. Devices of this kind have been called "reflectors" because they reflect the signals from the headset in much the same manner that a metallic mirror reflects light from an electric bulb. A device of this type, though, is not to be confused with loudspeakers

which actually do amplify; it will be found, however, to be an improvement over telephones lying upon a table or hanging on the wall.

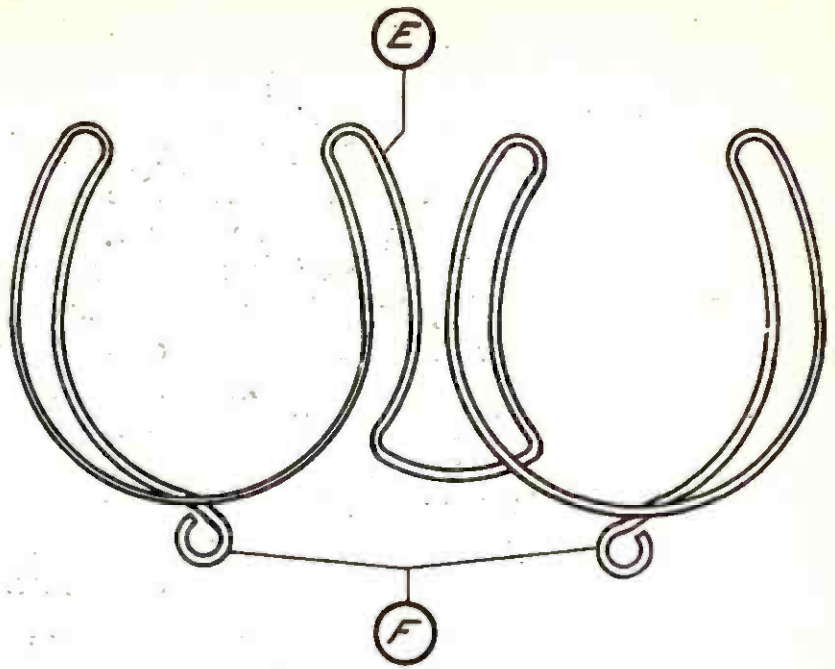
The reflector described here is easily made and the parts should not cost over 25 cents.

It will be seen that both of the receiving telephones of a headset may be held in place before the reflecting bowl without even removing the receivers from the



### HOW TO BEND THE WIRES THAT HOLD THE BOWL

FIGURE 1: The stiff iron wire is bent into shape as shown at the right and the two ends are bent into circular form at F, for fastening to the bowl with screws.



headband. This is a distinct advantage over many devices of this sort and also furnishes increased volume, because *both telephones* are used at once.

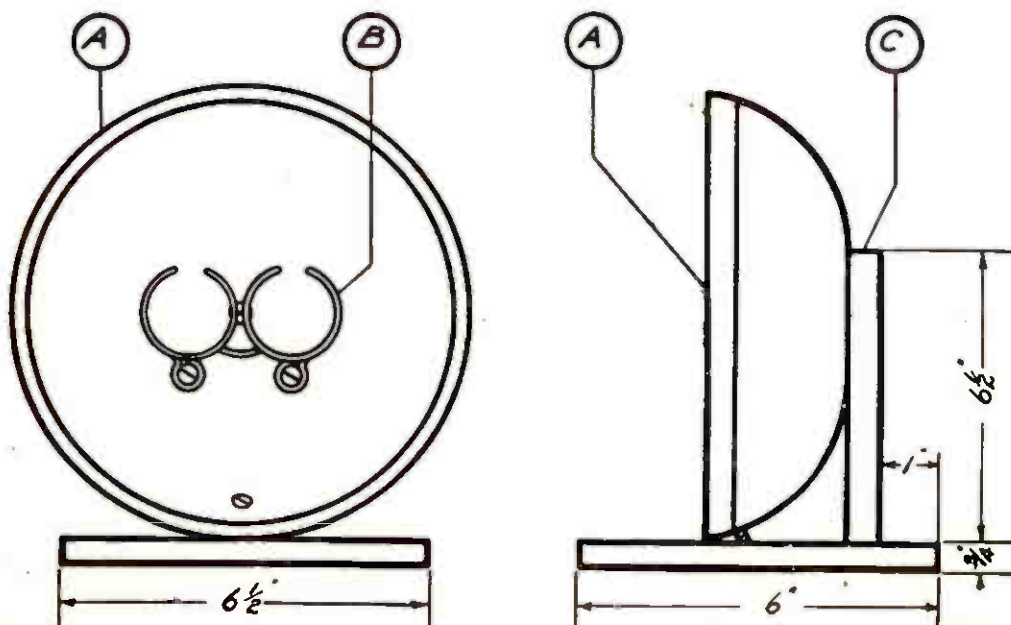
#### The Parts That are Needed

- 1 wooden chopping bowl about 2½ inches deep and 10 inches in diameter;
- 1 piece ½-inch wood 6½ inches by 6 inches;
- 1 piece ½-inch wood 1 inch by 6½ inches;
- 3 feet of stiff iron wire, about No. 16;
- 2 ¾-inch flat-head screws;
- 2 ⅜-inch flat-head screws;
- 1 1-inch flat head screw.

The chopping bowl may be procured from a hardware or ten-cent store; this forms the reflector. If the bowl is found to be impregnated with paraffin this

should be removed by washing with gasoline. The large piece of wood forms the base of the reflector; the smaller piece is used as a support for the bowl.

Finish off the wooden parts with sandpaper and then assemble them. The support is fastened to the base (see Figure 2) by means of the one-inch screw, which passes up through the base into the lower end of the support. The bowl is fastened by one screw passing through its center into the support and one screw passing through its lower edge into the base. When the parts are assembled they may be stained and then given a coat of shellac, or they may be waxed.



### HOW TO BUILD THE BASE

FIGURE 2: The bowl A, is fastened to the upright piece of wood C, and the base by ordinary wood-screws. The method of fastening the telephone supporting assembly is shown at B.

The stiff iron wire may be procured from a large hardware store. This wire is bent as shown in Figure 1, and forms a holder for the telephones. The two large loops of wire hold the telephones firmly by the rims of the phone caps. Each end of the wire is twisted into a small loop: screws passing through these loops secure the holder to the reflecting bowl.

The holder should be so adjusted that when the telephones are inserted in it (facing the bowl) they will be held securely  $\frac{1}{4}$ -inch away from the reflecting surface.

In use, the telephones may be either taken from the headband and left in the holder, or left in the headband and slipped in and out of the holder at will. The stiff iron wire will always hold the telephones firmly and yet permit them to be easily taken out.

This reflector has been tried out in comparison with several loudspeaking devices, costing up to \$15, and has been compared favorably with all of them. Keep in mind, however, that this device only *reflects* the sound of the headset, so be sure to use a good, loudspeaking pair of phones.



Gilliams Service

#### THE FIRST "RADIO CHURCH"

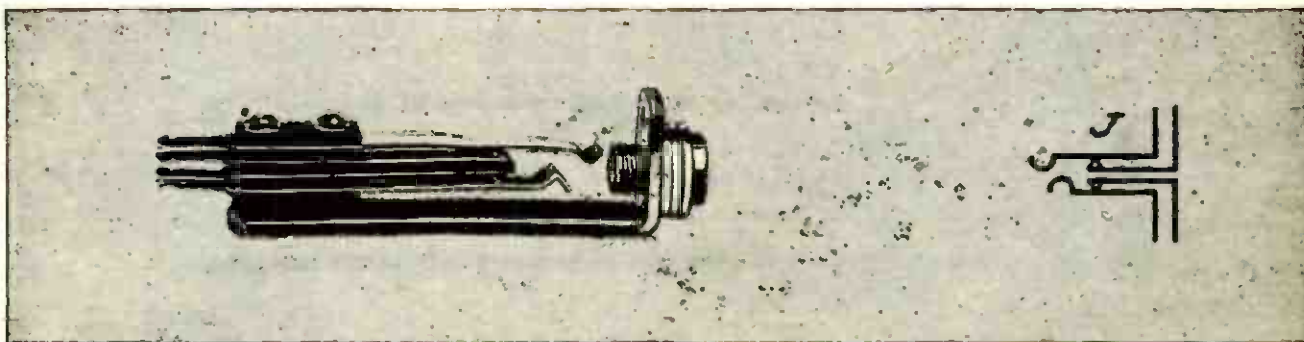
*In conservative old Boston this unusual little chapel, mounted on a motor car and equipped with a radio receiver and loudspeaker, has been operating for several months. This chapel is conducted by William H. Morgan and his wife, who drive the vehicle through the streets, stop at strategic corners—and assemble crowds by tuning in on a broadcast program.*

# HOW TO READ A DIAGRAM

## PART II

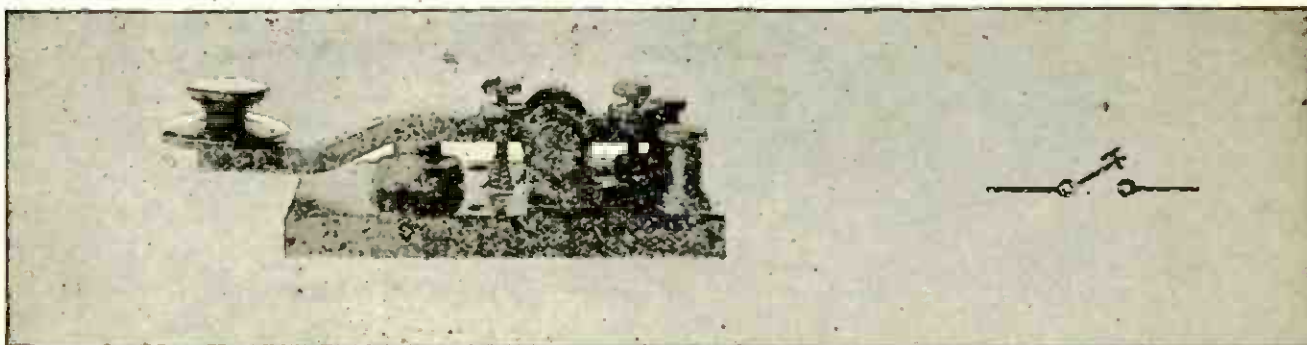
*Every radio fan should be familiar with the common symbols used in the diagrams of radio circuits. They are few in number, and a knowledge of them is necessary to the understanding of hook-up drawings. This two-part article has been carefully prepared for the special benefit of the beginner in radio; it shows both the apparatus and the symbol that identifies it. KEEP THIS ARTICLE FOR REFERENCE!*

By ALBERT G. CRAIG



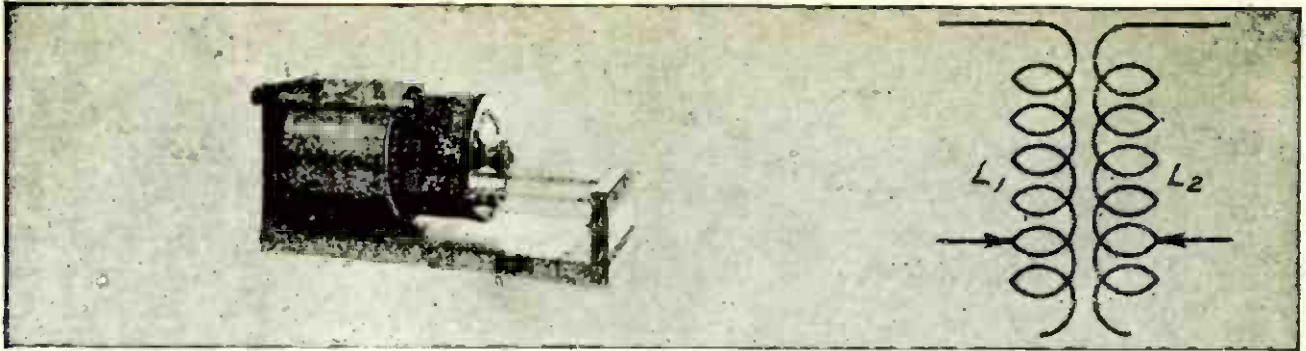
**TELEPHONE JACK**—The telephone jack gives us a means of using either the detector, or one or more stages of amplification at will. The ordinary jack for all but the last stage of amplification has four terminals; the two outside terminals are connected in series in the plate circuit of the preceding tube, that is, one to the "B" battery positive and one to the plate of the tube; the two inside terminals are connected to the primary of the following ampli-

fying transformer. When the plug is not inserted in the jack, the plate wire should make contact with the terminal marked P on the transformer and the "B" battery wire should make contact with the terminal B on the transformer, through the fingers of the jack. The last jack has two terminals and these are connected in series in the plate circuit of the preceding tube. The jack furnishes a convenient method for "plugging in" the headphones.



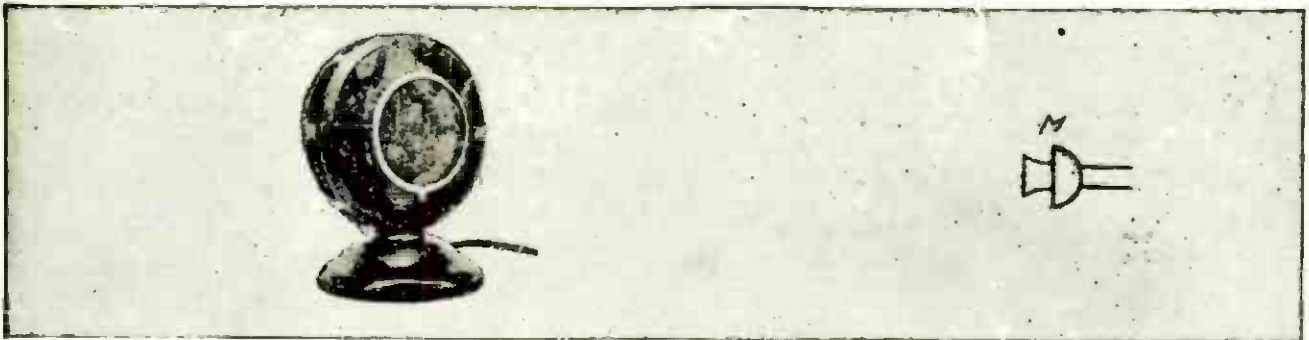
**KEY**—The key is used for breaking up the high-frequency current into dots and dashes for radio telegraphy. In the old-time spark transmitters the keys were very ponderous and unwieldy due to the fact that they had to handle (directly) very large currents, being inserted in series with the primary circuit of the power

transformer. However, with continuous-wave apparatus there are places where ever a small key may be inserted so that it will control the energy from several large vacuum tubes. There are always two connections to the key, these being shown by the two wires running to it in the diagram.



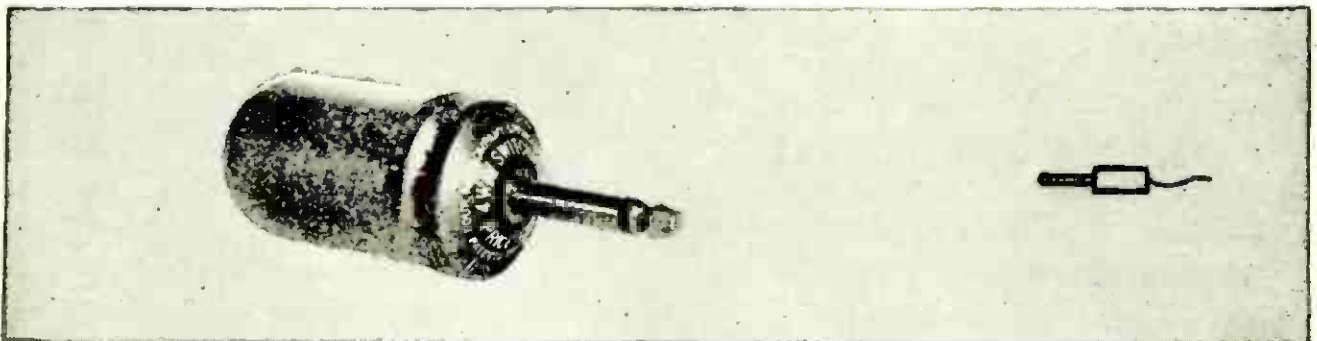
**LOOSE COUPLER**—The loose coupler is an older and less convenient device than the variocoupler, for coupling the primary and secondary circuits. The primary coil is stationary and is usually provided with a slider for varying the inductance by single turns. The secondary coil slides in and out of the primary to vary the coupling, and is provided with approximately

half a dozen switch points to change its inductance value. There are two primary connections, one to the slider and one to one end of the coil. Also there are two secondary connections, one to the switch arm and one to one end of the coil. The construction of the loose coupler makes it inconvenient for panel mounting and it has gradually fallen into disuse.



**MICROPHONE**—The ordinary carbon-grain microphone consists of two metal plates with a number of carbon grains between them. These two plates form the two connections to the microphone, and they are insulated from each other, of course, except through the path furnished by the carbon grains. To one of the plates the diaphragm of the microphone is at-

tached and the varying pressure of the diaphragm (caused by the sound waves) is transferred to the carbon grains. This changes the resistance of the microphone and consequently the amount of current which is flowing through it, so that the amount of current at any instant is representative of the sound wave striking the diaphragm at that time.



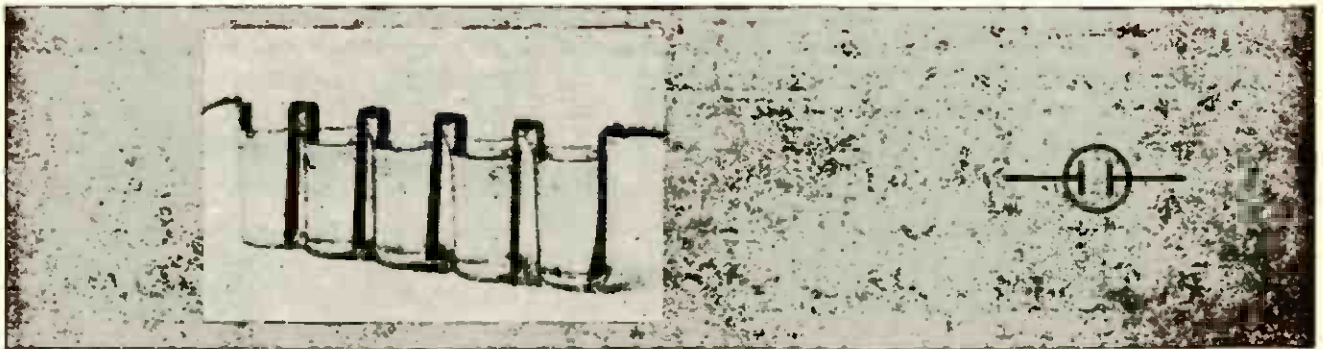
**TELEPHONE PLUG**—In connection with a jack, the telephone plug may be used to insert any given pair of telephones or any loudspeaker in the set instantly. There are two connections to the plug, one to the tip and one to the sleeve, and the two terminals of the telephones or the loudspeaker are merely joined to these. When a two-circuit jack is in the normal position, without the plug inserted, each outside spring makes contact with the corresponding inside

spring and the circuit is completed through the following transformer. When the plug is inserted, contact between the outside and inside springs is broken, and the tip and sleeve of the plug make contact with the outside springs of the jack, completing the circuit through the telephones. This places the telephones in the plate circuit of the preceding tube and disconnects the succeeding stages from the telephones and other stages of amplification.



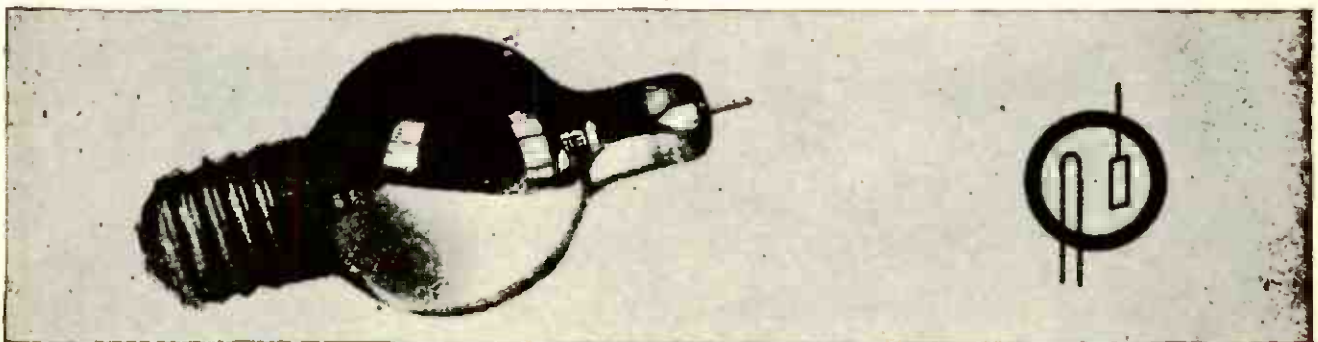
**POTENTIOMETER**—The theory of the potentiometer is based on the fact that the potential or voltage of a wire varies uniformly along its length from negative to positive, and that by tapping off at various points along the wire or resistance we can get any desired potential within the range of the battery. The two outside terminals of the potentiometer (ends of the winding) are connected across the "A" battery and the desired potential is obtained by

moving the third connection (the pointer) to different points from negative to positive. There are two principal uses for the potentiometer, the first being to vary the plate potential of a soft detector tube by connecting the negative "B" battery lead to the pointer of the potentiometer, and the second to vary the grid potential of radio-frequency amplifying tubes by connecting the grid return to the pointer. This allows a six-volt variation in either position.



**CHEMICAL RECTIFIER**—The chemical rectifier cell usually consists of one lead and one aluminum electrode immersed in a saturated borax solution. For battery charging, two to four cells having large electrodes may be connected in parallel in order to carry the heavy current. On the other hand for rectifying the plate current for vacuum tubes, a number of cells that have smaller electrodes are connected in series,

as the voltage is high and the current is low. The chemical rectifier is not very economical for battery charging as most often used, due to the fact that the current is most always cut down by a rheostat and a large part of the energy is lost in the rheostat in the form of heat. There are two connections to the rectifier, one to the positive aluminum electrode and one to the negative lead electrode.



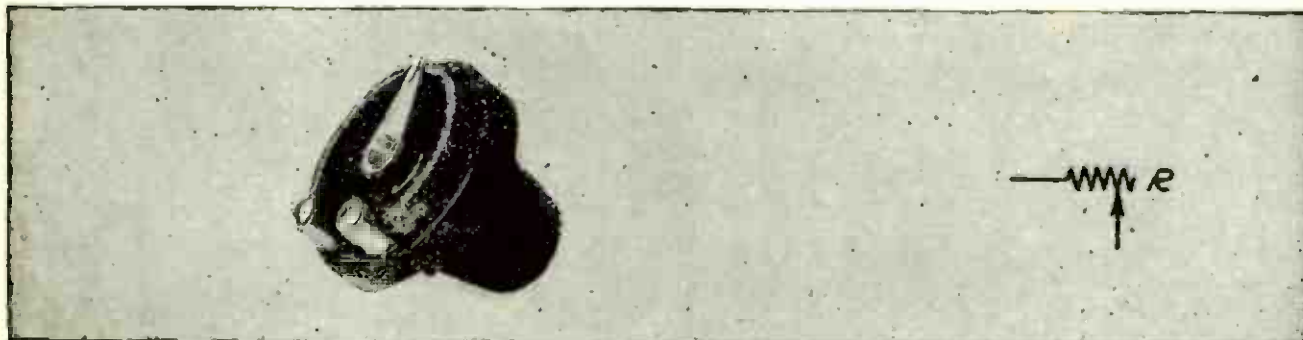
**RECTIFIER TUBE**—The rectifier tube is a two-element tube and will always have three terminals. Two of these are for lighting the filament and the third is the plate terminal of the tube. The filament-lighting circuit is merely an auxiliary circuit; the connections of the rectifying circuit proper are to one of the filament terminals and the plate terminal of the rectifier tube. The source of current to be rectified is connected in series with the

rectifier tube; since the current can only pass from the plate to the hot filament, the filament is always the positive pole and the plate the negative pole of the rectifier. Rectifiers range from the Tungar type (a low-voltage, high-current tube for battery charging) to the high-voltage rectifiers handling several thousand volts for the plate supply of large vacuum tubes that are used in transoceanic high-power telegraph transmitters.



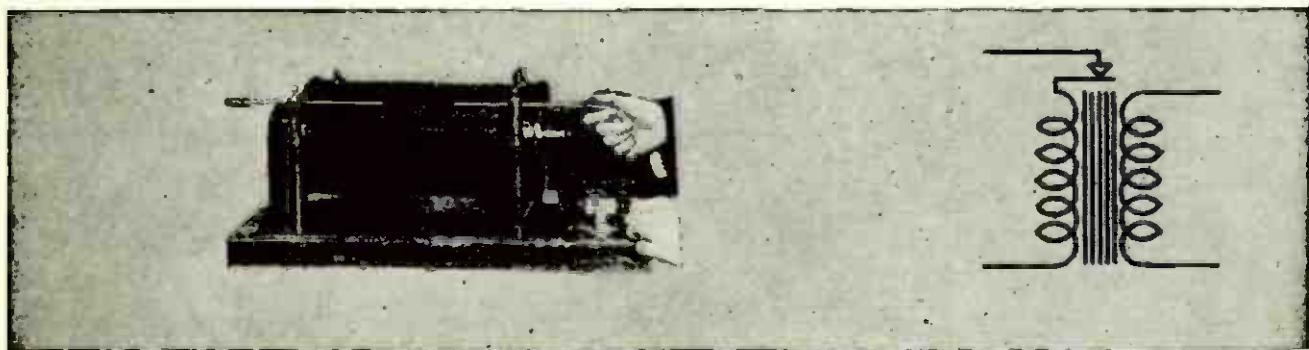
**FIXED RESISTANCE**—The fixed resistance can be used to couple amplifier circuits together, being placed in the plate circuit of one tube and the voltage drop across it used to operate the succeeding tube. Resistance coupling is not economical because a large quantity of the plate-circuit energy is lost in the resistance in the form of heat. On the other hand it has the advantage of amplifying nearly all frequencies

used in radio *uniformly*, and thus does not give distorted signals. The fixed resistance has two terminals, one at each end of the resistance element. The element may take the form of a continuous winding of wire or may be made up of some high-resistance material such as carbon or graphite. It should generally be non-inductive; in some circuits this is imperative but in others it doesn't matter.



**RHEOSTAT**—As the voltage of a battery gradually decreases with use, all tubes are designed to operate at a voltage somewhat less than that of the battery they are to be used with. The rheostat should, therefore, have sufficient resistance to cut the battery voltage down to the proper tube rating. Also the current-carrying capacity of the rheostat should be large enough to prevent undue heating; for in-

stance, an ordinary commercial 50-ohm rheostat would burn out immediately if used with a tube drawing one ampere or more. However, do not worry if the rheostat heats up to a certain extent, as that is the way the energy lost in it is dissipated. The rheostat has two connections, one to the pointer and one to one end of the winding. Use a rheostat with your tubes of the resistance specified by the manufacturer.



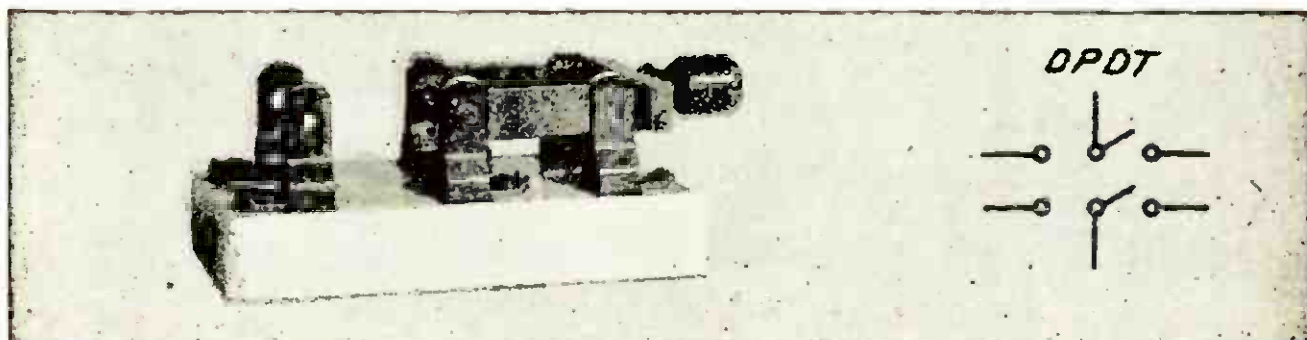
**SPARK COIL**—The spark coil is an instrument used to obtain a voltage high enough to jump a specified air gap, the discharge across the gap being used to send out waves at a radio frequency. The primary consists of a small number of turns and the secondary of many turns of fine wire, both being wound about a laminated iron core. A method of interrupting the primary circuit at regular intervals is provided, and this interruption gives us

an alternating secondary current of very high voltage. This current is used to charge a condenser until the voltage is sufficient to break down the air of the spark gap and discharge across the gap. Generally there are four connections to the spark coil, two to the primary and two to the secondary. The interrupter is usually made integral with the coil and placed in the primary circuit. However, the interrupter may be separate if connected properly in the circuit.



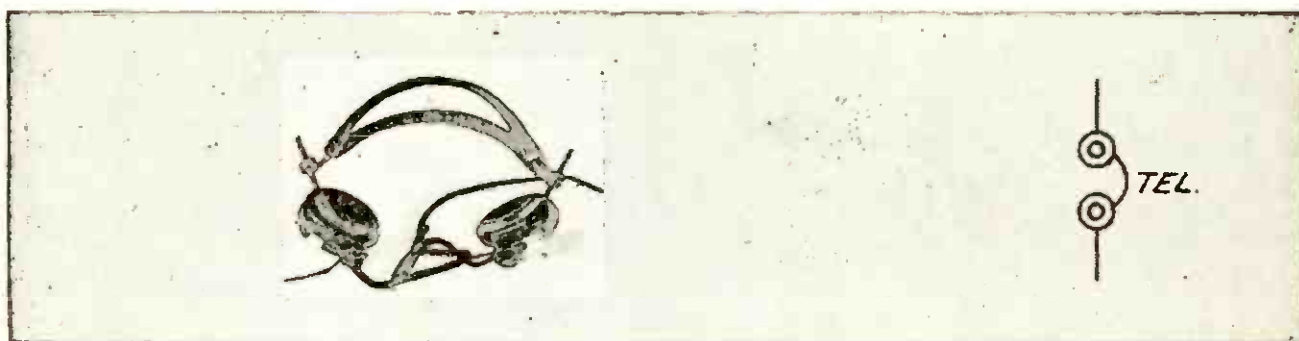
**SPARK GAP**—For any form of spark transmitter, some kind of spark gap must be provided. This is the point where the energy we put in the transmitter is changed from an audio frequency to radio frequency. The gap may be a plain two-electrode gap, a quenched gap, or a rotary gap. The various forms of spark gaps are used to give a better tone or

note to the transmitter. For example, the rotary gap may be supplied with sufficient electrodes to produce 500 sparks a second, thus giving a note which is more pleasing and easier to read than the lower frequencies of the plain gap. The spark gap will always have two fundamental connections even if there are a large number of electrodes.



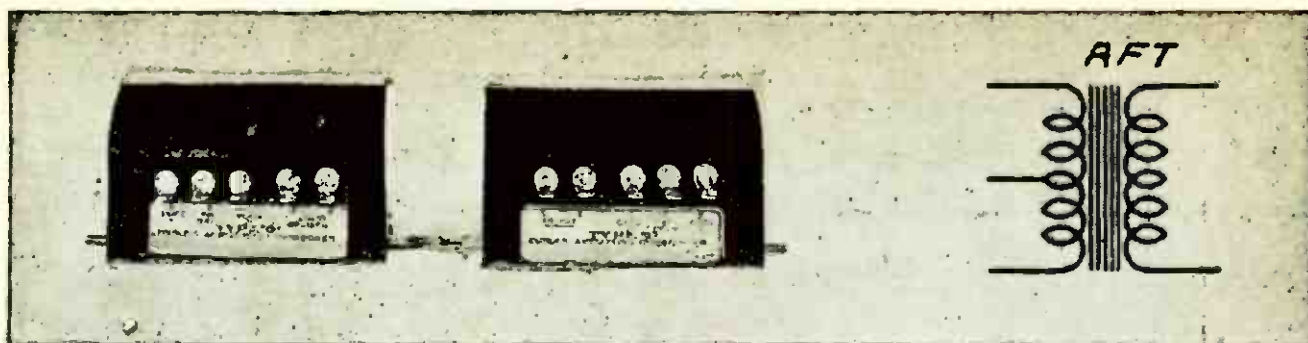
**SWITCHES**—The most common switches used in radio are the following: single-pole, single-throw (SPST) with two connections, single-pole, double-throw (SPDT) with three connections, double-pole, single-throw (DPST) with four connections and double-pole, double-throw (DPDT) with six connections. These switches are made up in standard form and also in a special anti-capacity type with the area

of the switch parts reduced to a minimum. Of course there are also three and four-pole switches but their use is less common. Whatever the number of connections, it is merely necessary to count them on the diagram and make sure that the switch itself has the same number of connections and the same number of switch arms. Such switches may be used for antenna switches, battery chargers, etc.



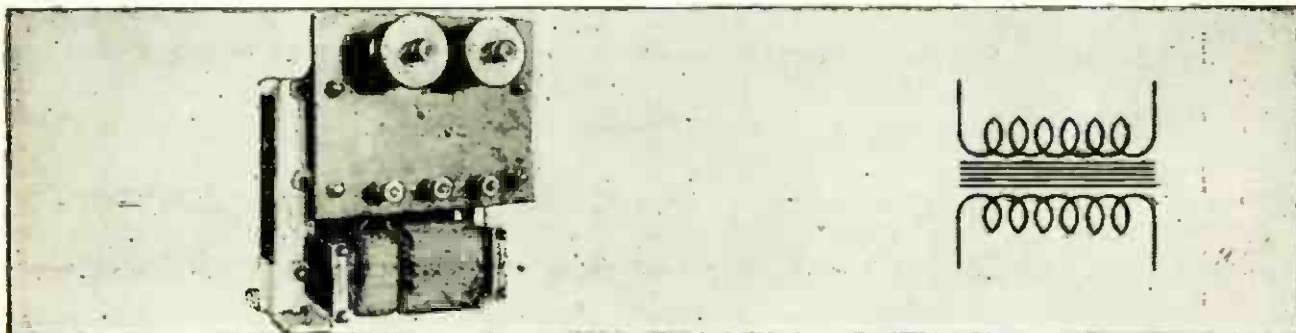
**TELEPHONES**—A good pair of telephones is essential for reception; probably the best way of selecting them is to buy from a reliable manufacturer. There are two common types: in one the magnets act directly on the iron diaphragm and in the other they act on an iron armature which is mechanically connected to a mica or composition diaphragm. Either of these types is satisfactory if well made. The two telephone receivers are always connected

in series, that is, one terminal of one phone is connected to one terminal of the other phone and the remaining two terminals are brought out for connections to the receiving set. For any good receiver, the telephone headpieces act as the mouthpiece and if they are of good design and quality the results will be good. If the telephones are inferior, however, reliable results cannot be expected. A good receiver deserves a good headset.



**PUSH-PULL TRANSFORMER**—For each stage of push-pull amplification we must have a special audio-frequency, input transformer with a tap at the center point of the secondary winding, and also a special audio-frequency output transformer with a tap at the center point of the primary winding. Therefore the push-pull transformers are usually sold in pairs. Push-pull amplification

varies the plate current of both tubes up and down from the normal, thus giving an increase in signal strength. In a stationary condition, that is without any signal being impressed on the tube, the direct current in one half of the output transformer opposes that in the other half and there is no flux in the core. With this condition we can use much higher voltages and get louder signals without distortion.



**TRANSFORMERS**—The transformer has two separate coils, both wound about the same closed iron core. The primary is the side connected to the source of power and has two terminals. The secondary is the side from which power is to be drawn at some voltage either higher or lower than that impressed on the primary. It has two terminals or may be tapped at several points to obtain a selection of

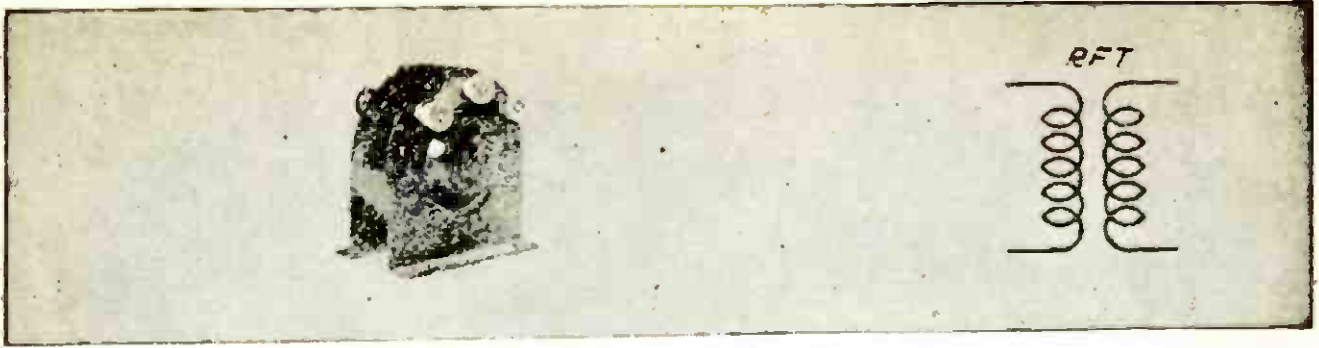
voltages. Therefore, it can be seen that the transformer is fundamentally a device for changing the voltage of the supply. When the voltage is cut down by utilizing the drop across a resistance much energy is lost in heat; on the contrary the efficiency of the transformer runs as high as 98 percent in the larger sizes. The transformer cannot be used on direct current.



**AUDIO-FREQUENCY TRANSFORMER**—The audio-frequency transformer is merely a step-up transformer designed for voice-frequency currents. The primary is inserted in the plate circuit of one tube and the secondary in the grid circuit of the succeeding tube. Due to the step-up ratio, any change in the primary current and voltage produces a much larger swing in the grid voltage of the succeeding tube, and this causes a correspondingly greater change in the plate current of the same tube.

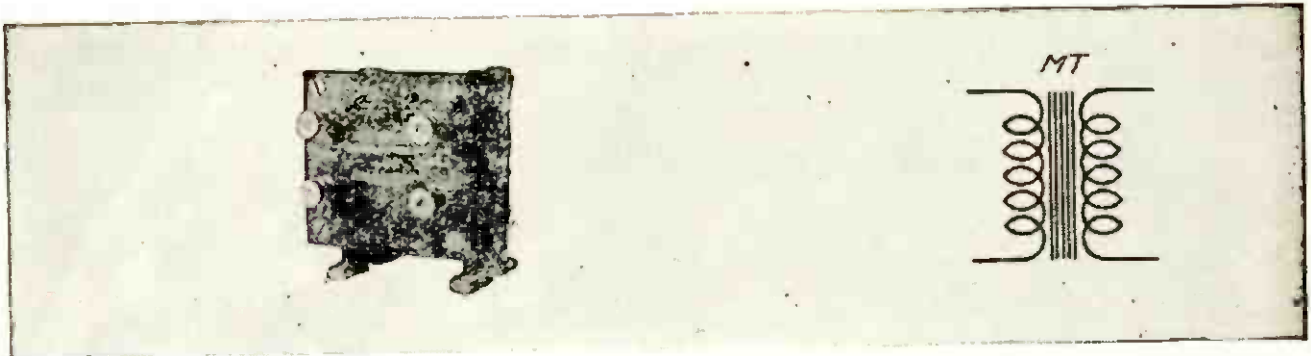
The simple audio-frequency transformer has four terminals, two for the primary and two for the secondary. The general practice is to mark the primary terminals P and B for the plate and "B" battery connections and the secondary terminals G and F for the grid and filament connections. A transformer should have such characteristics that it will amplify tones of all frequencies, within the audible range of the ear, with equal intensity. Transformers that do otherwise produce distortion.





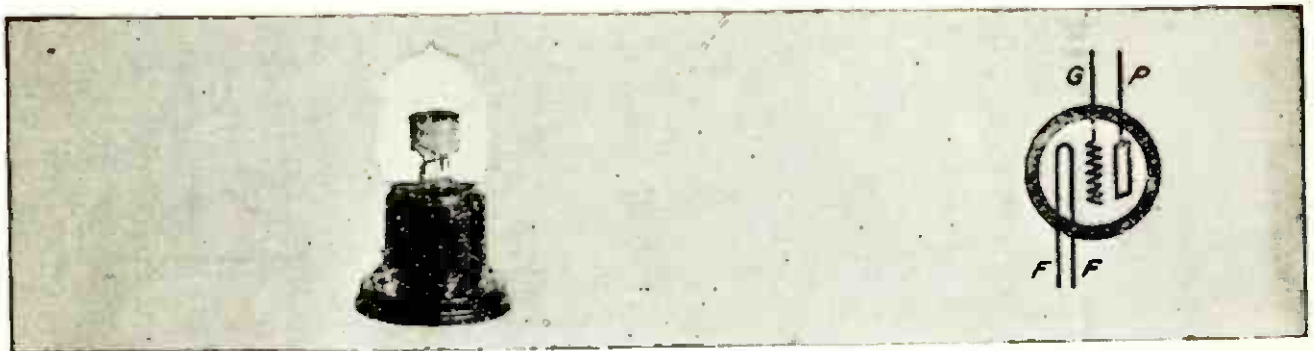
**RADIO-FREQUENCY TRANSFORMER**—The radio-frequency transformer operates on the same principle as the audio-frequency transformer, except that it is designed for high-frequency currents. It is often made with an air core, or at least with an open iron core. The radio-frequency transformer has four terminals, two for the primary and two for the secondary. The common practice is to mark the primary

terminals P and B for the plate and "B"-battery connections, and the secondary terminals G and F for the grid and filament connections. Some transformers have a metal link for short-circuiting part of the winding, thus giving a wider wavelength range. Two or three steps of radio-frequency amplification are practically a necessity for loop operation. This type of transformer is not as efficient as the tuned type.



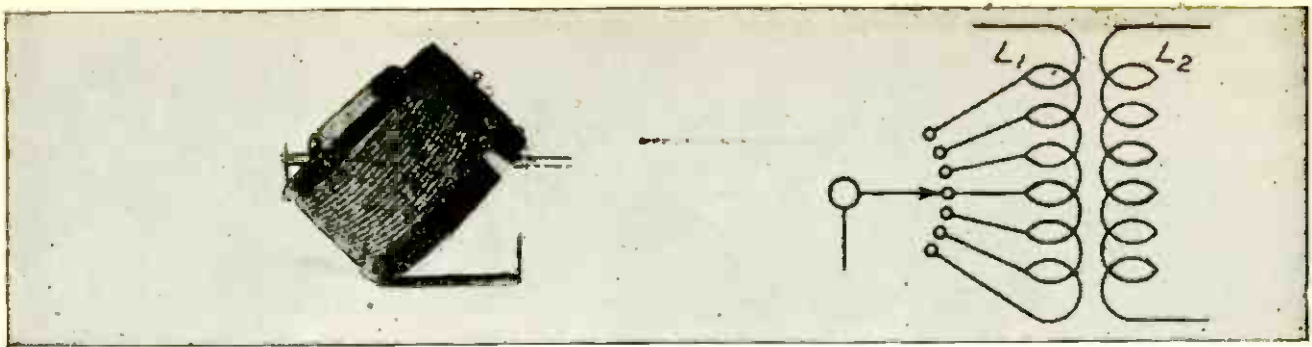
**MODULATION TRANSFORMER**—In order to couple together the microphone circuit and the grid circuit of a vacuum tube, a transformer must be used. Examples of this use are the grid-modulation, and Heising-modulation circuits. The modulation transformer is similar in appearance to the amplifying transformer, but usually has a higher step-up ratio. It has four terminals, two for the primary and two for

the secondary. The primary winding of the modulation transformer is simply connected in series with the microphone and a suitable battery. The secondary winding is connected to the grid circuit of the oscillator tube in the case of grid modulation or to the grid circuit of the modulator tube in the case of Heising modulation. The transformers should be built to withstand rather high voltages.



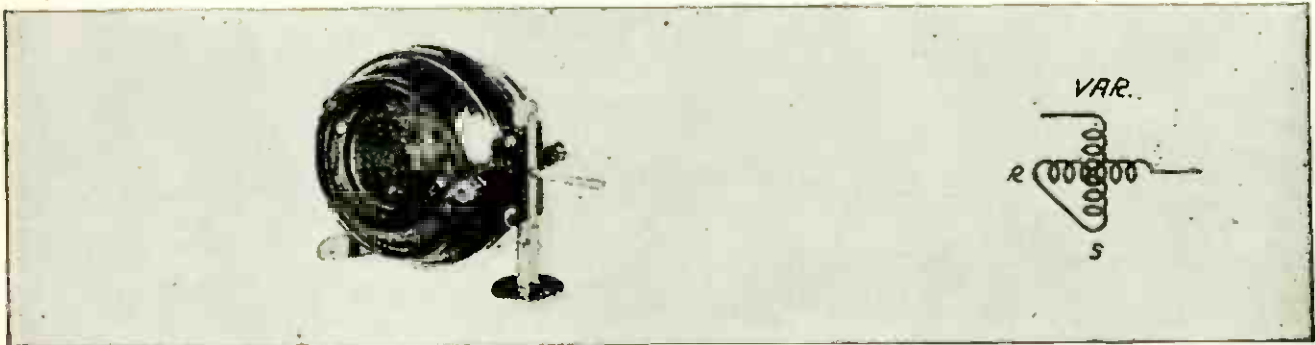
**VACUUM TUBE**—The three-element vacuum tube has four terminals: two of these are the ends of the filament, the third is the grid, and the fourth is the plate. Since there are no designations for these terminals on the tube itself, it is imperative to purchase a suitable vacuum-tube socket and follow out the circuit from the letters on the same. The two filament terminals will be marked F, the grid G, and the plate P. These same letters have been placed on the diagrammatic vacuum-tube

symbol shown, but will ordinarily be left off, as it is a simple matter to learn which element is which. The action of the vacuum tube cannot be treated here except to state that under normal operating conditions the telephone current flows from the plate to the filament, and that small changes in grid voltage will make comparatively large changes in the plate or telephone current. This process amplifies the currents passing through the telephones and produces louder signals.



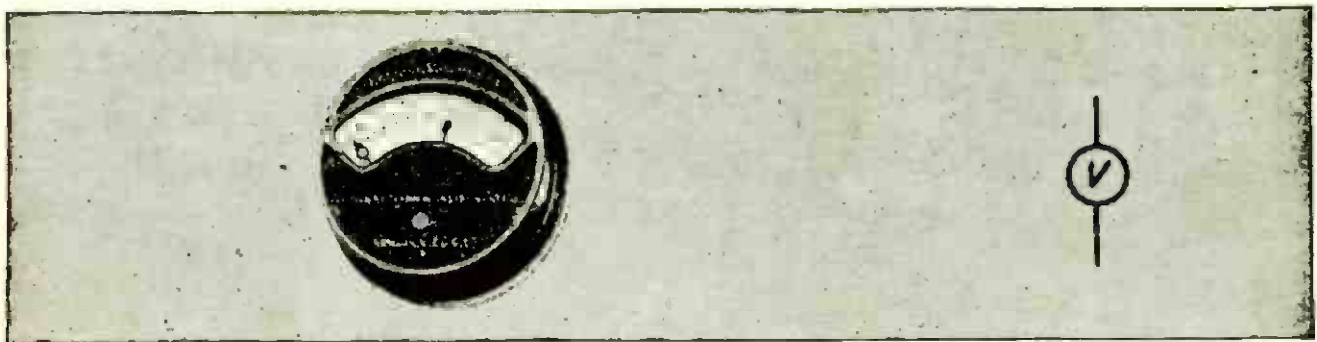
**VARIOCOUPLER**—The variocoupler is one of the most widely used instruments for coupling and tuning the primary and secondary circuits; it consists of a stationary primary coil, and a secondary coil rotating within the primary coil, so that the coupling between them may be varied. The primary of the variocoupler is provided with taps for changing the wavelength; there are two primary terminals, one

to the wavelength switch and one to the end of the coil. The secondary of the variocoupler has a fixed number of turns and is always tuned by means of a variable condenser connected across the coil or by a variometer in series with it; there are two secondary terminals, one to each end of the coil. These secondary terminals are brought out through the bearings or through "pigtail" connections.



**VARIOMETER**—The variometer provides a continuously variable inductance (within the range of the instrument); it consists of two coils connected in series and mounted so that one rotates within the other. When the current traverses the two coils in the same direction and when the axis of the two coils are parallel, the inductance of the variometer is

maximum; when the current traverses the two coils in opposite directions and when the axis of the two coils are again parallel, the inductance of the variometer is minimum and should theoretically approach zero. There are two connections to the variometer, one to the end of each coil; the opposite ends of the two coils are connected together.



**VOLTMETER**—The voltmeter is an instrument for measuring the potential difference (voltage) between two points in a circuit, that is, how much higher the voltage is at one point than at the other. For instance, it might be connected across the "A" battery to measure the difference in voltage between the positive and negative terminals. A voltage measurement is the only satisfactory method of test-

ing "B" batteries or of locating a bad unit among them. After the voltage of the 22½-volt unit has fallen below 16 it should be discarded. The same proportional drop can be applied to the larger units. The simple voltmeter will have two terminals for connecting to the two points where the voltage difference is to be measured. For "B" battery measurements the voltmeter should be of high resistance.

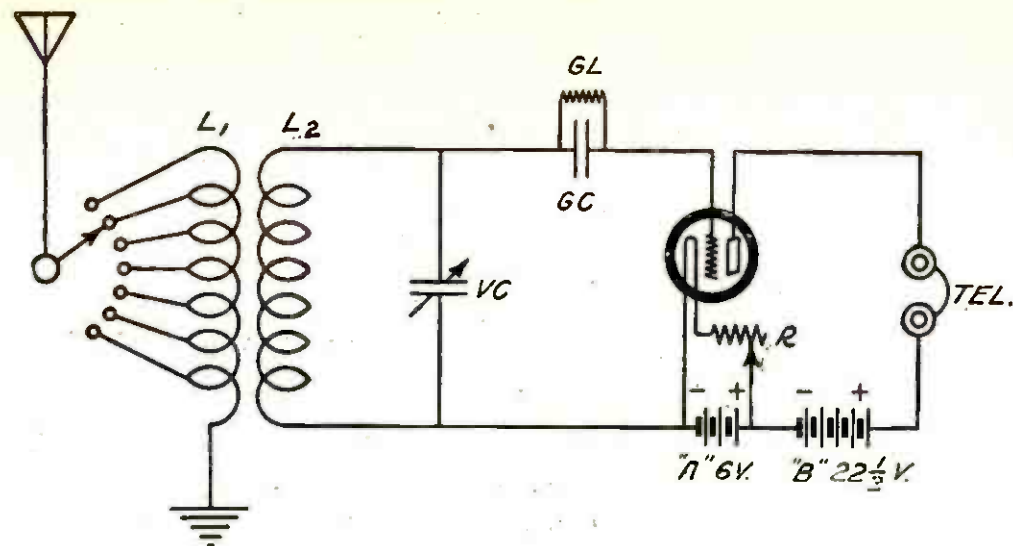


FIGURE 1: A DRAWING FOR A STRAIGHT AUDION CIRCUIT  
*Unless you know what these symbols mean, this diagram is unintelligible.  
 This article tells you how to read it.*

## How to Apply this Information to an Understanding of the Standard Diagram Above

From a reading of the foregoing the reader will notice that such instruments as the variable condenser, the variometer, the fixed condenser, the grid leak, the rheostat, tuning coil, choke coil, battery and others have only *two* terminals.

The potentiometer has *three* terminals.

Most types of transformers have four terminals—two for the primary winding and two for the secondary winding. Push and pull transformers, it will be noticed, have five connections.

Tube sockets have four connections, one marked G for the grid, one marked P for the plate, and the other two marked F for the filament connections.

Variocouplers have a number of taps (inductance terminals) for the primary and two connections for the secondary.

Some of the other more complicated accessories have a large number of terminals; among these are motor generators, tapped coils and power transformers.

Consider the specific case of a variable condenser; if you see the symbol for this instrument in a circuit diagram you will always find two lines (wires)

running to it, one from each side. If you were to connect this instrument in that particular circuit you would only have to connect these two wires to the two terminals that you would find on the condenser. This same line of reasoning holds true for instruments with three terminals, four, or more terminals.

In a variocoupler the primary coil is always the larger outside coil and the secondary is the smaller inside coil.

In a transformer (radio-frequency or audio-frequency) the primary terminals are marked P for the plate, and B for the wire going to the "B" batteries. The secondary terminals are marked G, for the grid wire and F for the wire leading to the filament.

The symbol for the vacuum tube, it will be noticed, contains four lead wires. The upper left-hand wire is the grid lead and when connecting up a vacuum-tube circuit this wire should always be connected to the terminal marked G on the tube socket. The upper right-hand wire is the plate lead and this should always be connected to the terminal marked P of the tube socket. The other two wire leads (in the diagram) are the filament

connections and should be connected respectively to the terminals marked F on the tube socket.

Now let us study the diagram in Figure 1.

This is a standard diagram for a straight audion circuit. We will first pick out the instruments that are used in this circuit. By referring to the upper left-hand portion of the diagram we will find the triangular-shaped symbol for the antenna. Directly below it we find the symbol for a variocoupler. And below this we find the symbol for the ground. Then connected to the secondary of the variocoupler we find the symbol for a variable condenser. And in the center of the diagram we find the symbol for a vacuum tube. Directly below this we find the symbol for a rheostat and an "A" battery. Connected between the grid of the tube and the variable condenser we find the symbols for a fixed condenser and a grid leak. To the right of the diagram at the top we find the symbol for the telephones and below this the symbol for a "B" battery. From this diagram, therefore, we learn that we need the following list of parts in order to make the set:

- 1—variocoupler;
- 1—variable condenser;
- 1—grid condenser;
- 1—grid leak;
- 1—vacuum tube;
- 1—vacuum-tube socket;
- 1—rheostat;
- 1—"A" battery (for lighting the filament);
- 1—pair of telephones;
- 1—"B" battery (for supplying the plate current).

The next thing to do would be to obtain these parts of suitable sizes to incorporate in the set. The sizes for the various instruments are almost always given in the text of the article of which the diagram is a part. These sizes include the proper capacities for the variable condensers and fixed condensers, the proper resistances for the grid leaks and rheostats, the proper type of tube to use for detector or amplifier and the proper voltages to use for the "A" batteries and "B" batteries.

To start wiring up a set like the one shown in the diagram the beginner should obtain the proper connecting wire, a soldering iron, some solder, soldering flux and a heavy red pencil.

A good layout for this particular set would be to mount the variocoupler at the left-hand end of the panel; place the variable condenser beside it, with the socket mounted alongside the variable condenser, at the right-hand end of the panel. The rheostat should be mounted on the panel directly in front of the vacuum-tube socket. The vacuum-tube socket should be mounted on the base with the plate and grid terminals turned toward the back of the set.

Now we should include on the left-hand end of the panel, two binding posts, one for the antenna and one for the ground. At the right-hand end of the panel should be mounted six binding posts, the top two being for the telephone, the second pair for the "B" battery, and the bottom two for the "A" battery.

After the instruments have been mounted on a panel in a manner which will keep the connecting wires as short as possible, we should commence the actual wiring.

From the diagram we see that there is a wire running from the antenna to the switch arm of the variocoupler. Cut a piece of wire long enough for this purpose and solder one end of it to the back of the antenna binding post of the set. Then run the wire as direct and neatly as possible to the shaft of the switch arm on the panel.

When this is completed *take the red pencil* and cover the line you have just completed (on the diagram) with a red line.

In looking at the diagram hereafter you will know that you have already completed this connection; it will be evident at a glance.

Now you will notice from the diagram that there is a wire running from the ground to the bottom end of the vario-

QUESTION: Would it be possible to use my four WD-11 tubes on a storage battery if I put all the tubes in series on the full six volts? I have a set that includes one stage of radio-frequency amplification, detector, and two stages of audio-frequency amplification: four tubes in all. I had the thought that I might put all the tubes in series on the six-volt storage battery that I have. At present I am using dry cells and the batteries run down so fast that I am getting tired of replacing them. That is what made me think of the storage battery. Each tube takes  $1\frac{1}{2}$  volts and the four would (it seems to me) operate on the six volts all right.

ERNEST H. ELLIS

ANSWER: You will be able to use the six-volt battery in the way you have described, with the four tubes connected in series. You will require, however, a potentiometer connected across the "A" battery with the midpoint of the potentiometer connected to the grid return of the first tube. The other three tubes should have their grid returns connected to the negative side of the filaments of each successive tube for proper action. Use only one rheostat for the four tubes. You may have to experiment with the set for a while before you get it going to the fullest efficiency but the thing can be done and should give very satisfactory results.

QUESTION: Can a counterpoise ground system be used for receiving as well as transmitting or is this form of ground suitable only for transmission?

J. B. BARTINDALE

ANSWER: The counterpoise can be used for both purposes. It will sharpen up the tuning in a receiving set, by reducing the radiation resistance of the whole antenna system.

\* \* \*

QUESTION: Are battery chargers really successful and reliable?

CHARLES JOHNSON

ANSWER: Battery chargers of reliable manufacture are not only successful but they have become an almost indispensable part of the equipment of a modern receiving or transmitting station.

\* \* \*

QUESTION: Will you please give me what you believe to be the most practical hook-up for a crystal detector. I want the simplest circuit that will be consistent with the greatest distance of reception, and sharpness of tuning.

LAWRENCE DURHAM

ANSWER: The circuit diagram is shown in Figure 1. C1, C2, and C3, are mica fixed condensers of .0001 mfd., .00025 mfd., and .0005 mfd. capacity, respectively. They are used to obtain a low, medium, or high wavelength range. The variometer VAR, is used for selective tuning.

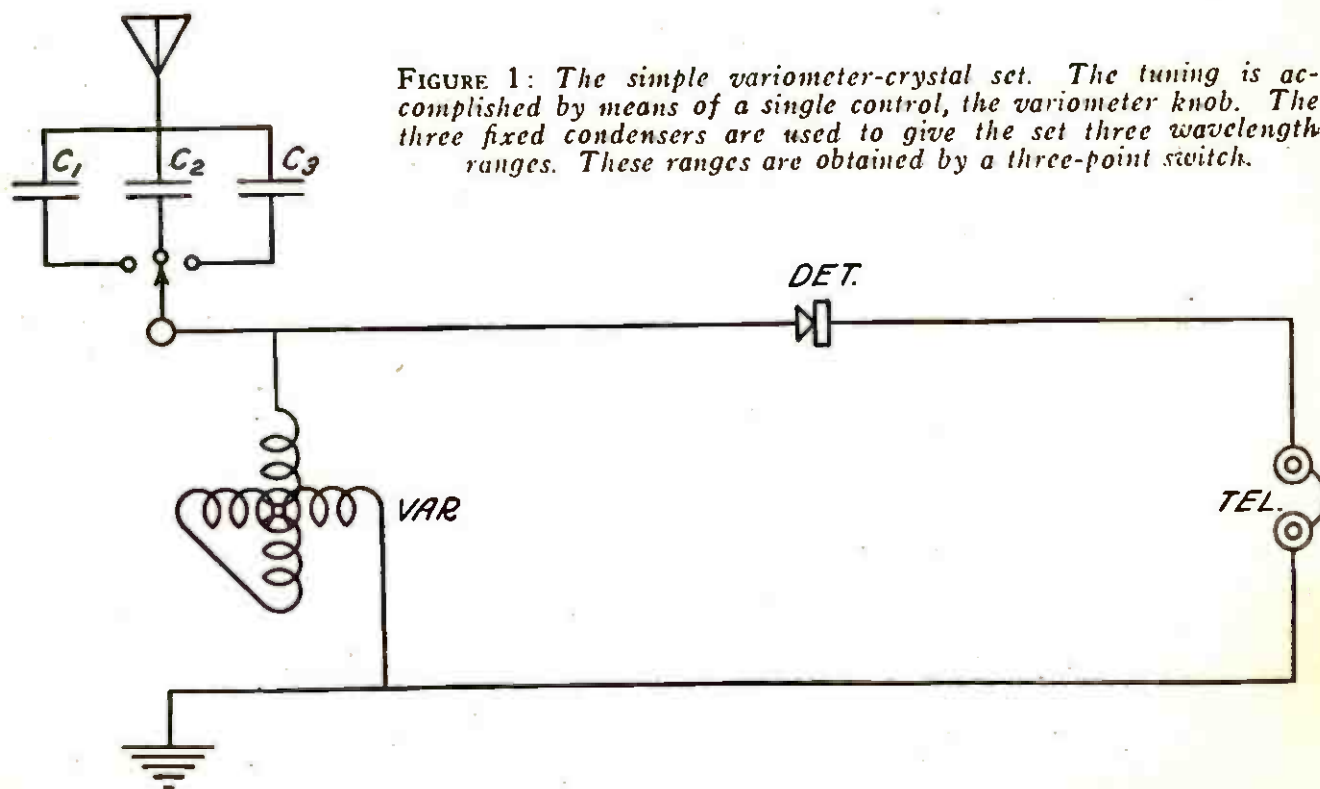
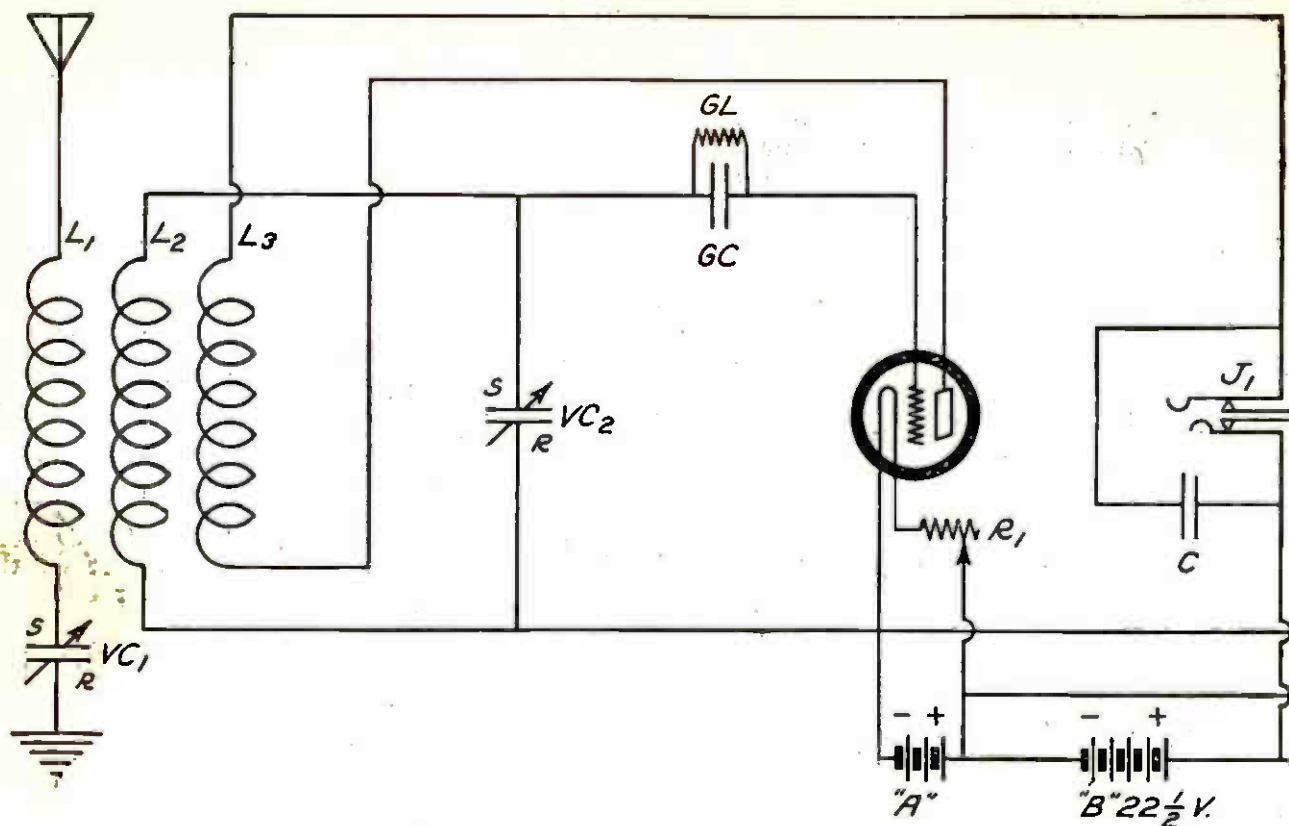


FIGURE 1: The simple variometer-crystal set. The tuning is accomplished by means of a single control, the variometer knob. The three fixed condensers are used to give the set three wavelength ranges. These ranges are obtained by a three-point switch.



QUESTION: I would like to get the proper information and the hook-up for adding two stages of audio-frequency amplification to my present triple-coil set. I have only one tube, and wish to use two more to work a loudspeaker.

Will you also furnish me with a list of parts?

HAROLD FREEMAN

ANSWER: The proper diagram for your completed set will be as found in Figure 2. The extra parts that you will need are:

AFT1 and AFT2—audio-frequency transformers;

J1 and J2—double-circuit jacks;

J3—single-circuit jack;

C—mica fixed condenser, .0005 mfd.;

R2 and R3—filament rheostats;

extra "B" batteries, 67½ volts.

\* \* \*

QUESTION: Will a variable grid leak be better in the four-circuit tuner than the fixed grid leak of two megohms? Will it make the set any more sensitive or is it unnecessary? Before I had my four-circuit set I used a honeycomb receiver and the variable grid leak helped me considerably.

A. V. McCOOMBS

ANSWER: The variable grid leak (if it is a good one) should help if it is connected across from the grid to the negative "A" battery terminal.

QUESTION: I have a single-tube Reinartz receiver, to which I want to add two stages of audio-frequency amplification. I am at present using a UV-200 detector tube and am undecided as to what kind of tube to use for the amplifiers. I have a storage battery that is capable of handling almost any type of tubes, I am told, so I would be obliged if you will tell me which are the best to use, taking into consideration the results, battery load, and operating life.

J. FENNEL

ANSWER: In the October, 1923, issue of POPULAR RADIO you will find an article that gives full instructions showing how to build a two-stage audio-frequency amplifier. This will give you ample details on both the construction and operation of the device. You may use UV-201-a tubes in the amplifier with fine results and with little drain on your batteries. These tubes draw but a quarter of an ampere.

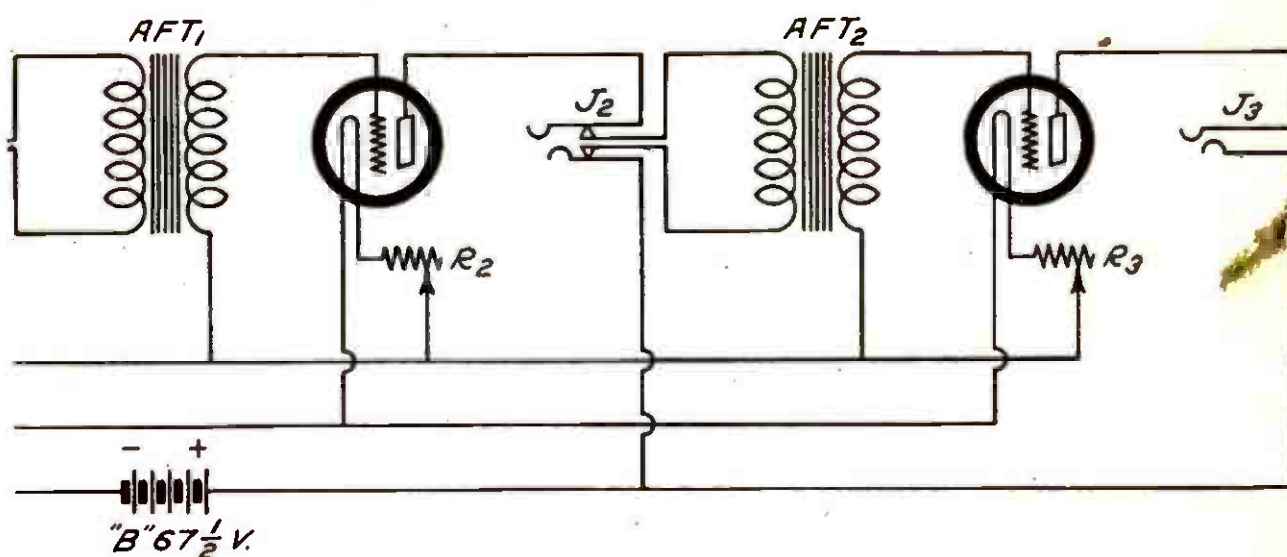
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QUESTION: Will a vernier rheostat help any in controlling regeneration in conjunction with a UV-200 detector tube in a twin variometer-variocoupler regenerative receiver?

K. F.

ANSWER: Yes. Either a wire rheostat with a vernier attachment or one of the reliable makes of carbon-pile rheostats will help considerably.

FIGURE 2: This diagram shows how to add two stages of audio-frequency amplification to the triple-coil regenerative receiver. This will allow of loudspeaker reception of local broadcasting and from out-of-town stations up to 1,000 miles.



QUESTION: What is the ordinary capacity range for fixed condensers used in the grid circuits of detector tubes? What is the capacity that would be the best average to use?

GEO. BRUHN

ANSWER: Grid circuits usually employ a condenser (for isolating the grid) of between .0001 and .00075 mfd. capacity. Any value between these two values will give good results. The most used capacity value, nowadays, is about .00025 mfd.

QUESTION: Are refilled tubes, that have had the filaments repaired any good? I have a number of old tubes with the filaments burned out and I have been considering the advisability of getting them repaired.

H. ANDREW BROWN

ANSWER: If the filament material which is replaced is of the same type and characteristics as the original, and the degree of vacuum repumped the same as when manufactured, the tube will be just as good. It is a question, however, whether a repair company can do this with all makes of tubes.

QUESTION: What materials and instruments should I have to make a good soldering job?

A. H. STEARNS

ANSWER: You will need a reliable electric soldering iron (about ½-pound size), a soldering-iron stand, some strip solder, a good grade of soldering paste, some alcohol, and a clean piece of cloth.

The alcohol and the cloth should be used, after the pieces have been soldered together, to clean off any excess soldering paste that may have run around the joint.

QUESTION: What will give the least hum when used as a voltage supply for a small transmitting radio telephone? I intend to use either an AC power transformer with chemical rectifiers and a filter or a motor generator with a filter. Which shall I use? I don't want to have any hum at all when the voice is used for transmitting.

GEORGE STAVERS

ANSWER: The motor generator and the filter will give the least hum. When you get the generator you can also write to the company that manufactures the apparatus and they will furnish you with the necessary data on the filter system to be used with it.

QUESTION: What is the least number of tubes to use in a super-heterodyne and still get some benefit out of this mode of amplification at a radio frequency?

K. G.

ANSWER: Not less than six tubes.

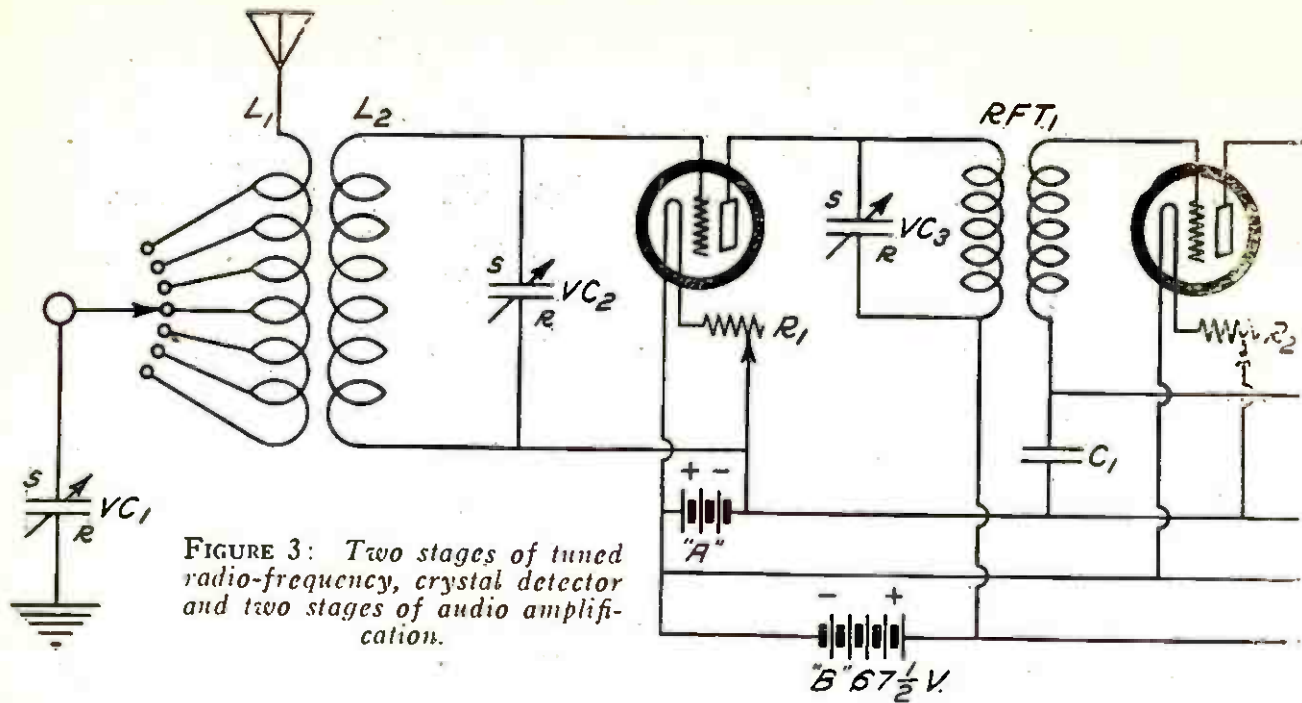


FIGURE 3: Two stages of tuned radio-frequency, crystal detector and two stages of audio amplification.

**QUESTION:** Will you please give me the wiring diagram for two stages of tuned radio-frequency amplification, crystal detector, and two stages of audio-frequency amplification, with the least number of tubes that will be practical. This will mean, I believe, that the reflex principle will have to be used. I have an Amertran and a new Federal transformer; will these be suitable? I also would like to use spiderweb or honeycomb coils for coupling the radio-frequency stages if possible. How many variable condensers will I have to use?

ARTHUR F. BATES

**ANSWER:** The diagram shown in Figure 3 shows how to connect up the instruments that we advise using. This circuit includes two stages of radio-frequency amplification, crystal detector, with one stage of audio-frequency amplification reflexed on the second radio-frequency stage, and one stage of audio added to the whole. This set-up uses only three tubes.

The parts you will require are the following:

L1 and L2—primary and secondary coils of a regular 180° variocoupler;

RFT1 and RFT2—coupler-coil sets, each made up of two honeycomb coils, size L-50, mounted in a double-coil mounting;

VC1—variable condenser, .001 mfd.;

VC2, VC3, and VC4—variable condensers, .0005 mfd.;

C1, C2, and C3—mica fixed condensers, .001 mfd.;

R1, R2, and R3—filament rheostats, (resistance to suit tubes used);

DET—crystal detector.

The two transformers you have mentioned will be suitable for the audio-frequency transformers shown on the diagram at AFT1, and AFT2, respectively.

\* \* \*

**QUESTION:** Would a large horizontal loop wound around the top of the square roof of my house work? The house is of wooden construction and I could set the wires out from the edges on insulators.

GEORGE MARX

**ANSWER:** This would work if the inductance was of the correct value for the wavelength range that you want to receive on. All you would need for tuning would be a variable condenser shunted across the two terminals of the loop. You could determine the correct number of turns to use by trying, say, two or three turns and then reducing the number of turns one at a time until you found the correct number. You might try this out at first, with bell wire and then when you find the correct number of turns to use, you could put in a permanent installation of good antenna wire.

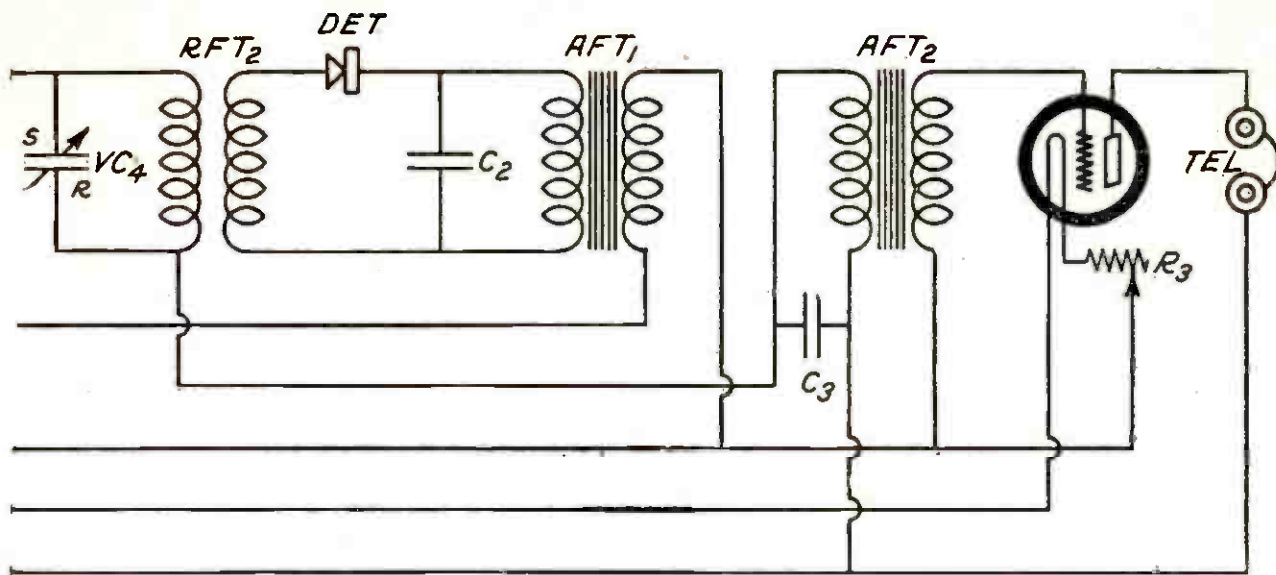
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**QUESTION:** Where can I obtain a license to manufacture regenerative receiving sets to sell to amateurs? I understand that this invention is patented by Armstrong.

A. C. D.

**ANSWER:** The patents on the regenerative receiver are controlled by the Westinghouse Company and the Radio Corporation. We understand that they are not issuing any further licenses for the manufacture of this type of receiver.





QUESTION: I want to get the simplest reflex hook-up that will give me results with one tube and a crystal detector. The hook-up should contain the smallest number of parts and the tuning should be done as simply as possible.

HAROLD V. B. STENTON

ANSWER: The simplest circuit that we know of that will be productive of satisfactory results is shown in Figure 4. Parts needed are:  
 VAR—variometer;  
 C1—mica fixed condenser, .0001 mfd.;

C2—mica fixed condenser, .00025 mfd.;  
 C3—mica fixed condenser, .0005 mfd.;  
 C4—mica fixed condenser, .001 mfd.;  
 C5—mica fixed condenser, .001 mfd.;  
 VC—variable condenser, .0005 mfd.;  
 RFT—two honeycomb coils, size L-50;  
 DET—crystal detector;  
 TEL—telephones;

Suitable vacuum tube, "A" and "B" batteries.

It will be noticed that there is no audio-frequency transformer used in this circuit; the rectified currents from the crystal detector being reflexed back across the fixed condenser C5 which is included directly in the grid circuit of the tube. This and the fact that two honeycomb coils are used in place of the ordinary radio-frequency transformer makes the set inexpensive.

The condenser VC is used to tune the plate circuit of the tube at a radio frequency. Antenna tuning is done, roughly, by placing the switch on either of the three condensers C1, C2, or C3, which brings in the loudest signals when VAR is rotated to the correct setting.

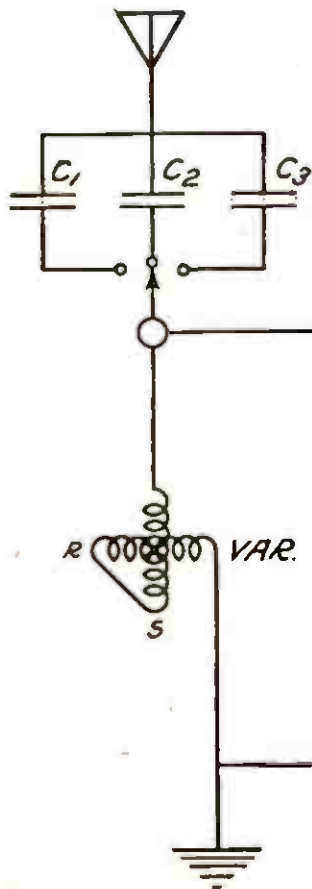
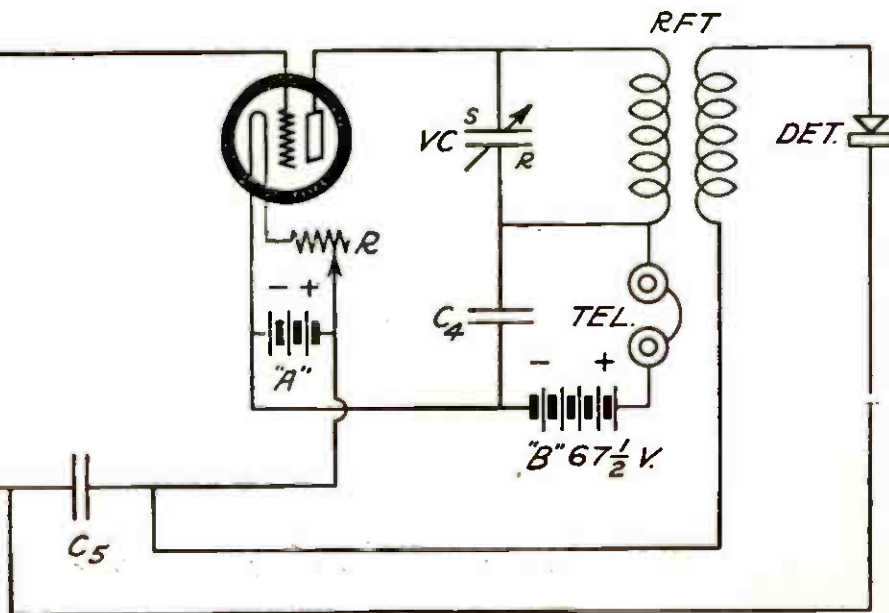


FIGURE 4: A simple reflex set without an audio-frequency transformer.





## BROADCASTS

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

### *Radio Reception from the Doorbell Wiring*

ALMOST anything will serve as an aerial if you have nothing else. Bedsprings, the kitchen stove, a string of cooking pots fastened together and hung on a line, the wire framework of grandmother's ancient bustle, all these and many more have joined the freak aerial list. A less freakish one that often is really useful is the wiring of the front doorbell. Either side of the line may be used and if the connection is made through a condenser there is no interference with the proper use of the bell circuit.

\* \* \*

### *Blind Listener to Check Up on Broadcasting*

WHAT may prove to be an important and remunerative occupation for the blind is forecast by the appointment of Miss Marjory Stewart, who is blind, as official critic on the staff of WBZ. It is well known that blind persons acquire an unusual delicacy of hearing. Judgment of purity of tone and precision of modulation ought to be better in the sightless than in ordinary people. As we have already professional tea-tasters and coffee-smellers whose income depends on especial delicacy of these senses so we may have before long a profession of expert listeners whose duty it will be to detect and report the minor faults of broadcasting quality.

\* \* \*

### *Communicating with Mars by Radio Photographs*

MR. CHARLES MACLEAN, the genial editor of the *Popular Magazine*, amuses himself with some reflections as to how we would make the Martians understand us even if we succeeded, by radio or otherwise, in communicating with our sister planet. Why not, he suggests, try the radio photograph? We can transmit pictures by radio; so, presumably, can the Martians. Following the example of the child's picture book we could send a picture of a cat and accompany it by the appropriate sound, which might be, we suppose, either "kat" or "meeow." Of course, this does not explain how we are to transport the necessary receiving apparatus to Mars, the Martians having failed, one imagines, to develop

the exact equivalent of Mr. Jenkins or Dr. Belin. But when one is engaged in interplanetary speculations it is unkind to suggest minor experimental difficulties like this.

\* \* \*

### *Broadcasting a Heartbeat*

MAGNIFYING the sound of the beating heart so that it can be heard loudly all over a large lecture room, is the latest radio stunt of Dr. Richard Cabot, a well-known Boston physician. Vacuum tube amplifiers are used, the object being to demonstrate to medical students the slight variations of the heart sounds that indicate certain diseased conditions. All the students can hear exactly the same sound at the same time and the instructor can explain just what it means.

\* \* \*

### *Attracting Attention to an S. O. S.*

SINCE not all ships at sea can have a radio operator actually at the listening set every moment day and night, a French inventor has devised a relay apparatus that will operate automatically on the receipt of the series of three dots, three dashes and three dots that constitutes the distress signal. This relay will then operate a bell or other signal that secures the immediate attention of the radio operator or other officer of the ship. The same device could be installed on shore stations, as, for example, in lighthouses and coast-guard stations.

\* \* \*

### *Sherlock Holmes Takes Watts Instead of Watson*

SCOTLAND YARD, the famous center of British police work, is to install two 500-watt transmitter units so that criminal news can be broadcast to the outlying police stations and to affiliated agencies in the provinces. An automobile has been equipped with another set so that officers in the field can keep in touch with the central office. We shall look for some new detective stories in which ether waves replace the footprints and chemical tests of the days when the famous Sherlock lived in Baker Street with the equally famous doctor.

*Why Does Sunlight Help a Crystal Detector?*

ONE of the most mysterious phenomena in the whole of radio science is the familiar crystal detector. Nobody knows, for example, why it is that a crystal will pass the current in one direction and refuse to pass it in the other. Another mystery is the effect of light on crystals. Most crystals will work better if a strong light, like sunlight condensed by a burning glass or the light of a powerful tungsten lamp, is focussed upon them. Galena behaves in this way and so do most samples of pyrite. Other pyrite crystals do not seem to be affected. Carborundum and the tellurium mixtures seem, also, to be unchanged when strongly illuminated. But everything in this field is uncertain and needs more precise scientific investigation. Any radio amateur has a good chance of making important contributions to radio science if he will work out carefully the behavior of known varieties of crystals under different conditions of light, temperature, electric potential and the like.

A \$10.00 crystal set and a dollar's worth of extra crystals may serve to put your name in the radio textbooks if you have patience and skill enough.

*A Curious Coincidence in Broadcasting Explained*

A RADIO listener at Providence, R. I., announces that recently he heard the same selection being broadcast at the same time and in the same key and tempo from two separate stations. A mathematical expert reports that the chances against such an occurrence, assuming that there are at the moment one hundred musical selections of equal popularity and equally likely to be selected for broadcasting, are more than sixteen billion to one. What this fan really heard was the simultaneous broadcasting of a program, via telephone wires, from stations WEAJ and WCAP.

\* \* \*

*Hunting Radio Needles in a Busy Haystack*

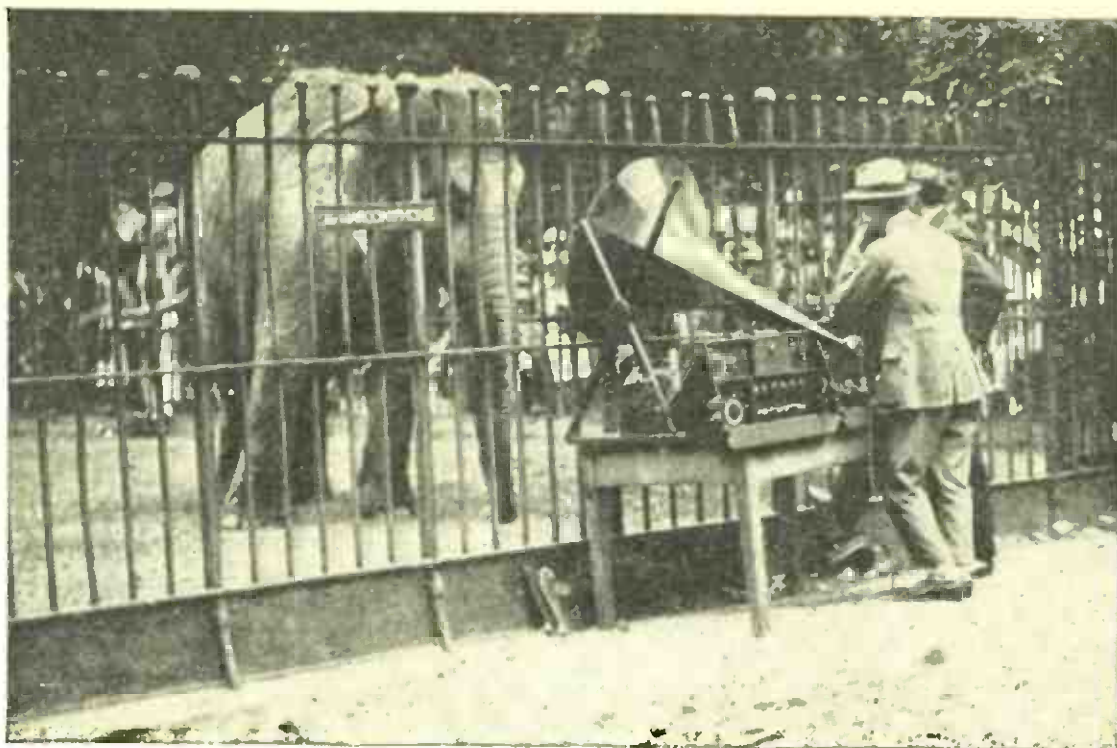
A NEW radio game that anyone can play was invented as a part of the amusement program at the recent Chicago convention of the American Radio Relay League. Somewhere in the city a secret transmitting station was concealed. Players were provided with small loop receiving sets. The game was to locate the secret station by direction bearings taken with the small loops and then trace it down and find it.



Kadel & Herbert

**A BROADCASTING STATION ON WHEELS**

*This interesting novelty is maintained by the Chesapeake & Potomac Telephone Co. for the purpose of enabling station WCAP to broadcast occasions of interest direct from the scene; the truck covers the entire area of the District of Columbia. It is here shown broadcasting the funeral services of President Harding direct from the church.*



#### A LONDON ELEPHANT GETS COMMANDS BY RADIO FROM—

*In an interesting experiment recently, at the London Zoo, this trained elephant was given orders that were broadcast by radio, his master speaking from a broadcasting station miles away. Perhaps the loudspeaker distorted the familiar accents; anyway, the elephant was skeptical and refused to perform.*

#### *Watch Tick Breaks Up Bishop's Speech*

It is unusual to find your enjoyment of the sermon marred because the minister's watch ticks so loudly that you cannot hear his words. Yet that is what happened recently when Bishop W. F. McDowell was broadcasting a sermon by radio. He inadvertently placed his watch close to the microphone and its ticks were magnified so loudly that many listeners complained of inability to hear what the Bishop was talking about.

\* \* \*

#### *Will Radio Make Plants Grow Faster?*

EXPERIMENTS indicating that the growth of plants is hastened by high-frequency electric currents have been reported recently by several separate investigators. Currents were used, not waves; whether actual radio waves will have similar effects remains to be investigated.

\* \* \*

#### *Finding Engine Troubles With a Radio Amplifier*

A NOVEL use for radio has been discovered by a British mechanical engineer. It is well known that the very beginnings of trouble with large rotating machinery, like high-power steam turbines or high-speed dynamos, is indicated by a slight change in the humming sound given out by the machine. Experienced engineers have been accustomed to press an ear now and then against shaft-hangers that they suspected of being not quite true or against bearings that showed signs of trying to get hot. Now this listening is being done by radio. A small microphone is pressed against the suspected

machine. Amplifiers increase the sound so that the faintest beginning of an abnormal chatter can be detected at once. It is suggested that permanent microphones may be installed attached to important machines or bearings, as, for example, to the vital parts of marine engines. These can be connected by wires to an amplifier and a telephone in the office of the chief engineer. By plugging in for each microphone in turn this official can keep a continual eye, or rather an ear, on all the machinery under his charge.

\* \* \*

#### *Sound Waves of Radio Frequency*

SOUND waves of frequencies so high as to be inaudible have been produced in France and used in scientific experiments. Though these waves are in air or water, not in the ether, they are well within the frequency range of radio waves.

\* \* \*

#### *Another Battleship To Be Equipped With Radio Control*

THE United States battleship, *North Dakota*, built in 1910 and now due to be scrapped under the disarmament treaty, is to be equipped with radio control and used in gunfire and bomb tests as the *Iowa* was last year. The cost of the ship was over \$7,000,000 and it is estimated that \$100,000 or more will be spent in refitting the ship for target use and in adding the apparatus for radio control. But the cost is felt to be justified by the information obtainable concerning the resisting power of armor plates and the effects of modern airplane bombs and



—HIS TRAINER, MILES DISTANT

This is Syed Ali, the Indian trainer of the elephant shown on the opposite page, broadcasting his command from Station 2LO in London.

high-power shells. Further valuable information will be acquired, we imagine, concerning the methods of controlling machinery of such bulk and complexity by radio signals.

\* \* \*

*Taking Congress to the Public*

The Chamber of Deputies of the Argentine Republic (corresponding to our Congress) has taken steps to make the public listen to their proceedings whether the public wants to do so or not. A broadcasting station has been installed in the chamber at Buenos Aires in which the Deputies meet. Debates are broadcast and trucks equipped with receiving sets and loudspeakers are stationed from point to point around the city to pick up these debates and pour them into the ears of such of the citizens as chance to be on the streets.

\* \* \*

*Amateurs Asked to Help Radio Test*

A TEST suggested some time ago by Mr. Thomas A. Edison is to be carried out by the Aerial League of America. Mr. Henry Woodhouse, President of the League, asks radio amateurs all over the world to co-operate during the present winter in keeping regular daily records of radio reception at their stations, including signal strength, direction of the wave and, if possible, any accompanying magnetic

conditions such as the aurora. Prizes are offered for the best report. Information can be obtained from the Aerial League of America, 280 Madison Ave., New York City.

\* \* \*

*Sound Waves from Explosions Fade Like Radio Signals*

RECENT experiments in Holland indicate that the sound wave going out from a great explosion shows phenomena of "dead spots" and "fading" the same as are exhibited by radio waves. The theory for this behavior of sound is still a mystery.

\* \* \*

*Is "Fading" Caused by City Smoke?*

COMPLICATED fading phenomena which have been causing trouble with broadcast reception in the neighborhood of London may be due, it is suggested, to the increased conductivity imparted by smoke particles to the air over the city.

\* \* \*

*Radio to Call the Car for You*

IF a recent suggestion of Dr. De Forest is adopted, the calling of automobiles for patrons of theaters and concert halls may be done by radio. The present systems of luminous number signals may go into the discard to join the former megaphone man who used to bawl out totally unintelligible numbers over the heads of the after-theater crowds. Each automobile might be equipped, Dr. De Forest suggests, with a small receiving set working on a loop. A tuned transmitting set could be installed at the theater exit. The man in charge of this transmitter would merely speak into it saying, for example, "Mrs. Jones' car is wanted at the side exit." All the waiting chauffeurs would be listening, even if they were around the corner out of sight or in a nearby garage. Mrs. Jones' car would arrive exactly where she wanted it much more quickly than is possible under any present system.

\* \* \*

*Will Three-foot Waves Prove Practical?*

EXPERIMENTERS in England are now working with transmission of signals over radio waves as short as one meter. These very short waves have been produced previously in laboratories but have had only a scientific interest.

\* \* \*

*Radio Lighthouses Grow in Favor*

EXPERIENCE with the revolving radio lighthouse at Inchkeith has been so successful that two new stations on the same system are to be erected by the British Government.

\* \* \*

*A Short-wave Broadcasting Station*

A NEW short-wave broadcasting station has been opened at Christiania, Norway. It transmits on a wavelength of 390 meters, the shortest wave in use so far on the Continent of Europe.

**Q** IN the next issue of POPULAR RADIO—for February—will appear a short article by Mr. Laurence M. Cockaday that will tell how to add to the Four-circuit Tuner described in May, 1923, to include the improvements contained in the article on page 23 of this number.

*Important Vibrations Even Below Audio Frequency*

THERE is a new profession, the vibration engineer. He is the man who studies and stops the annoying vibrations sometimes set up in steel buildings by machinery or other causes. Most of these vibrations are below the frequency of 30 or 40 vibrations a second, which is the lower limit of audible sound. Otherwise they are just like sound vibrations. The detector that the vibration engineer uses is a special form of seismograph, a modification of the instrument used to record earthquakes. The characteristics of these infra-audio vibrations, their resonance and interference and the like, are much the same as those of other vibrations. It is probable that the increased study of vibrations in general which has resulted from the advance of radio will assist the control and prevention of these mechanical vibrations as well. One branch of science sometimes proves of unexpected value to other branches. Radio has been no exception. It is already of the greatest service to many other sciences, as was pointed out by General Ferrié in the October number of POPULAR RADIO.

\* \* \*

*More Radio in the Arctic*

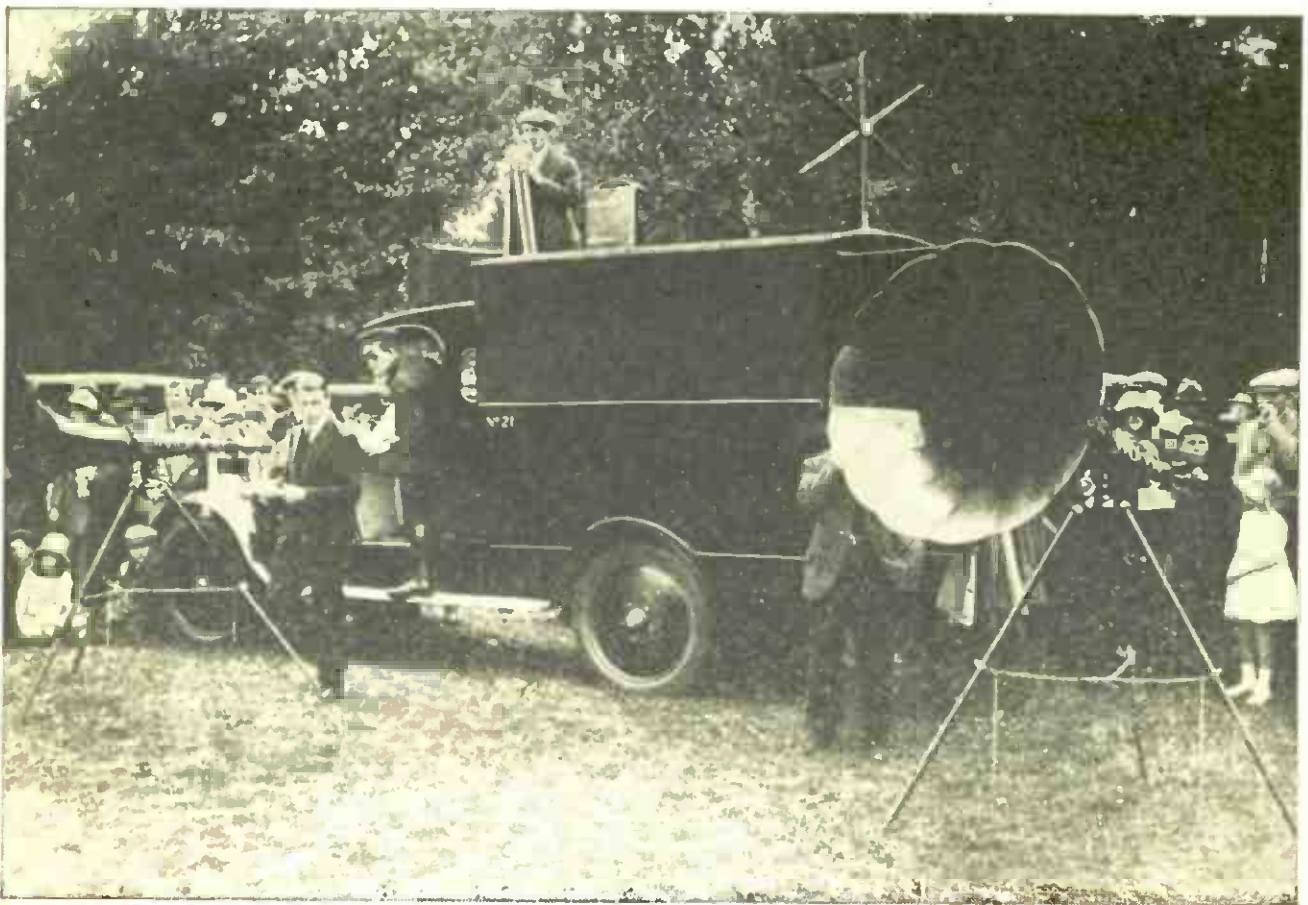
RECEIVING sets are to be distributed to the men in charge of the Hudson Bay Company

in northern Canada and elsewhere in the arctic where the posts are snowed in and communication is impossible all winter. It is hoped that broadcast concerts from the United States can be received and will help to pass the long winter nights for the men who have to live in these inhospitable regions. It is probable, also, that a good deal of information will be obtained concerning radio transmission in the arctic and in the neighborhood of the magnetic pole, and concerning the relations between radio transmission and the electromagnetic phenomena that accompany the Aurora, some problems of great scientific interest that are discussed by Mr. Henry Woodhouse in this number of POPULAR RADIO.

\* \* \*

*The Flood of Radio Literature*

ACCORDING to a count made by the exchange department of POPULAR RADIO there are now being published in the world 61 magazines devoted exclusively to radio. Of these 38 are in English. This count does not include about fifty periodicals that devote departments or special articles to radio nor does it take account of some two hundred newspapers, here and abroad, that have radio pages, columns or departments. It is safe to say that well over 400 separate radio publications are issued in the world each month.



International

**A UNIQUE "RADIO PICNIC"**

On this motor truck are mounted a powerful receiving set with huge loudspeakers and a loop antenna. When the Junior Oar Club recently held an outdoor festival at Burnham Beeches, England, this apparatus was used for picking up programs broadcast from the European stations, for the wholesale entertainment of its guests.



## IN THE WORLD'S LABORATORIES

### Shaking the Earth by Radio Power

THE often-quoted idea that the earth as a whole might be set into electric oscillations of high frequency, with valuable consequences for mankind, has been revived with greater scientific authority than ever before through a recent article of Mr. Leon Bouthillon, chief engineer in the telegraph service of the French Government.<sup>1</sup>

The idea itself is not unfamiliar to radio engineers. An antenna can be set into regular electric vibrations by any source of high-frequency oscillations and each antenna has, of course, its own "natural" frequency at which it will oscillate, if untuned by condensers or otherwise and if left to itself. The whole earth can be considered as such an antenna, or (to make the analogy more evident) the earth may be considered as a ball attached to the end of an oscillating antenna. Metallic balls like this, attached to wires, were used, in fact, in the early radio experiments of the great Italian physicist Righi, the scientific instructor of Marconi.

The earth, considered thus as an antenna, has, of course, its own natural frequency. It is, says Mr. Bouthillon, about six cycles a second, corresponding to a wave of 50,000,000 meters or approximately 31,000 miles. There is every reason to believe that the earth, once set into electric vibrations at this natural frequency, would continue to oscillate at the same frequency until the energy of the oscillation was extracted artificially or dissipated itself in some accidental way.

The practical possibilities depend, obviously, upon how fast the energy would be so dissipated. It might be absorbed rather rapidly by eddy currents in the rocks or in the ocean. It might come somehow into conflict with energy or material being received continually from the sun or from space. How effective these energy-absorbing factors might be cannot be foreseen.

But suppose they should prove, as is possible,

1. "Anticipations Concerning the Transmission of Energy to a Distance," by Leon Bouthillon. *Radio-Électricité*, Vol. 4, pages 397-400 (October 1, 1923).

to be comparatively ineffective. Suppose the earth should prove to be tunable, so that its oscillations would continue indefinitely at the same period. If these things should prove to be the case (and no one can assert that they are not) we would be possessed, says Mr. Bouthillon, of a new and remarkably effective way of transmitting power. Great power stations at favorable points, such as Niagara or the tremendous falls of Africa, now unused, would feed their energy into the oscillating earth in the form of currents at the natural frequency of six cycles a second. Tuned receivers anywhere on the earth could extract this energy at the same frequency, just as a radio receiver extracts the energy of a radio wave to which it is tuned.

The possibilities are alluring but it is too soon, as Mr. Bouthillon is careful to point out, to regard them as practicabilities. The vistas opened into the possible future do reinforce, however, the urgency of making accurate and comprehensive scientific studies of the electrical properties of the earth.

### Two Waves Work Better than One

A NEW radio system that is suitable for radiophone work or for use with CW code signals has been described by Mr. Howard J. Tyzzer.<sup>1</sup> It depends upon the use of a doubly modulated wave.

Suppose the primary wave is 300 meters. On top of this there is produced a continuous modulation at another frequency that is much lower than the frequency of the primary wave, corresponding (say) to a wavelength of 5,000 meters. This second or superposed frequency, which is still well above audible frequency, is soundless. The interruptions that correspond to code signals or the fluctuations (within audio frequencies) that correspond to the voice are then superposed by a second modulation upon the first, or 5,000 meter, modulation.

The advantage claimed for this system is that the receiving set can be tuned, in effect,

1. "A New Radio System," by Howard J. Tyzzer. *QST*, Vol. 7, No. 3, pages 15-18 (October, 1923).

for two separate frequencies, that of the primary wave (300 meters) and that of the continuously modulated wave (5,000 meters). This removes most of the interference and atmospherics, as only those interfering impulses that coincide with *both* of these critical frequencies will pass the doubly tuned filter mechanism of the receiving set. It is even possible, Mr. Tyzzer states, for two stations to transmit on the same primary wave (300 meters) without interference provided they use different superposed modulation frequencies; one, say, at 5,000 meters, the other at 6,000 meters.

Details of the necessary hook-ups are given in the article in *QST* and Mr. Tyzzer announces his willingness to supply further information to amateurs who are desirous of experimenting with this system. He may be addressed at the American Radio and Research Corporation, Medford Hillside, Mass.

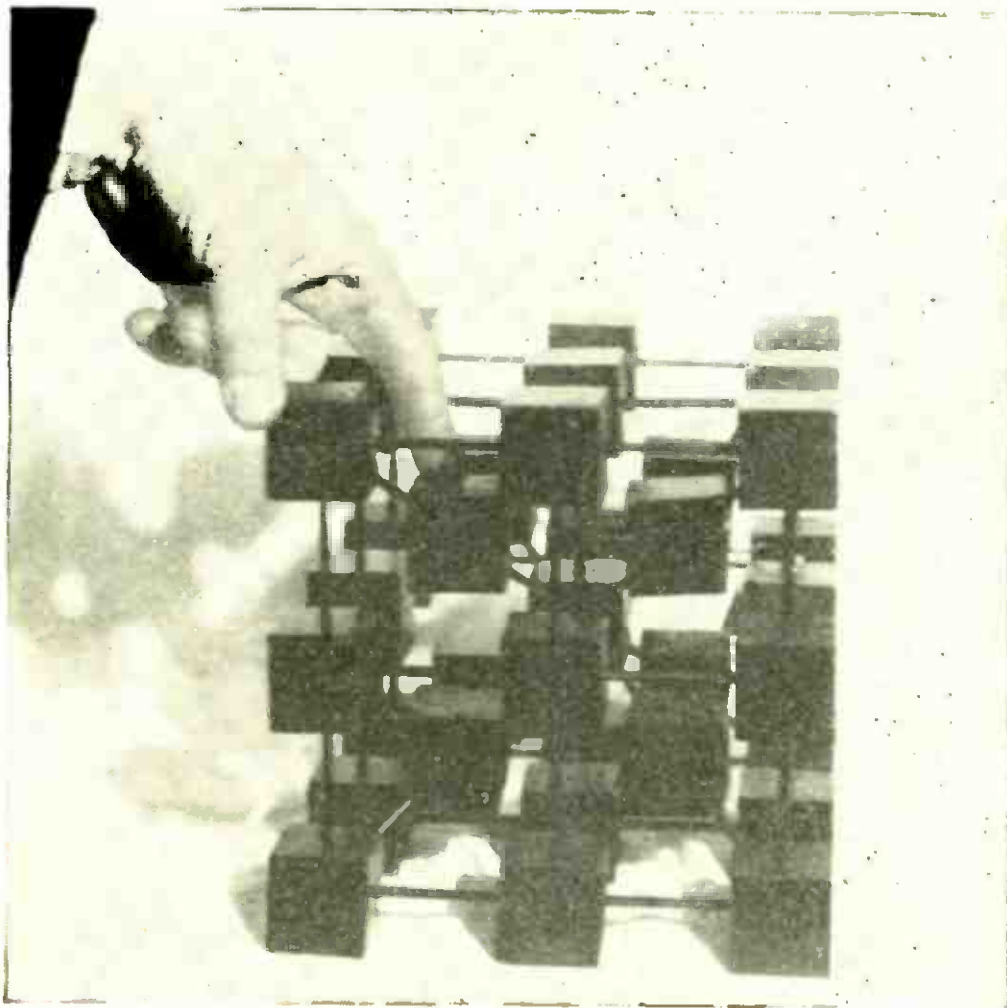
### Man Is Made of Electricity

FEW scientific events of 1923 have attracted more attention, from scientist and layman alike, than the presidential address of Sir Ernest Rutherford at the recent meeting of

the British Association for the Advancement of Science, delivered at Liverpool, England, on September 12. Sir Ernest's subject was no less than the basic substance of which everything in the material universe is built. This fundamental substance, he said, is electricity. The earth under our feet, the stars over our heads, the structures of the human body, even that mysterious organ, the brain, that embodies what we call the human mind; all of these consist, in the last analysis, of electricity and of nothing else.

Sir Ernest Rutherford has long been a leader among the scientists who have been experimenting on the ultimate structure of matter. He it is who accomplished recently the age-long dream of the alchemists and succeeded in transmuting one kind of matter into another kind. Conjointly with Dr. Chadwick he succeeded, in fact, in transmuting six different kinds of matter. The atoms of nitrogen, boron, sodium, fluorine, phosphorus and aluminum were disintegrated in these famous experiments and were made to yield, among other things, new atoms of hydrogen.

In his Liverpool address Sir Ernest reviewed the information that has been won from these and other experiments. He pictured vividly the modern conception of what



American Chemical Society

#### THE SKELETON IN A PIECE OF IRON

*The little wooden blocks of this model are arranged in the same positions as the central electric charges in the atoms of metallic iron.*





Brown Bros.

#### WEIGHT OF A FINGER BENDS THREE-INCH IRON BAR

*This apparatus developed by the United States Bureau of Standards demonstrates the extreme accuracy with which measurements can be made by using light waves. The weight of the finger bends the bar enough to be easily perceptible.*

an atom of matter is. It is entirely an electrical conception.

The simplest known atom is the atom of hydrogen. At the center of this atom there is a particle of positive electricity. Revolving around this central particle, in an orbit not unlike the orbit of our earth around the sun, is another particle, this time a particle of negative electricity. This outer, planetary particle is, in fact, nothing else than the familiar electron. That is all there is to the hydrogen atom. It is all electricity; a particle of positive electricity at the center and a negative electron revolving in an orbit around it.

This is, of course, the simplest atom. It has only one particle of each kind. But other kinds of atoms, those of iron or copper or radium or any of the other elements, are composed of these same particles only there are more of them. "There is," says Sir Ernest, "the strongest evidence that the atoms of matter are built up of these two electric units, *vis.*, the electron and the hydrogen nucleus or proton, as it is usually called when it forms part of the structure of any atom. It is probable that these two are the fundamental and indivisible units which build up our universe, but we may reserve in our mind the possibility that further inquiry may some

day show that these units are complex, and divisible into even more fundamental entities.

"On the views we have outlined the mass of the atom is the sum of the electrical masses of the individual charged units composing its structure, and there is no need to assume that any other kind of mass exists. At the same time, it is to be borne in mind that the actual mass of an atom may be somewhat less than the sum of the masses of component positive and negative electrons when in the free state. On account of the very close proximity of the charged units in the nucleus of an atom, and the consequent disturbance of the electric and magnetic field surrounding them, such a decrease of mass is to be anticipated on general theoretical grounds."

The attainment, in the past fifteen years, of this revolutionary and yet extremely simple conception of how the ground-stuff of the universe is made up must rank, Sir Ernest believes, among the most far-reaching of scientific achievements, an achievement for which he modestly gives most of the credit to others.

He is hopeful, too, that the progress of these fundamental investigations will continue, that discoveries of still greater moment are on the way. "There appears to be," he says, "no obvious sign that this period of great advances

has come to an end. There has never been a time when the enthusiasm of the scientific workers was greater, or when there was a more hopeful feeling that great advances were imminent."

## Testing the Einstein Theory with a Tile Pipe

WHEN Professor Einstein announced his famous theory he described three consequences, commonly called "proofs," of it. They were, *first*; the change in the orbit of the planet Mercury, unexplained by the ordinary theories; *second*; the bending of light rays from the stars as the rays pass close to the sun, and, *third*; a slight displacement of the spectrum lines in sunlight as compared with the same lines produced on earth.

Careful efforts to detect this third effect<sup>1</sup> have failed until this year, but at the meeting of the American Association for the Advancement of Science at Los Angeles in September, Dr. Charles E. St. John of Mount Wilson Observatory announced that he and his associates had finally succeeded in measuring the crucial spectrum lines with the requisite degree of precision. The results are confirmatory of the Einstein Theory, which marks another triumph for the theory and another step, presumably, toward its general acceptance by physicists.

Meanwhile Professor Albert A. Michelson of the University of Chicago (who devised the apparatus a year or two ago by which the size of the giant star Betelgeuse was measured) is planning still another test of the whole Einstein point of view. Jointly with Professor Henry G. Gale of the same university, Professor Michelson is installing a two-foot tile pipe across the military drill-ground used by the students. By apparatus in this pipe, the two professors will attempt preliminary experiments to determine whether or not there really is an ether which the earth drags with it as it rolls along through space. This is the same problem that was attacked by Professor Michelson and Dr. Morley many years ago in the famous experiment known by their names and which experiment led, when it failed to detect the ether, to the fundamental assumptions of the Einstein Theory.

If the new experiment comes out the same as the earlier one the Einstein Theory will be left undisturbed. But if this repeated attempt to detect the real existence of the ether should happen to succeed, Professor Einstein will have some difficulty in explaining it away.

In spite of great preparations, probably the greatest ever made by the scientific professions for a similar event, the eclipse of the sun that occurred in September was a scientific failure. The weather of Southern California, which in spite of the insistency with which it is advertised, is really admirable, proved for once to be fickle. Rain at this time of the year is almost unknown in Los Angeles but this year

it occurred and it picked out the very day and minute of the eclipse. Everything was obscured by clouds and no scientific results were obtained. A few photographs of the corona were obtained by a small expedition a little farther north, at Lompoc, California, and some results are reported from the Mexican expeditions. Apparently, however, no further information bearing on the Einstein Theory was obtained.

Another piece of news concerning the theory is that the allegations of plagiarism recently made against Professor Einstein have been disproved. Dr. Robert Trumpler, writing in a recent number of *Science* (New York) reports that he has examined the original paper of the long-dead mathematician, Soldner, from whom Einstein was alleged to have "borrowed" his value for the bending of light as it passes the sun.

The early astronomer did obtain, Dr. Trumpler reports, a value for the bending which is numerically almost the same as Einstein's value. But this result was accidental. Soldner made a mistake in his figures and this mistake made his result come out right though his theory was wrong. His work was in no sense an anticipation of the Einstein ideas.

## Radio Better During the Eclipse of the Sun

ALTHOUGH the attempt of the astronomers to secure new photographs of the solar eclipse were so largely unsuccessful, the radio experts were more fortunate. Measurements of the signal strength of KHJ, Los Angeles, before, during and after the eclipse were obtained at a number of stations located in Southern California and in Mexico within the band of total darkness.

The results, so far as they have been collected and studied, seem to indicate that the effect of the eclipse was indistinguishable from the effect of normal night-time darkness. Signal strength increased as soon as the shadow of the sun arrived, exactly as it does normally at sunset. As soon as the eclipse was over the signal strength decreased as it does at daybreak. Both the increase and the decrease were proportional, so far as could be determined, to the fading and brightening of the light itself.

It would seem, therefore, that the effect of the sun upon radio transmission, however this effect is produced, must be closely related either to the sunlight itself or to some other ray which travels through space with exactly the velocity of light. Were we to ascribe the radio differences between night and day to electrons or any other kind of material particles shot out from the sun we would expect a lag between the beginning of the eclipse as marked by the diminution of sunlight and the onset of the changes in radio transmission. No material particles could be expected to move through space with *exactly* the velocity of light, though they might approach it.

1. See POPULAR RADIO for November, page 410.



Brown Bros.

## A PHOTOGRAPH MADE BY RADIUM

*These coins and key, wrapped in light-tight black paper, were photographed by the rays from a tiny quantity of radium, just as though the black paper had not been there. These same radium rays can be made to operate a vacuum tube such as is commonly used in radio.*

### Can We Make Vacuum Tubes Out of Radium?

THERE are so many newspaper reports of new radium filaments and of radio-active vacuum tubes that it is worth while to see just what the possibilities are in this direction.

Radium gives out, among other things, a continual stream of electrons. A filament of metallic radium in a vacuum tube would produce electrons continuously, whether it were hot or cold, for thousands of years. It would avoid, therefore, any necessity of heating the filament. The heating battery could be dispensed with and the filament would never wear out or burn out.

This would be very pleasant, but filaments of metallic radium are impossible if for no other reason than because one of them would cost some half-million dollars. What is actually proposed and has been many times attempted is to construct a tube in which the hot filament as a source of electrons is replaced by a preparation containing a very little radium but which is still capable of giving off a continual stream of electrons. A familiar example is the material used in the face figures of the so-called radium watch. This

material really does contain a little radium. The activity of the radium produces light from another constituent of the material and that is why the figures shine in the dark.

Now similar compositions containing radium can be made so that they will produce electrons instead of light and they can be put into vacuum tubes instead of the filament. A radium tube is, therefore, possible in theory. It is quite another matter whether it would be really useful.

One of the great advantages of the heated filament as a source of electrons is that it is controllable. You can regulate the filament temperature as you wish. When it is hot you get many electrons and a large tube current. When it is cool you get few electrons and small current. With a radium tube you could not do this. The number of electrons would be absolutely constant, almost exactly the same number, second by second, for hundreds of years. It seems to us, therefore, that the advantages of avoiding the heating battery and of long life, which advantages a radium tube would presumably offer, are more than offset by the disadvantage that the electron emission would not be controllable so easily and directly.

## Novel Innovations in Radio Detectors

THREE years ago it was discovered that a charged metal plate placed in close contact with a non-conductor would adhere to it. The first experiments were with plates of metal pressed down tightly against the very smooth kind of stone used in lithography. The phenomenon was interpreted, no doubt correctly, as a special case of electrostatic attraction. Just as the negatively charged pith ball in the familiar high-school experiment approaches and adheres to the positively charged rod of glass or rubber, so the charged plate adheres to the stone, in which its charge has induced, of course, a charge of the opposite sign.

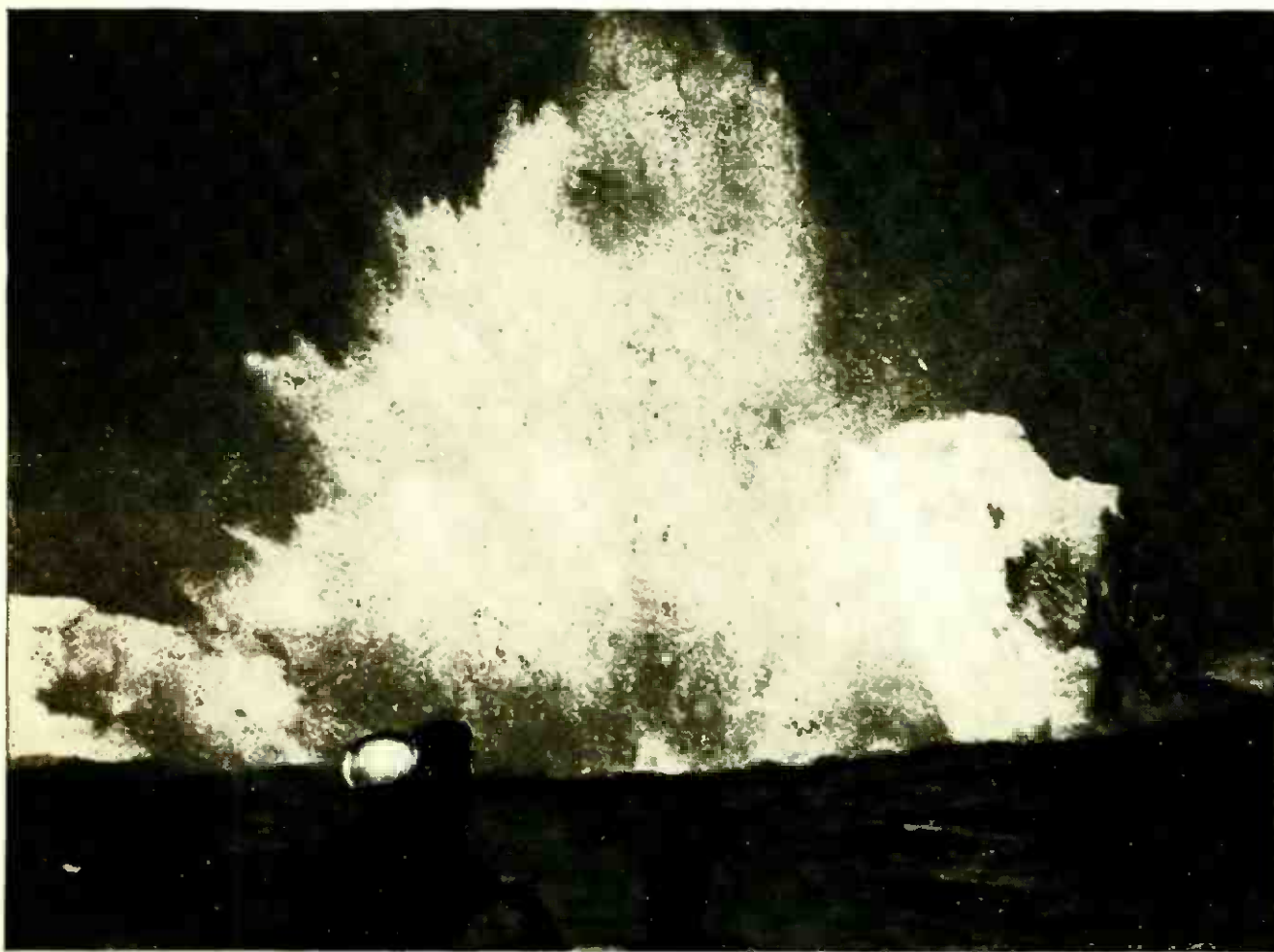
This effect was described by its discoverers, Dr. Alfred Johnsen and Dr. Knud Rahbek in the *Journal of the Institution of Electrical Engineers* (London) in 1921 and has since been well known to scientists under the name of the Johnsen-Rahbek effect.

According to a more recent article by these same scientists in the same *Journal* the effect has now been applied to the construction of several forms of telegraphic relay, one of

which can operate as a radio recorder, and to a new form of loudspeaker. The principle is the same as in the earlier experiments but the apparatus is differently arranged. The plate of stone is replaced by a non-conducting cylinder (which may be of stone) revolving inside a metal strip. When this metal strip is charged it adheres a little to the revolving cylinder and the friction between them increases, just as though they were two pieces of ice between which you had poured a handful of ashes. This makes, of course, an increased drag on the metal strip, which drag may be recorded by the movement of a pen attached to the strip or in any other convenient fashion.

For the receipt of radio signals and for the loudspeaker the electric impulses are communicated to the metal strip. Whenever the potential of the strip is raised (by the signal) the strip adheres and drags. This sets the strip in vibration, the frequency being the same as that of the signal.

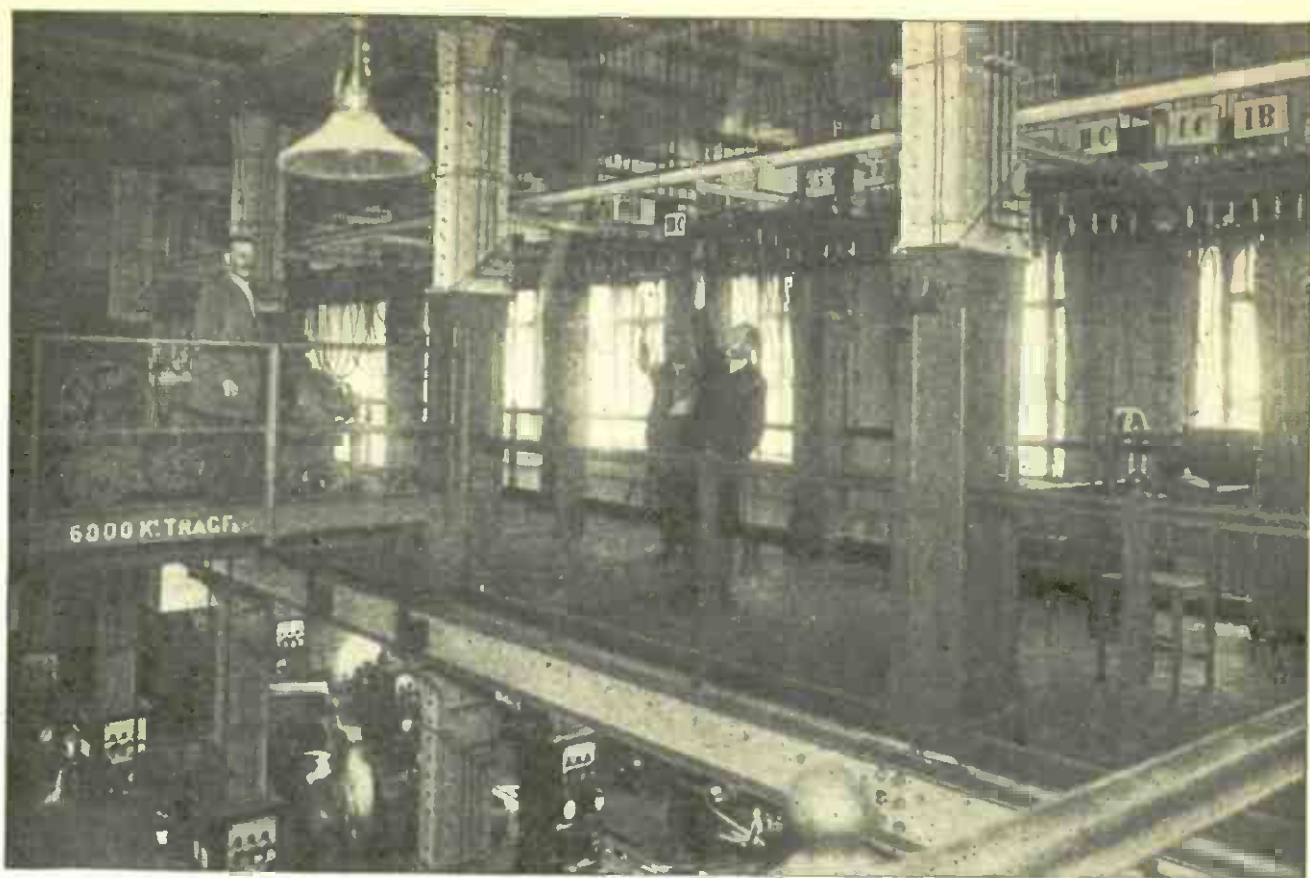
This application of electrostatics is interesting and well deserves attention but it does not seem to be quite as revolutionary as some of the published statements about it would



U. S. Coast Guard

### RADIO GUARDS AGAINST THE ICEBERG PERIL

*The chance of another great sea disaster like that of the ill-fated TITANIC is now much lessened by radio. Special patrol boats watch for icebergs and ship captains who chance to sight them report to the Coast Guard by radio and a cutter is dispatched immediately to blow up the dangerous berg with T. N. T.*



Armstrong Perry

#### A REMARKABLE ELECTRICAL LABORATORY IN AUSTRIA

*The various experimental set-ups in the Electrotechnical Institute at Vienna are located on the floor beneath and the balcony is used for making "connections" to the apparatus below; the two men in the picture with their arms outstretched above their heads are pushing in the connecting plugs into the sockets located in the overhead switchboard. The laboratory is fully equipped with almost any kind of electric current from low-voltage D.C. to high-voltage D.C. and with alternating currents of all frequencies and voltages imaginable.*

imply. In the loudspeaker, for example, it is difficult to see how this apparatus avoids trouble from the natural frequencies of the metal strip and of the attached apparatus, the same trouble that has caused so much difficulty with the forms of telephone and of loudspeaker that depend on vibrating diaphragms.

These objections do not apply, of course, to the use of the apparatus for the detection or recording of code signals, or for scientific uses or other purposes where it behaves merely as a sensitive relay. For example, a precision chronograph based on the Johnsen-Rahbek principle has been constructed in Germany<sup>1</sup> and it is announced that several other relay devices are in course of development.

There has been perfected in England a somewhat analogous form of detector which is now in use in several marine radio installations, including the Atlantic liner *Majestic*. This is the magnetic detector of Dr. N. W. McLachlan.<sup>2</sup> Instead of the revolving stone

1. "The Measurement of Bullet Velocities by an Electrical Apparatus Using the Johnsen-Rahbek Effect," by Karl Rottgardt. *Zeitschrift für technische Physik*, Vol. 4, pages 63-65 (1923).

2. "The Application of a Revolving Magnetic Drum to Electric Relays, Siphon Recorders and Radio Transmitting Keys," by N. W. McLachlan. *Journal of the Inst. of Electrical Engineers (London)*, Vol. 61, pages 903-933 (August, 1923).

cylinder of the Johnsen-Rahbek apparatus, Dr. McLachlan employs a revolving drum of soft iron. Inside this drum are coils through which pass the feeble currents from the reception antenna or whatever other currents it is desired to magnify. Against the surface of the revolving iron drum, or rather in a little groove machined into the drum, there presses a small iron armature. Whenever a current passes through the coils inside the drum the magnetic attraction induced in the iron of the drum itself attracts the armature so that it drags on the drum surface, just as the metal strip drags on the stone cylinder used by Johnsen and Rahbek.

So far, the apparatus is merely one form of electromagnetic relay. The new principle comes in in the surprising fact, discovered by Dr. McLachlan, that the drag thus produced on the iron armature is over *fifty times greater* than it ought to be according to the customary theories of electromagnetic induction and of mechanical friction. It is evident that there is coming into play some unusual force, probably analogous to the forces discovered by Johnsen and Rahbek, and that this force, like the ashes on ice, increases materially the adherence between the revolving iron drum and the iron armature which touches against it.

Still another piece of recent apparatus makes use, though in a somewhat different fashion, of the friction between a moving surface and a fixed one. This is the new loudspeaker developed in England by Mr. S. G. Brown and christened by him the "frenophone." In this apparatus a glass disk, much like the disk-record of a phonograph, is made to revolve under a small vertical rod tipped, on its lower end, by a pad of flannel. An electromagnetic device of usual character is arranged to receive the current impulses from the detector and to translate them into mechanical pressures. Whenever a pulse of current is received the little flannel pad on the end of the vertical rod is pressed down a trifle more heavily against the glass disk revolving under it. This increases, of course, the drag of the flannel pad against the disk. If the current pulses have an audio frequency, as they do in speech reception, the flannel-tipped rod is set into vibration. This vibration is transmitted by a taut string to a diaphragm and a considerable volume of sound is thus produced.

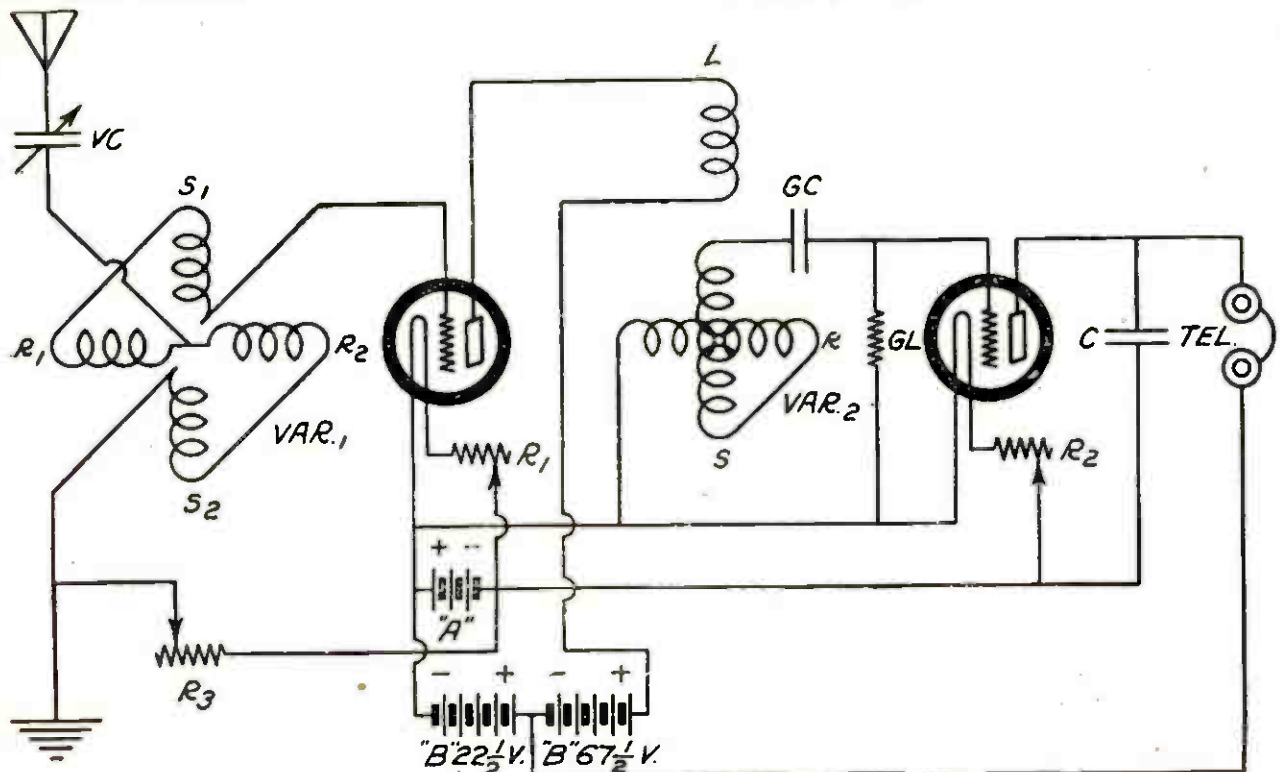
It is interesting to notice that all of these new devices accomplish really the same thing. They are mechanical amplifiers. A feeble disturbance created by the electric impulses is converted into a more ample disturbance, mechanically, not electrically. The extra power comes from the motor used to rotate the cylinder or the disk. Whether this plan of mechanical amplification will prove in the long run to be more efficient or less troublesome than electric amplification by vacuum tubes or electromagnetic amplification by transformers or relays, only time and further experiment will disclose.

## How to Seal Wires Through Glass Tubes

THE most difficult problem that confronts the amateur maker of vacuum tubes for experimental purposes is that of sealing the necessary lead-in wires through the glass of the bulb. Even to a more or less experienced glass-blower this is a matter of some difficulty because the expansion and contraction of the wire with change of temperature is not the same as the percentage expansion of the glass. This difference in expansion produces strains that appear as soon as the glass-wire joint cools and that usually either break the glass or pull the wire loose from it.

Aid for the experimenter confronted with this problem is furnished by Mr. William G. Housekeeper, well-known experimenter with high-power tubes, who describes in a recent article the methods that he has developed for making this difficult glass-metal seal.<sup>1</sup> The secret is to make the contact of the glass and the metal as broad as possible. The strain is thus distributed over a larger surface and becomes less dangerous. Three definite methods have been developed. One is to flatten the wire so that it is somewhat ribbon-like. A second is to use an actual ribbon of metal instead of a round wire. The third method is the tube seal, a glass tube being sealed fast to a metal tube of approximately the same diameter.

1. "The Art of Sealing Base Metals Through Glass," by William G. Housekeeper, *Journal of the Amer. Inst. of Electrical Engineers*, Vol. 42, pages 954-960 (Sept., 1923).



A NEW RECEIVER FOR USE BELOW 100 METERS

This combination of tuned radio frequency with regeneration is used in the new short wave receiver devised by Mr. William F. Diehl and described by him recently in the radio section of the *New York Sun and Globe*.

## HINTS FOR

## AMATEURS



COAT the terminals of the storage battery with a thin covering of vaseline and you will prevent them from eating away.

\* \* \*

Do not place the tuning coils (inductances, variocouplers, variometers) in your set so that they will be situated too near the wooden cabinet.

This will cause losses in the radio-frequency circuits if you do it. One set that was examined worked very poorly when the lid was shut down on it, but it worked well when the lid was left up. The tuning inductance was located so that it was extremely close to the varnished wood of the lid when it was down.

\* \* \*

THE more sensitive a receiver is, the more selective it ought to be. This is true for two reasons. One is that the wider the distance range of the receiver, the more stations it will include. Some of these stations may be operating on wavelengths closely approximating each other. The other reason is that no transmitting station emits an absolutely sharp wave (a wave of but a single frequency). When a receiver is extremely sensitive some of the harmonics of nearby stations may force themselves into it unless it is highly selective at the same time.

\* \* \*

ALWAYS ask for the best parts when you are buying apparatus for your new set. Pay a little more and get them from a reliable company. You will thus have better satisfaction when the set is completed and help to raise the standard of manufactured apparatus.

WHEN disconnecting batteries from a radio set, disconnect the wires at the batteries first. This will prevent short-circuits and will save the batteries. You will realize that if you disconnect the end of the wire attached to the set, first, it may twist or fly around and strike the opposite terminal of the battery before you get the other end disconnected. Always remember to do this and you will have no trouble with "shorts."

\* \* \*

EVERY amateur with a transmitter should also have a good wavemeter.

\* \* \*

SOMETIMES the connection tips of the vacuum tubes become corroded or dirty and the tube will not make proper connection in the vacuum-tube socket. This trouble is common and many fans never find out what the cause is.

Take a piece of fine emery cloth and shine up the lead on the tips till they are bright and then put the tube back in the socket and notice the difference in the strength of signals.

\* \* \*

If you have a tin or copper roof on your house, be sure that you place your antenna as high as possible above the roof; otherwise you will not have good results from either your transmitting or receiving apparatus.

\* \* \*

NEVER try to charge your batteries while they are connected to your receiving set. You are liable to blow out the fuses in the lighting lines or burn out the tubes in your receiving set.

THERE may be times when the family receiving set will be the center of rather heated argument. One of the family may wish to listen to WJZ to the athletic or sporting events and another of the family may insist on listening to famous cooking recipes broadcast from WEAJ. Or, one may insist on "opera" while another member wants "jazz."

In a dispute over possession of the headphones, there may be quite serious damage done to the phones, the set, or the family.

Here is one way to overcome the difficulty. Build a simple duplex receiver with three honeycomb coils that will allow of reception, with headphones, of two different programs *at the same time!*

The circuit is shown in Figure 1. The parts necessary for the construction of such a set are the following:

- L1, L2, and L3—honeycomb coils, size L-50, L-35, and L-50 respectively;
- VC1 and VC2—variable condenser, .0005 mfd.;

- GL1 and GL2—grid leaks, 2 megohms;
- GC1 and GC2—grid condensers, .00025 mfd.;
- VAR 1 and VAR 2—variometers;
- C1 and C2—mica fixed condensers, .0005 mfd.;
- R1 and R2—filament rheostats;
- TEL 1 and TEL 2—two pairs of headphones;
- Suitable tubes, and "A" and "B" batteries.

The three coils may be set in a triple-coil mounting and the two sets mounted in the same cabinet, with one set at the right with the tuning controls marked "For the ladies," and the other set at the left with the tuning controls marked "For the men."

The two sets may be used simultaneously without interference if the circuits are not allowed to oscillate. They will tune in two different programs with good signal strength.

In this way the set may furnish double service.

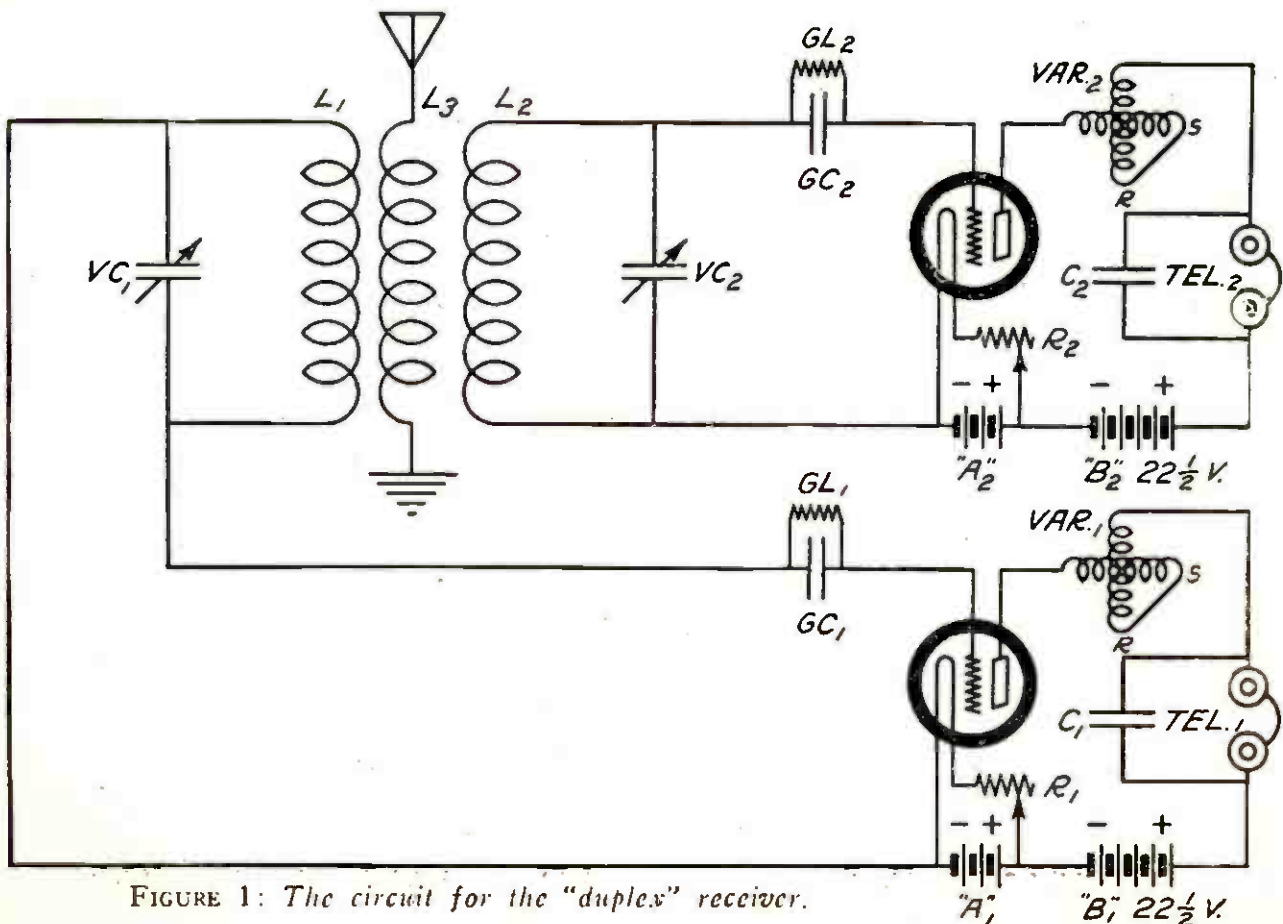


FIGURE 1: The circuit for the "duplex" receiver.





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.

## The Broadcasting Stations of the United States

HERE is a complete list of all of the broadcasting stations in this country, corrected up to November 16, 1923. Readers may keep this list up to date

without much trouble by noting the slight occasional changes that are recorded in the daily newspapers throughout the country.

Call Letters	Location of station	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)	Call Letters	Location of station.	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)
KDKA	East Pittsburgh, Pa.	1,000	326	920	KFDJ	Corvallis, Ore.	50	360	833
KDPM	Cleveland, Ohio	250	270	1,110	KFDL	Denver, Col.	5	360	833
KDPT	San Diego, Cal.	50	249	1,230	KFDO	Bozeman, Mont.	50	248	1,210
KDYL	Salt Lake City, Utah	50	360	833	KFDR	York, Neb.	10	360	833
KDYM	San Diego, Cal.	50	252	1,190	KFDU	Lincoln, Neb.	20	240	1,250
KDYO	Portland, Ore.	5	360	833	KFDV	Fayetteville, Ark.	200	360	833
KDYS	Great Falls, Mont.	50	360	833	KFDX	Shreveport, La.	100	360	833
KDYW	Phoenix, Ariz.	20	360	833	KFDY	Brookings, S. Dak.	100	360	833
KDYX	Honolulu, Hawaii	100	360	833	KFDZ	Minneapolis, Minn.	5	360	833
KDZB	Bakersfield, Cal.	100	240	1,250	KFEC	Portland, Ore.	50	360	833
KDZE	Seattle, Wash.	100	455	660	KFEJ	Tacoma, Wash.	10	360	833
KDZF	Los Angeles, Cal.	500	278	1,080	KFEL	Denver, Col.	50	360	833
KDZI	Wenatchee, Wash.	50	360	833	KFEP	Denver, Col.	10	240	1,250
KDZK	Reno, Nev.	25	360	833	KFEQ	Oak, Neb.	150	360	833
KDZO	Denver, Col.	10	360	833	KFER	Port Dodge, Iowa	20	231	1,300
KDZR	Bellingham, Wash.	50	261	1,150	KFEV	Douglas, Wyo.	100	263	1,140
KDZT	Seattle, Wash.	10	360	833	KFEX	Minneapolis, Minn.	100	261	1,150
KFAD	Phoenix, Ariz.	100	360	833	KFEY	Kellogg, Idaho	10	360	833
KFAE	Pullman, Wash.	500	360	833	KFEZ	St. Louis, Mo.	100	360	833
KFAF	Denver, Col.	500	360	833	KFFA	San Diego, Cal.	50	242	1,240
KFAJ	Boulder, Col.	100	360	833	KFFB	Boise, Idaho	10	240	1,250
KFAN	Moscow, Idaho	50	360	833	KFFE	Pendleton, Ore.	10	360	833
KFAP	Butte, Mont.	100	360	833	KFFO	Hillsboro, Ore.	5	229	1,310
KFAR	Hollywood, Cal.	200	280	1,070	KFFQ	Colorado Springs, Col.	100	360	833
KFAU	Boise, Idaho	150	270	1,110	KFFR	Sparks, Nev.	10	226	1,330
KFAV	Venice, Cal.	5	224	1,340	KFFV	Lamoni, Iowa	100	360	833
KFAW	Santa Ana, Cal.	10	280	1,070	KFFX	Omaha, Neb.	250	278	1,080
KFAY	Medford, Ore.	50	283	1,060	KFFY	Alexandria, La.	100	275	1,090
KFBB	Havre, Mont.	50	360	833	KFFZ	Dallas, Tex. (portable)	20	226	1,330
KFBC	San Diego, Cal.	20	278	1,080	KFGC	Baton Rouge, La.	100	254	1,180
KFBE	San Luis Obispo, Cal.	10	360	833	KFGD	Chickasha, Okla.	20	248	1,210
KFBG	Tacoma, Wash.	50	360	833	KFGH	Stanford University, Cal.	500	360	833
KFBK	Sacramento, Cal.	100	283	1,060	KFGJ	St. Louis, Mo.	250	266	1,130
KFBL	Everett, Wash.	10	224	1,340	KFGL	Arlington, Ore.	5	234	1,280
KFBS	Trinidad, Col.	15	360	833	KFGQ	Boone, Iowa	10	226	1,330
KFBU	Laramie, Wyo.	50	283	1,060	KFGV	Utica, Neb.	10	224	1,340
KFCB	Phoenix, Ariz.	10	238	1,260	KFGX	Orange, Tex.	500	250	1,200
KFCD	Salem, Ore.	20	360	833	KFGZ	Berrien Springs, Mich.	10	268	1,120
KFCF	Walla Walla, Wash.	50	360	833	KFHA	Gunnison, Col.	50	252	1,190
KFCH	Billings, Mont.	10	360	833	KFHB	Hood River, Ore.	5	280	1,070
KFCK	Colorado Springs, Col.	10	258	1,160	KFHD	St. Joseph, Mo.	100	226	1,330
KFCL	San Antonio, Cal.	500	360	833	KFHF	Shreveport, La.	150	266	1,130
KFCM	Richmond, Cal.	100	360	833	KFHH	Neah Bay, Wash.	50	283	1,060
KFCP	Ogden, Utah	25	360	833	KFHJ	Santa Barbara, Cal.	100	360	833
KFCV	Houston, Tex.	10	360	833	KFHO	Los Gatos, Cal.	5	242	1,240
KFCY	Lc Mars, Iowa	50	252	1,190	KFHR	Seattle, Wash.	100	270	1,110
KFCZ	Omaha, Neb.	100	258	1,160	KFHS	Lihue, Hawaii	30	275	1,090
KFDA	Baker, Ore.	5	360	833	KFHU	Mayville, N. Dak.	50	261	1,150
KFDD	Boise, Idaho	10	252	1,190	KFHX	Hutchinson, Kans.	50	229	1,310
KFDH	Tucson, Ariz.	150	360	833	KFI	Los Angeles, Cal.	500	469	640

Call Letters	Location of station	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)	Call Letters	Location of station	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)
KFIB	St. Louis, Mo.	10	244	1,230	WABC	Anderson, Ind.	10	229	1,310
KFID	Iola, Kan.	20	246	1,220	WABD	Dayton, Ohio	10	283	1,060
KFIF	Portland, Ore.	100	360	833	WABE	Washington, D. C.	50	283	1,060
KFIK	Gladbrook, Iowa	20	234	1,280	WABF	Mount Vernon, Ill.	100	234	1,280
KFIL	Louisburg, Kan.	30	234	1,280	WABG	Jacksonville, Fla.	10	248	1,210
KFIO	Spokane, Wash.	50	252	1,190	WABH	Sandusky, Ohio	20	240	1,250
KFIO	Yakima, Wash.	50	224	1,340	WABI	Bangor, Me.	50	240	1,250
KFIU	Juneau, Alaska	10	226	1,330	WABJ	South Bend, Ind.	10	240	1,250
KFIV	Pittsburg, Kan.	20	240	1,250	WABK	Worcester, Mass.	10	252	1,190
KFIX	Independence, Mo.	250	240	1,250	WABL	Storrs, Conn.	100	283	1,060
KFIY	Seattle, Wash.	15	236	1,270	WABM	Saginaw, Mich.	100	254	1,180
KFIZ	Fond du Lac, Wis.	100	273	1,100	WABN	La Crosse, Wis.	250	244	1,230
KFJA	Grand Island, Neb.	100	244	1,230	WABO	Rochester, N. Y.	10	252	1,190
KFJB	Marshalltown, Iowa	10	248	1,210	WABP	Dover, Ohio	100	266	1,130
KFJC	Seattle, Wash.	100	233	1,290	WBAA	West Lafayette, Ind.	250	360	833
KFJD	Greeley, Col.	50	236	1,270	WBAD	Minneapolis, Minn.	100	360	833
KFJF	Oklahoma City, Okla.	20	252	1,190	WWAE	Joliet, Ill.	500	227	1,320
KFJH	Selma, Cal.	10	273	1,100	WBAH	Minneapolis, Minn.	500	417	720
KFJI	Astoria, Ore.	10	252	1,190	WBAN	Paterson, N. J.	100	244	1,230
KFJJ	Carrollton, Mo.	50	236	1,270	WBAO	Decatur, Ill.	50	360	833
KFJK	Bristow, Okla.	100	233	1,290	WBAP	Fort Worth, Tex.	750	476	630
KFJL	Ottumwa, Iowa	10	242	1,240	WBAV	Columbus, Ohio	500	390	770
KFJM	Grand Forks, N. D.	100	229	1,310	WBAW	Marietta, Ohio	250	246	1,220
KFJR	Stevensville, Mont.	50	258	1,160	WBAX	Wilkes-Barre, Pa.	20	360	833
KFIU	Kearney, Neb.	10	234	1,280	WBAY	New York, N. Y.	500	492	610
KFJV	Dexter, Iowa	10	224	1,340	WBBA	Newark, Ohio	20	240	1,250
KFIW	Towanda, Kan.	10	226	1,330	WBBB	Reading, Pa.	50	234	1,280
KFIX	Cedar Falls, Iowa	50	229	1,310	WBL	Anthony, Kan.	100	261	1,150
KFJY	Fort Dodge, Iowa	50	246	1,220	WBS	Newark, N. J.	20	360	833
KFJZ	Fort Worth, Tex.	20	254	1,180	WBT	Charlotte, N. C.	500	360	833
KFKA	Greeley, Col.	50	248	1,210	WBZ	Springfield, Mass.	750	337	890
KPKB	Milford, Kan.	500	286	1,050	WCAD	Canton, N. Y.	250	280	1,070
KPKH	Lakeside, Col.	10	226	1,330	WCAE	Pittsburgh, Pa.	500	462	650
KPKX	Hastings, Neb.	500	286	1,050	WCAG	New Orleans, La.	50	268	1,120
KPLE	Denver, Col.	25	268	1,120	WCAH	Columbus, Ohio	100	286	1,050
KPLQ	Little Rock, Ark.	20	261	1,150	WCAJ	University Place, Neb.	500	360	833
KPLR	Albuquerque, N. M.	100	254	1,180	WCAK	Houston, Tex.	50	360	833
KGB	Tacoma, Wash.	50	252	1,190	WCAL	Northfield, Minn.	250	360	833
KGG	Portland, Ore.	50	360	833	WCAM	Villanova, Pa.	150	360	833
KGN	Portland, Ore.	100	360	833	WCAO	Baltimore, Md.	50	360	833
KGU	Honolulu, Hawaii, Waikiki Beach	250	360	833	WCAP	Washington, D. C.	500	469	640
KGW	Portland, Ore.	500	492	610	WCAR	San Antonio, Tex.	150	360	833
KGY	Lacy, Wash.	5	258	1,160	WCAS	Minneapolis, Minn.	100	246	1,220
KHJ	Los Angeles, Cal.	500	395	760	WCAT	Rapid City, S. D.	50	240	1,250
KHO	Seattle, Wash.	100	360	833	WCAU	Philadelphia, Pa.	250	286	1,050
KJO	Stockton, Cal.	5	360	833	WCAV	Little Rock, Ark.	20	360	833
KJR	Seattle, Wash.	100	270	1,110	WCAX	Burlington, Vt.	50	360	833
KJS	Los Angeles, Cal.	750	360	833	WCAY	Milwaukee, Wis.	250	261	1,150
KLN	Monterey, Cal.	10	261	1,150	WCAZ	Carthage, Ill.	50	246	1,220
KLS	Oakland, Cal.	250	360	833	WCBA	Allentown, Pa.	5	280	1,070
KLX	Oakland, Cal.	250	360	833	WCBB	Greenville, Ohio	100	240	1,250
KLZ	Denver, Col.	500	360	833	WCBD	Zion, Ill.	500	345	870
KMJ	Fresno, Cal.	250	273	1,100	WCE	Minneapolis, Minn.	250	360	833
KMO	Tacoma, Wash.	10	360	833	WCK	St. Louis, Mo.	100	360	833
KNJ	Roswell, N. Mex.	500	250	1,200	WCM	Austin, Tex.	500	360	833
KNT	Aberdeen, Wash.	250	263	1,140	WCX	Detroit, Mich.	500	517	580
KNV	Los Angeles, Cal.	100	256	1,179	WDAE	Tampa, Fla.	250	360	833
KNX	Los Angeles, Cal.	100	360	833	WDAF	Kansas City, Mo.	500	411	730
KOB	State College, N. Mex.	500	360	833	WDAG	Amarillo, Tex.	100	263	1,140
KOP	Detroit, Mich.	500	286	1,050	WDAH	El Paso, Tex.	100	286	1,120
KPO	San Francisco, Cal.	500	423	710	WDAI	Syracuse, N. Y.	100	246	1,220
KOI	Berkeley, Cal.	500	360	833	WDAK	Hartford, Conn.	100	261	1,150
KQP	Hood River, Ore.	10	360	833	WDAL	Jacksonville, Fla.	100	360	833
KQV	Pittsburgh, Pa.	500	360	833	WDAP	Dallas, Tex.	50	360	833
KQW	San Jose, Cal.	50	360	833	WDAP	Chicago, Ill.	500	360	833
KRE	Berkeley, Cal.	50	278	1,080	WDAR	Philadelphia, Pa.	500	395	760
KSD	St. Louis, Mo.	500	546	550	WDAS	Worcester, Mass.	5	360	833
KSS	Long Beach, Cal.	20	360	833	WDAU	New Bedford, Mass.	100	360	833
KTW	Seattle, Wash.	500	360	833	WDAX	Centerville, Iowa	100	360	833
KUO	San Francisco, Cal.	150	360	833	WDAY	Fargo, N. D.	50	244	1,230
KUS	Los Angeles, Cal.	100	360	833	WDBC	Lancaster, Pa.	50	258	1,160
KUY	El Monte, Cal.	50	256	1,170	WDBF	Youngstown, Ohio	50	261	1,150
KWG	Stockton, Cal.	100	360	833	WDM	Washington, D. C.	50	360	833
KWH	Los Angeles, Cal.	500	360	833	WDT	New York, N. Y.	500	405	740
KXD	Modesto, Cal.	10	252	1,190	WDZ	Tuscola, Ill.	10	278	1,080
KYQ	Honolulu, Hawaii	20	360	833	WEAA	Flint, Mich.	150	280	1,070
KYW	Chicago, Ill.	1,000	536	560	WEAF	New York, N. Y.	500	492	610
KZM	Oakland, Cal.	50	360	833	WEAH	Wichita, Kan.	50	244	1,230
KZN	Salt Lake City, Utah	500	360	833	WEAI	Ithaca, N. Y.	500	286	1,050
KZV	Wenatchee, Wash.	50	360	833	WEAJ	Vermillion, S. D.	200	283	1,060
WAAB	New Orleans, La.	100	268	1,120	WEAM	North Plainfield, N. J.	100	252	1,190
WAAC	New Orleans, La.	400	360	833	WEAN	Providence, R. I.	100	273	1,100
WAAD	Cincinnati, Ohio	25	360	833	WEAO	Columbus, Ohio	500	360	833
WAAP	Chicago, Ill.	200	286	1,050	WEAP	Mobile, Ala.	100	360	833
WAAK	Milwaukee, Wis.	100	280	1,070	WEAR	Baltimore, Md.	50	360	833
WAAM	Newark, N. J.	250	263	1,140	WEAS	Washington, D. C.	50	360	833
WAAN	Columbia, Mo.	50	254	1,180	WEAU	Sioux City, Iowa	100	360	833
WAAW	Omaha, Neb.	200	360	833	WEAY	Houston, Tex.	250	360	833
WAAZ	Emporia, Kan.	100	360	833	WEB	St. Louis, Mo.	500	360	833
WABB	Harrisburg, Pa.	10	266	1,130	WEV	Houston, Tex.	50	360	833
					WEW	St. Louis, Mo.	100	261	1,150

Call Letters	Location of station.	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)	Call Letters	Location of station	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)
WFAA	Dallas, Tex.	500	476	630	WKC	Baltimore, Md.	20	360	833
WPAB	Syracuse, N. Y.	200	234	1,280	WKY	Oklahoma, Okla.	100	360	833
WPAF	Poughkeepsie, N. Y.	20	360	833	WLAG	Minneapolis, Minn.	500	417	720
WPAH	Port Arthur, Tex.	150	236	1,270	WLAH	Syracuse, N. Y.	250	234	1,280
WPAJ	Asheville, N. C.	50	360	833	WLAJ	Waco, Tex.	150	360	833
WPAM	St. Cloud, Minn.	20	360	833	WLAK	Bellows Falls, Vt.	500	360	833
WPAN	Hutchinson, Minn.	100	360	833	WLAL	Tulsa, Okla.	100	360	833
WPAQ	Cameron, Mo.	10	360	833	WLAN	Houlton, Me.	250	283	1,060
WPAT	Sioux Falls, S. D.	100	360	833	WLAP	Louisville, Ky.	15	360	833
WPAV	Lincoln, Neb.	500	275	1,090	WLAQ	Kalamazoo, Mich.	20	360	833
WFI	Philadelphia, Pa.	500	395	760	WLAT	Burlington, Iowa	10	360	833
WGAL	Lancaster, Pa.	10	248	1,210	WLAV	Pensacola, Fla.	15	254	1,180
WGAN	Pensacola, Fla.	50	360	833	WLAW	New York, N. Y.	500	360	833
WGAQ	Shreveport, La.	100	360	833	WLAX	Greencastle, Ind.	10	231	1,300
WGAR	Fort Smith, Ark.	20	360	833	WLB	Minneapolis, Minn.	100	360	833
WGAU	Wooster, Ohio	20	226	1,330	WLW	Cincinnati, Ohio	500	309	970
WGAW	Altoona, Pa.	100	261	1,150	WMAB	Oklahoma, Okla.	100	360	833
WGAY	Madison, Wis.	100	360	833	WMAC	Cazenovia, N. Y.	200	261	1,150
WGAZ	South Bend, Ind.	50	360	833	WMAF	Dartmouth, Mass.	100-500	360	833
WGI	Medford Hillside, Mass.	500	360	833	WMAH	Lincoln, Neb.	100	254	1,180
WGL	Philadelphia, Pa.	500	360	833	WMAJ	Kansas City, Mo.	250	275	1,090
WGR	Buffalo, N. Y.	500	319	940	WMAK	Lockport, N. Y.	500	360	833
WGV	New Orleans, La.	100	360	833	WMAL	Trenton, N. J.	50	256	1,170
WGY	Schenectady, N. Y.	1,000	380	790	WMAN	Columbus, Ohio	10	286	1,050
WHA	Madison, Wis.	500	360	833	WMAP	Easton, Pa.	50	246	1,220
WHAA	Iowa City, Iowa	100	283	1,060	WMAQ	Chicago, Ill.	250	448	670
WHAB	Galveston, Tex.	200	360	833	WMAV	Auburn, Ala.	500	250	1,200
WHAC	Waterloo, Iowa	10	360	833	WMAZ	St. Louis, Mo.	100	280	1,070
WHAD	Milwaukee, Wis.	100	280	1,070	WMAZ	Macon, Ga.	50	268	1,120
WHAG	Cincinnati, Ohio	200	222	1,350	WMC	Memphis, Tenn.	500	500	600
WHAH	Joplin, Mo.	250	360	833	WMH	Cincinnati, Ohio	10	248	1,210
WHAI	Davenport, Iowa	50	360	833	WMU	Washington, D. C.	100	261	1,150
WHAK	Clarksburg, W. Va.	15	258	1,160	WNAC	Boston, Mass.	100	278	1,080
WHAL	Lansing, Mich.	20	248	1,210	WNAD	Norman, Okla.	100	360	833
WHAM	Rochester, N. Y.	100	360	833	WNAL	Omaha, Neb.	20	242	1,240
WHAP	Decatur, Ill.	50	360	833	WNAM	Evansville, Ind.	500	360	833
WHAQ	Washington, D. C.	10	360	833	WNAN	Syracuse, N. Y.	100	286	1,050
WHAR	Atlantic City, N. J.	10	231	1,300	WNAP	Springfield, Ohio	100	231	1,300
WHAS	Louisville, Ky.	500	400	750	WNAQ	Charleston, S. C.	10	360	833
WHAV	Wilmington, Del.	50	360	833	WNAK	Butler, Mo.	20	231	1,300
WHAZ	Troy, N. Y.	500	380	790	WNAS	Austin, Tex.	100	360	833
WHB	Kansas City, Mo.	500	411	730	WNAT	Philadelphia, Pa.	100	360	833
WHD	Morgantown, W. Va.	250	360	833	WNAV	Knoxville, Tenn.	500	236	1,270
WHK	Cleveland, Ohio	500	360	833	WNAW	Fort Monroe, Va.	5	360	833
WHN	New York, N. Y.	100	360	833	WNAX	Yankton, S. D.	100	244	1,230
WIAB	Rockford, Ill.	50	252	1,190	WNJ	Albany, N. Y.	55	360	833
WIAC	Galveston, Tex.	100	360	833	WOAA	Ardmore, Okla.	100	360	833
WIAD	Ocean City, N. J.	10	254	1,180	WOAC	Lima, Ohio	50	266	1,130
WIAF	New Orleans, La.	10	234	1,280	WOAD	Sigourney, Iowa	10	360	833
WIAH	Newton, Iowa	10	258	1,160	WOAE	Fremont, Neb.	20	360	833
WIAI	Springfield, Mo.	20	252	1,190	WOAF	Tyler, Tex.	10	360	833
WIAJ	Neenah, Wis.	100	224	1,340	WOAG	Belvidere, Ill.	100	224	1,340
WIAK	Omaha, Neb.	200	278	1,080	WOAH	Charleston, S. C.	100	360	833
WIAO	Milwaukee, Wis.	100	360	833	WOAI	San Antonio, Tex.	500	385	780
WIAQ	Marion, Ind.	10	226	1,330	WOAJ	Parsons, Kan.	15	258	1,160
WIAR	Paducah, Ky.	100	360	833	WOAL	Webster Groves, Mo.	500	229	1,310
WIAS	Burlington, Iowa	100	360	833	WOAN	Lawrenceburg, Tenn.	150	360	833
WIAT	Tarkio, Mo.	15	360	833	WOAO	Mishawaka, Ind.	50	360	833
WIAU	Le Mars, Iowa	20	360	833	WOAP	Kalamazoo, Mich.	50	240	1,250
WIK	McKeesport, Pa.	500	234	1,280	WOAQ	Portsmouth, Va.	15	360	833
WIL	Washington, D. C.	10	360	833	WOAT	Wilmington, Del.	50	360	833
WIP	Philadelphia, Pa.	500	509	590	WOAV	Eric, Pa.	100	242	1,240
WJAB	Lincoln, Neb.	500	360	833	WOAW	Omaha, Neb.	500	526	570
WJAD	Waco, Tex.	150	360	833	WOAX	Trenton, N. J.	100	240	1,250
WJAF	Muncie, Ind.	10	360	833	WOAZ	Stamford, Tex.	100	360	833
WJAG	Norfolk, Neb.	200	360	833	WOC	Davenport, Iowa	500	484	620
WJAK	Greentown, Ind.	30	254	1,180	WOI	Ames, Iowa	100	360	833
WJAM	Cedar Rapids, Iowa	20	268	1,120	WOK	Pine Bluff, Ark.	500	360	833
WJAN	Peoria, Ill.	100	280	1,070	WOO	Philadelphia, Pa.	500	509	590
WJAO	Topeka, Kan.	100	360	833	WOQ	Kansas City, Mo.	500	360	833
WJAR	Providence, R. I.	50	360	833	WOR	Newark, N. J.	500	405	740
WJAS	Pittsburgh, Pa.	500	360	833	WOS	Jefferson City, Mo.	500	441	680
WJAT	Marshall, Mo.	10	360	833	WPAB	State College, Pa.	500	360	833
WJAX	Cleveland, Ohio	500	390	770	WPAC	Okmulgee, Okla.	200	360	833
WJAZ	Chicago, Ill.	1,000	448	670	WPAD	Chicago, Ill.	500	360	833
WJD	Granville, Ohio	50	229	1,310	WPAH	Waupaca, Wis.	250	360	833
WJH	Washington, D. C.	50	273	1,100	WPAJ	New Haven, Conn.	10	268	1,120
WJX	New York, N. Y.	500	360	833	WPAK	Agricultural College, N. D.	250	360	833
WJY	New York, N. Y.	500	405	740	WPAL	Columbus, Ohio	100	286	1,050
WJZ	New York, N. Y.	500	455	660	WPAM	Topeka, Kan.	100	360	833
WKAA	Cedar Rapids, Iowa	100	268	1,120	WPAP	Winchester, Ky.	35	360	833
WKAD	East Providence, R. I.	10	240	1,250	WPAQ	Frostburg, Md.	10	360	833
WKAF	Wichita Falls, Tex.	100	360	833	WPAR	Beloit, Kan.	10	360	833
WKAN	Montgomery, Ala.	15	226	1,330	WPAT	El Paso, Tex.	20	360	833
WKAP	Cranston, R. I.	200	360	833	WPAU	Moorehead, Minn.	20	360	833
WKAO	San Juan, P. R.	100	360	833	WPBZ	Charleston, W. Va.	20	273	1,100
WKAZ	East Lansing, Mich.	250	280	1,070	WPG	New Lebanon, Ohio	50	234	1,280
WKAV	Springfield, Mo.	10	360	833	WQAA	Parkersburg, Pa.	500	360	833
WKAW	Lacomia, N. H.	50	254	1,180	WQAC	Amarillo, Tex.	100	360	833
WKAY	Beloit, Wis.	10	242	1,240	WQAD	Waterbury, Conn.	50	242	1,240
	Gainesville, Ga.	10	280	1,070	WQAE	Springfield, Vt.	50	275	1,090

Call Letters	Location of station	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)	Call Letters	Location of station	Power (watts)	Wave-length (meters)	Freq. (kilo-cycles)
WQAF	Sandusky, Ohio	5	240	1,250	WSAK	Middleport, Ohio	70	258	1,160
WQAH	Lexington, Ky.	10	254	1,180	WSAL	Brookville, Ind.	10	246	1,220
WQAL	Mattoon, Ill.	10	258	1,160	WSAN	Allentown, Pa.	10	229	1,310
WQAM	Miami, Fla.	100	360	833	WSAP	New York, N. Y.	250	360	833
WQAN	Scranton, Pa.	100	280	1,070	WSAR	Fall River, Mass.	10	254	1,180
WQAO	New York, N. Y.	100	360	833	WSAT	Plainview, Tex.	20	268	1,120
WQAO	Abilene, Tex.	100	360	833	WSAW	Canandaigua, N. Y.	100	275	1,090
WQAS	Lowell, Mass.	100	266	1,130	WSAX	Chicago, Ill.	20	268	1,120
WQAV	Greenville, S. C.	15	258	1,160	WSB	Atlanta, Ga.	500	429	700
WQAW	Washington, D. C.	5	236	1,270	WSL	Utica, N. Y.	100	273	1,100
WQAX	Peoria, Ill.	10	360	833	WSY	Birmingham, Ala.	500	360	833
WRAA	Houston, Tex.	200	360	833	WTAB	Fall River, Mass.	10	248	1,210
WRAD	Marion, Kan.	10	248	1,210	WTAC	Johnstown, Pa.	150	360	833
WRAP	Laporte, Ind.	10	224	1,340	WTAD	Carthage, Ill.	10	229	1,310
WRAH	Providence, R. I.	10	231	1,300	WTAF	New Orleans, La.	20	242	1,240
WRAL	St. Croix Falls, Wis.	100	248	1,210	WTAG	Providence, R. I.	10	258	1,160
WRAM	Galesburg, Ill.	250	244	1,230	WTAH	Belvidere, Ill.	10	236	1,270
WRAN	Waterloo, Iowa	10	236	1,270	WTAJ	Portland, Me.	50	236	1,270
WRAO	St. Louis, Mo.	100	360	833	WTAL	Toledo, Ohio	10	252	1,190
WRAU	Amarillo, Tex.	10	360	833	WTAM	Cleveland, Ohio	1,000	390	770
WRAV	Yellow Springs, Ohio	100	360	833	WTAN	Mattoon, Ill.	100	240	1,250
WRAW	Reading, Pa.	10	238	1,260	WTAP	Cambridge, Ill.	50	242	1,240
WRAX	Gloucester City, N. J.	100	268	1,120	WTAQ	Osseo, Wis.	100	226	1,330
WRAY	Scranton, Pa.	100	280	1,070	WTAR	Norfolk, Va.	100	280	1,070
WRAZ	Newark, N. J.	50	233	1,290	WTAS	Elgin, Ill. (portable)	500	275	1,090
WRC	Washington, D. C.	500	469	640	WTAT	Boston, Mass.	100	244	1,230
WRK	Hamilton, Ohio	200	360	833	WTAU	Tecumseh, Neb.	10	360	833
WRL	Schenectady, N. Y.	500	360	833	WTAW	College Station, Tex.	50	280	1,070
WRM	Urbana, Ill.	500	360	833	WTG	Manhattan, Kan.	1,000	360	833
WRR	Dallas, Tex.	20	360	833	WWAB	Trenton, N. J.	10	226	1,330
WRW	Tarrytown, N. Y.	150	273	1,100	WWAC	Waco, Tex.	50	360	833
WSAB	Cape Girardeau, Mo.	100	360	833	WWAD	Philadelphia, Pa.	50	360	833
WSAC	Clemson College, S. C.	500	360	833	WWAX	Laredo, Tex.	50	360	833
WSAD	Providence, R. I.	100	261	1,150	WWB	Canton, Ohio	100	268	1,120
WSAG	St. Petersburg, Fla.	10	244	1,230	WWI	Dearborn, Mich.	50	273	1,100
WSAH	Chicago, Ill.	500	248	1,210	WWJ	Detroit, Mich.	500	517	580
WSAI	Cincinnati, Ohio	500	309	970	WWL	New Orleans, La.	100	280	1,070
WSAJ	Grove City, Pa.	100	360	833					

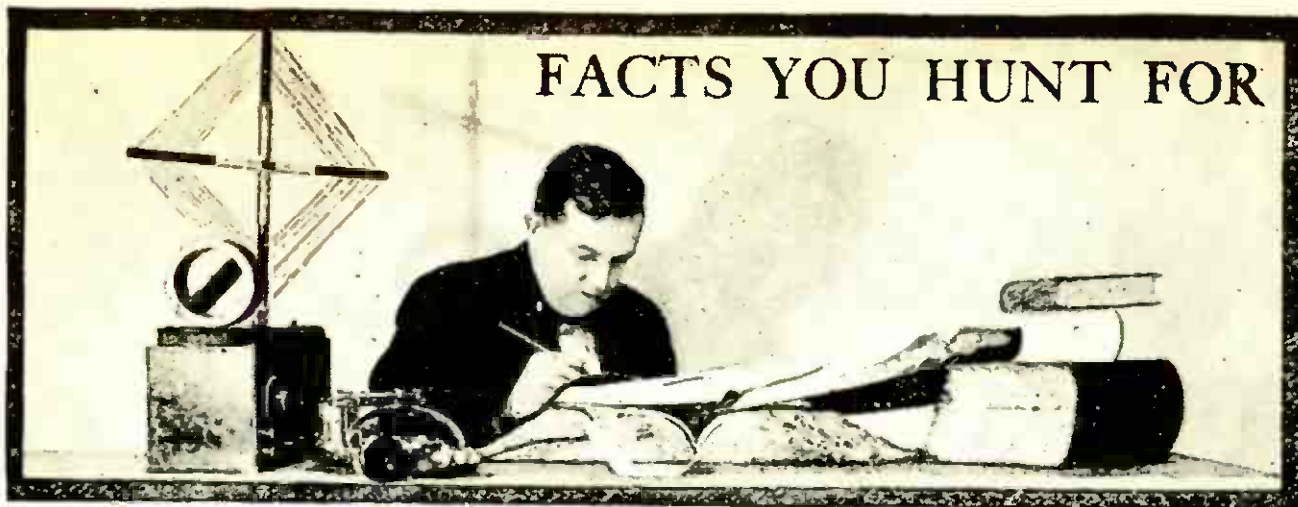
A LIST of the more important broadcasting stations abroad—stations that the American radio fans are most likely to pick up during this winter—was published in POPULAR RADIO for December, together with information concerning their usual program hours, location, wavelength and the general nature of their broadcast material.



Kadel &amp; Herbert

## How to Build a Three-tube Reflex Receiver

Two stages of radio-frequency amplification, a vacuum-tube detector, and two stages of audio-frequency amplification—and with only three tubes! A set that embodies these features of high amplification and tube economy will be described by Walter Remy in the February issue of POPULAR RADIO out January 20th. This set, by the way, won first prize at a recent amateur convention and radio show in New York.



## FACTS YOU HUNT FOR

*What is the latest information about the very long radio waves supposed to be coming from Mars?*

There has not been any very important work on these waves lately. The distinguished English scientist, Dr. Fournier d'Albe stated recently that these long-wave signals had been found, in Europe, to arrive simultaneously at all stations observing them. This apparently indicates that they are real and suggests, at least, an origin outside the earth. The prevailing opinion among scientific men seems to be that these waves originate in some sort of electrical disturbance in the sun. There is no reason at all to suspect that they represent attempts of inhabitants of Mars to communicate with us. The whole matter needs further study. Any amateur who has means and opportunity to construct receiving apparatus for these long waves (50,000 to 150,000 meters) could render great service to science by keeping exact records over a period of months of their times and strengths.

*Why does not a magnetic compass point exactly to the north?*

It points toward the earth's *magnetic pole* and this is not quite coincident with the real North Pole, which is the end of the axis about which the earth revolves. The magnetism of the earth is supposed to be due mainly to currents of electricity that circulate inside the earth, like the current in the wire around an electromagnet. Apparently these currents do not revolve around exactly the same axis as does the earth itself, so the magnetic forces are displaced sidewise a little. The currents are variable, too, so the position of the magnetic pole moves slowly, causing the actual direction of the compass to change a little each year.

*Why does an electric spark produce light?*

The light is *not* due directly to the electricity, as many people think. It is produced, really, by heat, just as the light is in a fire. An electric spark is caused by a great number

of electrons (which are, you remember, little particles of electricity) jumping across through the air from one wire to another. As this great crowd of electrons, billions of billions of them, jump through the air, they knock the atoms of the air itself about so much that these atoms get very hot—so hot that they give out light. There are also some atoms of copper or other material detached from the wires and carried along by the spark. These get hot and shine, too. That is why a spark from a copper wire looks greenish. The atoms of copper, when they get hot enough, shine with a greenish light instead of a white light.

*What is the smallest electric current that can be measured?*

The amount of electricity in one electron has been measured by Millikan, but this is a measurement, really, of electric *charge*, rather than of current. The smallest actual current measured so far is probably that detected last summer by Dr. C. G. Abbott of the Smithsonian Institution while he was engaged in determining, by means of a thermopile, the amount of heat received from an individual star. The current measured was about one-trillionth of an ampere. A current as small as this would have to flow for over 60,000 years in order to accumulate enough electricity to light an ordinary incandescent lamp for one second.

*When were electric waves discovered?*

The effect of an electric current on a magnetic needle (which is really, as we now know, an effect of the same kind as electric waves) was discovered by Oersted in 1819. Electromagnetic induction at a distance, the principle of the so-called magnetic detector, was discovered independently by Joseph Henry in the United States and by Michael Faraday in England in 1831. The theory that light is composed of electromagnetic waves was proposed by Maxwell in 1864. Such electric waves were actually produced experimentally by Hertz in 1888. It is this last date that is usually considered that of the first electric waves and the beginnings of radio, but the pre-

vious discoveries were necessary preliminaries. Final experimental *proof* that light and electric waves are identical was not obtained until the experiments of Nichols and Tear in 1922. (See POPULAR RADIO for July, 1923).

*What is the chemical composition of air?*

Following is the composition by volume:

Oxygen	21.00	percent
Nitrogen	78.05	" "
Argon	.93	" "
Carbon dioxide	.03	" "
Neon	.001	" "
Hydrogen	.0003	" "
Helium	.00015	" "
Krypton	.00010	" "
Xenon	.00005	" "

All constituents are somewhat variable, especially the carbon dioxide. Traces of carbon monoxide, sulphur dioxide, ammonia, nitric acid and other gases are sometimes present.

*It is reported that the recent eruption of Mt. Etna was accompanied by a large amount of "static" in near-by radio stations. Was this because the lava was charged electrically?*

Probably not. We have seen no detailed scientific accounts of radio disturbances accompanying this eruption but the electrical effects of volcanic eruptions in general, including the usual lightning flashes that play about the erupting crater, are believed to be due to the clouds of dust ejected into the air. Some electricity is produced by friction between the dust particles. More is gathered, presumably, because the particles act as nuclei on which atmospheric electricity can collect. The result is that large charges accumulate in different parts of the cloud and are relieved by lightning flashes, with the usual accompaniment of radio disturbances.

*Why will an electric dry battery quit working if you punch a hole in it?*

A "dry battery" is not really dry. It contains a solution of sal ammoniac in water. That is what causes the chemical reaction inside the battery and produces the electricity. This solution is soaked up in paper or charcoal or some other material inside the battery and is sealed in by the asphalt or sealing-wax seal. If the battery is opened the solution evaporates and the battery really becomes dry inside. Then the necessary chemical reactions of the sal ammoniac solution cannot go on any more and no electricity is produced.

*What is photoelectricity?*

Some substances, when light falls on them, give off some free electrons, just as the filament of a vacuum tube gives off electrons

when it is heated. Apparatus can be arranged to collect this electricity and measure it. It is called photoelectricity. There are a number of other effects of light on the electric properties of metals, for example, the change that occurs in the electrical conductivity of selenium when it is illuminated. Such "photoelectric effects" are among the physical phenomena now being studied most actively by the scientists.

*What is the difference between stress and strain?*

These two words are used in engineering language with perfectly definite meanings; both different from the loose use of these words in ordinary speech. The "strain," to the engineer, is the change in shape or size of anything when it is subject to force. The "stress" is the force that produces this change. For example, when you take hold of a knitting needle and bend it, the amount of bending is the *strain*; your muscular effort in doing so is the *stress*. Remembering this distinction will prevent much confusion in reading technical engineering literature.

*Why is helium gas to be used in the new United States airships?*

Because it will not explode. Helium is a chemical element belonging to the group of "inert" gases, so called because they will not combine with any other elements at all. The atoms of these gases are complete. There are no missing places where other electrons can be attached to the atom, as there are in other elements. Such attachments are what fasten atoms together and cause chemical combinations. Nearly all explosions are caused by some kind of chemical combination or decomposition. The inability of helium to combine with anything is the reason why it cannot explode.

*Is there any metal that conducts electricity better than copper does?*

Silver is the only such metal. Under ordinary conditions and with the usual commercial metals a silver wire has about six percent less resistance than a copper wire of the same size. But much depends on the purity of the metal and on how well the wire was annealed when it was made. The following table gives the approximate conductivity of the common metals, copper being taken as 100 percent:

Aluminum	60
Copper	100
Gold	72
Iron	17
Lead	8
Nickel	13
Platinum	14
Silver	106
Tin	12
Tungsten	32
Zinc	27

## "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**.

### WHAT A CRYSTAL FAN MADE AT HOME

A CRYSTAL set in De Walt, Texas, which receives programs from Denver and Memphis is described by Raymond Clift.

"On almost any clear night," he writes, "I can hear from five to twelve broadcasting stations with a home-made crystal set consisting of a variocoupler, a variable condenser, a fixed condenser, a crystal detector and a pair of phones.

"My antenna is a one-wire T type, 150 feet long and approximately 40 feet above the earth. Poor results with either a crystal or a tube are often due to a poor ground connection, I find. This is particularly true when only a short joint of pipe is driven into the earth for a connection. When the ground becomes dry a poor connection will result. I keep the earth around my ground connection in a moist condition and I think this helps my reception.

"My crystal detector is mounted on the wall and is connected into the circuit with flexible wire. By this means the crystal will not lose its adjustment easily when the instruments on my table are jarred. Instead of testing my crystal contact with a buzzer, I adjust it while a local station is broadcasting."

Some of the distant stations he has heard are WOC, Davenport, Ia.; WOAW, Omaha, Nebr.; KFAF, Denver, Colo.; KSD, St. Louis, Mo.; WOS, Jefferson City, Mo.; WMC, Memphis, Tenn., and a number which are closer.

\* \* \*

### ONE TUBE COVERS 2,300 MILES

WITH careful tuning of a single circuit, R. E. Jones, Jr., of Bay City, Mich., has heard a number of stations more than 1,000 miles away, his record distance being 2,300 miles. His set has only one tube but his log now includes 101 stations.

KPO of San Francisco, Calif., is the record station. Others are KFI, Los Angeles, Calif., 2,200 miles; CHBC, Calgary, Canada, 1,650; WCAK, Houston, Texas, 1,500; WPA, Fort Worth, Texas, 1,350; KFDF, Casper, Wyoming, 1,250; WWL, New Orleans, La.; WAAP, Wichita, Kansas, 1,034, and WKY, Oklahoma City, Okla., 1,000 miles.

\* \* \*

### DISTANCE WITH LIGHT WIRES FOR AN ANTENNA

LESTON W. BETTS of Hoboken, N. J., received from Chicago, Detroit and Omaha with a single tube and a plug in a lighting circuit for an antenna. His set is of the single-circuit type which as a rule sacrifices selectivity for distance and volume. He bases his success on the fact that he knows every "squeal" his set produces.

He hears WBAP of Fort Worth, Texas, which is 1,400 miles from Hoboken; WDAF, Kansas City, Mo.; KSD, St. Louis, Mo.; WMC, Memphis, Tenn.; WGM, Atlanta, Ga.; WLK, Minneapolis, Minn.; WMAQ, Chicago, Ill.; WWJ, Detroit, Mich., and WOAW, Omaha, Nebr.

\* \* \*

### THE COCKADAY CIRCUIT IN SUMMER

SOME of the stations John Gordon, Jr., of Rochester, N. Y., hears on his Cockaday Four-Circuit Tuner and two stages of amplification in summer weather are WAOW, Omaha, Nebr.; WLAG, Minneapolis, Minn.; WOC, Davenport, Ia.; WDAR, Philadelphia, Pa.; KSD, St. Louis, Mo., and WJAZ, Chicago, Ill.

Some of the stations were heard loud enough to operate a loudspeaker. He can receive from New York with his set when his local powerful station of WHAM is operating. He uses a UV-200 tube for a detector and a UV-201A for amplification.

## HE MAKES OLD ARMY SETS WORK

PROGRAMS from twenty distant stations come in through one tube in an old army set for C. E. Bogren of Washington, D. C. He used a dry-cell tube. An antenna eighty feet long brings in most of the powerful stations east of the Mississippi River.

Some of the stations he hears are WSB, Atlanta, Ga.; KYW, Chicago, Ill.; WLW, Cincinnati, O.; WGF, Des Moines, Ia.; KOP and WWJ, Detroit, Mich.; WOH, Indianapolis, Ind.; WGI, Medford Hillside, Mass., and WAAQ, Greenwich, Conn.

\* \* \*

## IT SURELY DID "PERK"

"I MADE a 'Greene' receiver like the one described in the June issue of POPULAR RADIO," writes Willis L. Nye of Stockton, Calif., "and it surely did 'perk' on KPO, KHJ, KGW and all of the other stations within 200 miles of here. I made some changes which seem to improve it for me. I like my vernier condenser in the ground lead and my potentiometer for tuning. I have heard amateurs in the sixth, seventh, eighth, third and fourth districts, and I have heard broadcasting from Denver and Calgary.

"Using a wavetrapp and one stage of audio-frequency amplification I have picked up everything west of Denver, south of Calgary and north of San Diego, and a number of stations beyond. My range on one tube includes 100 broadcasting stations."



*Fred B. Teeling's station at Bath, Maine, with which he is able to pick up any of the broadcasting stations in the eastern half of the U. S.*

## RECEIVES BOTH LOCAL AND DISTANT STATIONS

"I WANT to let you know how pleased I am with my four-circuit tuner, made from your description in the May number. I have made a great number of sets but have never before been able to tune out the local stations and bring in "DX," writes A. F. Wheeler of New York City.

"The other evening while two of our most powerful local stations were broadcasting, WJZ and WOR, I received the following stations on my loudspeaker: WGY, Schenectady, N. Y.; WOC, Davenport Ia.; KOP, Detroit, Mich.; KDKA, Pittsburgh, Pa.; KYW, Chicago, Ill., and several others which were easier to tune in. I have also heard PWX, Havana, Cuba, while the local stations were operating."

\* \* \*

## SIMPLE PEANUT SET MAKES RECORD

USING a 43-plate condenser, a variocoupler and a plate variometer, Lee Epperhart of New Westminster, B. C., Canada, hears most of the western-coast stations with one dry-cell tube.

His list of stations, some of them over 1,000 miles away, include KHJ, Los Angeles, Cal.; KPO and KUO, San Francisco, Cal.; KGW, KGG and KFAB, Portland, Ore.; KFAU, Boise, Idaho; KFAE, Pullman, Wash.; KFAF, Denver, Col.; CFCN, CHBC and CFAC of Calgary, Alta., Canada, and CHBE of Victoria, B. C.

\* \* \*

## IN SPITE OF HOT WEATHER

WILLIAM E. SMITH writes to say that he received WEF of New York at his home in Boston on a loudspeaker when the thermometer registered 90 degrees. He uses a Cockaday set with three tubes.

\* \* \*

## 3,000 MILES WITH ONE TUBE

WITH only a detector tube, C. H. Anderson of Lewistown, Mont., has heard PWX of Havana, Cuba, about 3,000 miles away. He uses a variocoupler and two variometers in the ordinary regenerative hook-up.

\* \* \*

## FOUR TUBES PUT MAINE ON THE MAP

FROM the state of Maine and the city of Bath comes the report that four vacuum tubes can transfer that outlying community to the heart of Radio America. A regenerative circuit with a detector and three stages of audio-frequency amplification are used by Fred B. Teeling to produce many of the broadcast programs from the eastern and central states on a loudspeaker. He finds that a single wire 179 feet long works well as an antenna.

Some of his distant stations which show the best work of his set are WOU, Omaha, Neb.; WGH, Montgomery, Ala.; WCE, Minneapolis, Minn.; WBAA, Lafayette, Ind.; WAAO, Charleston, W. Va., and WWI, Dearborn, Mich. In the illustration below is shown a six-tube set which Teeling uses in his automobile, in connection with a loop antenna.



## ADVENTURE IN THE AIR



WHAT is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from 50 to 300 words in length, the Editor will pay upon acceptance. Address contributions to the Editor, ADVENTURE IN THE AIR DEPARTMENT, 9 East 40th Street, New York City.

### I Go Up in the Air—and Get Married by Radio

SUPPOSE that you were a bride and that on your wedding day your groom were to lead you out before the waiting multitudes, strap you into an airplane, clap an earphone over your head, wave a signal to the pastor in a grandstand and whisk you up into the clouds to become his wedded wife by radio; by just how much would your thrill of getting married be intensified? Here's a reader who can tell us; she is one of a very few women in all the world to experience just exactly this particular adventure in the air:

I knew that the great event in a girl's life, her wedding, must be full of thrills. But to be married in an airplane, 3,000 feet up, and by radio, well.

But to begin at the beginning:

My fiancé and I had planned an airplane wedding. It was to be a feature of the Twin Cities Air Derby at the State Fair grounds in Minneapolis. But my fiancé was an ardent radio fan and he insisted that his wedding would not be complete unless the ceremony was performed by radio. So performed by radio it was.

The wedding party, consisting of my husband-to-be and I, with my sister as bridesmaid and my father, motored to the fair grounds. There my bridegroom and I climbed into a large Spa plane that was equipped with both sending and receiving apparatus. Amid the cheers of the crowd we put on the headphones and made ready for our great adventure.

In the meantime the minister, the Rev. E. A. Jordan, of the First Congregational Church St. Paul, had gone to the judges' stand, where there was installed a broadcasting set with a microphone. The Sixth Infantry band struck up the wedding march from *Lohengrin*, the motor of the airplane began to buzz, and off we went. The adventure had begun.

I did not know a great deal about radio (I must confess that all the technical details I am giving have been supplied by my husband) and I expected to hear the minister almost immediately. But instead (and this was a thrill in itself, for I had never before been up in an airplane) we flew around for twenty minutes, looped the loop and did other spectacular stunts.

Finally the minister's voice began to come in. In the excitement of the moment I hardly knew what had taken place or what I was doing. I have thought since that it must have been even more exciting for my husband, for he had to operate the receiving and sending apparatus, and it was difficult to tune in while we were careening up there in the sky. Besides, he had to keep me from getting frightened, and when the proper time came he had to find the ring and put it on the right finger.

There were 10,000 people in the stands and large amplifiers had been placed so that the ceremony could be heard by all of them. My friends later told me that I said "I do" as if I meant it. Probably I did, but with so much excitement all at once my memory is somewhat hazy on that point.

I remember vividly, however, the applause we received as we came down; the cheers came in to us by radio long before we reached the ground.

I can truthfully say that my great adventure was indeed a "thrill that comes once in a lifetime," intensified 300 per cent.

—MRS. E. J. MOLINE

## I Listen In on a Great Moment of History

**W**HEN the word of peace was finally sent forth to the staggering world, following the parleys that immediately preceded the historic Armistice in 1918, among the very first to know the news, naturally, were the radio men. Here is a first-hand account of how Trooper Bronte picked a thrill out of the ether on that occasion:

The lights were out. Our sputtering candle had been doused long before. I sat in the darkness and fingered the receiver controls; shells falling near knocked the detector inoperative, as each thudding bellow shook the terrain. Bombs burst on the earth with a concussion which was like nothing I have ever heard.

I looked about at the feeble protection which covered the frame of the radio shack. No thickness of tarpaper which covered the walls and roof would stop any missile that struck; even a hundred thicknesses of it would be as paper. Back in the woods near the command post the explosions were growing more fre-



### THE ADVENTURE STARTS

*Not only is this resolutely-smiling young woman about to take her first airplane flight, but she is about to be married by radio while still up in the clouds to the resolutely-smiling man beside her.*

quent, and a thin mixture of slow-moving gas stealthily went about its murderous business of seeking its prey in the dugouts.

Through the phones came the rough, coarse rasp of a spark coil in our lines. Somewhere close by was a German coil of extraordinary power splitting the ether, breaking up the coil signals from our trenches every time it opened up. It was deliberate and maddeningly efficient.

I tuned out this bedlam and went higher. Up to 1,800 meters I heard a faint rustle and going up "FL" burst in loud and clear above the hoarse roars of the explosions in the rear. I copied the words on a German military form under my hand in the darkness.

I called the adjutant on the field phone and read the words in French by the light of a match shaded by my hand. In its dull flicker I read words which meant the fall of two empires—the crashing of the most powerful military menace the world ever knew.

The message reported that an Armistice had been arranged, to take effect at 11 o'clock on the morrow, the 11th of November, 1918.

The wild thought surged through me that several million men would soon emerge from the mud and filth, vermin and dampness, from trench and dugout; several million men would lay down their steel and powder and breathe God's good air, and would soon be on the way back to some little town in Wyoming or Virginia or California.

The war was over!

—JACK BRONTE

\* \* \*

## A Home-made Hero Borrows Some Glory

**A** GLIMPSE behind the scenes when Fate staged one of the most dramatic tragedies of maritime history is given in the following adventure sent in by an old-time radioman who spent eleven years in the navy. The man who first picked up the radio call for help from the *Titanic* was Harry Lang:

At the time the *Titanic* struck the iceberg in the Atlantic, back in 1912, and gave civilization a shock that even the World War has not belittled, I was on duty at Portsmouth, New Hampshire. My station, NAC, was the first to pick up the "CQD" (which was then the distress call) from the ill-fated liner. We answered at once, of course, and promptly called the revenue cutter that was anchored off Portland, Maine, and started her out to sea. Next we called another cutter at Boston and started her out similarly; then we called a navy cruiser stationed at Norfolk, Virginia. After that we assisted vessels near the *Titanic* by directing them to her latitude and longitude. Finally we notified the *Boston Herald*, which, of course, issued an extra on the information that we furnished.



### 10,000 PEOPLE HEAR THE RADIO BRIDE ANSWER "I WILL"

*At the moment the happy couple happened to be miles away, soaring through the clouds in a plane, and responding between loops to the wedding service conducted by a minister on the ground.*

It was at this point that the amusing part of the story enters.

The paper asked for a photograph of the operator who picked up the call for help. We did not happen to have a picture of this particular operator in our station. I wanted to oblige, however, so I gave the newspaper reporter a picture of another chap who was connected with our station. Thus the unsuspecting unknown was made the hero of the occasion—even if he did not know it until he happened to pick up a paper in another city and read all about it!

—THOMAS BAKER

\* \* \*

### Cupid Rides the Ether Waves

**H**ERE'S a chap in College Park, Georgia, who gets us all excited about a romance by radio—and leaves us in suspense about the outcome:

It was a warm June night, during my vacation, when the indefinable came riding through the regenerative circuit on chariots of electromagnetic waves. As the waves were continuous, I adjusted the tuning on the one-tube set

to perfection and listened to a broadcasting station from my own home town.

All at once my heart thumped when it was announced that "the next number would be a song by Miss Blank." We had both graduated from high school in the same class; I had not been entirely immune to her charms. I had not thought seriously about her before, but as she began to sing I began to vision her as the most beautiful and desirable girl in the world. I became so absorbed in her recital that I fear my co-hearers detected it.

When she finished I found that I had lost interest in the rest of the program. And that night I wrote to her.

—WALKER L. CURTIS

\* \* \*

### I Get a Thrill from an Uncoded Message

**F**ROM a veteran of the Radio Section of the Signal Corps comes this evidence that all of the excitement in the A. E. F. did not end with the Armistice—even in the ether:

I was on duty in Germany with the Signal



### "I PRONOUNCE YOU MAN AND WIFE"

*So announces Pastor Jordan, who is here seen at the conclusion of the ceremony that united a couple in a far-off airplane. As evidence of the sporting quality of the occasion he is using as a pulpit—and radio station—the judges' stand at the State Fair grounds.*

Corps of the American Army. The ether was practically silent. I was sitting in a great chair consuming a supply of golden brown waffles, which (needless to report) did not come from the headquarters company kitchen, but from the kitchen of the German house in which we had erected our radio station. A robust young peasant girl had climbed three flights of "high inductance" stairways to bring them to me. The war was over. The waffles were fine and the coffee was hot; altogether it was a gay old life for a *soldat* stationed in a hostile country.

Suddenly a rasping coil broke up my business at hand. I copied the signals with consternation. The more I copied the more astonished I became.

"... Three thousand enemy infantry are crossing the ford and are headed for X. Hurry to meet them. Artillery will support you. (Signed) Warner, 1st Brigade."

So the Germans were in revolt! Already they had amassed forces and probably were sweeping through the sparsely occupied country. Why had not we been notified? I leaped to the window, expecting to see the batteries prepared for action or on the march. All I saw were three German soldiers who were talking idly with a girl across the road. An M.P. was dozing at the corner. Were the enemy on the advance? Were these the advance guard idly gossiping with the women? Where was the

colonel? What was headquarters doing about this enemy advance? I became panic-stricken at the thought of a plot that would conceivably sweep our brigade into the back areas or annihilate it on the spot. I must act quickly.

I grasped the field phone that hung by the receiver. The telephone operator in the exchange down the street answered my insistent buzzer.

"Just a minute, OM," he said, and he said it with exasperating calmness.

"Minute? Hell!" I roared in the phone. "Connect me with the radio officers' billet and do it quick."

"Hold your animile," came back the blithe reply. "We are busy here with practice manoeuvre messages. . . . Yes. Yes!" went on the operator in a mild voice, speaking to someone else on the line. "All right! Three thousand infantry. Yes, go on, OK. . . ."

I banged the telephone on the table. So all that I had heard were practice messages relating to practice manoeuvres! It certainly was a let-down.

I took up again the important work of stowing away the waffles. But I wanted to get my fingers under the ear lobe of the second "Looie" who failed to put that radio message in code, as he certainly should have done.

—JACK BRONTE

Please mention POPULAR RADIO when answering advertisements.



## “Here’s the panel I want”

**T**HE panel is the “front door” of your radio set. The selection of the panel is an important step. You want a good-looking panel. And you want a panel that has high dielectric strength.

Your Celoron panel comes wrapped in a dust-proof glassine envelope. Dust and grit cannot scratch it. Human hands cannot leave greasy fingerprints on it.

Because of its high dielectric strength, Celoron, a bakelite product, is approved by the U. S. Navy and the U. S. Signal Corps.

Celoron radio panels are finished in *black, oak and mahogany*. They come ready to use in these standard sizes:

1—6 x 7 x $\frac{1}{8}$	5—7 x 18 x $\frac{3}{16}$
2—7 x 9 x $\frac{1}{8}$	6—7 x 21 x $\frac{3}{16}$
3—7 x 12 x $\frac{1}{8}$	7—7 x 24 x $\frac{3}{16}$
4—7 x 14 x $\frac{3}{16}$	8—12 x 18 x $\frac{3}{16}$
	9—7 x 26 x $\frac{3}{16}$

Other sizes are cut to order from sheet Celoron. *Ask your dealer.*

An interesting booklet for the radio set builder is “*Getting the Right Hook-Up.*” This booklet is sent *Free* upon request.

*To radio dealers: Send for special dealer price list showing standard assortments*

## Diamond State Fibre Company

BRIDGEPORT

(near Philadelphia)

PENNSYLVANIA

Offices in Principal Cities

In Canada: Diamond State Fibre Company of Canada, Limited, 245 Carlaw Ave., Toronto

CONDENSITE  
**CELORON**  
STANDARD RADIO PANEL

# Equal to All Demands

THIS IS NUMBER FOUR OF A SERIES

Every tube you add to your receiver makes it just that much more important for you to use Eveready "B" Batteries, for each additional tube increases the work the "B" battery has to do. It demands a more capable, long-lived battery.

Here is a table that shows just what each type of receiving tube draws from your "B" battery. The current is measured in milliamperes, or thousandths of an ampere.

Current (in milliamperes) Taken from the "B" Battery by Various Tubes

"B" Volts	WD-11	UV-199	UV-201	UV-201-A
	WD-12	C-299	C-301	C-301-A
22½	0.5	0.5	0.5	0.5
45	1.5	1.4	1.5	1.5
67½	2.5	2.4	2.5	3.5
90	4.5	4.0	3.9	6.0

Above figures are at zero grid bias

The table shows that the "B" battery current drain increases much more rapidly than the increase in voltage. For example, if the voltage doubles from 45 to 90, the current drain increases threefold in one case and fourfold in another case. This all means that the life of the "B" battery may be materially lengthened by not using a higher voltage than is necessary to obtain the desired results.

The most popular type of receiver today has at least three tubes, operating a loud speaker. As ordinarily employed, it places a fairly heavy drain on the "B" battery.

Under light and heavy service, Eveready "B" Batteries prove up. More and more fans buy them every day because they are the most economical. According to the work they have to do, so is their life.

You get most energy for your money in Eveready "B" Batteries—they last longer.

## "the life of your radio"



The Metal Case Eveready "B" Battery No. 766. The popular 22½-volt Eveready Battery in a new, handsome, durable, waterproof

metal case. At all dealers, \$3.00.

Eveready "B" Battery No. 767. Contains 30 large size cells, as used in the popular No. 766. Voltage, 45. Made especially for sets using detector and one or more stages of amplification. The most economical "B" Battery where 45 volts are required. At all dealers, \$5.50.



Eveready Radio Battery No. 771. The Eveready "Three," the ideal "C" Battery. Voltage, 4½—three terminals permitting the use of 1½, 3, or 4½ volts. The correct use of this battery greatly prolongs the life of the

"B" Battery. At all dealers, 70 cents.

Manufactured and guaranteed by

NATIONAL CARBON COMPANY, INC.  
Headquarters for Radio Battery information  
New York, N. Y.

# EVEREADY

## Radio Batteries

—they last longer

NOTE—This is No. 4 of a series of informative advertisements, printed to enable users to realize the utmost in battery economy. If you have any battery problem, write to G. C. Furness, Manager, Radio Division, National Carbon Co., Inc., 128 Thompson Avenue, Long Island City, N. Y. Ask for special booklets on "A", "B" and "C" batteries.

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



## When Radio called, Eveready was ready

**T**WENTY-ONE years ago, when wireless telegraphy had its first birthday, National Carbon Company's dry cell batteries were nine years old. Even then, its batteries were world famous as convenient, economical and efficient sources of electric energy.

With the introduction of popular broadcasting, radio leaped into universal service. Radio engineers used Eveready Batteries as their standard in designing tubes and receiving sets. Eveready engineers, backed by the most complete research and testing

laboratories known to the industry, worked with them to discover how the known dry cell could be improved for radio work.

The fruit of these efforts is the Eveready family of radio batteries conspicuous for vitality and endurance—the right battery by test and proof for every radio use.

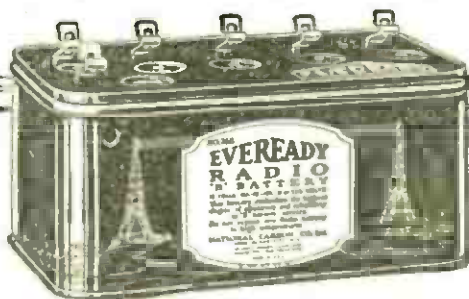
Insist on Eveready Batteries—they last longer.

Informative and money-saving booklets on Radio Batteries sent free on request.

NATIONAL CARBON COMPANY, INC.  
New York, N. Y.

### Headquarters for Radio Battery Information

If you have any battery problem, write to RADIO DIVISION, NATIONAL CARBON COMPANY, INC.  
128 Thompson Ave., Long Island City, N. Y.



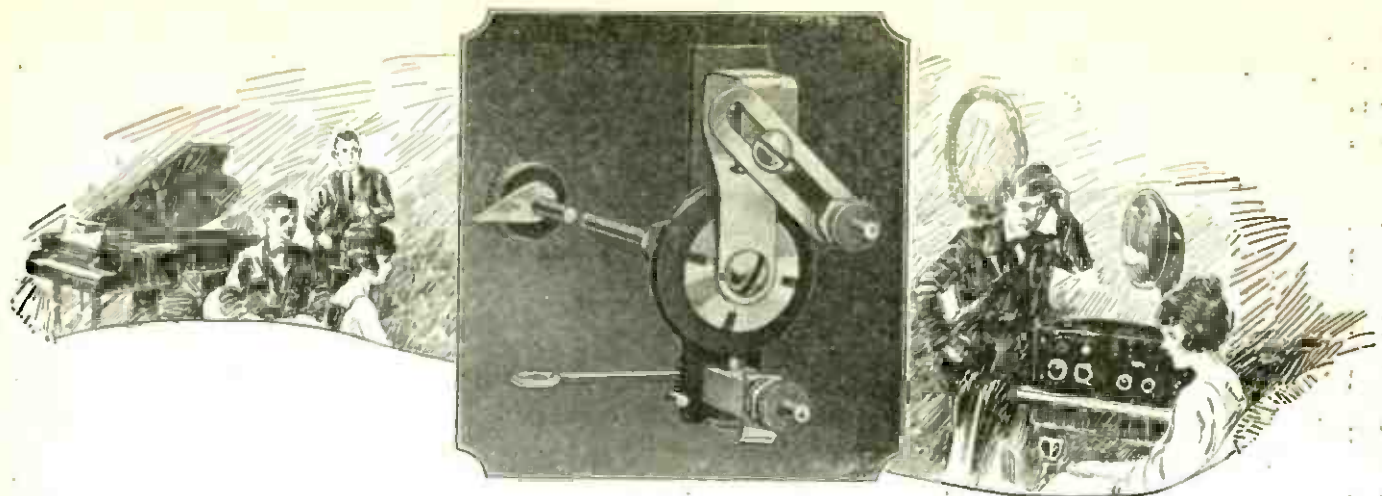
Eveready "B", 22½ volts,  
No 766 with Six Fahnestock  
Spring Clip Connectors

Radio has moved from the laboratory and amateur's work-table out into the refined surroundings of the family living room. In keeping with this new companionship we offer this reliable, long-lived Eveready "B" Battery, in an attractive, new metal case, worthy to stand beside the rich cabinets of fine radio sets.



# EVEREADY Radio Batteries

*-they last longer*



## He Tried a New Tube—and Then Learned the Secret of Grid Control

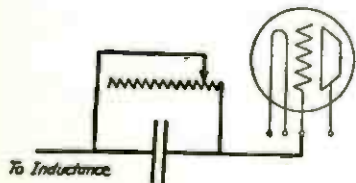
*Many Sets Can Have Increased Range and Better Reception Through Proper Control of the Grid Condenser*

He was a careful buyer. He knew the folly of using cheap equipment in his set—for precision decides between results and failure in radio. And he built carefully.

But when the set was finished he had only fair results. The distant stations that he wanted could not be heard consistently. And when they were tuned in, they *faded*, so that adjustments had to be made continuously. At times the program would die away and be lost. At others, there was a distinct clicking heard, with alternate periods of clear and muffled reception.

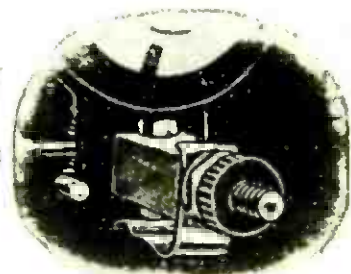
His friends said the set was not *stable*—and there were as many suggestions for corrections as there were friends. But each time the circuit was checked it showed no wrong connections. Every joint was soldered, every binding post tight.

Then one day his detector tube passed into the great beyond from which no tube returns. And it was then that he learned the secret of his poor results.



Unless a "Leak" of the proper resistance is placed across the grid condenser, the tube will either choke or the effect of the condenser be destroyed. The value depends on both the characteristics of the tube and the circuit—it can be obtained only in an accurate variable grid leak of proper design.

With a new tube the set produced perfect concerts—tones clear and natural—fading and clicking were eliminated. Like a flash he realized that the characteristics of this new tube were better suited to the constants of his circuit. To prove it he tried another tube—of exactly the same type. And again his results were better. Stations he had never received before could be heard, and those that he had copied only on perfect nights could be tuned in at will. His lack of control of the grid condenser cost months of unsatisfactory reception.



The carefully milled rotor of the C-H Variable Grid Leak constantly accumulates graphite from the specially prepared brush, reducing the resistance of the leak. If this becomes too low for the tube used, merely wiping the rotor with a clean cloth restores it to a high value for readjustment.

### *Are Your Results Choked Off in the Grid Condenser?*

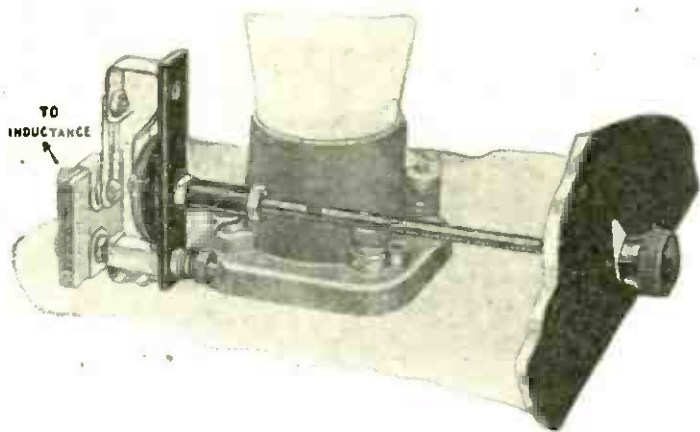
For every tube and for every circuit there is a certain value of resistance that allows the charge which "piles up" on the detector grid to "leak off" at just the proper rate. If this value is too high the charge



# CUTLER-



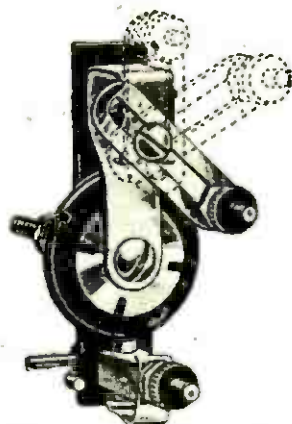
accumulates, and the tube chokes—if too low, reception is “mushy,” in some cases the grid condenser cannot function at all. Therefore, the *Grid Leak* must be of variable resistance to adapt itself to the characteristics of the circuit in which it is expected to operate. To insert a *fixed* leak is merely a gamble—a chance against large odds of hitting the proper value with all the results of your set at stake.



### Put a C-H Variable Grid Leak in Your Set and Be Certain of Maximum Efficiency

The C-H Grid Leak is worthy of the trademark it carries. It was designed by the master builders of all electrical control apparatus, and is produced with watch-like precision to give accurate control. It can be installed in a few minutes in any set. A special flexible mounting link makes it easy to attach directly to the grid terminal of the tube socket or wherever else desired. A long, fully threaded brass control rod (which can be cut to any length required) is furnished with bakelite insulating joint, Thermoplax knob and pointer for panel control. The leak is adjustable, arranged to care for any style of grid condenser.

Install one in your set tonight for better, clearer, more consistent reception. No wiring is required. Attach it to the grid terminal of your tube socket, and attach the wire you removed from that post to the one on the Leak marked “to inductance.” Carried by jobbers and dealers everywhere. Sample can be obtained direct from factory at list price, \$1.50 plus 10c for wrapping and postage.



The C-H Variable Grid Leak is fully adjustable for all styles and sizes of grid condensers.

**THE CUTLER-HAMMER MFG. CO.**

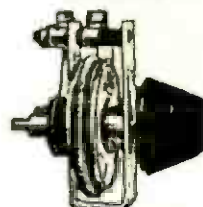
Member Radio Section  
Associated Manufacturers of Electrical Supplies

MILWAUKEE, WISCONSIN

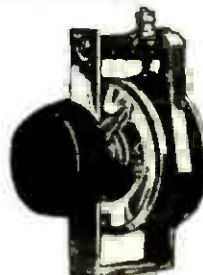
# HAMMER

**CH**

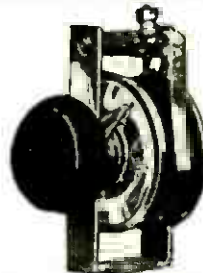
Instruments of Guaranteed  
Quality Assure Success  
in Radio



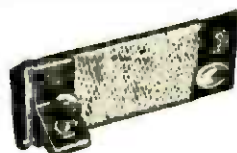
The C-H 4 Ohm Vernier Rheostat—Perfect detector tube control. Also furnished without vernier for amplifier tube control.



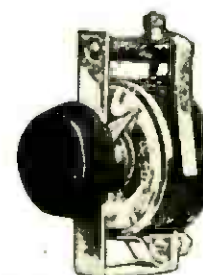
The C-H 30 Ohm Radio Rheostat—For control of the 1/4 ampere, “UV201A-C301A” type receiving tubes and the “UV199-C299” type.



The C-H 125 Ohm Radio Rheostat—The rheostat that makes it possible to use a 6V storage cell with the UV199 or C299 tubes.



The C-H Variable Resistance Unit—Attach it to your present 4 ohm rheostats to obtain the required 30 ohms for the new tubes.



The C-H Radio Potentiometer—The potentiometer with the resistance unit that does not wear and cannot be displaced under constant usage.

Please mention POPULAR RADIO when answering advertisements.

**AMSCO TUBE SOCKET**  
Base of highly polished Con-  
densite. Nickered brass sleeve.

**AMSCO VERNIER CONDENSERS**  
Precision made, for accurate  
tuning.

**AMSCO RHEOSTATS  
AND POTENTIOMETERS**  
Suitable for either table or  
panel mounting.

**The Vitreous Enameling Co.**  
GRANT AVE. NEAR E. 71 STREET  
CLEVELAND  
November 16, 1925

Benjamin B. Price, President  
AMSCO Products Company  
New York, N. Y.

Dear Mr. Price:

Your **WELCO Supreme Receiver** is starting in its efficiency. The following four points make it the ideal receiver for the home:

- 1. EASE OF TUNING.** It is a wave meter. Dial settings for given wave lengths are always the same, and the whole dial range is used from 200 to 600 meters, as shown by attached chart.
- 2. RANGE.** I have tuned in as many as 30 different broadcasting stations in a single evening. In six evenings, 80 stations were tuned in, including KFAP, KJZ, KJW, and KWA. These 80 include every station in Radio Digest's list entitled "In Evening At Home With The Radio", except four, namely, Calgary, Montreal, Portland, and San Juan.
- 3. SELECTIVITY.** WJAZ, Cleveland, 300 meters, can easily be tuned out, and WGT, Schenectady, 380 meters, tuned in. Using compensating condensers, distant stations on same wave length can be admirably separated.
- 4. VOLUME.** On non-power loud speaker, using 25 foot indoor aerial, stations in crystal distance can be heard without audio amplification; stations within 1500 miles, using the single stage audio frequency. The western and Pacific coast stations are clear and loud in phones without audio amplification.

Your success with this receiver is indeed merited.

Sincerely,  
*W. B. Anderson*  
Vice-President

RDW/1

Write for Complete Descriptive Literature.


# AMSCO PRODUCTS, Inc.

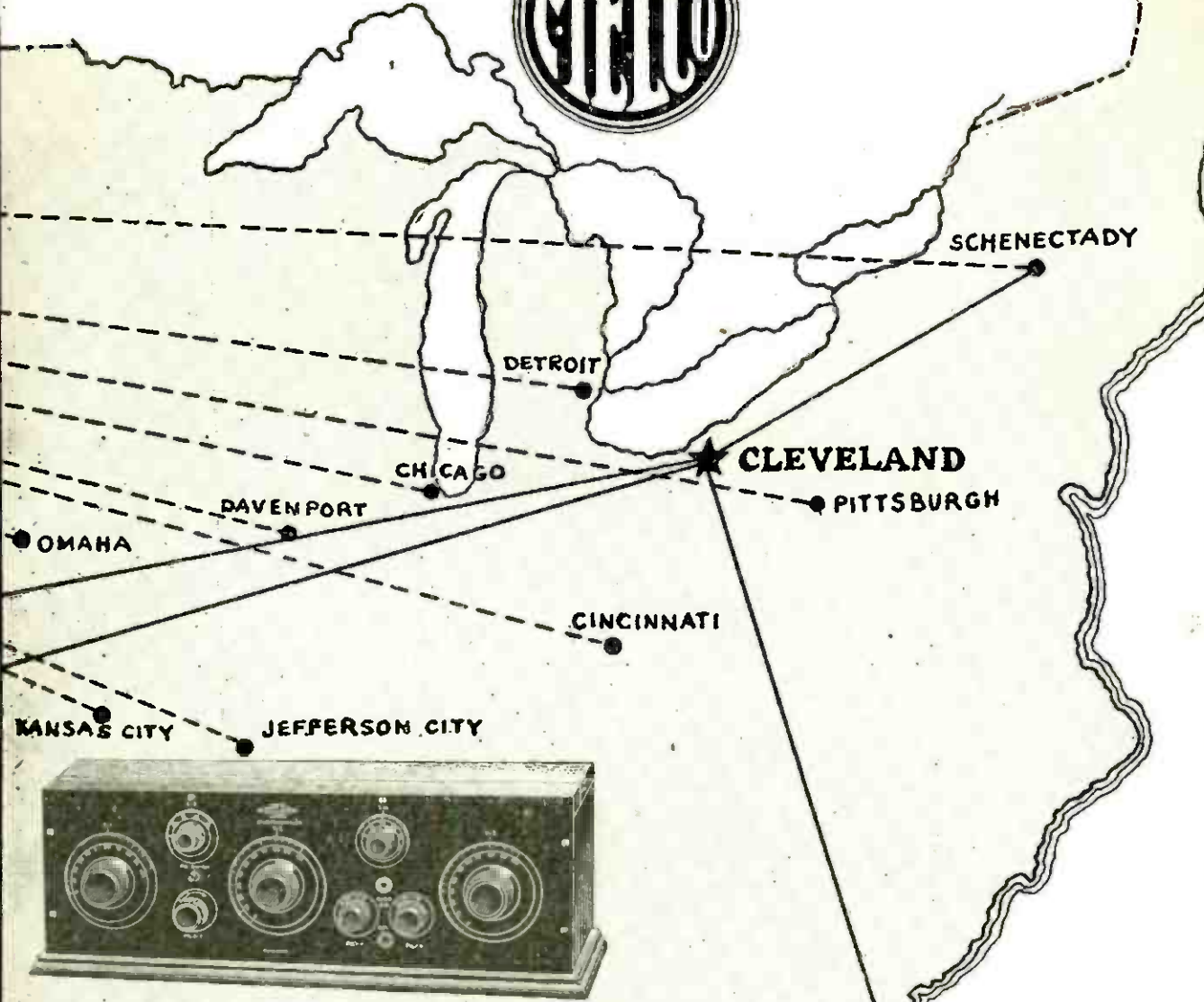
## FAIRBANKS BUILDING

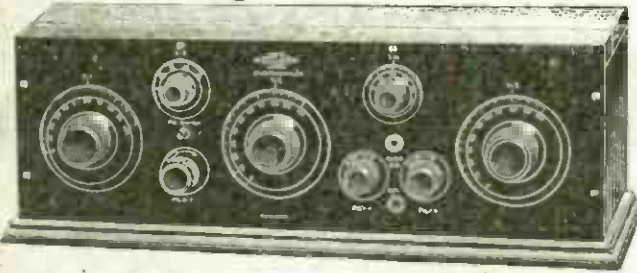
BROOME & LAFAYETTE STS.

NEW YORK CITY

Please mention POPULAR RADIO when answering advertisements.







**MELCO SUPREME**  
The Tuned Radio-Frequency Amplifying Receiver that—

Operates with merely a 10 FT. WIRE—not even a ground necessary.  
Offers exceptional **CLARITY** without the slightest loss of tone quality.  
Assures unusual program **SELECTIVITY** through its single tuning adjustment.  
Affords real **LONG DISTANCE** by covering all Broadcasting ranges from 180 to 610 Meters.

**PRICE ONLY \$140**

Complete knock-down parts for Melco Supreme including drilled engraved Bakelite panel and solid mahogany cabinet.


**Price \$90.00**

<b>WESTERN UNION</b>	
<b>TELEGRAM</b>	
RECEIVED AT	1923 NOV 15 AM 9.00
TRDCC 00	PORTLAND 070 14
AMSCO PRODUCTS	1923 NOV 14 PM 10 00
FAIRBANKS ELCO WENTON BY	
BETTER THE LAST YEAR WE HAVE HEARD WITH GOOD TOLERANCE ON LOUD SPEAKERS	
FOR JEFFERSONCITY MISSOURI EDNA PITTSBURGH 024P CHICAGO 02P	
DETROIT 024M OMAHA 02P KANSASCITY 024P FAIRBANKS 024P DALLAS TEXAS	
024P CALGARY 024P SALT LAKE 024P DAVENPORT 024P SCHENECTADY 024P	
024P CINCINNATI ARE ABLE TO HEAR PITTSBURGH CHICAGO DETROIT KANSASCITY	
FOR AN HOUR AT A TIME THROUGH STROVE LOCAL INTERFERENCE COUSIDER	
MELCO SUPREME RECEIVES THE BEST SET WE EVER OPERATED AND TRUST YOU CAN	
DOUBT SETTING OUR ORDER AS OUR TRADE AND CLAIMING FOR MELCO SUPREME	
ELECTRO WFO AND SALES CO.	

**AMSCO PRODUCTS, Inc.**

**FAIRBANKS BUILDING**

BROOME & LAFAYETTE STS.      NEW YORK CITY



Please mention POPULAR RADIO when answering advertisements.

# The Supreme Insulation **RADION** Panels



are easiest to  
drill, saw, or  
engrave with  
simple tools  
at home

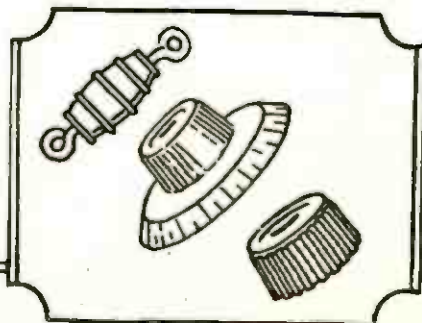
18 Stock Sizes  
Radion Panels

*Black and Mahogany*

6 x 7	6 x 10 $\frac{1}{2}$	6 x 14
6 x 21	7 x 9	7 x 10
7 x 12	7 x 14	7 x 18
7 x 21	7 x 24	7 x 48
9 x 14	10 x 12	12 x 14
12 x 21	14 x 18	20 x 24



Look for this stamp  
on every genuine  
RADION Panel.  
Beware of substi-  
tutes and imitations.



AMERICAN HARD RUBBER CO., 11 Mercer St., N. Y.

Please mention POPULAR RADIO when answering advertisements.

# Radio Broadcast Contest reveals Bradleystat supremacy for Long Distance Reception



RADIO Broadcast recently conducted a prize contest, open to all radio enthusiasts, for the purpose of interesting amateurs in long-distance reception. Ninety contestants were entered, and the names of all, including prize winners, were published in several issues of Radio Broadcast, after the contest closed.

## How the remarkable Bradleystat records were discovered!

AFTER the names were published, a letter was written by the Allen-Bradley Co. to each contestant to ascertain what filament rheostat was used in each radio set. Seventy-two reports were received, and after they were tabulated, the most amazing discoveries were made about Bradleystat performance and Bradleystat popularity.

## The Bradleystat captured first place in all leading events!

The superiority of the Bradleystat was proved, conclusively, by these facts:

1. The First Prize Winner used the Bradleystat in his set.
2. The greatest mileage record of 305,420 miles, total, was made by a Bradleystat user.
3. The Bradleystat was the most popular rheostat in the entire contest.
4. More Bradleystats were used than the next four types of rheostats, combined, "see diagram."
5. No carbon or metallic powder rheostat was reported in competition with the Bradleystat in this record-breaking contest.

Your radio set needs a Bradleystat. Try one tonight!



**\$1.85**

IN CANADA  
**\$2.50**

PARCEL POST  
10¢ EXTRA

## Bradleystat Leads by Big Margin



### Analysis of Returns

Each line represents a different type of rheostat used in the contest. The numbers indicate how many of each were used. Note the overwhelming popularity of the Bradleystat, first on the list.

**Allen-Bradley Co.**

Electric Controlling Apparatus

276 Greenfield Avenue



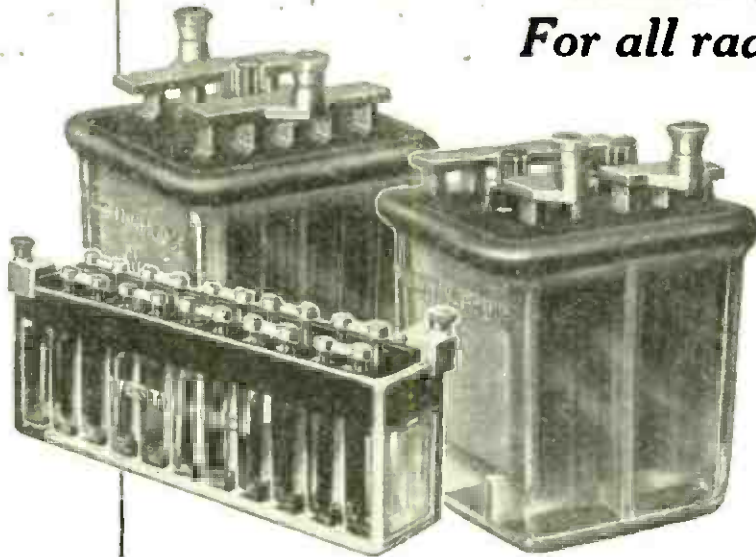
MILWAUKEE, Wisconsin

THE ALLEN-BRADLEY CO. HAS BUILT GRAPHITE DISC RHEOSTATS FOR OVER 20 YEARS

# WESTINGHOUSE

## CRYSTAL CASE "A," "B" and "C" BATTERIES

*For all radio requirements*



### *Better Batteries— Better Radio Reception*

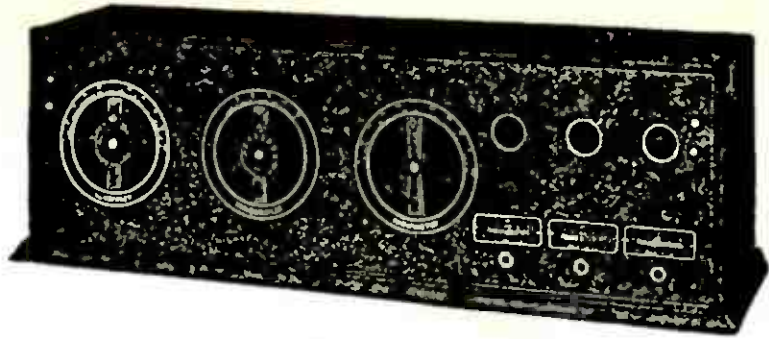
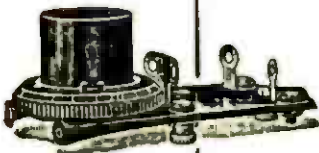
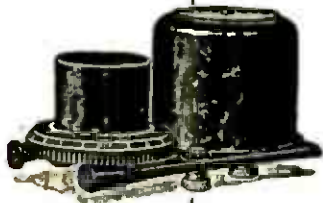
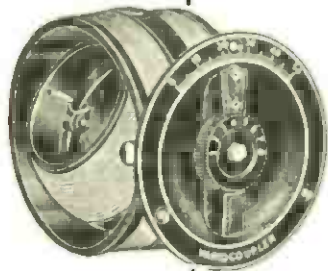
Every radio fan knows the importance of sustained battery voltage in a radio receiving set. A sudden drop in filament voltage, for example, is exasperating. Right here the name Westinghouse becomes significant. As in automobile batteries, Westinghouse Radio Batteries are the finest Westinghouse can build. The new CRYSTAL CASE types are especially efficient. Even-powered, slow-discharging, you'll quickly note their superiority for fine tuning, signal holding and sound volume. So economical, too! They last indefinitely and are easily recharged at a few cents' cost.

**CRYSTAL CASE "A" Batteries**—One-piece glass case with solid glass cell partitions and plate rests. Visible interior. 2, 4 and 6-volt sizes. **CRYSTAL CASE "B" Batteries**—The 22-MG-2 (22 volts) is a wonder for steady, noiseless, full-powered service. Rechargeable, of course. Larger types, too. Also "C" batteries in 6-volt units.

WESTINGHOUSE UNION BATTERY CO.  
Swissvale, Pa.



Please mention POPULAR RADIO when answering advertisements.



## *Build your own Radio Set*

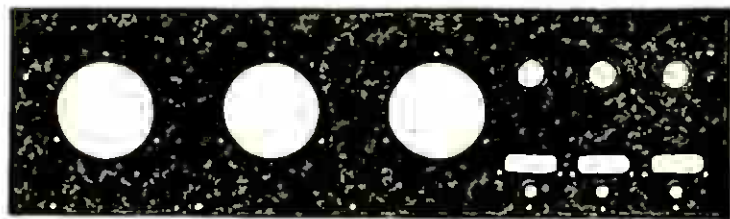
—and save half the labor customarily involved.

The panels are completely drilled, and the parts are simply fastened with screws and nuts.

Any circuit desired may be employed. We have eight different types of panels.

The crystal black panel finish, together with the concave dials, lend a pleasing effect—the absence of knobs giving a clean, flush appearance.

You can build, or buy, a cabinet to suit your individual taste.



*Illustrated catalog upon request*

**EISEMANN MAGNETO CORPORATION**

William N. Shaw, *President*

46-33rd STREET, BROOKLYN, N. Y.

Please mention POPULAR RADIO when answering advertisements.



*Modern Replacement  
For Fixed and  
Variable Condensers*

## The GREWOL Vari-Grid

Used as a 11 or 23 Plate Vernier Condenser as well as a variable grid control.

The capacity of the grid of your tube **must** be varied to secure maximum efficiency, distance, clearness and sharp tuning. This is the purpose of the Grewol vari-grid. **PRICE**

Equipped with grid leak, removable when Vari-Grid is used as vernier condenser in other circuits than the grid. Costs less! One hole to drill  $1\frac{3}{4}$ " in diameter, an efficient quality instrument. Write for descriptive booklet. **\$ 2.25**

### GREWOL Fixed Detector

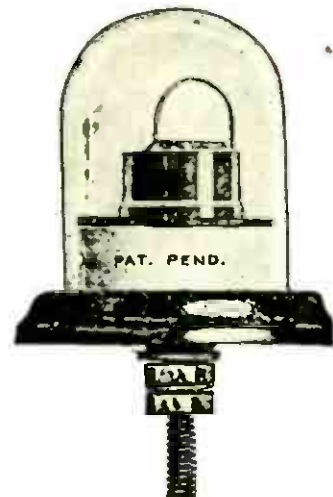
Positive, sensitive adjustment **ALWAYS**, instead of continual guessing and adjusting. Therefore, preferred for all reflex and other super-sensitive circuits. Glass-enclosed, solid mounting (vibration-proof). Adds to the appearance of your set, imitated but never equalled. Others cost more but none give better satisfaction.

**PRICE**  
**\$ 2**

*Each detector equipped with Special Reflex Crystal,  
guaranteed not to burn out*

WRITE FOR NEW REFLEX HOOK-UP FREE

Both of these GREWOL Products  
At Your Dealers or Direct  
Upon Receipt of Price



(Actual Size)

## RANDEL WIRELESS CO.

4 CENTRAL AVENUE

NEWARK, N. J.

*Jobbers and Dealers write for Proposition*





# The Music of the Immortals in Your Own Home

People sometimes sit hours in hot, stuffy opera houses to hear our famous opera singers. Yet the immortal notes of those same stars are broadcasted from radio stations and are listened to by thousands in the comfort and seclusion of their own homes.

Perhaps you would rather follow an athletic contest play by play, or listen to a speech by some famous man. Or perhaps the market, crop and weather reports would prove more interesting to you.

## PARAGON

Reg. U.S. Pat. Off.

### RADIO PRODUCTS

With the new PARAGON Three-Circuit Receiver Type RB-2 you can pick out the program you wish to hear and hear it clearly from beginning to end. For the greatest enjoyment of radio, for complete satisfaction, you should listen in with a Paragon set.

In appearance it is an addition to any home. All cabinet work is of mahogany with a brown mahogany finish. All metal parts showing, inside as well as outside of the cabinet, are nickel plated. 98% of the wiring is invisible. The whole outfit is compact, neat, solidly built, and finely finished. It is the ideal Radio receiver and the ideal holiday gift.

*Illustrated Bulletins on Paragon  
Radio Products Are Yours for the Asking.*

DEALERS: We believe in the proper distribution of Paragon Radio Products. Our exclusive Distributors are particularly interested in territorially protected dealers, who will concentrate, solicit and serve the consumer in the sale of Paragon Radio Receivers. If interested, write us for details.

**ADAMS-MORGAN COMPANY**  
20 Alvin Ave., Upper Montclair, N. J.

Illustration shows the new Paragon RB-2 Regenerative Receiver with two-stage tone amplifier  
Price \$135.00

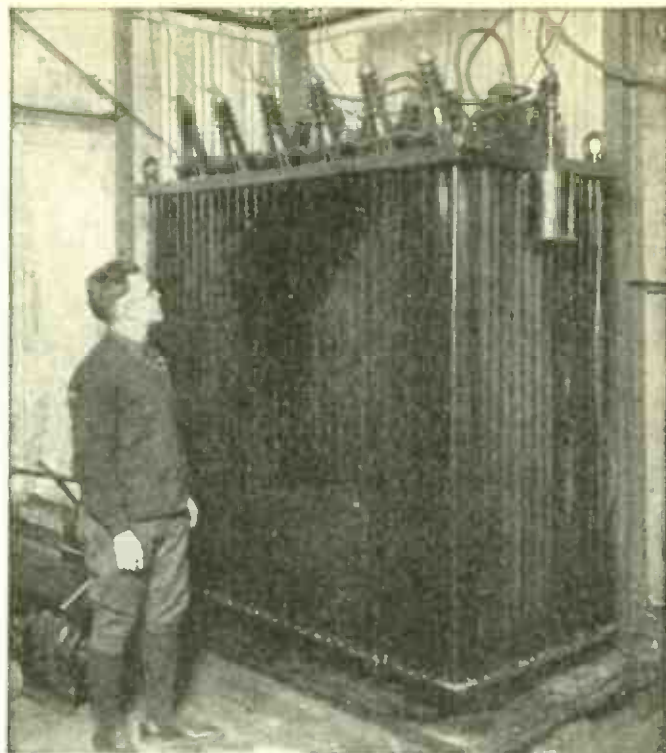
(Licensed under  
Armstrong Patent  
No. 1,113,149)

Please mention POPULAR RADIO when answering advertisements.

## A real contribution to Radio Progress

The photograph at the right illustrates the special service transformer installed at the Radio Central, Rocky Point, L. I., for talking across the ocean.

It represents a long step forward from the pioneer days, over 20 years ago, when we also equipped the stations of the Marconi Company with the large transmitting transformers for the first commercial transatlantic wireless communication.



By Courtesy of Western Electric Co.

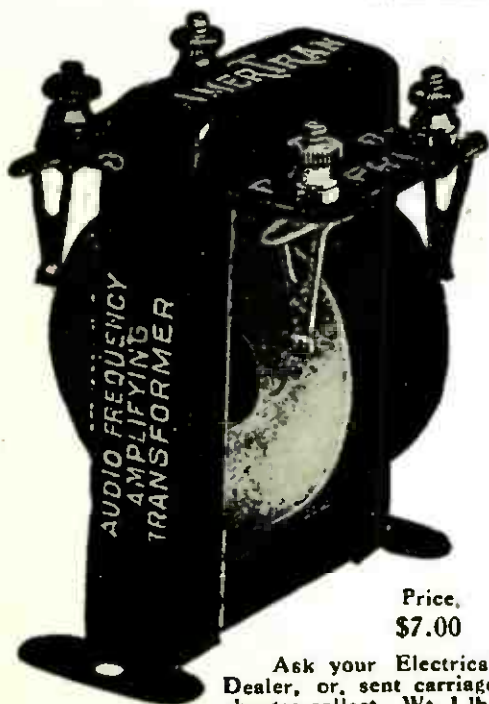
300 k.v.a., 60 cycle, 3-phase, 22,000 volt, oil-cooled special service transformer, Radio Central, Rocky Point, L. I.

—With all tubes—

# AMERTRAN

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

—In all stages—



Price,  
\$7.00

Ask your Electrical  
Dealer, or, sent carriage  
charges collect. Wt. 1 lb.

This experience in transformer design and construction has produced The AmerTran — an audio frequency transformer for the amateur and professional alike.

Its flat-top distortionless amplification curve assures a pure tone rendering of the full musical scale.

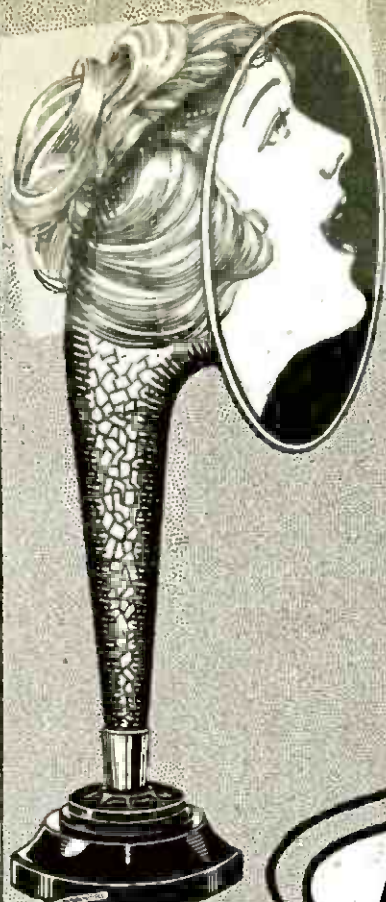
It amplifies in one stage from 30 to 40 times in the flat part of the curve, depending on the tube constant — the amplification is approximately 5 times the tube constant.

*In One Type Only. Turn Ratio, 5:1*

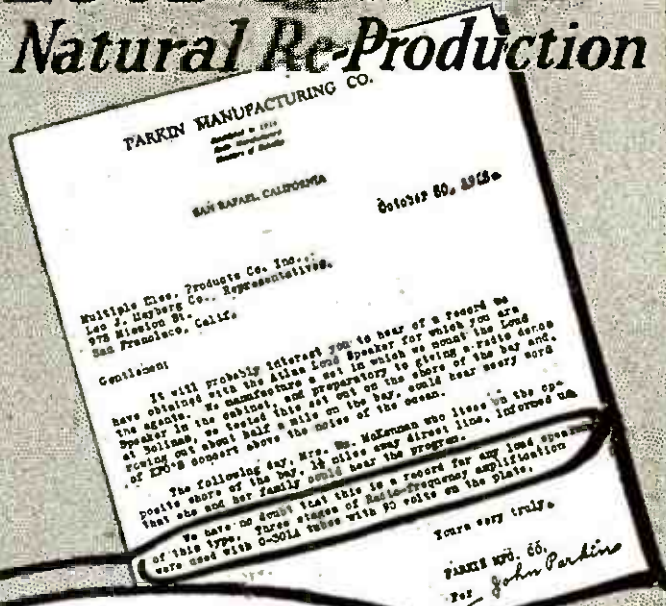
## American Transformer Company

*Designers and builders of radio  
transformers for over 22 years*

181 Emmet Street :: Newark, N. J.



# Atlas LOUD SPEAKER Natural Re-Production



## A Record!

**E**NTHUSIASTIC TESTIMONY straight from an impartial authority. Re-Production is a fact. The delicate overtones which give music its roundness, resonance and timbre, are faithfully re-born through the modern magic of the patented "double diaphragm." This extremely responsive device is adjustable to the exact requirements of your set and individual receiving conditions. *Write for Illustrated Booklet "B"*

### Atlas Loud Speaker Unit

With Phonograph Attachment . . . . \$13.50  
 Without Phonograph Attachment . . . \$12.50

### Letters From Users Requested

What have you accomplished with your Atlas Amplitone? Tell us about it.

Sole Canadian Distributors  
 The Marconi Wireless Telegraph Company  
 of Canada, Limited

Ask Your Dealer  
 for a  
 Demonstration  
 List Price  
 Complete

**\$25**

**Multiple Electric Products Co. Inc.**  
 ORANGE ST.,      RADIO DIVISION      NEWARK, N. J.

Please mention POPULAR RADIO when answering advertisements.

*New 1924 Model*



# LOUD SPEAKER



Mahogany Finish

Price Now

**\$ 17<sup>50</sup>**

(West of Mississippi \$19.00)

## *See It Today*

Step into your dealer's store—he will gladly give you a demonstration without obligation. See this wonderful new value, placed on the market now for the first time. You will realize the outstanding superiority of the new

Pathé Loud Speaker. Notice its beautiful Mahogany finish and its ability to reproduce long distance signals clearly. With the new low price it is the best buy on the market.

### FREE PAMPHLETS

Write now for free pamphlets on the Pathé Loud Speaker, Pathé Variometer, Pathé Variocoupler, Pathé Dials and the new Curtantenna.

*Jobbers and dealers write for new special proposition*

**PATHÉ PHONOGRAPH & RADIO CORPORATION**

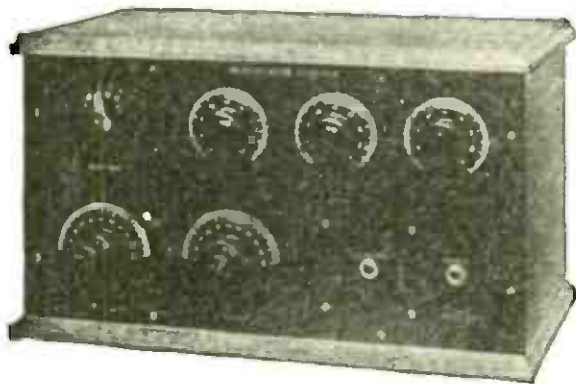
20 GRAND AVE., BROOKLYN, N. Y.

Western Sales Office, 533 Wabash Ave., Chicago, Ill.

Please mention POPULAR RADIO when answering advertisements.



## Performance!—Read this Letter



Receiver No. 102  
PRICE, \$95.00  
(Licensed under Armstrong Patent 1113149)



Audio Frequency Transformer, No. 50  
Gives maximum amplification without distortion  
Ratio 3¼ to 1. Moisture proof  
PRICE, \$4.50



Vernier Variable Condenser, No. 10  
Twenty-three plates, capacity .0005 M. F. Built  
in vernier—low resistance and losses.  
PRICE, \$4.50

Melrose, Mass., November 10, 1923.  
National Chelsea Radio Corp., Boston, Mass.

Gentlemen: I know that you will be interested in the remarkable reception which I obtained with one of your Type No. 102 Regenerative Receivers.

I received the instrument Friday, November 2, and connected it in the presence of two of the Boston Edison Company's engineers. On this evening without any previous experience, I heard practically every station throughout the Middle West on a loud speaker. I am very much delighted with the performance of this receiver.

I am attaching below a list of stations which I have heard during the past six days. All of these stations were received on the loud speaker with sufficient volume to be heard all over my home with the exception of Denver. Nearly all of these were received prior to 10 p.m.

WOC	Davenport	WJZ	New York City
WOAI	San Antonio	WOS	Jefferson, Mo.
KLG	Denver	WCAU	Phila., Pa.
WHN	New York City	WFI	Phila., Pa.
KHJ	Los Angeles	WNAC	Boston
WFAA	Dallas	WGI	Medford
WDAR	Phila., Pa.	WDAP	Chicago, Ill.
KDKA	Pittsburgh, Pa.	WTAM	Cleveland, Ohio
WRC	Washington, D. C.	WLAG	Minneapolis, Minn.
WEAF	New York City	WHW	Cincinnati
WOR	Newark	KOW	Pittsburgh
CFCF	Montreal	WIP	Phila., Pa.
WGY	Schenectady	WCAE	Pittsburgh
WBZ	Springfield	WWJ	Detroit
WHAZ	Troy, N. Y.	KYW	Chicago
WCBD	Zion, Ill.	WDAP	Chicago
WAAM	Newark, N. J.	WSB	Atlanta
WGR	Buffalo	KSD	Kansas City
		WHAS	Louisville

Assuring you that I am an enthusiastic booster of Chelsea Receivers I remain,

Yours very truly,

AUBREY R. GOODWIN.

You can secure the same results with this wonderful Chelsea Receiver.

### CHELSEA PARTS

The marvelous results obtained by CHELSEA RECEIVERS are largely due to the Chelsea Parts. If you are building your own set you may be certain that the use of Chelsea Parts will give you the maximum results.

Write for our large Catalog No. 3 illustrating a complete line of sets and parts

**NATIONAL CHELSEA RADIO CORP.**  
739 Boylston St., Boston, Mass.

# AMPLION

The World's Standard Loud Speaker

## A few practical points about Amplion supremacy

The Amplion requires no power amplifier—no battery. You simply attach it to regular head phone connections.

The diaphragm is made of a special alloy, found to have no equal after years of experiment with all other materials.

The electro-acoustical device is insulated entirely from the horn to eliminate distortion, ring or resonance.

Its Non-vibrating wood horn surpasses all other materials for true tone and clearness.

An Adjustable feature makes the Amplion sound true with any make of receiving set, and ensures faithful reproduction.

The Amplion mechanism is not new—it has not been hurriedly devised to meet the radio boom. Rather, it is a development, for radio purposes, of a loud speaking device used for years by leading Navies of the world.

The Amplion is manufactured by the oldest manufacturer of loud speakers in the world.

The Mahogany horn—the enameled sound conduit—the highly polished nickeled base—the reproducing mechanism—all are of the highest quality.

Ask your dealer for a demonstration.

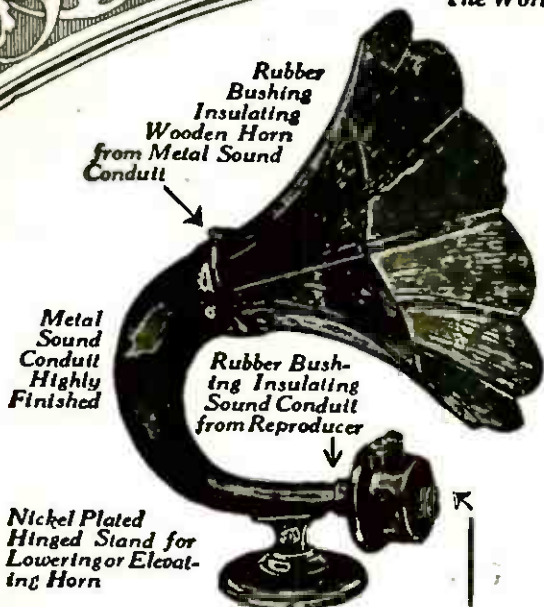
Patentees: ALFRED GRAHAM & CO.

**SIGNAL ELECTRIC MFG. COMPANY**

Sole United States Distributors Menominee, Michigan

BURNDEPT OF CANADA, LTD.

Canadian Distributors — 172 King Street W., Toronto



Rubber Bushing Insulating Wooden Horn from Metal Sound Conduit

Metal Sound Conduit Highly Finished

Rubber Bushing Insulating Sound Conduit from Reproducer

Nickel Plated Hinged Stand for Lowering or Elevating Horn

Screw for adjusting diaphragm to meet all conditions of Rec. Sets

Amplion Deagon AR-19

\$40.00

Phonograph Unit AR-35  
\$24.00



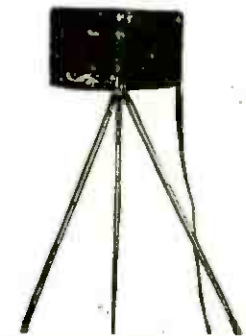
Amplion Beauty AR-15

\$46.00



Amplion Junior DeLuxe AR-45

\$26.00



Amplion Portable AR-61

\$50.00



Amplion Junior AR-39

\$18.00

The Supremacy of The Amplion is The Supremacy of Actual Performance

Please mention POPULAR RADIO when answering advertisements.



## The Improved **MIRACO** Gets 'em from Coast to Coast

**Model K**  
(SHOWN ABOVE)  
**\$29.50**

It is a two-tube outfit consisting of one stage of tuned impedance radio-frequency amplification with a tuner and vacuum tube detector. This radio-frequency receiver amplifies before it detects, eliminates interference to a marked degree and has much more volume than most one-tube sets.

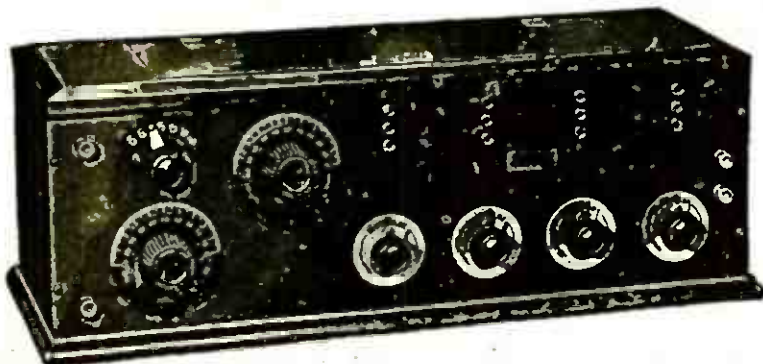
**Model MW**  
(SHOWN BELOW)  
**\$54.50**

The Model MW consists of the same high-grade units as our Model K, with the addition of a two step audio-frequency amplifier in a single beautifully finished solid mahogany cabinet. It is a four-tube set, comprising one stage of tuned impedance radio-frequency amplification, detector and two stages of audio-frequency.

Just like the sweet, mellow tones of a flute or violin floating in from afar out on a lake—that's the way concerts come in through MIRACO receivers—and—  
Not only from the nearby stations either. For our users tell us that Cincinnati hears 'Frisco, Denver hears Schenectady New York hears Havana! Scores of long-distance records were made on these instruments last year so, with the many new refinements incorporated, the results obtainable will be far better now than ever.

### HIGHEST QUALITY AT LOWEST PRICE

When the radio craze swept the country like a storm late in 1921, MIRACO was one of the first real successful sets to be placed on the market. *Highest quality at the lowest price* has always been our keynote, and the thousands of sets now in use all over the world are a fitting tribute to Miraco's excellent performance. Many new improvements have just been made in the MIRACO Models K and MW, such as new sockets resting on shock absorbing pads is a refinement found only in the most expensive and elaborate sets. Improved rheostats with multiple resistance windings makes it possible to use any type of tubes and a new aluminum shield prevents annoying body capacity effects. The cabinet is of solid mahogany, workmanship throughout is the finest while its operation is extremely simple yet always dependable.



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 CO., 812 MAIN STREET  
CINCINNATI, OHIO**

# Impartial Experts Testify!

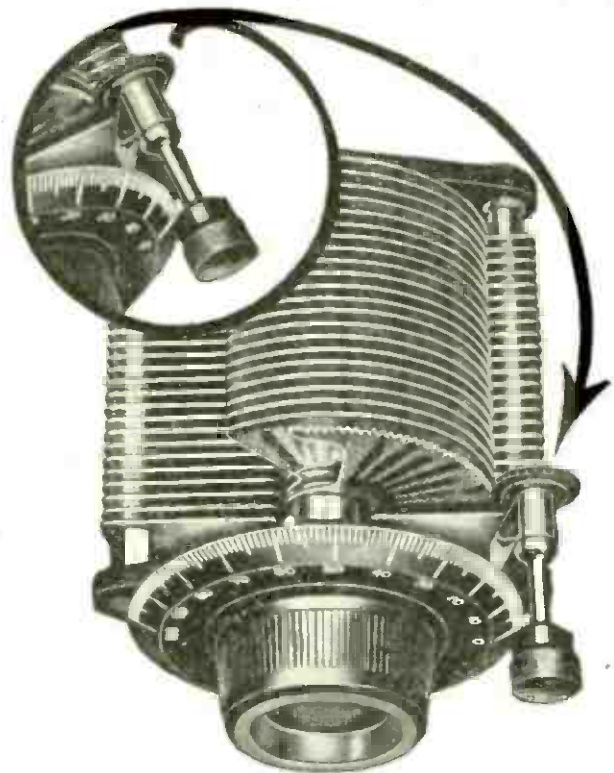
For a long time, set builders have wanted some definite, authoritative guide to condenser quality. Complying with this demand, HEATH RADIANT CONDENSERS were submitted to two of the greatest radio testing laboratories. Below are salient phrases from their reports. Copies of the complete reports free to anyone interested.

## Electrical Testing Laboratories of New York, Says—

“... the equivalent series resistance of each of the condensers is very small. That is, it is so *small* that it may be considered as *negligible*.”

## Radio News Laboratories, Says—

“... considered one of the best condensers we have tested. A dielectric loss resistance of 46 ohms at 1000 cycles.”



# HEATH RADIANT CONDENSERS

### Permanently Flat Plates

*Precise*, when you examine it at the store, and, still more important, *p-r-e-c-i-s-e always*, for years—the most durable, continuously efficient part of your set. *Warping plates made impossible* by the *Heath* process of stamping and hardening which makes each one permanently **FLAT PLATES**.

### Micrometer-Adjusting Geared Vernier

Reducing gear, engaging with teeth cut into the outer rim of the vernier plate, affords infinitely delicate adjustment. An added feature of satisfaction that makes it well worth your while insisting upon *Heath Radiant Condensers*.

Write for Booklet

List Prices—Vernier Type (With  $2\frac{1}{8}$ " dial and knob)  
13 Plate, \$5.<sup>00</sup> 25 Plate, \$5.<sup>50</sup> 45 Plate, \$6.<sup>50</sup>

## HEATH RADIO & ELEC. MFG. CO.

204 First Street

::

::

::

Newark, N. J.



Please mention POPULAR RADIO when answering advertisements.

*Establishing a New Horizon for Radio*



The New  
**MU-RAD**  **RECEIVER**

**T**HE HORIZON of the radio art extended and broadened by this new perfection of radio reception—the more versatile, more simply operated receiver, *Mu-Rad MA-15*. Many important refinements—plug-in type radio frequency transformers, so that the MA-15 can be accommodated to any future changes of wave lengths or tubes, volt-meter for instantaneous readings of “A” or “B” batteries, new type vernier dials, operated by cams to eliminate back-lash, no other aerial than a 2-foot loop needed, and a wave length switch for bringing in short wave stations. Solid mahogany cabinet, with an engraved Formica panel. The MA-15 anticipates every possible use and requirement. *Guaranteed range, 1,000 miles using 2-foot loop.*

**Another New MU-RAD Receiver MA-17**

Three stages of radio and two of audio frequency amplification and detector. *One* tuning dial and two selecting dials, each independent of the other. Plug-in type r. f. transformers to care for changes of tube type or wave lengths. Panel-mounted volt-meter for quick reading of A and B batteries. Solid mahogany, Adam Brown hand-rubbed finish cabinet with loop fitted into top and compartment in base for B batteries. Guaranteed for 1000 miles reception using only a 2-foot loop.

WRITE FOR BOOKLET AND NAME OF NEAREST DEALER

**MU-RAD LABORATORIES, INC.**

809 FIFTH AVE ASBURY PARK, NEW JERSEY

Please mention POPULAR RADIO when answering advertisements.



Model "D"  
N & K  
4,000 Ohms

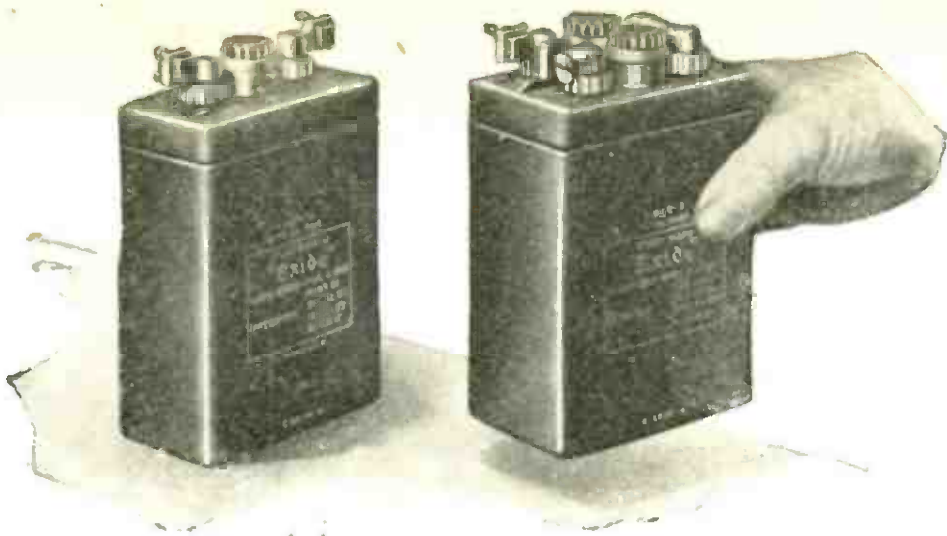
# DEALERS!

N. & K. Phones can be had at any time and in any quantity. We, as exclusive distributors for the United States and Canada, are always carrying in New York a large stock of these truly fine headsets in order to supply the demand promptly. N. & K. headsets are manufactured by Neufeldt & Kuhnke, Kiel, Germany — known the world over as leaders in their line.

We have a Profit Proposition to offer dealers. Write us for complete details.

*Kindly address inquiries to Dept. C.*

**Th. Goldschmidt Corporation**  
15 William Street, N. Y. C.



## What you have been waiting for

**H**ERE are two rugged little storage batteries designed particularly for low-voltage tubes.

Although they weigh only 5 and 6 pounds, they are of true Exide quality. Highly efficient and with ample power for long-distance receiving, these batteries will give you a type of service that you would find it hard to duplicate.

These sturdy little batteries are neat and compact. They were 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 four-volt A Battery, having two cells, will light the filament of a UV-199 tube for 200 hours.



**For six-volt tubes**  
Like all Exide Storage Batteries, the Exide A Battery for six-volt tubes is dependable and long-lasting. It is made in four sizes, of 25, 50, 100 and 150 ampere hour capacities.

adjustment that make radio receiving an unalloyed pleasure.

As you know, any variation of current in the plate circuit produces weird sounds in your phones. With an Exide B Battery hooked up to your set, static is the only undesirable sound you will have to contend with. The Exide B Battery supplies steady, noiseless current. It permits the niceties of

The Exide A Battery for six-volt tubes has extra-heavy plates, assuring constant potential and uniform current over a long period of discharge. Like all Exide Batteries, it embodies the finest materials available.

### *In marine and commercial wireless*

On sea and on land the Exide plays an important role in the industrial life of the nation. In marine wireless, Exide Batteries provide an indispensable store of emergency current. A majority of all government and commercial wireless plants are equipped with Exides.

Exide Radio Batteries are sold by radio dealers and Exide Service Stations everywhere. Ask your dealer for booklets describing in detail the complete line of Exide Radio Batteries. Or write direct to us.



**Exide B Batteries**  
give noiseless, full-powered service over a long period of discharge. Designed throughout to prevent electrical leakage. Capacity, 3 ampere hours.

# Exide

## RADIO BATTERIES

**THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA**

*Oldest and largest manufacturers in the world of storage batteries for every purpose*

Service Stations Everywhere

Branches in Seventeen Cities

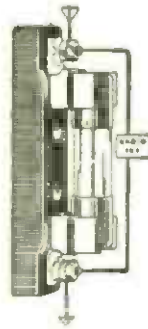
Please mention POPULAR RADIO when answering advertisements.

# *A Lightning Arrester - Is Required by the 1923 National Electric Code*

Our Lightning Arrester No. 606 provides means whereby the static electricity that collects on every antenna during certain atmospheric conditions may discharge to ground without injury to coils, condensers or other delicate apparatus.

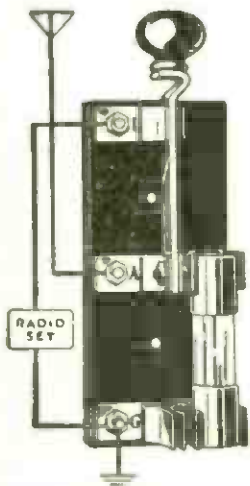
It is a Vacuum Tube Arrester of the highest workmanship and material, designed along lines that our experience has proven to be correct.

This Lightning Arrester is approved by the Underwriters Laboratories.



Cat. No. 606, Price \$2.00

## *For Those - Who want the best*



Cat. No. 602, Price \$3.50

"For those who want the best" our Lightning Arrester Switch No. 602 has no competitor on the radio market.

The Vacuum Tube Arrester is always on the job ready to spill any overcharge. With the switch blade the antenna may be disconnected from your set and thrown directly on ground.

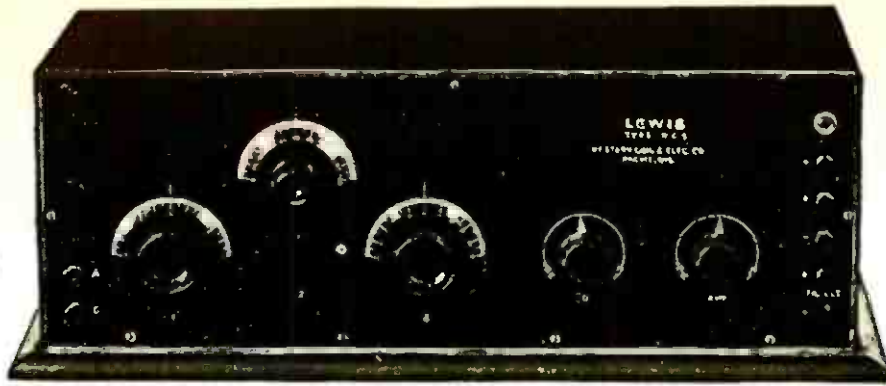
This device combines on one base the requirements and the added recommendations of the 1923 National Electrical Code. It is approved by the Underwriters Laboratories.

CHICAGO, ILL.  
15 S. CLINTON ST.

# BARKELEY

SAN FRANCISCO.  
72 FREMONT ST.

ELECTRIC MANUFACTURING CO.  
MIDDLETOWN, OHIO.



## A Special Low Wave Set for Transmitting Amateurs

Does your receiving set respond readily to short wave signals? The WC-5-SW set shown above was designed by short wave specialists to help you. It picks up signals on wave lengths from 90 to 380 meters sharp and clear. The WC-5-SW has proven itself to be the most practical receiving set for low wave specialists.

### WC-5-SW

Built Especially for Transmitting Amateurs

The WC-5-SW is a 4 tube set. One stage of tuned Radio Frequency amplification is employed ahead of the detector to make it supersensitive. Two stages of audio frequency are used to bring up the signal strength. Uses any type of tubes. Gives perfect control of audibility. Detector rectifies only. Uses antenna compensating condenser. Only two control adjustments. Pure negative biasing on all tubes, thus marked saving on B Battery current. Tuned Radio Frequency sharpest known and most selective principle ever adopted. Plate potential non-critical. Mono-block tube socket. No grid plate leads on audio amplifiers. Audio amplification absolutely necessary when using low efficiency receiving antenna, i.e., underground or indoor. Mahogany cabinet, piano rub finish. Rabbited-in panel. Split lid cover. The price is \$85.00.

Write for complete description and illustrated folder on this practical set for low wave specialists. All transmitting amateurs will be interested in this literature.

### OTT RADIO, Inc.

222 Main Street

La Crosse, Wis.

Please mention POPULAR RADIO when answering advertisements.

# SOLID COMFORT Comes With The Use Of The

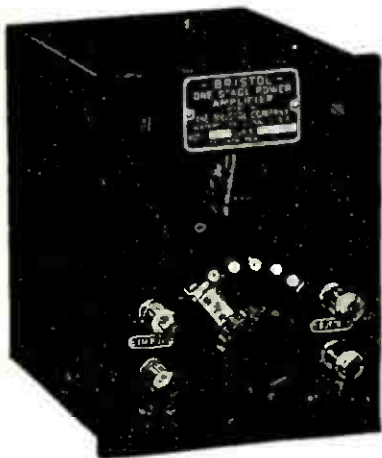
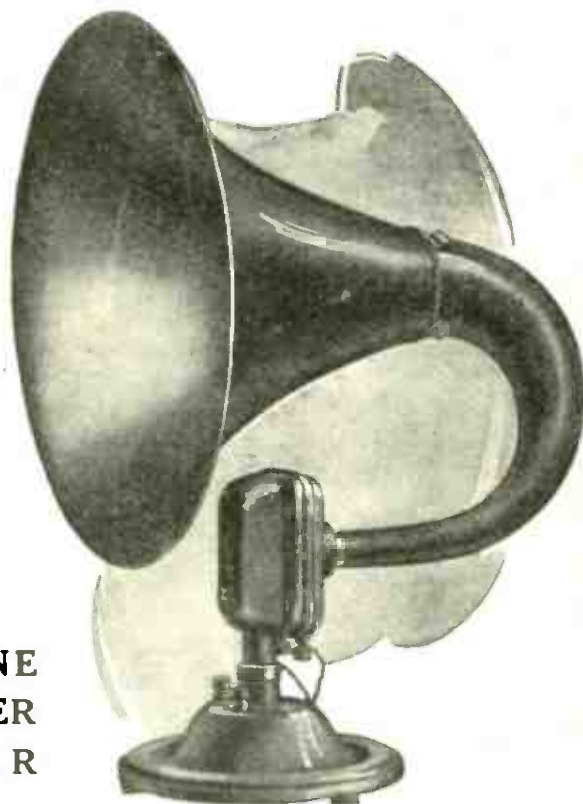
TRADE MARK  
**AUDIOPHONE**  
REG. U. S. PAT. OFFICE

**because nothing is lost from  
the original broadcasting**

Not only is it easily possible to distinguish the words of the speaker, but also the minute graduations in pitch, timbre and quality of overtones which distinguish individual voices.

The Audiophone is complete and self-contained—needs no separate battery or other accessories—goes to you ready for use on connecting to your receiving set. It will prove a source of lasting pride and pleasure.

Audiophone Sr. . . . . Price \$32.50  
Audiophone Jr. . . . . Price 22.50



**BRISTOL ONE  
STAGE POWER  
AMPLIFIER**

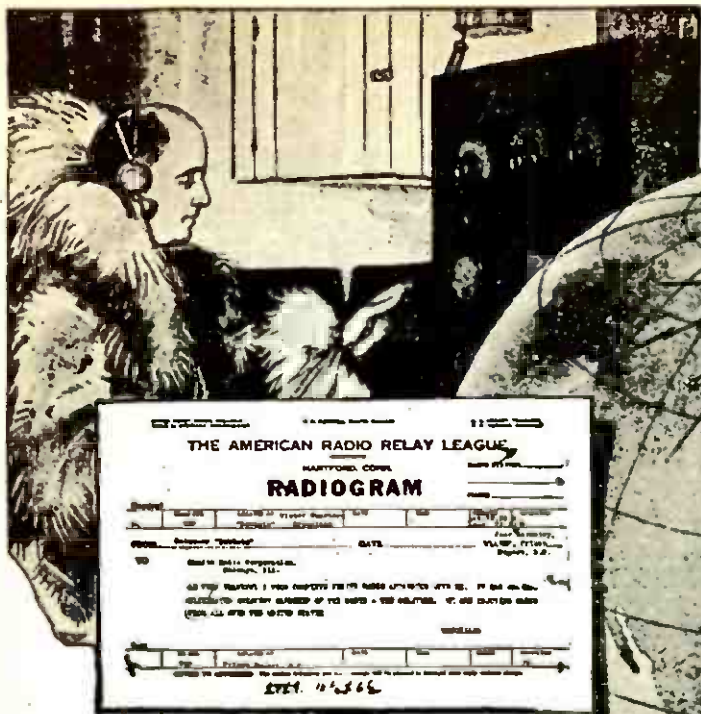
If greater volume is desired, over what you already obtain, use the Bristol One Stage Power Amplifier. No C Battery required  
Price \$25.00

**THE BRISTOL COMPANY**  
WATERBURY, CONN.

**THE BRISTOL COMPANY**  
Waterbury, Conn.

Please send me without cost or obligation to myself, Bulletins Nos. 3006 and 3011-L on Bristol Audiophone and One Stage Power Amplifier.

Name.....  
Street and No.....  
City.....State.....



THE AMERICAN RADIO RELAY LEAGUE  
 HARTFORD, CONN.  
**RADIOGRAM**

TO: \_\_\_\_\_

FROM: \_\_\_\_\_

DATE: \_\_\_\_\_

TIME: \_\_\_\_\_

CLASS: \_\_\_\_\_

REMARKS: \_\_\_\_\_

STATION: \_\_\_\_\_

# ZENITH

Licensed under  
 Armstrong  
 U. S. Patent  
 No. 1,115,149

## AT THE NORTH POLE



**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 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**



**MODEL 3R**—The new Zenith 3R "Long-Distance" Receiver-Amplifier combines a specially designed distortionless three-stage amplifier with the super-efficient 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**

**I**NSIDE the Arctic Circle, nine degrees from the North Pole; a little 89-foot schooner is frozen fast in the ice of Smith Sound. Aboard this schooner a group of brave men are enduring, as best they can, the desperate cold of the Arctic—cold that often drops to 60 degrees below zero. Human atoms in a boundless field of ice!

Cold is hard to endure, but far more terrible is the Arctic solitude—unbelievably oppressive. Radio, at length, has broken this spell forever!

### Concerts from Honolulu!

Daily, by means of powerful sending and receiving apparatus, the crew of the "Bowdoin" are in communication with relatives and friends in the far-off States. Daily they listen to concerts as far away as Chicago, Dallas and Honolulu!

When the sanity, the very lives of one's shipmates may depend upon contact with the outside world, none but the **BEST** is good enough.

### Dr. MacMillan's Choice—the Zenith

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**.

Already his operator, on board the "Bowdoin" **IN NORTHERN GREENLAND**, has tuned in several hundred stations. You along the Atlantic who brag a little when you tune in Catalina Island—what would you say if you tuned in Hawaii **FROM THE ARCTIC CIRCLE?**

The set that Dr. MacMillan has is a standard Zenith receiving set. And you can do all that MacMillan does, and more, with either of the two new models shown at the right. Their moderate price brings them easily within your reach. Write today for full particulars.

**Zenith Radio Corporation**  
 McCormick Building, Chicago



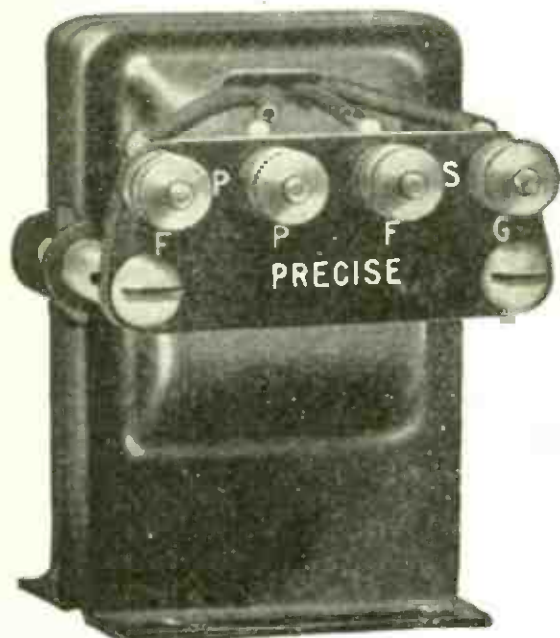
**ZENITH RADIO CORPORATION,**  
 Dept. C. 328 South Michigan Ave., Chicago, Ill.

Gentlemen:—  
 Please send me illustrated literature on Zenith Radio.

Name .....

Address .....

# By Merit Alone,



Model 285A—\$5.75

*Precise Audio Transformers are the choice of those who discriminate.*

The 4½ to 1 ratio yields the highest degree of amplification without distortion, and the deeper tones so often lost find their place in the wonderfully realistic recreation of broadcasted music. Recommended for neutrodyne circuits.

Our voltage amplification test chart No. 1094 is convincing of the remarkable performance of this transformer.

Write today for this chart and illustrated circular describing our VERNIER RHEOSTAT and SWITCH LEVER.

### Trial Offer

If your dealer cannot furnish these, send us his name or on receipt of price we will forward you any instrument for ten days trial and will refund your money on return if unsatisfactory.

## PRECISE MANUFACTURING CORPORATION

Rochester, :: :: :: New York

### BRANCHES

53 W. Jackson Blvd.  
Chicago, Ill.

821 Market Street  
San Francisco, Cal.

Distributed in Canada by Perkins Electric, Ltd.

Toronto

Montreal

Winnipeg

## Clear as a Silver Bell



The O-T is the only genuine Silvertone Tube. Fully guaranteed. Beware of imitations.

## O-T SILVERTONE TUBES

(Registered)

### In your radio set assure—

sharp, clear, mellow tones—  
music with its delightful and thrilling modulations—  
speeches without distortion, audible down to a whisper—  
and all the other joys of Radio at their best

### Three Models

O. T. 1A—2 to 4 volts,  
Battery Draw .15 amps. Price, \$6.00

O. T. 9—2 to 4 volts,  
Battery Draw .06 amps. Price, \$6.50

O. T. Power Tube—5 volts,  
Battery Draw .25 to .35 amps. Price, \$7.50

At your dealer or direct by mail.  
Write for complete literature.

Manufactured by DeForest Tel. & Tel. Co.

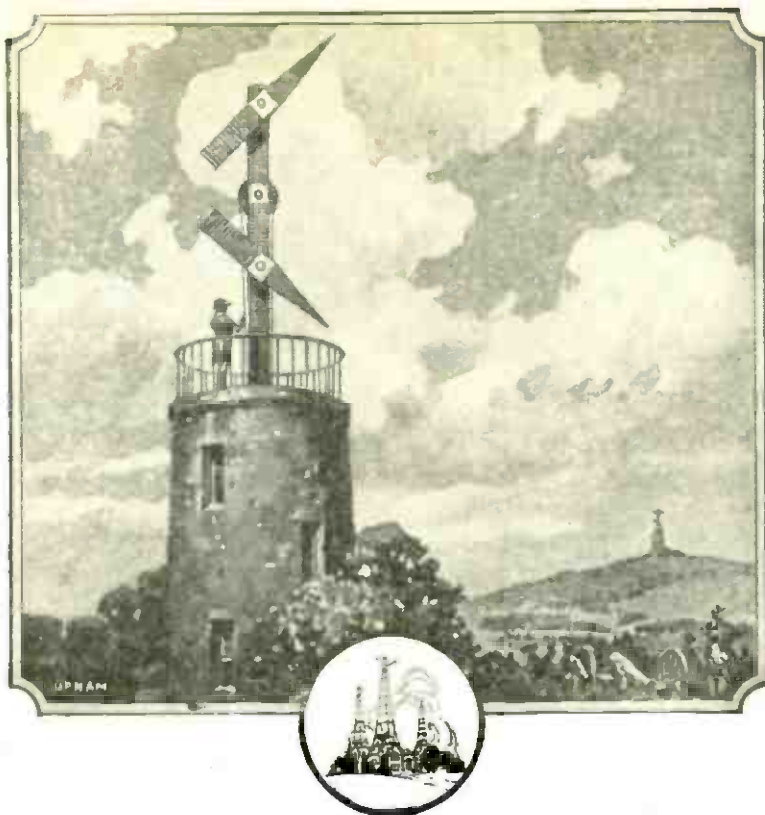
Exclusively for the

## O. & T. Electric Corporation

1819 Broadway, New York

High class representatives wanted.





## IN NAPOLEON'S DAY

**I**N the early part of the nineteenth century the semaphore was the quickest means of transmitting information. Great battles often hinged on the information received or sent by this method.

Today, due to sensitive instruments and electricity, messages are conveyed over vast distances with the speed of light.

Your radio set receives the faint electric waves sent through space and builds them up into relatively strong currents, but it is your head phones that transform this current into the music or spoken words that you hear.

Your set can be no better than your head phones and, as the enjoyment of broadcasting depends upon the quality of sound, you cannot be satisfied with inferior phones.

Holtzer-Cabot Phones are the perfected results of over twenty-five years specialization in sensitive electrical instruments. With Holtzer-Cabot Head Sets you may be sure that you are getting all the enjoyment that your radio set can give.

Holtzer-Cabot Loud Speaker, \$25.00

Holtzer-Cabot Phonograph attachment, 10.00

No. 2 Universal Head Phones, 9.50

No. 4 National Head Phones, 6.00

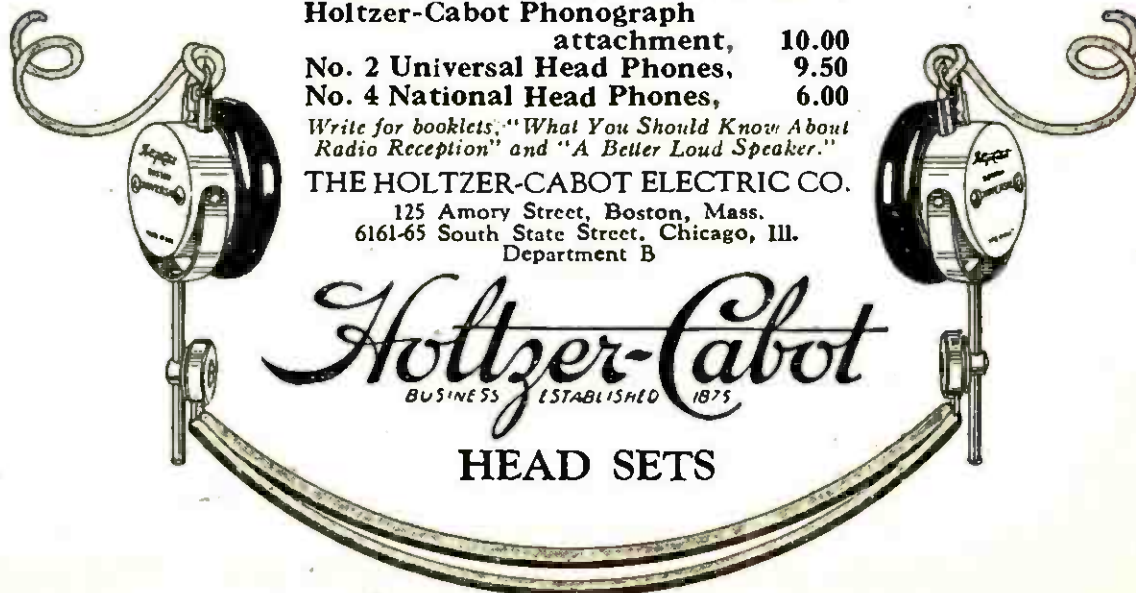
Write for booklets, "What You Should Know About Radio Reception" and "A Better Loud Speaker."

THE HOLTZER-CABOT ELECTRIC CO.

125 Amory Street, Boston, Mass.  
6161-65 South State Street, Chicago, Ill.  
Department B

*Holtzer-Cabot*  
BUSINESS ESTABLISHED 1875

HEAD SETS





**ANYONE CAN OPERATE THE**

**RADIODYNE**

*"The Voice of the Nation"*

You don't have to be an expert to install and operate the RADIODYNE effectively. It is operated by simply grounding to a water pipe or radiator and throwing a few feet of wire on the floor.

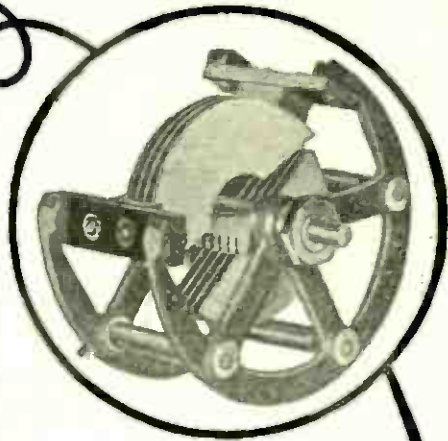
For use in apartments, boats, automobiles, railroad trains, etc., the RADIODYNE is enjoyable where other types of receiving sets would not be practical.

Stations within a radius of 2000 miles can be picked up on the loud speaker; any wavelength from 200 to 700 meters. The RADIODYNE is so sensitive that it picks up Radio telephone speech and music when other types of equipment fail.

*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

# The E.J. Flewelling Condenser



Extra rugged construction—plates heavy enough to eliminate all possibility of misalignment made the Flewelling Condenser one of the acknowledged hits of the Chicago Radio Show.

Its careful electrical and mechanical design places it among the few really efficient instruments.

All Flewelling parts maintain this high standard and are the latest and most up-to-the-minute designs of modern Radio.

**Twenty-three  
Plate  
.0005  
\$8.00**

**Flewelling  
Tuners  
\$8.00**

**Flewelling  
Sockets  
\$1.00**

**Eleven Plate  
.00025**

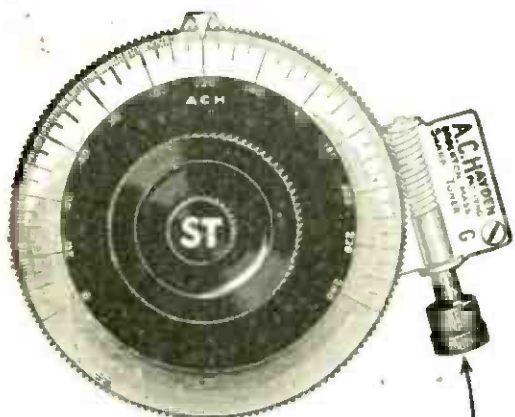
**\$6.00 / At  
Your  
Dealer's  
or Postpaid**

**BUELL MANUFACTURING COMPANY**  
2977 Cottage Grove Avenue  
**CHICAGO**

# A PLEASANT SURPRISE

Awaits the User of the

## A. C. H. SHARP TUNER DIALS



Why the A.C.H. is different

3 in. DIAL → A.C.H. → 156-TO-1

4 in. DIAL → A.C.H. → 215-TO-1

ROUGH TUNING OR 1,000 OF  
AN INCH IN EITHER DIREC-  
TION

CAN BE INSTALLED AND  
WILL IMPROVE ANY RE-  
CEIVING SET MAKING DIF-  
FICULT TUNING EASY

Price 3 inch size.....\$2.50 complete

Price 4 inch size.....\$5.00 complete

Regular fitting 5/16 shaft 1/4 and 3/16, 5 cts. each, extra

### Money Back Guarantee

The principal of the A. C. H. Sharp Tuner has only been embodied on very expensive instruments where the most delicate adjustment is necessary and then as a permanent part.

### 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 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.

BROCKTON, MASS., U. S. A.

SOLD BY RADIO LTD., MONTREAL, CANADA

Please mention POPULAR RADIO when answering advertisements.

## "RESIST-O-METER Means Perfect Resistance Control"



TYPE-2A



## Ideal Filament Control Over All Receiving Tubes

(Also 5 Watt Power Tubes)

RANGE 0—60 OHMS

Complete vernier action over entire range.

Non-packing fibrous cushion type of resistance variation.

Positively silent in operation.

Size back of panel, 1 1/8", diameter 2 3/8".

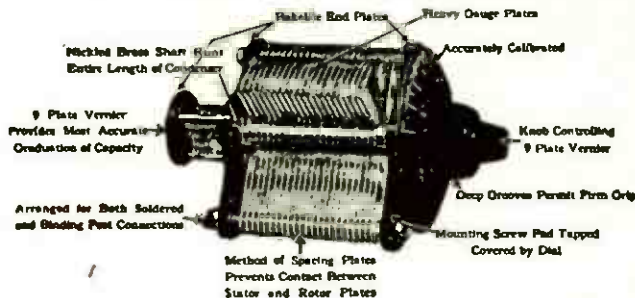
PRICE \$1.80

SCHOLES RADIO & MFG. CORP., 32 W. 18th St., N.Y.



## The New CHELTEN RADIOSCOPE Condensers

Produce results not possible with ordinary type condensers. The 9 plate VERNIER feature is far more selective than the single or any multiplication of larger plates. THE RADIOSCOPE is made in 45 and 23 plate type. It is extremely accurate and tunes sharply. See accompanying illustration.



## The CHELTEN SPECIAL CONDENSER

Carefully designed for high oscillating RADIO FREQUENCY Circuits. We have developed a Special High Resistance Insulation which is used between the rotor and stator plates to prevent leakage of Radio Frequency Currents. This Special Insulation shows lower losses than any of the Phenol Insulating materials now on the market. Made in 45 and 23 plate type with and without Vernier.

### THE CHELTEN MIDGET Vernier Condenser

Ideal for use with any Variable Condenser as a Vernier. Has 13 plates which permits of finer graduation of Capacity than is possible with a single plate Vernier. Can be used to advantage in many circuits. Price is only \$1.50.

### CHELTEN MICROFARAD JR. Low Capacity Condenser

A special Neutralizing Condenser of extremely low capacity having only 9 plates. Adjustments are made by a turn of the knob. No body capacity when making adjustments. The most satisfactory Neutralizing Condenser made. Price \$1.75.



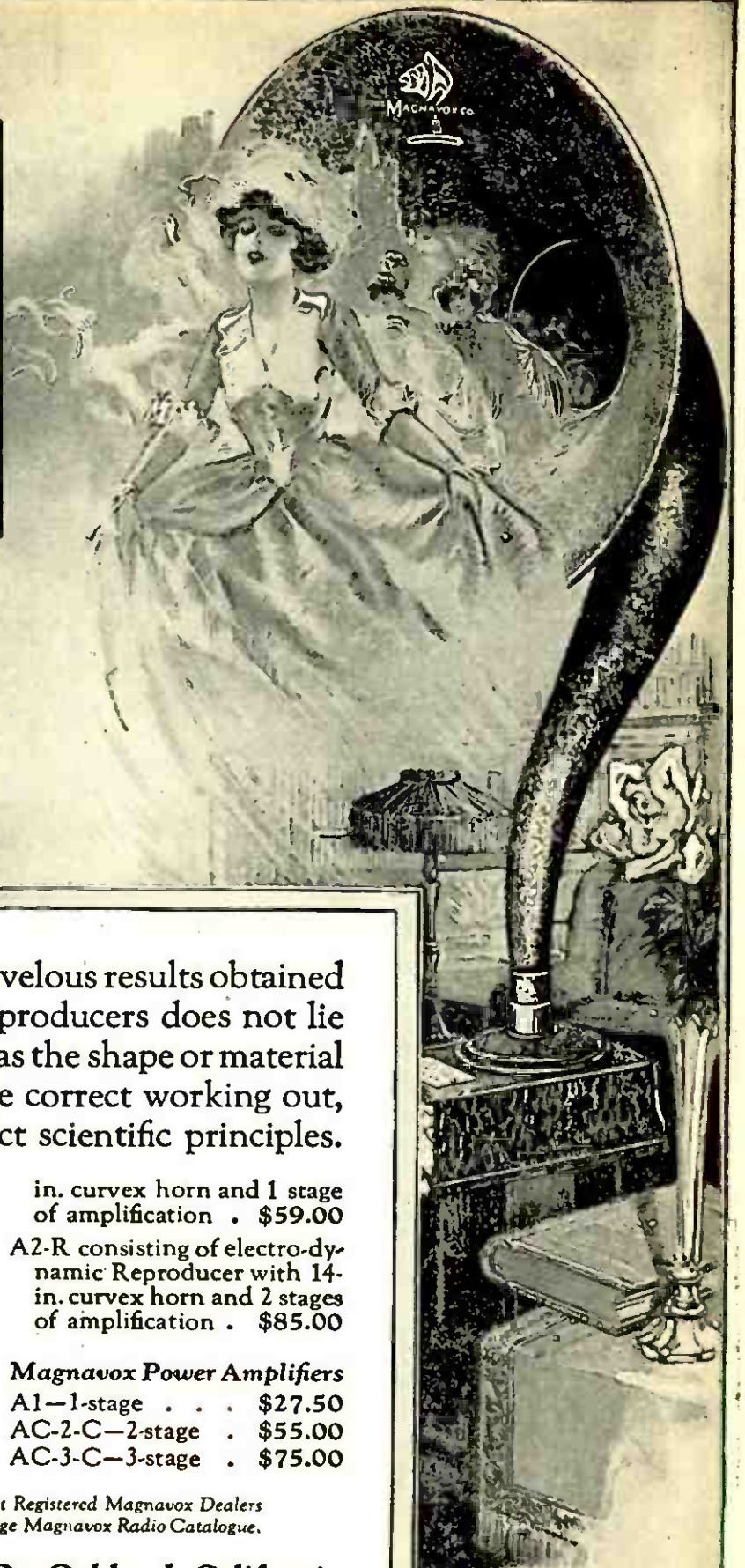
Send for Catalogue of Chelten Radio Products

**THE CHELTEN ELECTRIC COMPANY**  
4861 Stenton Avenue, Philadelphia



*In an easy chair  
at home MAGNAVOX  
gives you the melody  
of concert and opera*

**MAGNAVOX**  
Radio  
Reproducers and Amplifiers



**T**HE secret of the marvelous results obtained with Magnavox Reproducers does not lie in any one feature (such as the shape or material of the horn) but in the correct working out, in all features, of correct scientific principles.

- |  |   |
|--|---|
| <b>Magnavox Reproducer</b>                             |   |
| R2 with 18-inch curvex horn                            | in. curvex horn and 1 stage of amplification . \$59.00  |
| \$60.00  |   |
| R3 with 14-inch curvex horn                            | A2-R consisting of electro-dynamic Reproducer with 14-in. curvex horn and 2 stages of amplification . \$85.00 |
| \$35.00  |   |
| M1 with 14-inch curvex horn.                           |   |
| Requires no battery for the field . . . . .            |   |
| \$35.00  |   |
| <b>Magnavox Combination Sets</b>                       | <b>Magnavox Power Amplifiers</b>  |
| A1-R consisting of electro-dynamic Reproducer with 14- | A1-1-stage . . . \$27.50  |
|  | AC-2-C-2-stage . \$55.00  |
|  | AC-3-C-3-stage . \$75.00  |

Magnavox Products are for sale at Registered Magnavox Dealers everywhere. Write for new 32-page Magnavox Radio Catalogue.

**THE MAGNAVOX CO., Oakland, California**  
New York Office: 370 Seventh Avenue  
Perkins Electric, Ltd., Toronto, Montreal, Winnipeg  
Canadian Distributors

1R

*For every  
Receiving Set  
there is a  
MAGNAVOX*

# Biggest dollar's worth in RADIO



## JUST OUT

Compiled by  
**HARRY F. DART, B.S.E.E.**  
Formerly with the Western Electric Co., and U.S. Army Instructor of Radio  
Technically edited by  
**F. H. DOANE**

**THE** greatest book on Radio ever written. Price only \$1. Filled with sound, practical, tested information for every radio fan, from beginner to hard-boiled owl. Written, compiled and edited by radio experts of national reputation.

You may dip into this I. C. S. Radio Handbook at random, or hunt up special information you want, or read it right through. Starts with simple explanations of Radio phenomena and leads you along gently until you can understand the most technical diagram. Hundreds of suggestions for getting more pleasure out of Radio. Will save you from wasting money on things that won't work.

*New—Authoritative—Complete*

**514 PAGES  
150 ILLUSTRATIONS**

Every page tells you something useful. And there are 514 pages! More than 150 illustrations and diagrams! Note this partial list of contents:

Different types of receiving and sending hookups, electrical terms, condensers, oscillating circuits, coupled circuits, induction coils, antenna systems, electric batteries, generators and motors, protective devices, crystal detectors, arc generators, transmitters, filters, wavemeters, radio experiments, International and Morse codes, commercial receiving sets, tables and data, radio transmitting and broadcasting stations (with call letters), Radio License Regulations, etc.

Send \$1 to-day and get this 514-page I. C. S. Radio Handbook before you spend another cent on parts. Money back if not satisfied.

**MAIL THE COUPON TO-DAY**

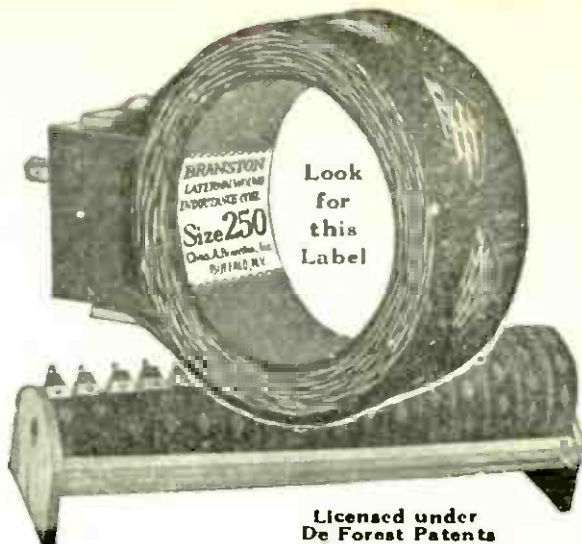
Name.....  
Address.....

International Correspondence Schools  
Box 8252-B  
Scranton, Penna.

I enclose One Dollar. Please send me—postpaid—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.

## Money back if not satisfied

## BRANSTON RADIO



Licensed under De Forest Patents

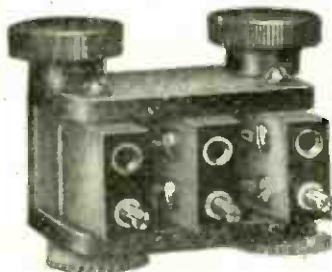
Select the coil combination for the wave lengths you want  
**Sixteen sizes to choose from**

Using Branston D.L. Lateral Wound Honeycomb Inductance Coils you can choose the two or three coil combination that will give you the field of wave lengths in

which you wish to operate. Branston Coils are interchangeable with all coil mountings, wave lengths from 150 to 21,000 meters.

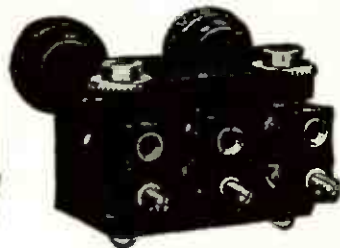
## Branston New Front and Rear Panel Honeycomb Coil Mountings Are Better

Note the simple, sturdy, substantial, front and back panel three coil mountings, illustrated below. We show but two of a complete line of two and three coil mountings.



**R-61** Three Coil Geared Type. Front Panel Mounting. \$5.00

Substantial gears give vernier adjustment. Very neat appearance; made of Genuine Bakelite, complete with flexible leads.



**R-62** Three Coil Bevel Gearing Type. Back Panel Mounting. \$6.00

Bevel gears provide very smooth operation and vernier adjustment. Made of Genuine Bakelite, complete with flexible leads. Arrow knobs show position of coils.



Look for this trademark card in your dealer's window or salesroom

## Send 2c Stamp for New Honeycomb Coil Hookups

Compiled by experts and includes five good Honeycomb Coil "Hookups" and complete catalog of famous Branston Radio Apparatus. Write today. Give us name of your radio dealer. If he cannot supply you, write

**CHAS. A. BRANSTON, Inc.**  
Manufacturers of Branston Violet Ray High Frequency Generators  
811 Main St., Buffalo, N. Y.  
In Canada—Chas. A. Branston, Ltd., Toronto

1923 Please mention POPULAR RADIO when answering advertisements.

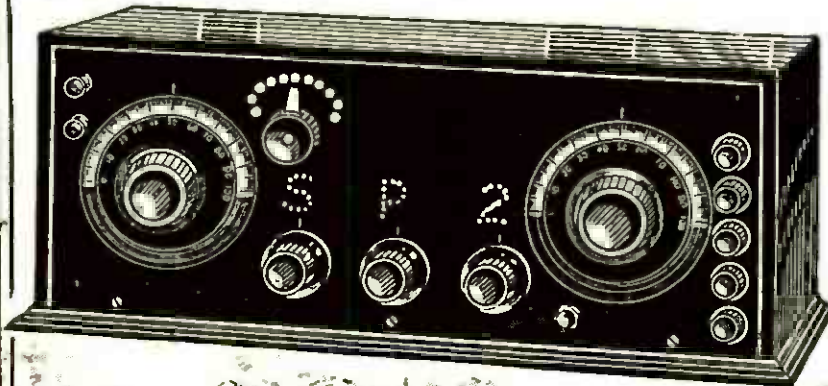
# OVERSOLD!

As this page is written (November 19th) the SP2 RECEIVER is OVERSOLD till after Christmas.

The Receiver that *sells*—the most remarkable *merchandising* set on the market.

In a Chicago store, over 300 SP2 Receivers sold in *one* day; 2000 sold in less than two weeks in one store.

You are not in the Radio business till you handle the SP2. Demonstration invariably inspires sale. Makes wonderfully satisfied customers. Builds business. Quick sales—big volume—satisfactory profit.



The **SP-2 RECEIVER**  
Radio's most phenomenal success!

Write Today  
for Catalog No. 101A

**Pittsburgh Radio Supply House**

963 Liberty Avenue

Pittsburgh, Pa.



# The RāBAT

a Rechargeable  
Wet 'B' Battery  
at Only \$3.96

A rechargeable wet "B" Radio battery built strictly on storage battery principles. Yet it costs only a trifle more than an ordinary dry cell battery.

The Rabat at the low price of \$3.96 has 12 cells with a total of 24 volts and ample capacity. It is noiseless, fool-proof, and compactly constructed. Built on a solid rubber base. Small, but neat and efficient. All elements visible. No internal discharge. More economical. Longer life. Higher and more continuous voltage. Easily recharged at home with aid of inexpensive Rabat Rectifier. If your dealer cannot supply you send direct.

*Rabat Rectifier for Recharging \$ .75*

**THE RADIO RABAT COMPANY**

300 RUSSELL BUILDING Playhouse Square CLEVELAND, O.

12 CELLS *The RāBAT* 24 VOLTS



## \$25.00 for \$10.00 Loud Speaker Direct

Cut out all dealers' and middlemen's profits—this marvelous Loud Speaker comes direct from factory to your door.

Prepaid **\$10.00** Delivered to  
Your Door

You are saving three profits, manufacturer to distributor,  
distributor to jobber, jobber to dealer.

The outstanding features of the Bel-Canto Loud Speaker are:—

1. Unbreakable fiber horn, crystalline finish.
2. Our own adjustable loud speaking unit giving a wide range of tone quality and volume without distortion.
3. Base of cast iron weighing 4 pounds eliminates top heaviness.
4. All other metal parts cast aluminum, highly polished.
5. Complete instruments stand 24" high, 10" bell.

Guaranteed one year from date of purchase against mechanical defects of any kind and if found mechanically defective within that period of time we will replace it with a new one without charge to you.

We further guarantee to the publication carrying this advertisement that each and every Speaker sold will be exactly as advertised in this issue.

**\$25.00 for \$10.00**

One complete Loud Speaker as described above sent on receipt of post office money order or sent C.O.D. delivered to your door. Give the postman \$10.00 after you have received it.

**BEL-CANTO MANUFACTURING COMPANY**  
Bensel-Bonis Company, Inc.

General Office and Factory: 417-419-421 East 34th Street, New York City

TELEPHONE YOUR ORDER FOR IMMEDIATE DELIVERY!

TELEPHONE VANDERBILT 8959





# Save $\frac{1}{3}$ on Guaranteed Radio Equipment

**Write us a post card—  
Address Dept. 38-R**

and we will send you free this 52 page catalogue of radio sets and parts. It also contains explanation of radio terms, map and list of broadcasting stations and much radio information, including an explanation of successful hook-ups and circuits.

You will be amazed at the low prices Ward's quote. A complete tube set having a range of 500 miles and more, including tube, head set, batteries, and antenna equipment, as low as \$23.50.

This catalogue contains everything for the expert and amateur. Complete sets and every improved part for building sets, all the most up-to-date devices—at the lowest possible prices.

## Headquarters for Radio

Montgomery Ward & Co. is headquarters for Radio, selling everything direct by mail without the usual "Radio-profits." Why pay higher prices? Ward quality is the best and the prices will often save you one-third. Everything sold under our Fifty Year Old Guarantee—Your Money Back if You Are Not Satisfied. Write today for your copy of this complete 52-page Radio Book.

**Write to our house nearest you  
Address Dept. 38-R**

**Chicago    Kansas City    St. Paul    Portland, Ore.  
                 Ft. Worth            Oakland, Cal.**

**This Radio  
Catalogue  
FREE**

Established 1872  
**Montgomery Ward & Co.**

**The Oldest Mail Order House is Today the Most Progressive**

*Rely on  
De Forest  
Audions*



**WHEN** you wonder what vacuum tube will work best in your radio set, find out who invented the 3-electrode tube as used in all present day radio. The answer—like the answer to most radio questions—is De Forest.

## RADIO CATALOGS FREE

Send us your name and address and we will send you the new De Forest Catalog with full details and prices on sets, audions, and parts. Prices plus approximately 6% for territories west of the Rockies.

**DE FOREST RADIO TEL. & TEL. CO.**  
Dept. P. R. 5 Jersey City, N. J.

*If located west of Pennsylvania address*

**DE FOREST RADIO TEL. & TEL. CO.**  
Western Sales Division  
Dept. P. R. 5 5680-12th Street, Detroit, Mich.



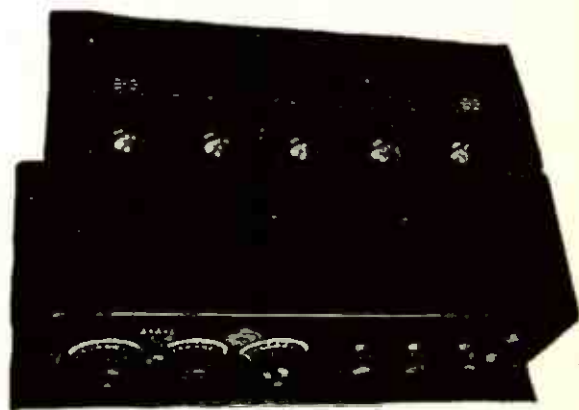
## The "Radio Magnet"

which will attract desired programmes and eliminate undesired signals, etc., is known as Service Type 212 Receiver. Greatest distance, clarity and freedom from unwanted "noises."

"Hearing" is believing. Ask your dealer for a demonstration.



Price **\$150** With Loop Antenna



*This is a TELEFORCE product*

**SERVICE RADIO CO.**

4745 Montgomery Ave.  
NORWOOD, OHIO

Thrill your best Friend  
this Christmas!

—delight him with a distance-getting



# ALL-AMERICAN

The Largest Selling

## AMPLIFYING TRANSFORMER

Audio Frequency

Radio Frequency

Without distortion, "All-Americans" bring in distant and nearby stations with volume and tone-quality that mean real thrills. The best known and most widely used transformers on the market. Over 300,000 in use. All the "old-timers" are for the "All-American." Standard equipment on the better sets. They give unequalled results in *all* circuits.

All better dealers sell "All-American."

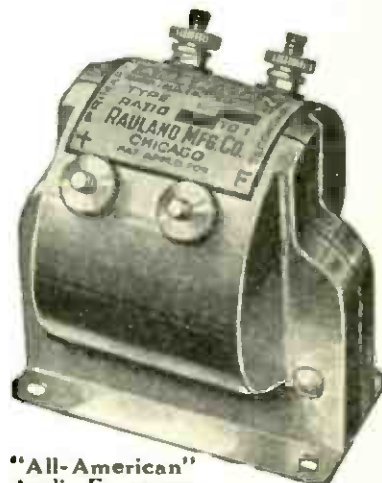
### RAULAND MFG. CO.

200 North Jefferson St.  
CHICAGO

Pioneers in the Industry

### Special Free Offer

Book of tested hook-ups for getting new thrills out of your present radio outfit. Enclose 2 cent stamp for postage.



"All-American"  
Audio Frequency  
Transformer. Comes in 3 ratios



"All-American"  
Bakelite Tube  
Socket—Base or  
Panel Mounting 75c

# ALL-AMERICAN

Largest Selling Transformers in the World

# Remember

the letters "C. I. C." when you buy a loud speaker or a phonograph attachment. You will never forget your satisfaction.

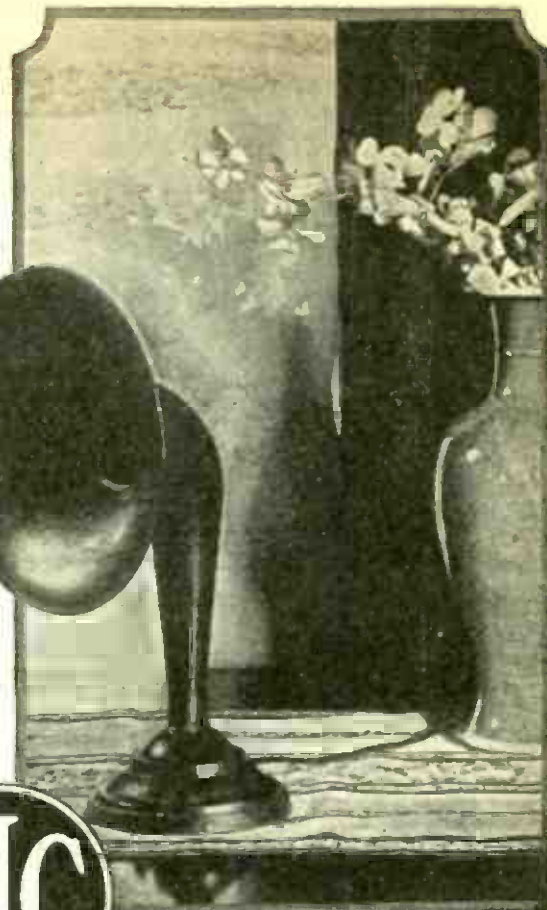
The C. I. C. Loud Speaker is small in size and small in price—but great in tone quality and volume.

The C. I. C. loud speaking unit and phonograph attachment has a mica diaphragm and an adjustable air gap—it fits the standard makes of phonographs and can be used on any horn.

Send for Leaflet "Loud Speaker Facts"

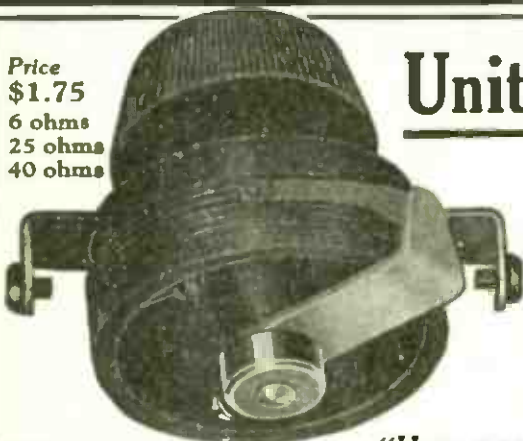
**Connecticut Instrument Co.**

Stamford, Conn.



**\$14.50 Loud Speaker**

Price  
\$1.75  
6 ohms  
25 ohms  
40 ohms



## Unity Rheostats are the Best

Vernier and Non-Vernier

### The Unity Vernier Rheostat

(Successor to The Jenkins Rheostat)

Recommended for the detector tube of Cockaday four circuit tuners.

The highest type electrical instrument made for controlling resistance.

A refinement in tuning adjustment, far surpassing the possibilities of any other instrument, is very easily obtained.

The Unity Vernier Rheostat is the only Rheostat with a cut-out switch operating with no change in tuning adjustment.

--- "Hear a set that uses Unity Rheostats" ---

### The Unity Non-Vernier Rheostat

or the Cartridge Rheostat

Where a non-vernier rheostat is sufficient, the Unity Cartridge Rheostat is the best made.

In addition, resistance cartridges are interchangeable without removing the bracket from the panel.

Unity Potentiometer Cartridges also fit the Unity Brackets

If your dealer cannot supply you, send your check or money-order to the factory with dealer's name.

**UNITY MFG. CO., 228 North Halsted St., Chicago**

Automatic Screw Machine Products, Stampings, General Manufacturing on Contract or Royalty.

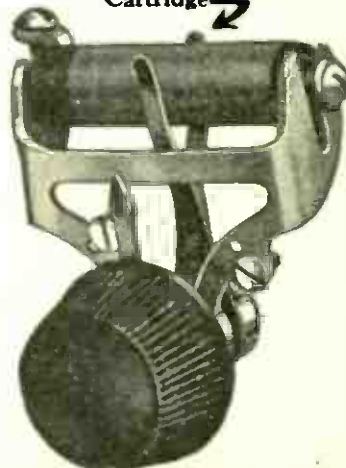
Dealers are offered a free Counter Display Card.

6 ohms  
25 ohms  
40 ohms

Other resistances if desired

Complete Rheostats - - \$ .80  
Brackets only .45  
Cartridges, any resistance - .35  
Potentiometers, complete, 200 or 400 ohms 1.45  
Potentiometer cartridges only 1.00

Interchangeable Resistance Cartridge



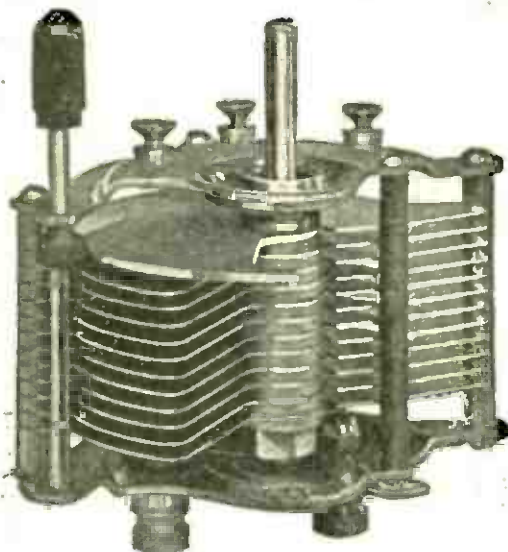
Please mention POPULAR RADIO when answering advertisements.

# A Standard of Condenser Excellence

—note the points of proven Superiority!!

## 5 POINTS

1. Stator plates pressed into slots, assuring perfect electrical contact.
2. Proper capacities, and no over-rating of same.
3. Rigid construction, so original adjustment is maintained.
4. Rotor and stator plates of logarithmic curve type.
5. Formica insulation throughout.



## 5 MORE!


1. Patented vernier arrangement, eliminating body capacity.
2. Special spring aluminum plates.
3. Lowest dielectric losses, proven by laboratory tests.
4. Special friction bearing on rotor shaft.
5. Independent vernier control. Vernier does not rotate with main rotor plates.

A radio receiving set is no better than its variable condensers!



TRADE MARK

## V A R I A B L E VERNIER CONDENSER

Upon the condensers used depends the efficiency of your set. Buy only the best! You can pay a higher price—but cannot get a better condenser than 

Type G 13 Pl. 3.00    Type H, 23 Pl. 3.50    Type J, 43 Pl. 4.00  
.0002 mfd.    .0005 mfd.    .001 mfd.

A Product of **HAIG & HAIG** Manufacturing Co.  
ROCHESTER, NEW YORK

If your dealer has none send his name with your remittance direct to

**RADIO STORES CORPORATION**  
Sole International Distributors

NEW YORK—CHICAGO—MINNEAPOLIS—LOS ANGELES—  
CLEVELAND—ST. LOUIS—OMAHA—SAN FRANCISCO.  
HOME OFFICE, 220 West 34th Street, NEW YORK, N. Y.

—insist on 

## Burgess "A" Battery Introduces a New Silent Partner



Notice that—

*He's exactly my size—same height—same width—same weight. We look like twins. (He's good looking, too.) Look us over.*

Burgess is a big family. I have a lot of brothers. Perhaps the most famous of them is BIG BROTHER "B." He had the field to himself until Burgess introduced Vertical "B."

Now comes my new partner. He is VERTICAL "B" JUNIOR. He has the same 22½ volts of pep as the rest of the Burgess "B" family. He is quiet—never talks to himself and he never lays down on the job.

Burgess calls us "Work-mates." He ought to know. We are silent partners in your radio entertainment.

Your radio set is no better than your batteries. Without them would be like having a marriage license and no bride. One is no good without the other.

Try it tonight. I'll heat your tube filament while my twin partner takes care of the plate circuit.

*A Laboratory Product*

# BURGESS BATTERIES

"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

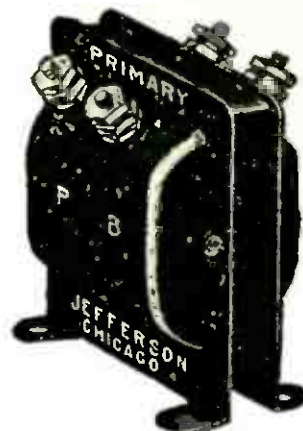
### BRANCHES

NEW YORK      BOSTON      KANSAS CITY      MINNEAPOLIS  
WASHINGTON      PITTSBURGH      ST. LOUIS      NEW ORLEANS

### IN CANADA

PLANTS: NIAGARA FALLS AND WINNIPEG  
BRANCHES: TORONTO • MONTREAL • ST. JOHN

## The Final Authority in RADIO FREQUENCY



The New Jefferson Radio Frequency Amplifiers need very little introduction. The name JEFFERSON is known wherever transformers are used. Both professional and amateur radioists are familiar with JEFFERSON Audio Frequency Transformers. They know from actual tests how superior they are to others and they have been waiting for a JEFFERSON Radio Frequency Transformer.

After many months of research and almost endless tests and experiments JEFFERSON Radio Frequency amplifiers have been pronounced by leading radio engineers to represent the very last word in this type of amplifier.

These new transformers cover the entire new wave length band (200 to 650 meters) and function with equal efficiency in standard Radio Frequency, Reflex, Inverse, Duplex or Neutrodyne circuits. Their scientific and careful construction sets a new standard for radio frequency amplification—the reasonable price appeals to all.

No. 80 Jefferson Radio Frequency Transformer (1st stage) . . . \$2.50

No. 85 Jefferson Radio Frequency Transformer (2d stage) . . . \$2.50

Descriptive bulletins, circuits and the recommendations of our Radio Engineering Department are at your disposal.

## Jefferson Electric Mfg. Co.

427 South Green Street, Chicago, Ill.

Please mention POPULAR RADIO when answering advertisements.



## The Golden Rule Tube

The discovery of the principle upon which the Sodian Tube was developed marks a new and better Era in Radio.

The tube itself is different from any you have ever known.

Different in principle—different in operation and different in results.

As its name implies, it makes such effective use of the peculiar properties of the sodium ion that there is no need of regeneration to build up the strength of your reception.

The fact that it does not oscillate not only eliminates all semblance of whistles and howls in your own reception, but makes it impossible for you to interfere with the reception of others. It is the practical application of the Golden Rule to Radio.

Crystal tone reception.

Unusually sensitive to weak signals.

Stable and uniform in operation.

Runs for hours without adjustment.

Operates on dry cells or storage battery.

*Bulletin A-100 upon request*



**CONNECTICUT**  
MERIDEN

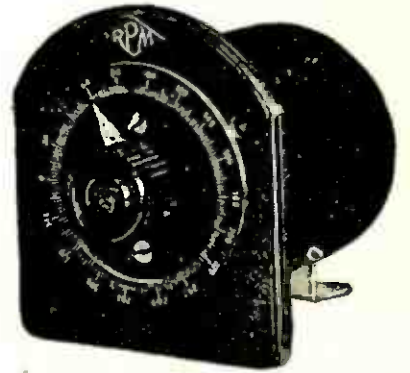
TELEPHONE  
& ELECTRIC  
Radio Division

**COMPANY**  
CONNECTICUT



## Robert J. Casey (Chicago Daily News) —builds set of R P M Units

"The set is a two-tube regenerative double-jointed reflex designed by the engineers of the Radio Products Mfg. Co.," writes Mr. Casey in Chicago Daily News, Nov. 3rd. In action it is a distinct surprise. Both tubes give a R.F. amplification stronger than many other circuits. Tuning sharp enough for anybody... One of the novelties of this hook-up is the standardization of parts, permitting easy change of the component elements.



"Another is the variable condenser which affords a micrometer adjustment with a variation from minimum to maximum that will do the work of any 1 to 43 plate condenser."



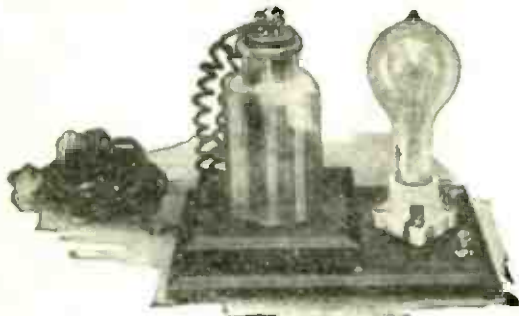
At a big saving, you can build this—or any other set—using R P M Standardized Units. Hook-ups in every package. No soldering of joints, no tools necessary. Merely connect binding posts. Each R P M Unit is complete in itself. Moulded Bakelite—very handsome, R P M units are efficient in performance, superior in quality and have absolutely no body capacity. You can pay more but you can't buy better units. At your dealers' or write us.

A UNIT FOR EVERY RECEIVING PURPOSE. MOUNTED AND UNMOUNTED VARIOMETERS, VARIOCOUPERS, VARIABLE CONDENSERS, COUPLED CIRCUIT TUNERS. ALSO DETECTOR AND AMPLIFYING UNITS.

Unconditional Guarantee

**RADIO PRODUCTS MFG. CO.**

667 W. 14th St., Chicago



Mounted Charger



100 Volt Panel type

### Trinidad Government Pleased with KIC-O Efficiency

"We are ordering this battery on behalf of the Trinidad Government whose wireless officer was impressed with the efficiency of the Kic-o battery we are using with our receiving set." The above extract is only one of the many endorsements we are receiving of Kic-o Batteries. Alkaline type, won't sulphate or buckle. Life unlimited. Not harmed by short circuiting, over-charging, or idleness. Panel switches give single cell variations. Recharge from any 110-volt A. C. line with small home rectifier. Charge lasts 3 to 6 months on 3 tube receiver.

#### GUARANTEE

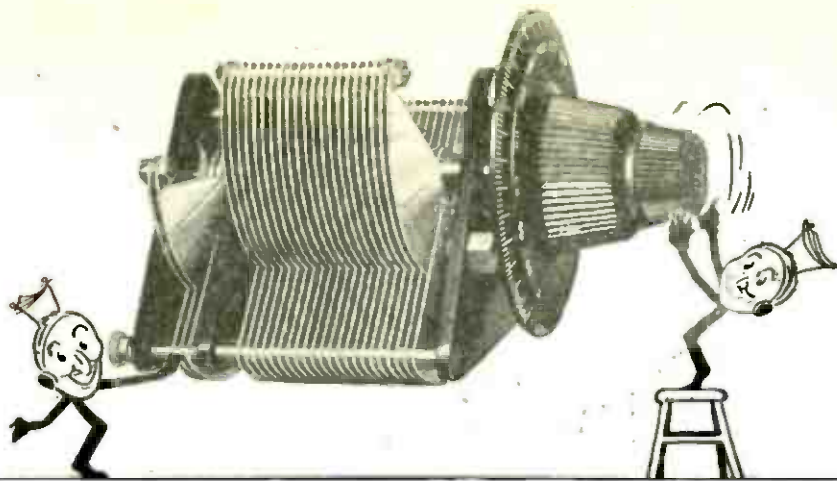
Your money back on any KIC-O Battery if not satisfied within 30 days' trial. Write for full information on "A" and "B" Batteries.  
Unmounted Rectifier.....\$1.00  
Mounted Rectifier.....\$2.50

**KIMLEY ELECTRIC COMPANY, Inc.**  
2667 Main Street Buffalo, N. Y.

**KIC-O** Storage "B" Batteries—  
long service, low cost

Cells	Volts	Price, Plain	With Panels
16	22	\$5.50	
24	32	7.25	\$11.75
36	48	9.50	14.00
50	68	12.50	17.00
78	100	17.50	22.50
108	145	23.50	28.50





## "Some Condenser" Says the "Radio Bug"

Makes your receiving set respond to every broadcasting station operating. The size of the Kellogg Condenser and dial gives easy accurate tuning. The vernier makes unusually sharp tuning a simple matter. The end plates are of the best radio insulation in use today—Bakelite. The Kellogg accurately built dial is also of Bakelite, which retains its handsome appearance indefinitely. Its heavy reinforced construction and beauty of design add to the appearance of any set.

The rotor plates are properly spaced and bolted together, making it impossible for them to make contact with the stator plates. Large bearing surfaces assure smooth, even rotation of the rotor plates and reduce wear to a minimum.

The high class workmanship, with the fine materials used in Kellogg Variable Condensers place them in a class by themselves. The relations of the capacities is such that as great a flexibility as desired in any set may be maintained by the use of the various models.

The resistance to alternating currents at the average wave length is low thus assuring full use of all current intercepted by the antenna.

The Kellogg variable condenser is a precision instrument built in size, proportion and ratio for use as a decrometer or wave meter, as well as for control of capacity in the radio broadcasting and receiving sets. This makes it of far greater value to the amateur as well as the laboratory expert.

*Kellogg Variable Condensers are made in the following styles:*

Code No.	Zero Cap.	Max. Cap.	Ratio	Price
601-11 plate Vernier	.000120	.000262	2.1:1	
with vernier All Plates	.000120	.000600	5 :1	\$6.75
602-11 plate	.000045	.000396	2.8:1	4.50
603-23 plate Vernier	.000071	.000210	3 :1	
with vernier All Plates	.000071	.000990	14 :1	7.75
604-23 plate	.000071	.000885	12.6:1	5.50
605-43 plate Vernier	.000102	.000250	2.4:0	
with vernier All Plates	.000102	.001800	17.6:1	8.75
606-43 plate	.000082	.001690	20.7:1	6.50



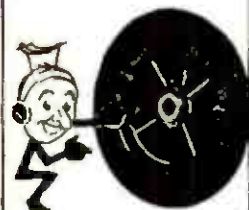
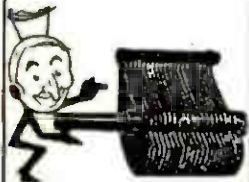
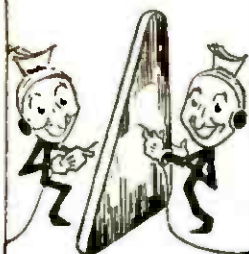
Have your dealer furnish you with Kellogg radio equipment and know you have the best

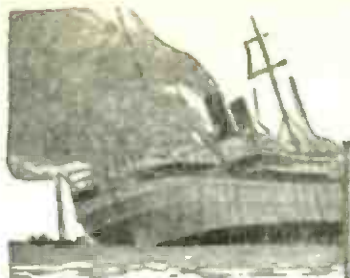
*All Kellogg Radio Parts are manufactured and guaranteed by*

**Kellogg Switchboard & Supply Company**  
CHICAGO, ILLINOIS

Columbus, Ohio    Kansas City, Mo.    San Francisco, Calif.    Portland, Oregon

*Kellogg Apparatus exclusively is used in building the Symphony Receiver*





Radio Officer N. C. Kumler, graduate of the Radio Institute of America, awarded a gold medal by the city of Los Angeles, and \$500 by the Radio Corporation of America for heroic services at the sinking of the S.S. Honolulu.



## Wanted— Trained RADIO Men

Over 6,000 operators have already graduated from our school. And many more trained men are needed. Study at home in your spare time.

You may know nothing of radio today. But in a few months study, you can earn your U. S. Government operator's license.

The Radio Corporation of America, which places more operators than any other organization in the world, prefers our graduates, for their thorough training. Many among them have become the biggest men in radio today.

### 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.....

Like old Friends—  
Always Reliable

## The "Regal" Line

Biggest and Best in Radio



### New "Regal" No. 162 Double Arm Induc- tance Switch

A 15 Point Switch complete in one unit. No more messy soldering. No more drilling of hole. No more chipped panels. Complete with hard rubber Knob and Dial

\$1.50

### New "Regal" No. 200 Audio Frequency Ampli- fying Transformer

For clearness of tone, amplification of voice and music from nearby and distant broadcasting stations, is unequaled by any Transformer on the market

3½ to 1 Ratio.....\$4.25  
5 to 1 Ratio..... 4.50



### New "Regal" No. 120 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  
10-Ohms..... 1.25

### No. 140 "Regal" Rheostat

Without an equal for fine tuning. Special base construction—fine filament control

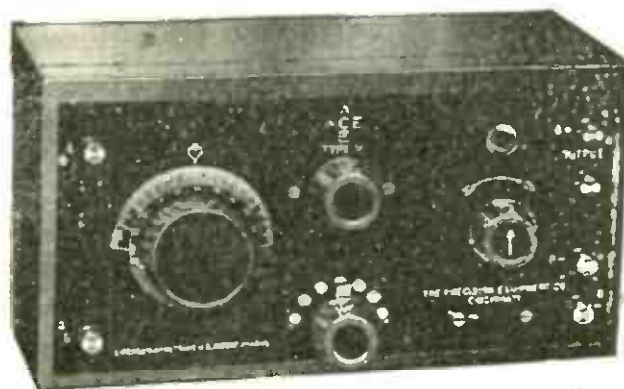
6-Ohms.....\$1.00  
30-Ohms..... 1.10



Write for folder No. 24 show-  
ing 30 big "Regal" items

The American Specialty Co.  
Bridgeport - - Conn.

# The Gift For That Boy of Yours



## Ace Type V

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

While primarily building Radio apparatus for broadcast listeners, hundreds of amateurs everywhere have learned of the wonderful efficiency of ACE Radio Receiving Sets for amateurs D.X. Radio reception.

With their sharp and efficient tuning range over the broad band of wave lengths from below 200 meters to 600 meters, combining Armstrong Regenerative principles with careful design of parts and elimination of high frequency resistance in each unit, and absolutely free from body capacity effects, Ace Receivers in the hands of the D.X. "ham" will produce better results, tube for tube, than any receiver that you can build or buy.

Almost unbelievable reports of stations copied have been received by the manufacturer from some of the best D.X. men in the business.

Ask your dealer to let you try out an Ace Receiver and you will find that it is just what you have been looking for.

Recommend to some of your young friends who are just entering the game that they purchase an Ace TYPE V \$20.00 receiver—for the more advanced amateur, the three tube ACE 3 Combined Regenerative Detector—and two stage Audio Frequency Amplifier—will be the best thing you ever had on your table.

## The Precision Equipment Company

*Powel Crosley, Jr., President*  
116 Vandalia Ave., Cincinnati, O.

Please mention POPULAR RADIO when answering advertisements.

# RHAMSTINE\*

Presents the New VICTOPHONE  
—for all Phonograph and Loud-Speaking Horns



\$7.50 Postpaid  
Complete with Cord

Relentless research in the field of loud-speaker units has resulted in Rhamstine\* achieving the ultimate in tone and volume. The New Victophone will exceed your expectations; you will appreciate its superiority upon comparison with other loud-speakers. Every part of this new Phonograph unit was designed and built to excel in efficiency and in beauty all other makes. 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

## The Rhamstine\* Electric Solder Set New Round Type



\$2.50 Postpaid  
Complete with Cord, two-piece Plug and Solder

Here is the new model—round type—electric solder set. A more handsome and heavier iron than the original flat model. The tip is easily replaced when worn out. Especially adapted for radio work. It is highly plated and polished. Can be used on 110 volts A. C. or D. C. Guaranteed one year. Order an electric solder set and solve your soldering problems. Only \$2.50 postpaid.

Manufactured by

**J. THOS. RHAMSTINE\***  
Woodbridge at Beaubien Detroit, Michigan  
\*Maker of Radio and Electrical Products

# RADECO SAFETY FUSES

(Patented)

Now available for  
**DEALERS' SALE**



Radio users have learned that *Radeco Safety Fuses* are a necessary tube protection—that their price (50 cents) is small compared with the great service they render.

The merit of the fuses, their low price and our extensive advertising have created a ready style.

Up to now these fuses have been sold direct by mail, but the demand is so great that we want to distribute them in larger units through the trade channels. You will find *Radeco Fuses* a profitable item to add to your stock.

To assist you in handling them, we have made up attractive display boxes in colors containing an assortment of two dozen fuses.

Price per box (2 dozen fuses)  
**\$12.00**

Subject to Regular Trade Discounts  
**ORDER TODAY**

*Radio Fans! Radeco Fuses can now be purchased at your Dealers.*

## RADIO EQUIPMENT COMPANY

*New England's Oldest Exclusive Radio House*

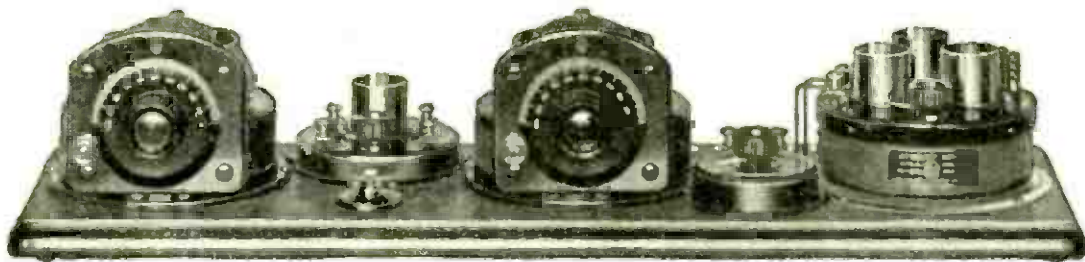
20 STUART STREET

BOSTON, MASS.

Please mention POPULAR RADIO when answering advertisements.

# ATWATER KENT

## RADIO EQUIPMENT



*Atwater Kent Model 9 Receiving Set*

ATWATER KENT Receiving Sets are a truly remarkable achievement. Their wide range of operation; the volume and clearness of tones obtained from distant points, together with the ease with which desired broadcasting stations can be tuned in are the outstanding features of their unusual performance.

The ATWATER KENT Loud Speaker will give you a new conception of clear reproduction:—the true gift of the broadcasting artist is brought undistorted into your home.

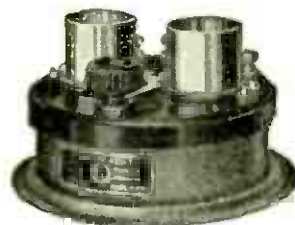
If you are now working with a one-tube set, the ATWATER KENT 2-Stage Amplifier will give you the necessary volume to use a loud speaker.

ATWATER KENT Radio Equipment includes complete sets and every instrument necessary for the assembling of complete sets.

*Literature describing the entire line of Atwater Kent Radio Sets and Parts sent on request*



*Atwater Kent Loud Speaker*



*2-Stage Amplifier*

ATWATER KENT MANUFACTURING COMPANY, PHILADELPHIA, PA.  
4933 STENTON AVENUE

# "IT'S A MORRISON!"

"Exactly what I wanted—the whole family will enjoy radio now!" Several thousand lovers of real radio will say something like that Christmas morning when they open a package containing "Morrison Loud Speaker." Give a Morrison and you are sure to please.

Attach to your phonograph or use it with a horn. Morrison is the Loud Speaker that reproduces music and voices naturally without vibration—as loud as you like it. You can adjust tone soft or loud by simple turn of thumbscrew on back—no other adjustment necessary—nothing to break or get out of order.

We guarantee your money back if not satisfactory.

Complete with 5 foot cord  
Nickel Plated Model

**\$10**

Gold Plated Model

**\$15**

If your dealer doesn't carry it  
order direct from factory.

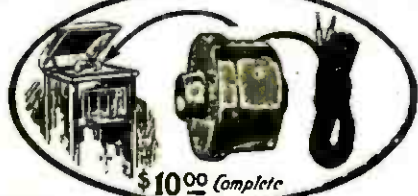
Beautifully Illustrated Catalog  
free on request.

#### DEALERS

Be sure to stock up now for Holiday business. Orders filled in turn as they come in. Christmas sales will break all radio records. Wire or write today for our special offer.

**MORRISON LABORATORIES, INC.**  
345 Jefferson Avenue, East; Detroit, Mich.

## Morrison



\$10<sup>00</sup> Complete

*Loud Speaker*



# How?

can you expect  
good reception,  
no matter how  
expensive your set,  
if you haven't  
the right plug!  
Sounds strange, but the  
plug is the last link in  
perfect reception.

## The ORIGINAL

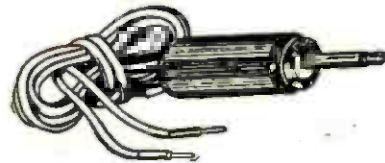
COMSCO



COMSCO

### AUTOMATIC BULLDOG GRIP PLUG

Licensed Under Pat. Pend. Serial No. D 8010—No. 578540



Saves you from short circuits  
and battery kicks. No more  
burned out phones or ruined  
transformers. No more  
broken finger nails.

### Simple to operate

#### INSERT

by a single touch,  
and the connect-  
ing tips of your  
phone cords ac-  
complish automatically the most perfect electrical contact.



#### RELEASE

by pressing the  
small knob and the  
tips will slide out  
easily without pull-  
ing the electrical  
contacts.



For one pair phones \$1.00  
For two pair phones \$1.50

For sale at your dealer. Otherwise send us the  
purchase price and you will be supplied.

**GENERAL INSTRUMENT CORP.**

123 LIBERTY STREET

NEW YORK CITY

# This FREE BOOK on RADIO

## Has Shown Thousands How to Make More Money

This wonderful book has opened the eyes of thousands to the amazing Big-Money Opportunities opening right now in Radio. It has shown them how they could get their share of the tremendous profits of this newest and fastest growing world industry—regardless of what their previous training or experience had been. Hundreds of men today are earning far more than they ever did before—all through having read this Free Book of Radio Opportunities, which we will mail to you without the slightest obligation on your part.

### Scores of New Opportunities Waiting for YOU in RADIO!

In the entire history of industry, there probably never has been a business development which can compare with that of Radio! Within a few years it has jumped into the ranks of the world's largest and most profitable fields of endeavor. Broadcasting stations are springing up all over the country. Hundreds of thousands of receiving sets are in operation. Hundreds of ships are installing more and latest equipment. Radio is everywhere being adopted in business. \$100,000,000 was spent last year just for receiving sets alone.

"This amazing expansion of Radio has opened up hundreds of new positions on land and sea. It has created opportunities never dreamed of in other fields. Big money—fascinating work—advancement—a real future in the world's fastest growing industry!

### Easy to Learn Radio at Home

If you are ambitious—if you are looking for a field where opportunities are unlimited—get into Radio. Become

a Certified Radiotrician—become a highly trained specialist in a new, uncrowded profession.

Thousands of Certified Radiotricians are needed to operate broadcasting stations; to design radio sets; to repair and sell radio apparatus; to take charge of radio departments; to operate on board ship or at commercial and government land stations; to go into business for themselves; to fill the hundreds of attractive positions in this wonderful new field.

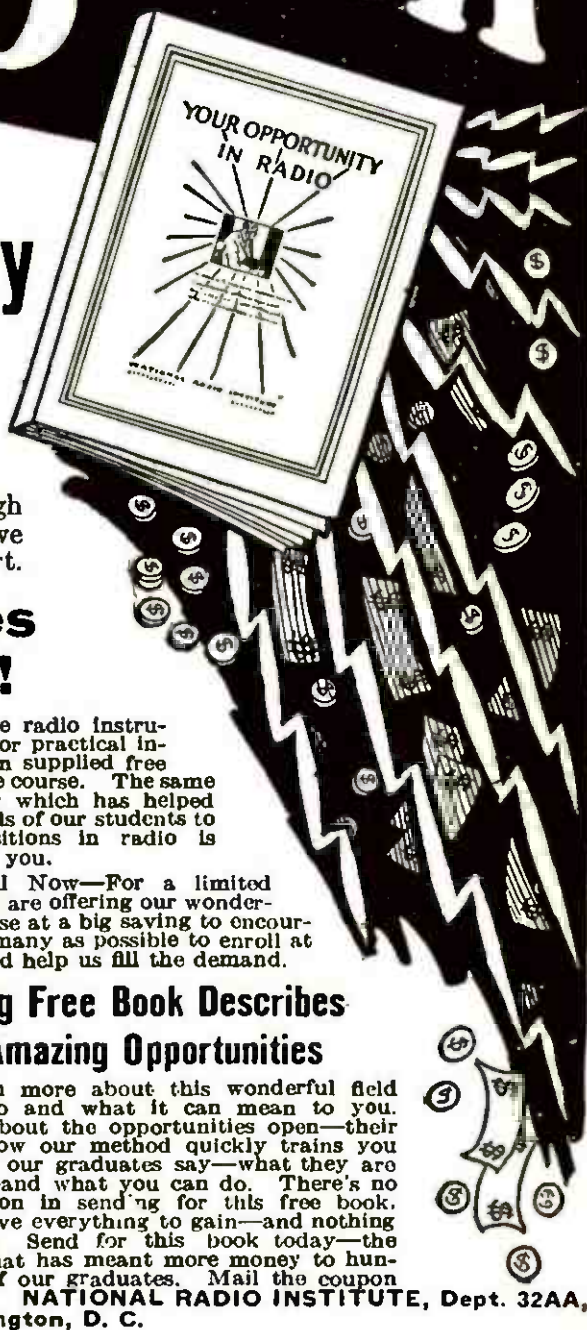
And now you can easily and quickly qualify in your spare time at home through the help of the National Radio Institute, one of the oldest and largest radio schools in the world. Hundreds of graduates of this school are today profiting by the amazing demand for radio experts. Prominent radio experts help you in your training.

#### What Free Book Has Meant to Just a Few of Our Recent Graduates

**Tripled His Salary As Radio Engineer**  
Thanks to your course and help it gave me, I have had another boost in pay. This is the third one in less than a year. Today I am getting three times as much as I got before I began your course.  
**MERLE WETZEL,**  
Chicago Heights, Ill.

**\$300 a Month and All Expenses As Salesman**  
Your course was worth \$500 to me, but I wouldn't take ten times that for the value I've gained from it. I signed up with a company for \$300 a month and expenses paid. I owe this to your course.  
**EMMET WELCH,**  
Peculiar, Mo.

**Prepares For All Radio Jobs**  
It will interest you to know that since completing your course I was 1st operator on Steamship Lake Giltedge. Last summer I had charge of Broadcasting Station WIAI, and in December connected with the Colin B. Kennedy Radio Corp., as sales correspondent handling all technical inquiries which I enjoy immensely. All due to N. R. I.  
**WILLIAM WEST,**  
St. Louis, Mo.



Valuable radio instruments for practical instruction supplied free with the course. The same training which has helped hundreds of our students to big positions in radio is open to you.

Enroll Now—For a limited time we are offering our wonderful course at a big saving to encourage as many as possible to enroll at once and help us fill the demand.

### Big Free Book Describes Amazing Opportunities

Learn more about this wonderful field of radio and what it can mean to you. Read about the opportunities open—their pay—how our method quickly trains you—what our graduates say—what they are doing—and what you can do. There's no obligation in sending for this free book. You have everything to gain—and nothing to lose. Send for this book today—the book that has meant more money to hundreds of our graduates. Mail the coupon NOW. NATIONAL RADIO INSTITUTE, Dept. 32AA, Washington, D. C.

#### ----- FREE BOOK COUPON -----

NATIONAL RADIO INSTITUTE, Dept. 32AA,  
Washington, D. C.

Without obligation, send me your free book "Your Opportunity in Radio," which tells all about the opportunities in Radio, how spare time study at home will qualify me quickly as a Certified Radiotrician so I can get one of these splendid positions and how your free Employment Service helps me to secure a big pay job.

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

Street.....

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

NOTE: Radio Firms Secure practical Radio experts among our graduates. Write us today.

**THE  
ULTRA  
MARVEL**  
Type 404

Only  
**\$70**



at last—

**an Efficient 3-Tube Radio-Receiver Within the Reach of all!**

AT LAST—You can now secure a Radiophone Broadcast Receiver with an efficiency equal to any of the high priced sets for only \$70. The Ultra-Marvel has a wave length range of 225 to 575 meters with maximum efficiency on all waves and has a conservative range of 1,000 miles with a volume sufficient to operate a loud speaker satisfactorily. Can be used with inside antenna (wire stretched around room) if desired. It is small, compact, very easily tuned and highly selective. Two stages of radio frequency amplification, rectification and one stage of audio-frequency amplification are secured with

but **THREE TUBES**. This receiver can be installed by anyone and operated successfully anywhere.

The construction of this instrument has been greatly simplified and is mechanically perfect. It has not been necessary to combine cheap materials to offer it at such a low price.

The Ultra-Marvel is a beautiful instrument with **EVERYTHING INCLOSED** in a handsome cabinet. By far the most efficient Radio Set ever produced for less than \$150. If your dealer cannot supply you write direct for literature and full information to

**INDUSTRIAL RADIO SERVICE, Newton and Rust Aves., Saginaw, Mich.**

**UNITED**

*Make Your Tubes  
Give You Full Service!*

Just as several messages pass over the line at the same time in modern telegraphy, so in the modern Radio circuits two frequencies can be amplified by the same tube.

Our Engineers have perfected the United Radio Frequency Transformer. Its success in reflex circuits, when used with United Audio Frequency Transformer has been so pronounced as to be the outstanding advance in Radio this season.

To get the best results from the circuits you use to build your set, you must use the parts stipulated in the circuit diagram.

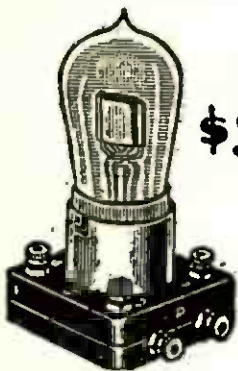
Our reflex circuit is yours for the asking. Its long distance reception and strength of signals will both please and surprise you, but it must be built with United parts, we cannot recommend it otherwise.

**Special Transformer**

We are in a position to supply special Transformer, having Split primary and secondary, adaptable for Push-Pull circuits. Price \$11 per pair.

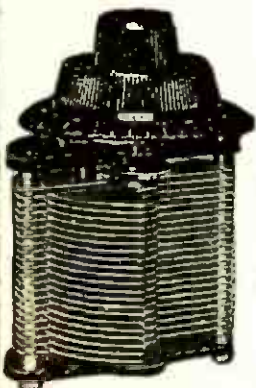
**UNITED MFG. & DISTRIBUTING CO.**  
9704 Cottage Grove Ave., :: Chicago  
New York Office: 50 Church Street, N. Y.  
San Francisco: 709 Mission St., San Francisco, Cal.

**UNITED RADIO PARTS**



**\$3.50**

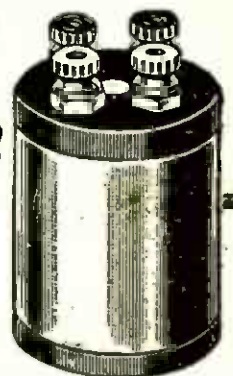
Radio Frequency Unit



**\$2.25**  
to  
**\$6.50**

Condensers  
Vernier and Plain

**\$2.50**



Radio-Frequency  
Transformer

**\$4.50**



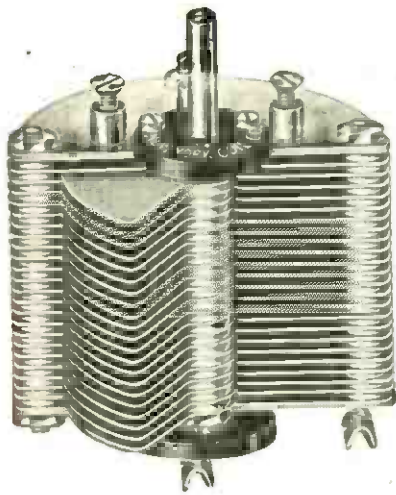
Unit Audio Frequency  
Amplifying Trans-  
formers



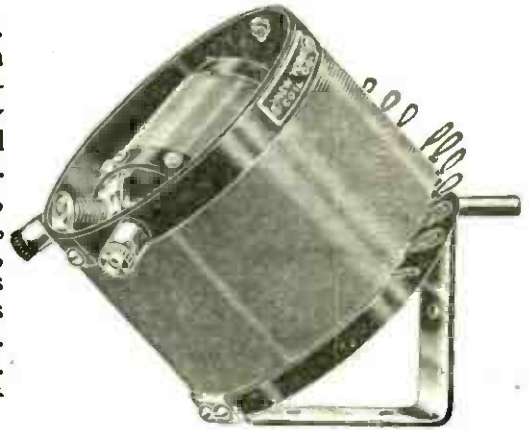
Please mention POPULAR RADIO when answering advertisements.

# New York Coil Company's Radio Products

Have An Established Reputation for Honest Value, Maximum Results and Ease of Installing



**New York 180° Coupler.** Is the last word in high grade precision construction and is incomparably superior in both electrical and mechanical details. Genuine Bakelite tubing, double supported solid shaft, double silk wire employed, flexible pig-tail connections with correct number of turns for the new wave lengths. Metal parts nickel plated. **The best buy in couplers. Price, \$4.00.**

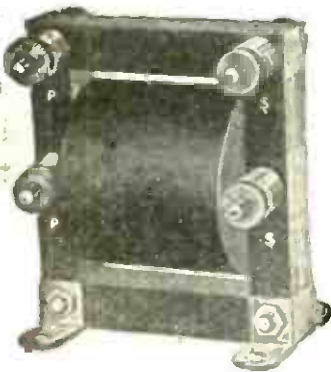


New York Condensers bring in the broadcasting loud and clear with the true tone, because the construction eliminates all leakage and electrical losses—the standard by which others are judged.

11 Plate	\$1.50	43 Plate	\$3.00
23 " "	2.00	3 " "	1.25

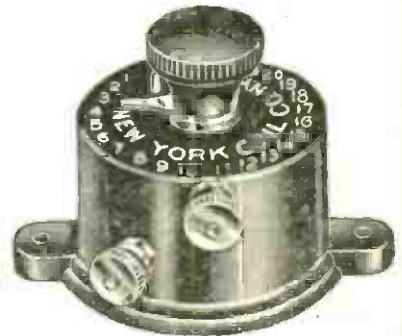


**Mica Fixed Condensers** of tested and permanent capacity, ranging from .0001 to .006, 35 cents to 75 cents, of superior quality.



Insist on New York Amplifying Transformers. Do not be satisfied with something claimed to be "just as good." They are universally recognized for their marvelous amplification, purity of tone and ability to produce uniformly perfect results with any style of standard tube. Price \$4.00 and worth it.

**The New York Variable Grid Leak** easily tops the field in precision, permanency and efficiency. Price, \$1.50. For panel mounting, \$1.75.

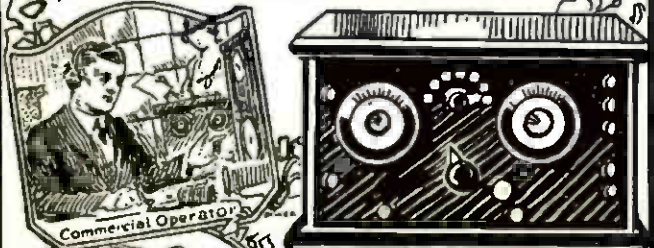


Get literature on Variometers, Couplers, Mica Condensers, Inductance Tap Switches

**NEW YORK COIL COMPANY**  
338 Pearl St. New York City

Pacific Coast—MARS BANK SALES CO., 1240 S. Main Street, Los Angeles, California

# RADIO BIG MONEY IN A FASCINATING INDUSTRY



## FREE With Our Home Study Course

Right at home you can speedily qualify yourself to accept big paying positions in the great field of Radio. Never before such sensational opportunity. Get in on the ground floor. We start your training by giving you this wonderful tube receiving set. Range up to 1000 miles. ABSOLUTELY FREE. Our practical instruction method guarantees your success—you learn by actual work on the set.

## ENORMOUS DEMAND FOR EXPERTS

From everywhere comes the call for Radio Experts. Big salaries are waiting for trained men who can construct, install, operate, repair and sell radio equipment. Tremendous profits can be made in your own neighborhood taking orders for sets. Thousands are winning success in this fastest growing industry—you can too.

### Turn Spare Time Into Cash

Just a few hours each week of pleasant home study trains you in amazingly short time. Make your spare time earn you cash. We show you how. Many are earning from \$3,000 to \$10,000 a year.

**A. G. MOHAUPT, Radio Engineer,  
American Radio Ass'n**

4513 Ravenswood Ave., Dept. 51 Chicago

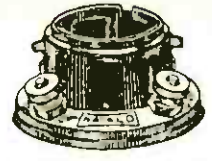
Mail Coupon

A. G. MOHAUPT, Radio Engr.  
American Radio Ass'n,  
4513 Ravenswood Ave., Dept. 51, Chicago, Ill.

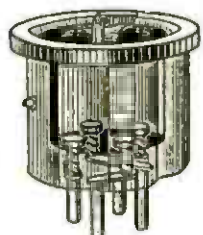
Please send me details of your Home Study Course—also your Free "Radio Facts" and information on how I can get a FREE 1000 mile Radio Set.

NAME.....  
ADDRESS.....  
CITY..... STATE.....

## It's the contact that counts



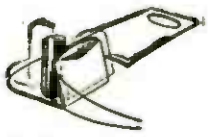
Na-ald Special Socket No. 499 for UV-199 and C-299 Tubes. Price 50c



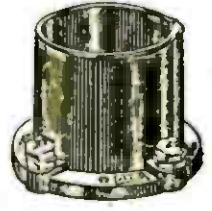
Na-ald Adapter No. 429 for UV-199 and C-299 Tubes. Price 75c



De Luxe No. 400 Price 75c



De Luxe Contact



Small Space No. 401 35c, 3 for \$1.00



Na-ald W. D. 11 No. 411. Price 75c

Weak reception due to inferior contacts is banished when Na-ald sockets are placed in a set. Na-ald contacts exert a strong, wiping pressure on tube prongs over a broad surface, regardless of frequent removal of bulbs or variation in the length of prongs.

You can count on Na-ald sockets under all conditions. They are moulded of genuine Bakelite, with uniform cross-section and cure. These features prevent plate-to-grid losses and insure full efficiency from tubes.

Insist on Na-ald sockets and put an end to weak reception. All good dealers carry them.

### NA-ALD INSIDE INFORMATION (No. 429)

Have you realized that the matter of design in anything as simple as an adapter will make a big difference in the results obtained with a U. V. 199 or C 299 tube? Na-ald No. 429 Adapter makes it possible to use these excellent tubes in regular standard sockets. Not only must means be provided for holding the tube, but had we used flat springs or allowed broad flat surfaces to run parallel in this adapter, the capacity would rob this tube of much of its effectiveness. Again, full-surface, positive contacts were necessary. These are provided by plunger pads backed with music wire springs pressing against metal cross-overs moulded in solid Bakelite. Na-ald adapters cost but 75c, a very reasonable price in view of their assurance of the highest tube efficiency.

### Alden Manufacturing Company

Largest Makers of Radio Sockets and Dials in the World—Why?  
52 Willow St. Springfield, Mass.  
Dept. C Cable Address, Aldenco



Please mention POPULAR RADIO when answering advertisements.



## Boys are the Backbone of the Radio Business

The President speaks, and all over the country millions of radio sets are tuning in to catch his words. Four years ago a favored few, living near by, might have listened in. Now the whole country listens. Radio has captured the home, and the conquest was only made possible by the tremendous energy, ingenuity and curiosity of boys.

Boys' imaginations were caught by the lure of radio. They pioneered with

their home-made sets. They spent their hard-saved nickels for parts. They enlisted the interest and roused the enthusiasm of their parents. They opened the family coffers. Dad went out to get his son the best he could afford, with son acting as advisor, buyer and constructor-in-chief. And to-day, the vast majority of radio sales are made to boys, or to parents buying for boys or with the boys' advice.

**THE  
AMERICAN BOY**  
"The Biggest, Brightest, Best Magazine  
for Boys in All the World"

goes right to the heart of the boy market. It is the favored magazine of 500,000 radio-inoculated boys averaging 15½ to 16 years old—sons of well-to-do parents. Its stories and articles deal with radio authoritatively. All its contents hold their interest and confidence.

Always striving to improve their sets,

indefatigable in insistent wanting, commanding their parents' enthusiastic cooperation in their radio activities—these youths are the backbone of the radio business; the radio manufacturer's greatest market.

Copy reaching us by January 15th will catch the March issue.

**THE SPRAGUE PUBLISHING COMPANY**

(Member A.B.C.)

**548 Lafayette Boulevard, Detroit, Michigan**

# RAVEN RADIO



Raven Super 180 Degree Coupler  
Catalogue No. B-104

RAVEN INSTRUMENTS have given wonderful satisfaction and our long list of satisfied Jobbers and Dealers prove that our apparatus is the best repeat seller on the market.

Our Variometers and Couplers are made to conform to all wave lengths. Their size makes them adaptable to all circuits. Beautifully constructed of Red Moulded Bakelite, wound with green silk wire and assembled with nickeled brass throughout.

- Bakelite Variometer.....B-101
- Bakelite Vario-coupler...B-102
- Bakelite 180° Coupler.....B-104
- Bakelite Rheostat.....B-106
- Wooden Variometer.....C-101

Radio jobbers and dealers should write for our prices and descriptive literature on our complete line.

*Every Raven instrument is unconditionally guaranteed*



The Raven Bakelite Variometer  
Catalogue No. B-101

**RAVEN RADIO, Inc.** 8 Learned Street,  
ALBANY, N. Y.

**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.

Please mention POPULAR RADIO when answering advertisements.

## We believe that you can buy most intelligently when you can see *what is inside*.

Here then is your opportunity to see the care that is built into a Timmons Talker.

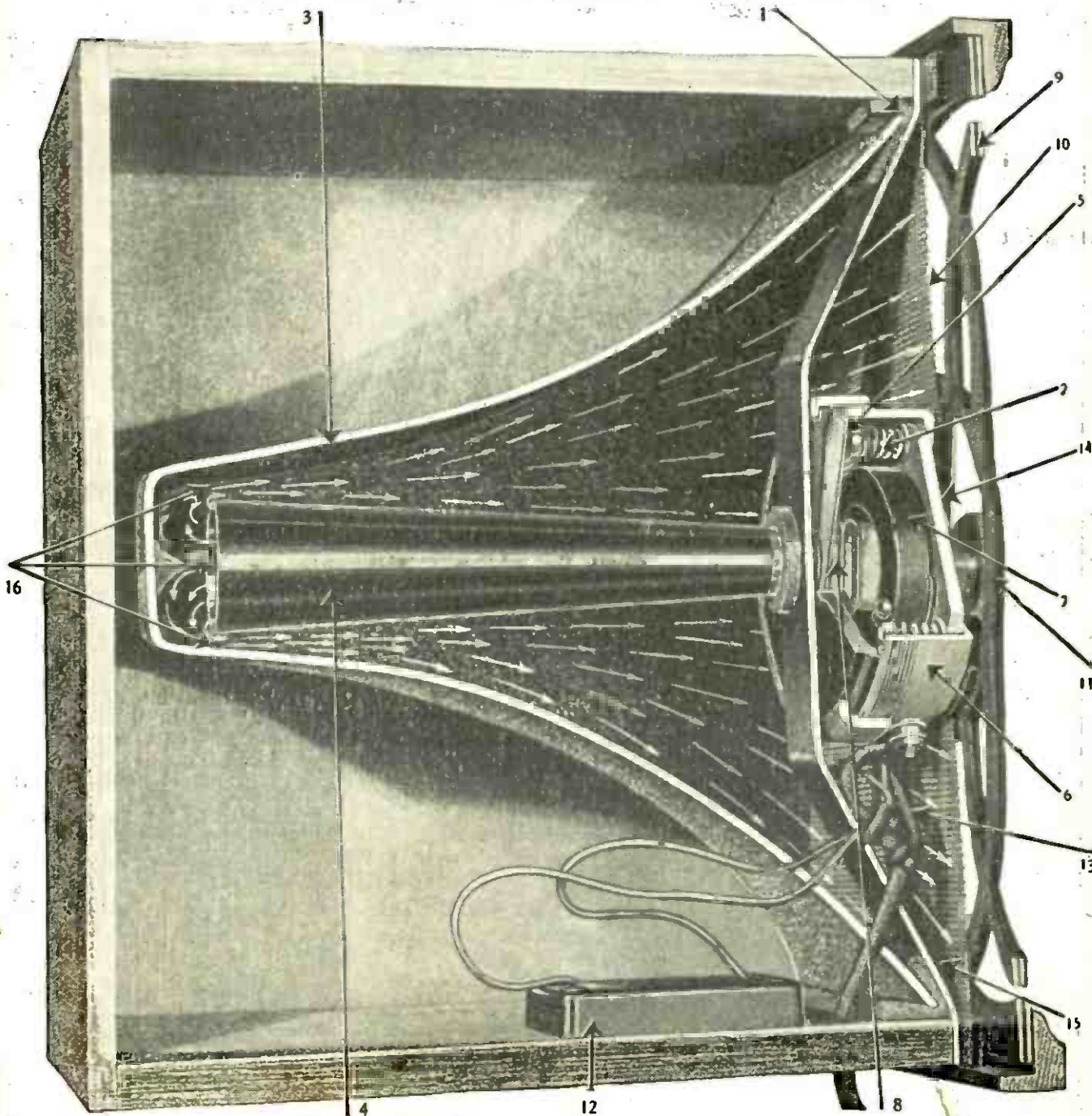
Every one of these 16 features is the result of an honest attempt to give you a loud speaker that has the sweetest tone and greatest volume of any non-power loud speaker made.

We hope now that after seeing all of these things that we have tried to do, you will hear the Timmons.

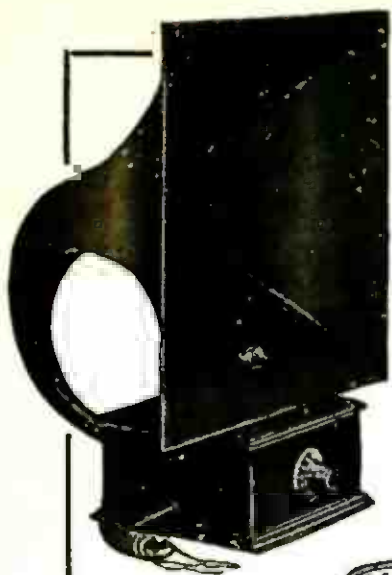
—at your dealer—\$35 and \$25.

Your dealer has "Volume Without Noise"—the Timmons folder. Or write us.

**J. S. TIMMONS**  
339 E. Tulpehocken St., Germantown, Philadelphia



# Timmons Talkers



**\$35.00**

Type R-1202



## The Height of PERFECTION in Loud Speakers

Smooth, even tones — pleasing volume — even distribution of sound — no metallic vibrations or distortions. These are the achievements of the Callophone — made possible by long experience in voice amplification.

A dial controls the magnets, permitting accurate adjustment to the various conditions produced by different types of tubes and varying strength of incoming signals.

The Callophone can be used on any set equipped for a loud speaker. No extra batteries are required.

Every instrument is tested under actual operating conditions before leaving the factory.

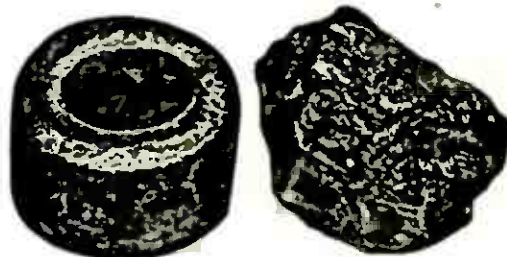
Order your Callophone today! Use it ten days — if it does not do all we claim, return it and your money will be refunded.

**CALLOPHONE COMPANY  
OF NEW YORK, Inc.**

216-222 Mercer Street  
New York, N. Y.

**Make Your  
Reflex Set  
100% Efficient  
by Using**

## **MPM Million Point Mineral CRYSTAL**



35c Mounted      **PRICE**      25c Unmounted

### **M. P. M. Million Point Mineral CRYSTALS**

This remarkable crystal is super-sensitive — reproducing from every point on its surface. Greatly increases both audibility and radius — records having been reported up to 1200 miles. Will not burn out or corrode. M. P. M. crystal is unsurpassed for reception both with or without amplification.



### **M. P. M. Reflex Radio Frequency TRANSFORMER**

**PRICE**  
\$4.50

Absolute precision in the assembling of these transformers assures remarkable range and volume with positive elimination of distortion.

#### *Special Offer*

Detailed working diagram of a successful reflex circuit will be sent free with all orders for either crystals or transformers.

**M. P. M. Sales Co.**  
Dept P, 247 South Central Ave.,  
Los Angeles, California



CHICAGO

# Getting distance ~ with ease!

ONLY those who have built their own sets experience that priceless thrill of personal achievement which comes surging in with the sound waves caught from afar off.

Tuning out or in at will, erasing interference in favor of the sending point sought, is always most easily accomplished by *synchronized* apparatus.

Don't build mongrel sets. Even if parts used are each of highest quality—but the products of various makers, they will hardly work together as efficiently or harmoniously as if they were the products of one reputable manufacturer. You'll find sets built up of

## Gilfillan Radio Parts

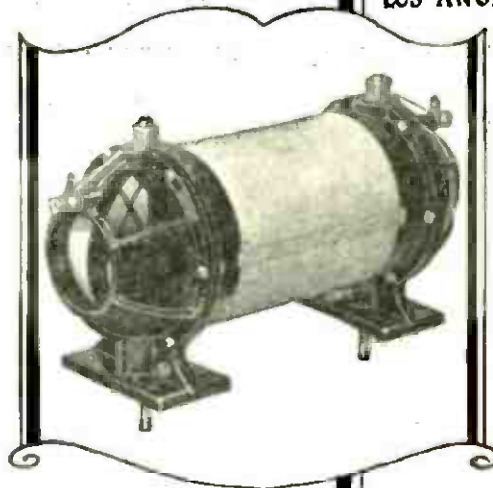
*perfectly synchronized.* While these parts will of course do good work in conjunction with apparatus of other makers—the best results—at probably no greater expense, is obtained by using Gilfillan parts throughout.

See your dealer today and have him show you Gilfillan parts. Even on sight you'll appreciate their superiority.

If your dealer does not handle this superior line, write us for name of nearest dealer, descriptive folder and list.



LOS ANGELES



Gilfillan Tuning Unit

Another Gilfillan achievement making for increased simplicity and greater efficiency. This unit replaces two variometers and one variocoupler. Note how compact it is. Wave length range 225 to 890 meters, covering all broadcasting. High selectivity in tuning. Brown moulded bakelite. Split bronze bearings. Net weight 22 oz. Height 4 1/4". Diameter 3 1/4". Length 8 1/4".

## GILFILLAN BROS. INC.

1925 McGee St.,  
Kansas City, Mo.

1815 W. 16th St.,  
Los Angeles, Cal.

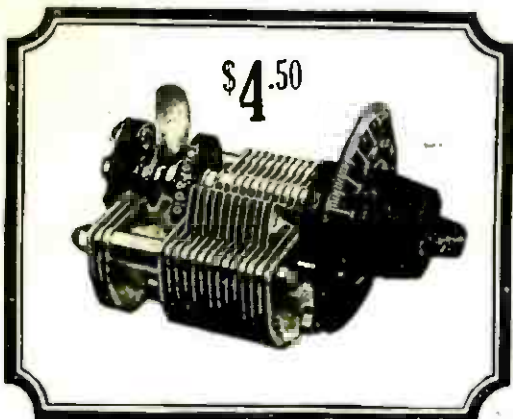
225 W. 57th St.,  
New York, N. Y.

Licensed General Bakelite Co.

Genuine Gilfillan  
Radio Parts can  
always be identified  
by this trade-mark  
—look for it



# Teleradio



## Continuous Satisfaction

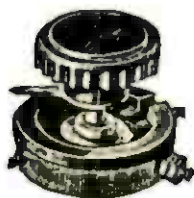
The expectations of the radio enthusiast who is endeavoring to get sharp tuning in his set, are fulfilled by the continuous satisfaction of the Teleradio Vernier Condenser.

His joy in finding accuracy and dependability in this instrument reflects the efforts of the manufacturer to fully please the owners of Teleradio products.

With extra heavy polished hard aluminum plates that will not warp, a special locking feature preventing short circuiting of vernier and providing permanent and perfect contact, an accurate and constant capacity, and with rigid construction throughout, there is positive assurance of continuous satisfaction from this precision instrument.

Guaranteed electrically and mechanically.

**TELERADIO ENGINEERING CORP.**  
488-490 Broome Street New York

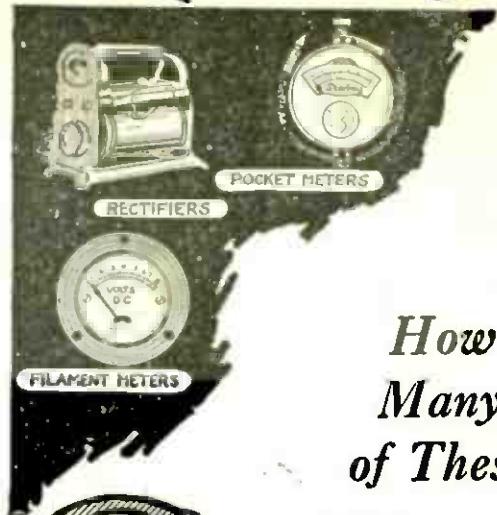


### FILAMENT RHEOSTAT

Is reversible and can be mounted on either panel or base. Double brass bearing on spindle insures smooth action and prevents looseness. Contact arm is phosphor bronze. Will carry 1½ amperes without heating. Price (6 or 30 ohm).....\$1.00

**VERNIER CONDENSERS** 23 plate \$4.50; 43 plate \$5.50; **VARIABLE CONDENSERS** 3 plate \$2.00; 11 plate \$2.50; 23 plate \$3.00; 43 plate \$5.50; **HEAD PHONES** 2000 ohm \$5.50; 2200 ohm \$6.00; 3000 ohm \$7.00; **LIGHTNING ARRESTER** \$1.00.

## TELERADIO PRODUCTS



How Many of These

# Sterling

RADIO NECESSITIES

Are You Using?

YOU SHOULD BE FULLY EQUIPPED TO GET REAL RADIO ENJOYMENT

- PORTABLE RECTIFIER.** For charging batteries from 110 volt A.C. circuit. Absolutely safe. Cannot overcharge. No freezing or sticking. Charged by 5 ampere maximum rate. 50 to 60 cycle. 6 volt, \$16.00; 25 cycle, \$18.50. Add \$1.00 West of Rocky Mts.
- 12 POINT ROTARY SWITCH.** Improves appearance of board contact points—a complete unit for rear of panel mounting to which variocoupler taps may be easily soldered. \$1.50.
- FILAMENT RHEOSTAT.** Fine adjustment. May be used for either back of panel or table mounting. Types especially designed for various tubes. 75c. and \$1.00.
- AUDIO AND RADIO FREQUENCY TRANSFORMERS.** Audio in 4 to 1 and 6 to 1 ratios, give high amplification without distortion. Shielded type protects from influence of stray fields. \$4.00. Radio in fixed and tuned range types give sharp tuning and high selectivity of resonance. \$4.00.
- POCKET METERS,** voltmeters, ammeters and voltammeters to cover all the needs of the radio battery user for testing "A" and "B" Batteries both dry and storage. Draw just right amount of current from battery. Thoroughly accurate. \$1.00 to \$4.00.

See Your Dealer for These Items or check any of above on which you want further information.

## The Sterling Mfg. Co.

2843 Prospect Ave.  
Cleveland  
Ohio



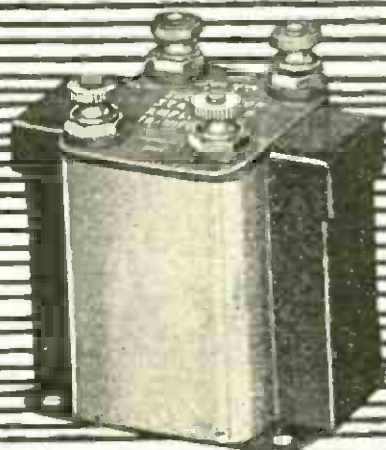


Please mention POPULAR RADIO when answering advertisements.

# THORDARSON

## SUPER TRANSFORMER

AUDIO FREQUENCY



**THE CROWNING GLORY  
OF THORDARSON ACHIEVEMENTS**  
**EQUAL AMPLIFICATION OVER  
THE ENTIRE MUSICAL RANGE**

**THORDARSON**  
ELECTRIC MFG. CO.

Huron and Kingsbury Streets

Chicago, Ill.



# Results— Right Now!

WITH A  
**CONTROL-O-METER**

Wherever you are located, the CONTROL-O-METER will permit distant programs to be received right through the local broadcasting stations.

Each CONTROL-O-METER is individually tested in our Laboratory and a Chart provided showing the setting for each wave length.

The CONTROL-O-METER has made good in the most congested radio districts of the United States. You will get results the moment you turn the dial.

If your dealer cannot supply you,  
order direct

**\$12.50**  
POSTPAID

**MALONE-LEMMON PRODUCTS**

Made by **STEPHENSON LABORATORIES**  
342 MADISON AVENUE  
NEW YORK CITY



**T W O P O P U L A R D E V I C E S !**

**HORNE**  
**"VERNI-TUNER"**  
Price \$5.00



**3 in 1** Primary, Secondary and  
Variable Condenser  
Combined fixed coupler and  
Variable Condenser

For constructing all Regenerative Circuits, Radio Frequency, Reflex and Tuned Radio Frequency. No Taps—Extreme Selectivity—Free "Hook-Ups" with each device. VERNI-TUNER WAVE TRAP for all sets in cabinet with Bakelite Panel and Binding Posts. **\$8.50**

**HORNE**  
**TUBULAR VARIOMETERS**



Substantial Black Tube  
No wood or Heavy Dielectric

No. 313 Radio Frequency Variometer. . . . \$6.00  
No. 314 Split Variometer. . . . . 5.75  
No. 315 Plain Variometer. . . . . 5.50

At your dealer, or mailed direct upon receipt of purchase price. Booklet of 10 latest radio circuits, 20c.

**HORNE ELECTRIC & MFG. CO.**  
Mercer & Colgate Sts., Jersey City, N. J.

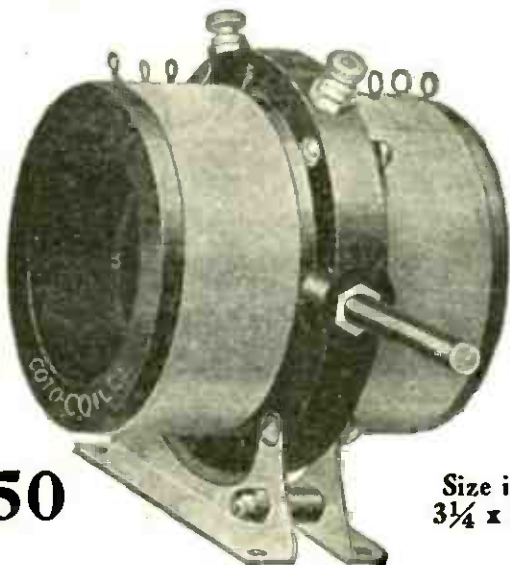
**Coto**

"Built First to Last"

## Build Your Own Set And Build It Compact

Your radio dealer will recommend a good dependable and selective circuit. He will advise you, work with you, and make your success easy. A set assembled from Coto Compact Radio Parts, will be worth double its cost, especially next summer when you will carry it along on radio outings.

*Insist on Coto Quality  
and Coto Compactness*



**\$5.50**

Size is only  
 $3\frac{1}{4} \times 3 \times 3\frac{3}{4}$

### New Coto Compact Moulded Variocoupler

In polished brown bakelite. Range is 200 to 600 meters. Has eight taps for use with primary condenser. Pigtail connection to rotor. Base or panel mount. Type 9000.

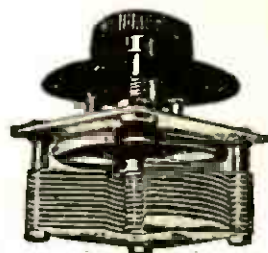
*Dealers! Jobbers!*

You can jump right into selling volume on the Coto Compact line because quality is right and demand established by national advertising.

**COTO-COIL CO.** 87 Willard Ave., Providence, R.I.

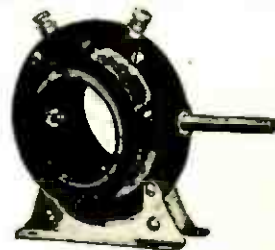
BRANCH OFFICES

Los Angeles, 329 Union League Bldg.  
Minneapolis, Geo. F. Darling, 705 Plymouth Bldg.  
Atlanta, C. P. Atkinson, Atlanta Trust Co. Bldg.



### Coto Compact Air Condenser with Vernier

Only  $2\frac{1}{8}$  inches square. Rotor plates soldered to shaft. Stator plates soldered at three points. .0005 Mfd. \$5. .001 Mfd. \$6.



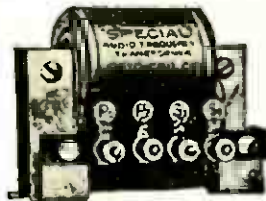
### Coto Compact Variometer

Especially designed for new wave lengths, 200 to 600 meters and for the much demanded compactness. Size  $3\frac{1}{4} \times 1\frac{1}{4} \times 3\frac{3}{4}$  in. In brown polished bakelite with honeycomb wound stator. Pigtail connections to rotor. Base or panel mount. Type 8000... **\$5.00**



### Cotogrip Tube Socket

Has unique double positive grip of tube terminal posts. Best hard rubber insulation. Type 7000. 85c



### Coto Special Audio Frequency Transformer

Turn ratio of 3 to 1. Coto quality throughout but made to sell at a popular price. Type 4500... **\$2.50**

# AMPL-TONE PHONES



ALWAYS FRESH  
Sample to dealers \$3.20

This is our only  
ADVERTISEMENT

It sells our entire product  
Merit does the rest for us

**C. M. FRENCH MFG. CO.**  
SEYMOUR, CONN.



## Fits Anywhere

The same range of reception for which you now require a 100 foot or longer aerial,—infinitely improved upon by the *Warren Radio Loop* that fits into a coat pocket. Interference eliminated. Selects and tunes with remarkable ease and accuracy. All enclosed by Bakelite shields. Four compact sizes for every purpose. The best known—the best liked.

Write for the name of the nearest Warren dealer and Bulletin I-102.

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-OE-CO RADIO MFG. CO., Dept. F, Asbury Park, N. J.

## The New Freshman CAPACITY FINDER

permits you to actually measure the condenser values necessary in your hook-up



**31**  
CAPACITIES  
FOR THE  
COST OF  
**5**  
FIND OUT

just what value of a condenser will give your hook-up the best results in the grid circuit, across the phones, in the Antenna Circuit, across transformers, battery circuits, etc.

Price \$2.25  
including the 5 special Freshman Condensers.

At your dealer, otherwise send purchase price and you will be supplied postpaid. Ask your dealer or write direct for complete instructions free.

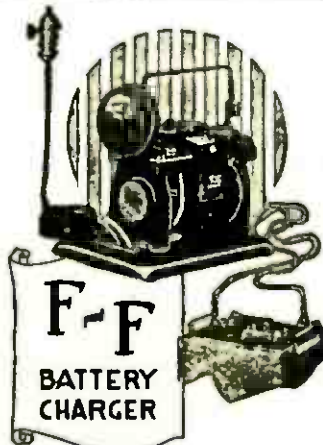
**Chas. Freshman Co. Inc.**  
*Radio Condenser Products*  
106 Seventh Avenue New York

## The Satisfactory Charger For Ten Years Past

The F-F, the first successful mechanical charger, is now the most popular. F-F features are distinctive, its construction is simple, and the absence of breakable parts which are expensive to replace, is almost sufficient reason for you to own the F-F; but the satisfaction you will buy with the low purchase price of the F-F is further reason why you should insist on the F-F.

Buy from your dealer. There's a type for every need. If he cannot supply you, write for literature or enclose remittance covering express or postal charges on 9 lbs.

IT'S FREE—Write for Bulletin No. 44



**\$15.00**

F. O. B.  
Cleveland

Type 6 charges 6 volt Storage Battery from any 110 volt 60 Cycle lamp socket at average rate of 6 amperes, or over if battery needs it.

The  
**France Mfg. Co.**  
10444 Berea Road  
Cleveland, Ohio

Oldest Manufacturer of the First  
Successful Mechanical Charger

Please mention POPULAR RADIO when answering advertisements.

# RADIO FREQUENCY AMPLIFICATION

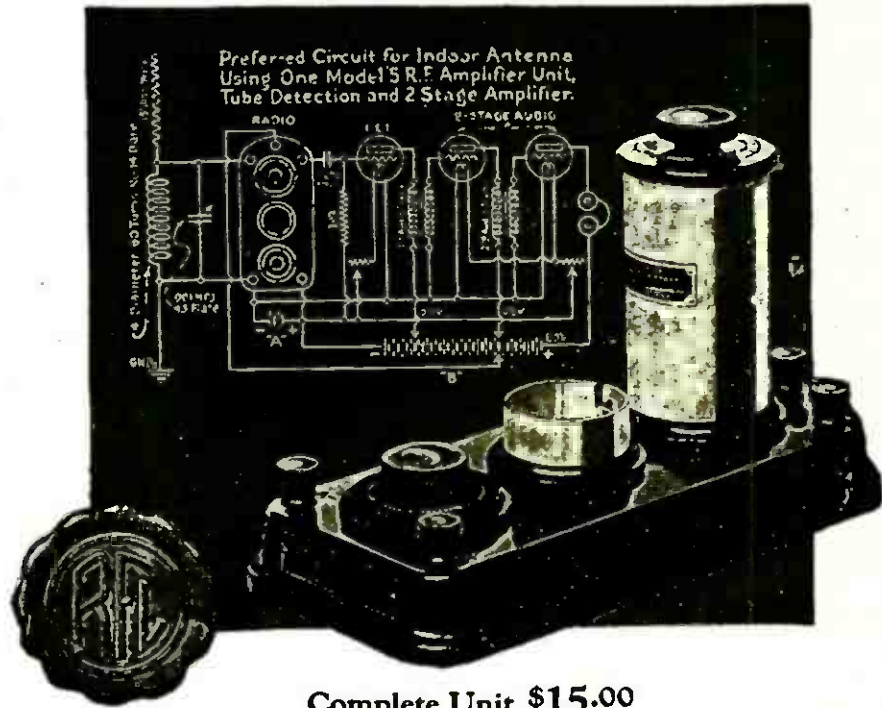
WITH

## Ballantine Variotransformers

(Patents Pending)



Model 5 \$9.60



Complete Unit \$15.00

### “TURN THE KNOB”

1. Continuous variation in wave length.
2. Self-contained and shielded.
3. Control of regeneration and tuning by single knob: *no potentiometer.*
4. Fits your set — either base or panel mounting.
5. Improved tone quality.

“Radio Frequency Amplification with the Ballantine Variotransformers” — a 25-page booklet — mailed free on request.

**BOONTON RUBBER MFG. CO.**

*Pioneers in Bakelite Moulding*

224 FANNY ROAD

BOONTON, NEW JERSEY

3

the

the complete  
MURDOCK  
LOUDSPEAKER  
for \$5<sup>00</sup>

the new  
MURDOCK  
PLUG-JACK  
for \$1<sup>00</sup>

a pair of  
MURDOCK  
HEAD PHONES  
\$4<sup>00</sup> or \$4<sup>50</sup>

best in  
radio

AT ALL RADIO DEALERS

If your dealer cannot supply you, send money direct and your order will be promptly filled.

WM. J. MURDOCK COMPANY

354 Washington Ave., Chelsea, Mass.

HARTMAN



Patent Applied for

\$4.50 VARIOCOUPLER \$4.50

Here is a distinctively high grade Variocoupler at an exceptionally low price.

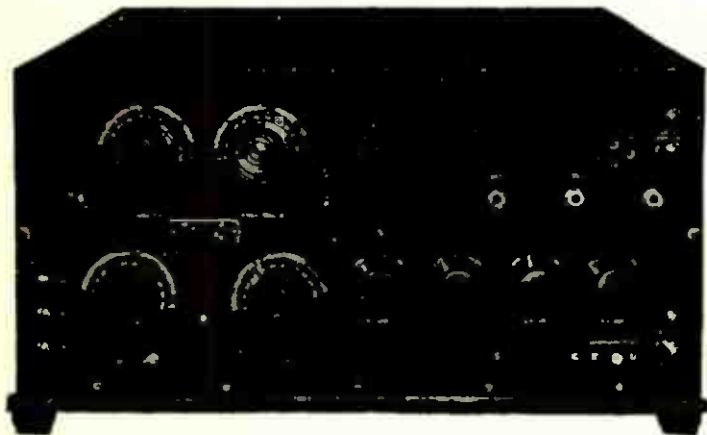
Check the following points and verify this claim.

(1) Spider web rotor. The only means of obtaining minimum coupling. (2) Pig tail contacts. (3) Bakelite tube. (4) Green silk wire. (5) No live brackets. (6) Improved taps. (7) Dead shaft and no capacity effect in tuning. (8) 180° dial adjustment without the rotor being submerged in stator field.

THE HARTMAN ELECTRICAL MFG. CO.

Mansfield, Ohio

## TYPE R-B-4



This is the set you have been looking for, and the one that you need.

Having one stage Radio Frequency, Tuned Impedance, Detector and Two Stages of Audio Frequency.

All apparatus mounted on panel 10 inches high, 21 inches long, and set in panel cabinet 10 x 21 x 10 inches deep.

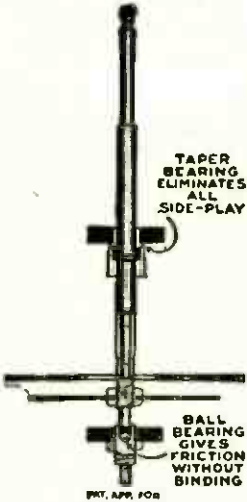
Price \$125.00 without tubes or batteries

WIRELESS ELECTRIC CO.

204 Stanwix St.

Pittsburgh, Pa.

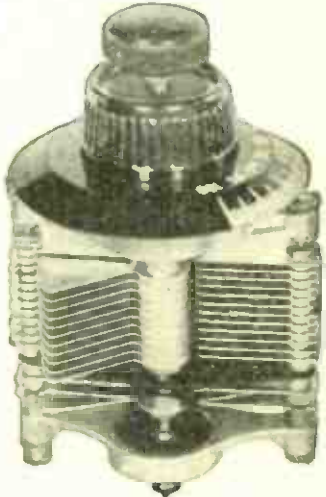
For Sturdiness and Accuracy Use  
Lombardi Condensers



TAPER BEARING ELIMINATES ALL SIDE-PLAY

BALL BEARING GIVES FRICTION WITHOUT BINDING

PNT. APP. FOR



A rugged condenser built on an entirely new principle, made to last a lifetime. The tension is adjusted by tightening a thrust plug causing the proper tension between a hardened steel ball and a 45 degree tapered brass bushing.

Also makers of coils and sockets.

*Literature and prices furnished upon request*

Lombardi Radio Mfg. Co.

67 MINERVA ST.

DERBY, CONN.

# Haynes-Griffin

RADIO SERVICE, Inc. 41 West 43rd St., N. Y. City



A. J. HAYNES

Assoc. Institute of Radio Engineers

Designer of the Haynes Circuit described by Mr. Cockaday as the ideal tuning element of the Super-Heterodyne.

## The Simplified Super-Heterodyne

Not in several years has any series of articles on radio attracted so much favorable attention as the description of the HAYNES CIRCUIT, written by Laurence M. Cockaday, and published in the September, October, November, and December (1923) issues of "Popular Radio".

Besides describing the circuit which has become generally known "1,000 miles for \$15" these articles also tell how to construct the special units which, when used with it, constitute the Simplified Super-Heterodyne.

### SEPTEMBER

In this first article (published in the September issue of "Popular Radio"), Mr. Cockaday tells how to make the Haynes Circuit—the finest one-tube receiver that can be built. Combines wonderful selectivity and extreme long distance range with a simplicity of construction never before equalled. 1,000 miles for \$15.00.

### OCTOBER

In the October article Mr. Cockaday explains the first addition that the ambitious experimenter can make to his original Haynes Circuit. He describes the Haynes Two-Stage Audio Frequency Amplifier, which converts the Haynes Circuit to a three-tube receiver, permitting the use of a Loud Speaker.

### NOVEMBER

The November article is regarded by many as the most important contribution to radio in the last year. Mr. Cockaday describes the construction of a Separate Oscillator—the first step necessary to the construction of a simplified Super-Heterodyne circuit using the Haynes Circuit as the tuning element.

### DECEMBER

And finally in the December issue Mr. Cockaday describes the construction of the Intermediate Wave Radio Frequency Amplifier. In this concluding article is explained how the four units combined constitute a complete Super-Heterodyne receiver—the Master DX Receiver of the Age, the Rolls Royce of Radio.

Haynes-Griffin Transformer

\$4.25



A new air core radio frequency transformer sharply tuned to 3,000 meters. Upon the use of this transformer depends much of the success of the simplified Super-Heterodyne. Haynes-Griffin Input Transformer also \$4.25.

Special Oscillator Coupler

\$3.50



Specially designed by Mr. Haynes for use in the Super-Heterodyne. An indispensable adjunct for the proper operation of this wonderful circuit.

## NOW WE ARE READY

The tremendous public interest displayed in these articles left us temporarily short of material, with resulting slow shipments. Now, once again, Haynes-Griffin with added space, increased manufacturing facilities and enlarged personnel, is ready to render its usual prompt, efficient service.

We are prepared to furnish the identical apparatus recommended by Mr. Cockaday without changes or substitutions of any kind.

Send for FREE LEAFLETS telling how to construct the Haynes Circuit and the Super-Heterodyne. Use the handy coupon.

Parcel Post Prepaid in U. S. anywhere east of the Mississippi River

New York's Largest Radio Store

Haynes-Griffin, 41 West 43rd Street, New York City.

Send me at once complete data and prices on all material mentioned in Mr. Cockaday's articles describing the Haynes Circuit and the Super-Heterodyne. I enclose a two-cent stamp for each of the leaflets checked below.

- Haynes Circuit
- Separate Oscillator
- Haynes Amplifier
- Intermediate Amplifier

HAYNES-GRIFFIN RADIO SERVICE, Inc.

41 West 43rd Street, New York City

## THE NEW METALECTRIC SOLDERING IRON

Operates with the Simplicity—  
Ease and Efficiency of a  
Pencil on any Electric Current

ACCEPTED  
As the Logical Solution  
to Radio Soldering  
Problems

Ample Heating Capacity  
Handle Always Cool

\$5.50

"Worth it"

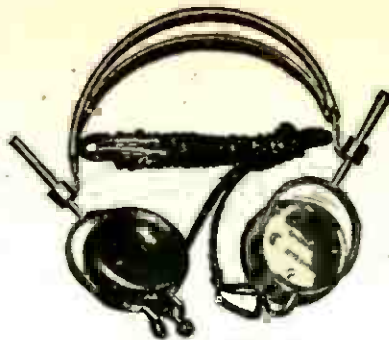
Inter-  
changeable  
Tip



"An All-metal  
Quality Instrument  
with a worthwhile Guarantee"

of Your Dealer or Write

Post Elec. Co., Mfrs. (Invt. Div.) 30 E. 42 St., N. Y. C.



Radio  
Veterans  
Demand

## "Dependable" TRIMM HEADSETS

"Professional" \$7.65

"Dependable" \$5.00

Positively the only headset on the market sold with a lifetime guarantee that covers every detail of materials and workmanship, excepting only cords and shells which cannot be guaranteed against breakage if dropped. Absolutely no charge AT ANY TIME for repairs, replacements or re-magnetizing. The headsets to buy and to sell.

See! Hear! These

## TRIMM LOUD TALKERS

All fitted with Special TRIMM jumbo size  
loud talker unit

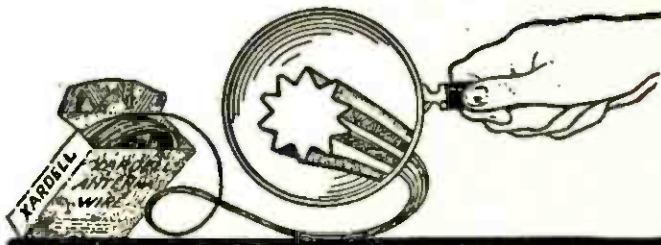
ACOUSTICOLA	Phonograph Attachment	\$10.00
ACOUSTICOLA	with composition horn	22.50
ACOUSTICOLA GRAND	with cast aluminum horn	35.00

Write for folder. Or order samples with privilege of return after 5 days examination and test

## TRIMM RADIO MFG. CO.

Dept. 59, 24 S. Canal St., Chicago

## DX-10-POINT



## ANTENNA WIRE

\$2<sup>00</sup>

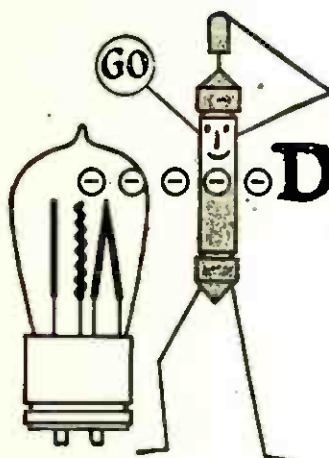
PER  
HUNDRED  
FEET

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



Do your tubes  
st-tut-tutter?

## DURHAM Variables

Will stop it

Just a touch of the  
plunger clears out  
that mush and makes  
way for real DX.

No. 101—0.1 to 5  
megohms for soft  
tubes

No. 201A—2 to 10  
megohms for hard  
tubes

75c



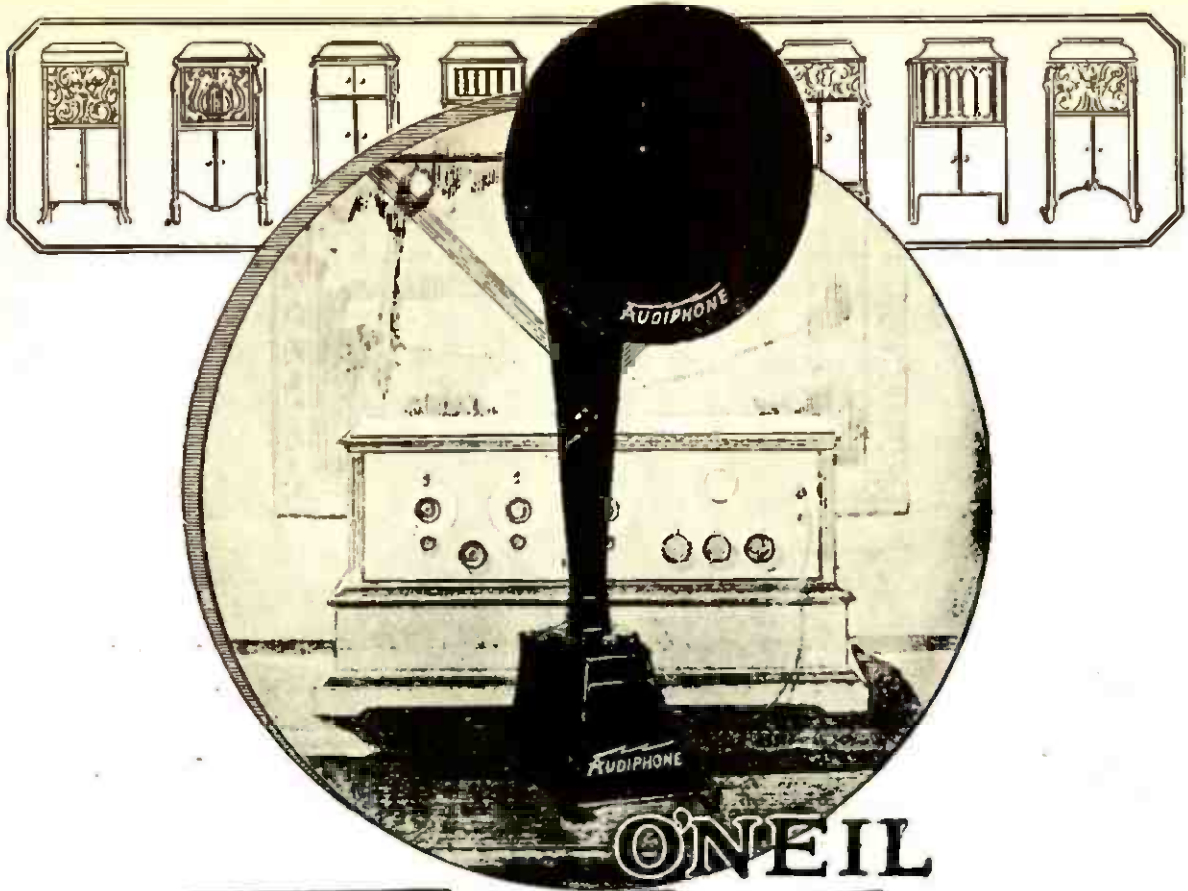
Durham Base, 30c

FREE folder tells how variable grid  
leaks work. Ask your dealer for copy

**DURHAM & CO., Inc.**  
1930 Market St., Philadelphia

Dealers: These units will clear up your sales troubles,  
too. For DURHAMS give guaranteed satisfaction.





# O'NEIL AUDIPHONE

Complete with 5 feet connecting cord.

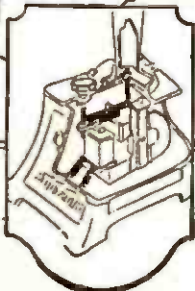
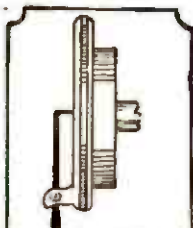
PRICE

**\$25**

THE *eventual* radio reproducer, designed on phonograph principles and built by electro-acoustic engineers and phonograph craftsmen. The *O'Neil Audiphone* marks the departure from the common earphone type of loud speaker, and the adaption of phonograph reproduction to radio.

The "laminated voice core" displaces the usual head-phone magnets, amplifying *all* the music, yet without extra batteries. The result is the actual music itself, unaltered, real as the original, uncannily **NATURAL**. The patented, external adjusting feature enables you to regulate the **AUDIPHONE** to individual receiving conditions.

Hear the radical improvement in radio reception at the nearest *Audiphone* dealer. Write us for his name and for literature.



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 and actuated by an elbow stylus bar. The principle of sound production is the same, resulting in perfect reproduction.

**O'Neil Mfg. Co.**

714 Palisade Ave.

West New York, New Jersey

# RATHBUN

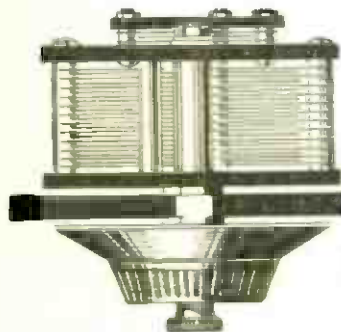
SINGLE-HOLE MOUNTING

## SUPERIOR CONDENSERS

NOT a particle of steel or iron in Rathbun Condensers, hence no stray magnetic fields. Further evidence of the experience and conscientious forethought behind each Rathbun Condenser. Other points of superiority are single-hole mounting, long brass bearings, anchored stator plates, precisely spaced, and a perfect concentric shaft. Write for the complete evidence and the name of the nearest Rathbun dealer.

LIST PRICES		
Plain Type		
5 Plate	.000125	\$3.00
11 ..	.00025	3.00
23 ..	.0005	3.50
43 ..	.001	4.50
Vernier Type		
3 Plate	.000075	\$1.00
Combination Vernier Type		
3-11 Vernier Variable		\$4.50
3-23 ..		5.00
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Write TODAY for the name of the nearest Rathbun dealer and for illustrated literature.



RATHBUN MFG. CO.  
Jamestown, N. Y.



## "Above the Ordinary" Radio Products

### Automatic Plug

Phone cords connected, disconnected in a moment. Pulling on cords automatically tightens grip, lever instantly releases. No taking apart or soldering.

**\$1**

### Perfect Jack

Easy soldering crowfoot—off-set terminals with solder flux compound, nickel-plated rounded corner brass brackets, spring German silver blades and sterling silver contact points.

### List Prices

No. 1	Single Circuit, Open	50c
No. 2	" " closed	55c
No. 3	Double	70c
No. 4	Single Filament control	75c
No. 5	Double	80c

Write for Folder

The SATURN Mfg. & Sales Co.

48 Beekman St.  
New York, N. Y.



# Reliable RADIO Goods

## Distributors for

Radio Corporation of America	Magnavox
Grebe	Western Coil
Atwater Kent	Burgess
Brandes	Gould
Murdock	Eveready
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Western Electric	Carter
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and other standard manufacturers

We carry a comprehensive stock of the latest receiving sets, parts and supplies of the leading manufacturers, and ship from stock promptly.

**FREE CATALOG** Illustrated, sent on request

DEALERS: Buy reliable equipment from a house of established reputation. Send for catalog of tested and approved apparatus, and our discount sheet.

**JULIUS ANDRAE & SONS CO.**  
127 Michigan St., Milwaukee, Wis.

**ANDRAE** In Business Since 1860

## Distance & Volume

are found in

## 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. "D" for Neutrolizing 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 and RCS one and three tube sets. 50 cents a set.

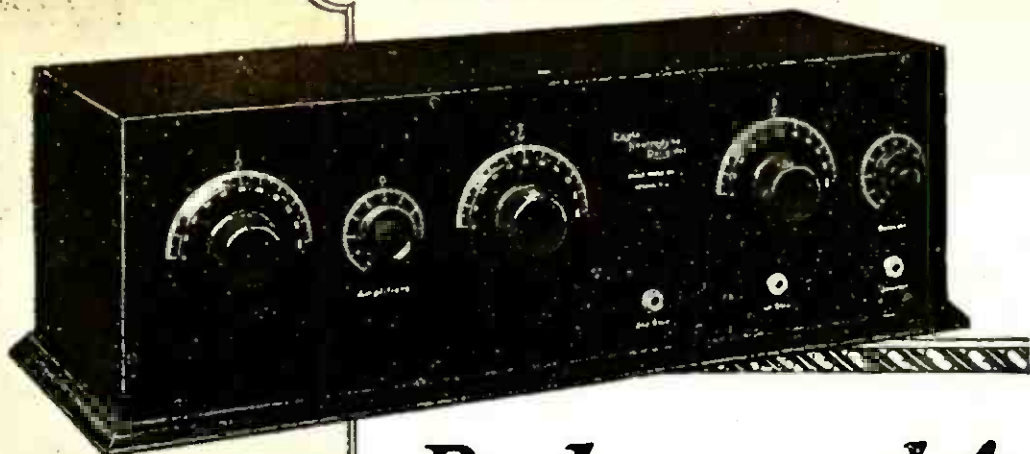
If your dealer cannot supply you, send direct to us and we will mail them post paid anywhere in the U. S. A.

**R. C. SCHOONHOVEN**

Major Q. M. R. C.  
ELGIN, ILL.

Please mention POPULAR RADIO when answering advertisements.

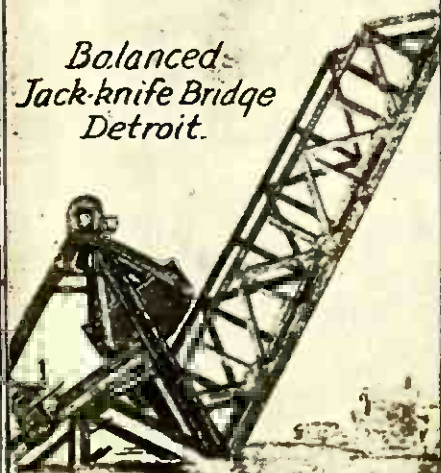
Licensed by Independent Radio Manufacturers, Inc., under Hazeltine Patent No. 1,450,080, dated March 27th, 1923, and other patents pending.



## Balanced!

THE portals of advanced radio, new realms of pleasure and utility, once locked to all but the professional, now swung wide open to everyone, however unfamiliar with radio by the marvelous proficiency and easy operation of this super-set.

Balanced  
Jack-knife Bridge  
Detroit.



# The Eagle

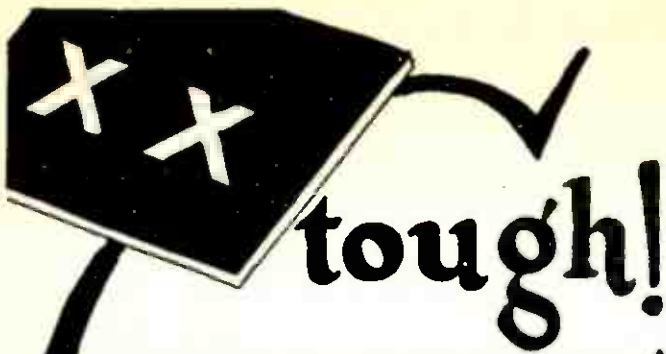
## Balanced Neutrodyne RADIO RECEIVER

The uncertain element—tube capacities—balanced (neutralized) as perfectly as the jack-knife bridge, removes the guess from radio reception. *Gone for good* are the familiar annoyances—regeneration, reradiation and body capacity effects. Extremely sharp tuning and a perfect ease of adjustment. Each *Eagle Neutrodyne Receiver* individually tested. A splendid reputation staked on each *Eagle Receiver*. Guaranteed absolutely without reservation.



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Booklet NOW!

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The radio-advantages of Bakelite-Dilecto (xx grade) are unequaled by any other material. It is positively perfect for the purpose.

# bakelite-dilecto!

(A Laminated Phenolic Condensation Material)  
Use B D X X for panels, frames, bases, bushings, platform mountings, coil winding tubes, variable condenser ends and other vital radio parts.

It gives absolute insulation. Resists water, heat, milder acids, fumes and solvents. Amazingly tough, yet readily machined. Won't warp. Highest dielectric strength. Any electrical man can get it cut and drilled for you. Insist on B D X X.

**THE CONTINENTAL FIBRE CO.**

Factory: Newark, Delaware

Dealer Service from:  
New York, 233 Broadway  
Pittsburgh, 301 Fifth Ave.  
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San Francisco, 75 Fremont St.  
Los Angeles, 411 S. Main St.  
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# HOWARD

HOWARD



No. 1001

6 1/2 Ohm Rheostat... \$1.10  
25 Ohm Rheostat... 1.10  
40 Ohm Rheostat... 1.10  
Patd. 870,042

HOWARD



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6 1/2 Ohm Micro-meter Rheostat... \$1.50  
25 Ohm Micro-meter Rheostat... 1.50  
40 Ohm Micro-meter Rheostat... 1.50  
Patd. July 10, 1923

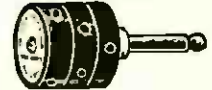
HOWARD



No. 1003

200 Ohm Potentiometer... \$1.50  
400 Ohm Potentiometer... 2.00  
Patd. 870,042

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

Ask the man to show you the Howard line of quality Radio Merchandise. Every piece is sold with the guarantee of satisfactory performance.

Jobbers write for discounts.

**HOWARD RADIO CO., Inc.**

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SCHINDLER'S

# BUILD-UP



50c to 75c

## MICA CONDENSER

Schindler's "Build-Up" Condensers fill a definite need for reasonably priced condensers that may be easily increased or decreased in capacity.

By the use of a "Build-Up" Mica Condenser you can change from an ordinary phone condenser to a special .006 value used in the Flewelling Circuit.

By simply adding extra plates of mica and copper to the "Build-Up" base, you can obtain any definite capacity from .00025 to .006. (Each mica plate with the alternate copper plate has a capacity of about .002 Mfd.)

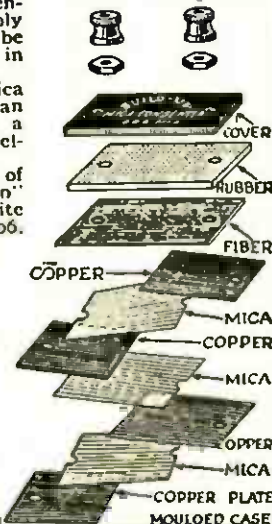
"Build-Up" Condensers are dilation proof. They insure high efficiency and will add satisfaction to the operation of any set. Each assembled complete in neat carton. Prices:

Mfd.	List Price	Mfd.	List Price
.00025	50c	.0025	65c
.0005	60c	.005	70c
.001	65c	.006	75c
.002	60c		

Extra envelope containing 20 mica and 20 copper plates, or sufficient to build up a condenser from .00025 to .006 list price 25c. Table showing required number of plates for any capacity is furnished with each condenser.

Ask your dealer or order direct.

**CHARLES SCHINDLER**  
1405 West Delaware Avenue  
TOLEDO, OHIO



Patent Pending



# HEAR HERE

100% with the

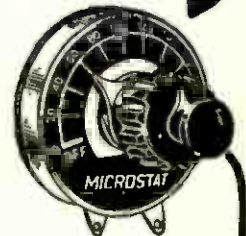
## PREMIER

# "Microstat"

Trade Mark

Super Vernier RHEOSTAT

\$3.00 AND WORTH IT



THERE is no substitute for the Premier "Microstat"—no other instrument that gives such perfect control of the current delivered to the filament of radio tubes. New principle—two windings in parallel—one 6 ohm—other 40 ohm. Absolutely noiseless—infinite control—handles any tube. Cap. 3 Amp. Bakelite moulded—silver etched dial. Do not install a Rheostat until you know all about the "Microstat." Our bulletin No. 97 explains it in detail. Send for it. It's FREE.

**Premier Electric Company**

3807 Ravenswood Ave.

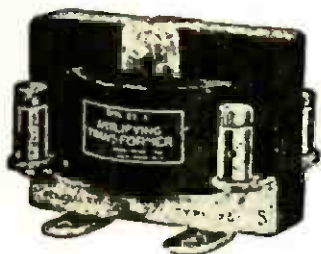
CHICAGO

Ask your Dealer for PREMIER "MICROSTAT"

TRADE MARK

# SUCCESSFUL AMPLIFICATION

Successful audio frequency amplification is not alone a question of tubes and transformers, but rather one of a careful choice of all parts entering into the amplifying circuit.

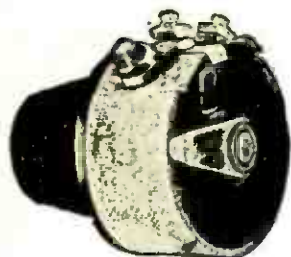
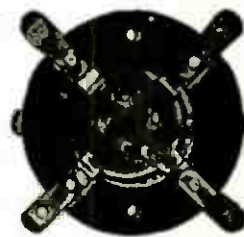
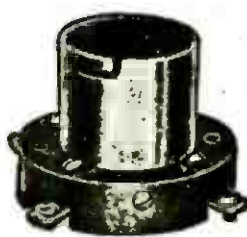


The transformer is of first importance. Little need be said nowadays of the necessity of freedom from distortion as this has been so well emphasized that purchasers today will accept only transformers of proven quality. Let us call your attention again to the fact that the General Radio Co. was the first company to supply commercially closed core audio frequency amplifying transformers. The quality of these transformers has been synonymous with successful amplification.

**TYPE 231A AMPLIFYING TRANSFORMER, \$5.00**

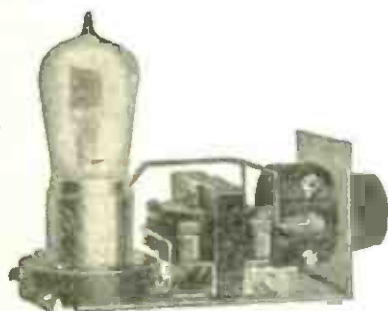
Socket springs must make a clean gripping contact with the vacuum tube prongs. Many disturbing noises may be introduced by a poorly designed socket. The Type 156 socket has positive contact springs, a base of real bakelite, and a polished nickel tube. It cannot help giving satisfaction.

**TYPE 156 SOCKET, \$1.00**



The resistance wire of the Type 301 rheostat is firmly wound on a specially treated fibre strip. The contact arm runs smooth and makes a clean positive contact. The base is of real bakelite. This rheostat is strictly a quality product.

**TYPE 301 30 OHM RHEOSTAT, \$1.25**



In this unit there are combined the three successful instruments listed above. The result is an amplifier unit representing the best in quality, yet at a price within the reach of all.

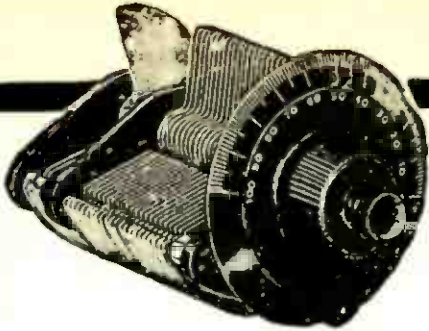
**TYPE 300D AMPLIFIER UNIT, \$8.25**

**TYPE 300C AMPLIFIER UNIT FOR  
UV199 TUBES, \$7.75**

Send for **FREE RADIO BULLETIN 916U**

## GENERAL RADIO COMPANY

Massachusetts Avenue and Windsor Street  
CAMBRIDGE 39 MASSACHUSETTS



## U. S. TOOL CONDENSERS

**O**XIDIZING of ordinary plates and spacers, creates a high resistance to the weak radio frequency currents. U. S. Tool Condensers are protected from this deterioration by a special counter-chemical treatment. End plates of Laminated Condensite-Celeron. Reasons for the persistent efficiency of *U. S. Tool Condensers*. Unconditionally guaranteed. Write for booklet.

**U. S. TOOL COMPANY INC.** 116 Mechanic St. Newark, N. J.



### "EVERYTONE"

(Guaranteed)

RADIO HEADSET

**\$3.50** 2200 OHMS  
3000 Ohms \$3.75

**A** BETTER headset at a lower price. Advanced features assure clear reception and long, satisfactory service. Send for Catalog P-1 of Pacent Radio Essentials.

Pacent Electric Co., Inc.  
22 Park Place, New York

**Pacent**  
RADIO ESSENTIALS

## 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

## THE MOVING FINGER—

Just as the Moving Finger writes never to return, so the undetected radio waves slip by your set, gone forever; while the set is all too often "damned with faint praise" because it fails to operate properly.

**PERHAPS** it's your set; and *perhaps* it's **YOUR** fault. An adjustable grid-leak can do much to assure both the distance and clarity you seek. The

## TURN-IT

adjustable GRID-LEAK

is just what you need; fits all standard mounts, gives instant response and always the exact value you seek for your tube, circuit and signal.

The TURN-IT Grid-Leak is now being sold in ever increasing quantities by practically every worth while dealer. It is priced right; is in active demand and is a perfect piece of radio mechanism. If not sold by your dealer, you can purchase it direct from the manufacturer.

**CHARLES E. BONINE**

20 So. 15th Street  
Philadelphia

**75c.**

(Postpaid)

If ordered C.O.D. 10c extra



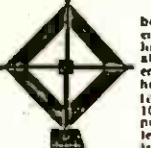
# "BUILD YOUR OWN" WITH "RASCO" PARTS!

THE Radio Specialty Company—"RASCO" for short—now in its third year, is unquestionably the oldest and most unique radio parts supply house in the United States, if not in the whole world. This Company makes a specialty of small orders. No order is too small to get immediate and prompt attention. The reason is simple: 80% of our orders are small. The reputation of this house was built upon service. Ask any of your radio acquaintances what they think of "RASCO" service. "RASCO" promptness. Thousands of unsolicited testimonials are in our files. To prove that we serve the public as it has never been served in radio merchandise before. Be sure to get our great 84-page catalog, containing over 500 different parts. Catalog contains over 300 illustrations. "WE CAN ONLY DISAPPOINT YOU ONCE." Try us with a 50c. order and make us prove what we say. Prices include delivery to your door.

Order direct from this page. We pay all transportation charges. All goods sent prepaid in 24 hours.


**NOTE BIG PRICE REDUCTIONS THIS MONTH**

Money refunded if goods do not satisfy



**LOOP AERIAL**  
The loop aerial you have been waiting for. Made entirely of well seasoned hard wood. Complete with all parts and base. No. 22 enameled wire used. Total height of loop 36". 2 feet on the side; loop is 10 convolutions. Can be put together by anyone in less than 2 minutes. Satisfaction guaranteed. .... \$1.15

R-2600. Two foot loop aerial, complete. .... \$1.15




**STORAGE BATTERIES**  
New! New! New! Two coil, 60 ampere hour storage battery for use with W.D.M., 12, and U.V. 199 tubes. Don't keep on buying dry cells continuously. This storage battery will pay for itself in two months. Only best materials used. Guaranteed for 3 years. You can connect up to 6 dry cell tubes on a single one of these batteries. Can be recharged for a few cents. Hard rubber container encased in impregnated wood. Due to low price and large weight of batteries, shipped express collect.

R-2400. Two coil, 60 ampere hour storage battery, size 2 1/2" x 4 1/2" x 9" ..... \$4.25  
R-640. Six coil, 60 ampere hour storage battery, size 4 1/2" x 7 1/2" x 9" ..... 6.75  
R-660. Six coil, 60 ampere hour storage battery, size 6 1/2" x 9" ..... 11.00




**WOOD CABINETS**  
Finest grade mahogany cabinets made. Best hand rubbed finish. Top is hinged. Front of cabinet rabbeted to fit panel. Price delivered to your door; no panel included in these prices. Entire cabinet made of 1/4" well seasoned stock.

R-714. Wood cabinet, panel size 7" x 14" ..... \$3.35  
R-716. Wood cabinet, panel size 7" x 18" ..... 3.60  
R-718. Wood cabinet, panel size 7" x 24" ..... 4.40  
R-712. Wood cabinet, panel size 7" x 10" ..... 3.00  
R-710. Wood cabinet, panel size 7" x 12" ..... 3.50  
R-721. Wood cabinet, panel size 7" x 21" ..... 3.90




**CARDBOARD TUBING**  
Only seamless tubing made in United States. "Veribond" reinforced heavy wall (I.D.)—Inside Diameter, O.D.—Outside Diameter, L.—Length.

R-6600. 3" I.D., 3/4" O.D. x 7' L. .... \$3.00  
R-6601. 3 1/4" I.D., 3/4" O.D. x 7' L. .... 3.35  
R-6602. 3 1/2" I.D., 3/4" O.D. x 7' L. .... 3.70  
R-6603. 3 3/4" I.D., 3/4" O.D. x 7' L. .... 4.05  
R-6604. 4" I.D., 3/4" O.D. x 7' L. .... 4.40  
R-6605. 2 1/4" I.D., 3/4" O.D. x 2 1/2' L. .... 1.75




**"RASCO" BEZELS**  
The finest bezel on the market. Best brass mesh used. The bezel comes entirely nickel plated. Will improve looking of your meter. Can be used on 1/4" or 3/16" panel.

R-1700. Rasco bezel, ..... \$1.15  
R-1701. Bezel 1 1/4" diam. .... 20



**FORMICA PANELS**  
Clearance Sale. This sheeting is positively the best grade on the market. High finish on both sides. Too well known to require much explanation. Due to the fact that we are discontinuing these particular sizes, this material is now offered practically at cost. Prices are about 40 per cent lower than our catalogue list. Note also that we ship these panels prepaid. This alone amounts to a considerable saving.

R-350. 6" x 12" x 3/16" thick, each ..... \$1.50  
R-352. 7" x 12" x 3/16" thick, each ..... 1.75  
R-353. 12" x 18" x 3/16" thick, each ..... 4.00  
R-354. 6 1/2" x 19 1/2" x 3/16" thick, each ..... 1.90  
R-356. 6 1/2" x 14 1/2" x 3/16" thick, each ..... 1.60  
R-357. 6 1/2" x 11 1/2" x 3/16" thick, each ..... .65



**RASCO 100 VARIOCOUPLER**  
This Coupler while extremely low in price will do anything and everything that the more expensive ones accomplish. With wire wound on babble tubes. There are six taps. Wave length of coupler is from 150 to 200 meters. Coupler is made for push mounting. 1/2" shaft. Your money refunded if it does not do all that we claim for it.

R-3100 Variocoupler, prepaid. .... \$1.50



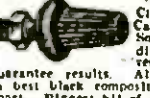
**MELOTONE LOUD SPEAKER**  
The best popular loud speaker on the market. Has tuned feature the same as all "Rasco" phones. Fibre horn, best metal base, five foot cord. Nickel 200 mesh. Greatest lumen loud talker. Compares favorably with most expensive speakers. Size overall 14 1/2"; horn length 11 1/2"; bell 6 1/2"; total height 9".

R-235. Melotone Speaker ..... \$4.90



**RICO TUNED RECEIVERS**  
No better phones made. Super sensitive. Awarded Radio News Laboratory Certificate of Merit. The only tuned phone on the market. Can be tuned for any intensity and semi-trivial. Magnet pole of phone is in mathematical center of diaphragm. Turn the cap to tune.

R-2020. 2000 ohms, double head set ..... \$4.45  
R-3030. 2000 ohms, double head set ..... \$5.50



**"RASCO" VERNIER**  
Cleverest variable made. Can be used with any dial. Soft rubber tire encases dial. Does away with vernier condenser. Guarantee results. All metal parts moulded in best black composition. Nothing to come apart. Biggest hit of the season.

R-1450. Vernier ..... \$3.30

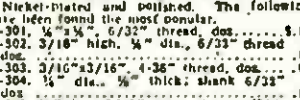


**"RASCO" POSTS**  
R-630. Post made entirely of best black composition—8/32" ferrule—each ..... \$0.08  
R-202. Post has nickel-plated bakelite ferrule, each ..... .50  
R-302. Post has nickel-plated bakelite ferrule, each ..... .90



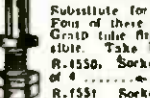
**"RASCO" SWITCH POINTS**  
Nickel-plated and polished. The following have been found the most popular.

R-301. 1/4" x 1/4" x 3/32" thread, dos. .... \$1.10  
R-302. 3/16" thick, 1/4" dia., 6/32" thread, dos. .... .10  
R-303. 3/16" x 3/16" x 3/32" thread, dos. .... .10  
R-304. 1/4" dia., 3/16" thick; shank 6/32" dia. .... .10  
R-305. 1/4" dia., 3/16" thick; shank 4/32" dia. .... .10  
R-306. 3/16" dia., 3/16" thick; shank 4/32" dia. .... .10  
R-307. 3/16" dia., 1/4" thick; shank 4/32" dia. .... .10  
R-375. Switch Stop, 1/4" long, 4/32" thread, complete with nut, each ..... .10




**"RASCO" SOCKETTES**  
Substitute for Vacuum Tube Sockets. Four of these take one Vacuum Tube Grid tube firmly. Best contact possible. Take less room. Are better.

R-4550. Sockettes, nickel-plated, set of 4 ..... \$2.25  
R-4551. Sockettes, nickel-plated, set of 4 (to take WD-11 Tube) ..... 25  
Note: Set of 4 sufficient to hold 1 Tube.




**COPPER FOIL**  
Thinnest copper foil made. .001" thick. Comes 4" wide.

R-5023. Copper Foil, per ft. x 8 in 10-ft. length ..... .80



**PHONEHORN**  
Fills a new and distinct want. Base consists of R-1310 Phonodapter d-4 screwed on this base into which fits a fine enameled fibre horn. Size of horn 12"; bell 6 1/2". RHP Phonodapter end on a single telephone receiver and you have the lowest priced loud talker ever made. Mounted in your set or hung in corner of room it will bring sound all over the room. A most useful article. Welcome by all radio fans.

R-1321 Phonehorn, prepaid ..... \$1.45



**AUDIO FREQUENCY TRANSFORMERS**  
No better transformer on the market. Highest class materials. Impregnated coils. Silicon steel stampings used. Save 50 per cent by assembling it yourself.

R-1100. A.F. Transformer, ratio 4 1/2" to 1" ..... \$2.00  
R-1150. A.F. Transformer, ratio 6 1/2" to 1" ..... \$2.00



**RADIO FREQUENCY TRANSFORMERS**  
The best Radio Frequency Transformers developed as yet. Designed for us by Mr. R. E. Lacroix, Associate Editor of RADIO NEWS. Air core. Guaranteed to do the work. This Transformer brings in the long distance.

R-1200. Radio Frequency Transformer, size 1 1/2" x 2 1/2" ..... \$1.50



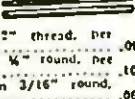
**RHEOSTATS AND POTENTIOMETERS**  
Highest grade Rheostat made. High heat dielectric composition base. Wound with best non-corrosive resistance wire. Comes with a paper d. knurled knob. Diameter, 3/4". Complete with pointer.

R-4310—6 ohms, each ..... \$4.45  
R-4311—10 ohms, for 301a and 201a tubes, each ..... .65  
R-4312—Potentiometer, for 200 Ohms, each ..... .85




**SPIDER WEB FORMS**  
At least 100 fine forms to wind your spider webs. Made from hard, well seasoned, 1-1/16" thick, center and side holes for wiring. 3200 has 13 slots, 3201, 11 slots, hood, 5" diameter. 3201 has projection for mounting.

R-2200—Spider web form, each ..... \$1.25  
R-3201—Spider web form, each ..... \$2.25  
R-3201 ..... \$2.25



**BRASS RODS**  
Sold in 6" lengths only.

R-4321. Brass Rod, 6/32" thread, per length ..... \$0.80  
R-6032. Brass Rod, 6/32" thread, per length ..... .06  
R-4325. Brass Rod, plain 1/4" round, per length ..... .10  
R-3616 Brass Rod, plain 3/16" round, per length ..... .06



**"RASCO" NAME PLATES**  
The circular plate is our new binding Post Name Plate. Hassets, 3" diam. denominations. PHONES, CHURNS, OUTPUT, "A" BATTERY, "C" BATTERY, LOOP TICKLER, INPUT, "A" BATTERY, "C" BATTERY, FILAMENT.

R-6000 to 6019. Binding Post Name Plates, each denomination ..... \$1.00  
Dozen ..... \$3.00



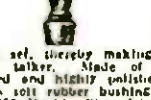
**REINARTZ SPIDERWEB COIL**  
Here is a very fine inductance for Reinartz circuit, 200-600 meters. 10 taps. Size 4 1/2" diameter; 1 1/2" center opening. Can be used in nearly all new circuits. Construction: dimensionally throughout. Coil is firm and will not fall apart as is case with many inferior coils. A few of these coils will work wonders in your set.

R-2650 Spiderweb Heliprene coil ..... \$1.15



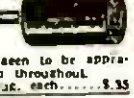
**PHONODAPTER**  
The Phonodapter will fit any phone. Metal tube fits any standard Phonograph. Make your Phonograph a loud talker. Fits Columbia, Victor and Sonora Phonographs. Is made entirely of pure but rubber which brass tube inserted.

R-4310 Phonodapter ..... \$1.50




**DOUBLE PHONODAPTER**  
The Double Phonodapter fits all phonographs and will take any standard double head set, thereby making your phonograph a loud talker. Made of pure natural nickel plated and highly polished. Has three generous soft rubber bushings.

R-1320 Double Phonodapter ..... \$1.65



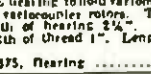
**RASCO TELEPHONE PLUG**  
This is the plug that is sold from 25c. to \$1.00 everywhere. Has hard rubber composition shell and patented cord tip holder. Must be seen to be appreciated. Finest workmanship throughout.

R-1030—Rasco Telephone Plug, each ..... \$3.35




**LITZ WIRE**

R-823. equals No. 25 I.R.S. per foot ..... \$1.02  
R-890. equals No. 28 I.R.S. per foot ..... .81  
R-891. equals No. 21 I.R.S. per foot ..... .63  
R-892. equals No. 20 I.R.S. per foot ..... .54  
Discounts of 10 percent in 100-ft. lots.



**UNIVERSAL BEARING**  
This bearing is sold in a few minutes spare time. Capacities guaranteed.

R-1111 11 plate condenser, .00025 mfd. .... \$1.10  
R-2121 21 plate condenser, .0005 mfd. .... 1.22  
R-4343 43 plate condenser, .001 mfd. .... 1.36



**PANEL MOUNTING VARIABLE CONDENSERS**  
This condenser presents the latest word in precision mechanics. Plates, washers, and all other parts are accurately machined. Positively no better condenser on the market. Shaft 1/4" Bore from 40% to 60% by assembling condenser four-leaf. A child can do it in a few minutes spare time.



**The "Rasco" Catalog**  
CONTAINS 75 VACUUM TUBE NOOKS. UPS. 35 ILLUSTRATIONS No. 10. 550 ARTICLES, 84 PAGES

All Armstrong Circuits: These important circuits are explained clearly, all values having been given leaving out nothing that could puzzle you. Just to name a few of the Vacuum Tube circuits. The V.T. as a detector and one-step amplifier. Iron-core circuits: one-step radio frequency amplifier and detector; three stage audio frequency amplifier; short wave regenerative circuits; 4-stage radio frequency amplifier; radio and audio frequency amplifier; industrial coupling amplifier; Armstrong Superheterodyne, etc.

**SENT ANYWHERE FREE**

**Radio Specialty Co.**  
96A Park Place - New York City  
Oldest and Original Exclusive Radio Parts House in U. S.  
Factories: Brooklyn, N. Y. Elkridge, Md.

**DEALERS**  
Get Our Special Proposition

## New Hook-Ups Are Easy Now



You'll save hours of labor and make connections as solid as soldering with

### Stevens Spintite Wrenches

Hollow stem goes down over projecting screws—hex socket gets firm grip—chromized handle for comfortable leverage—very easy to reach difficult places. Used by radio manufacturers.

Set makes happy Christmas gift



Send **\$1.00** for set of 3 radio sizes

**STEVENS & COMPANY**  
377 Broadway, New York

**Stevens SPEED UP Tools**

## FOUR CIRCUIT COIL SET

**\$2.50**



A" Coil covered square wire

D" Coil bank wound

Full set A, B, C and D coils made exactly according to Cockaday's specifications. Full size blue prints and illustrated instructions with each set.

Materials for standard Four Circuit Tuner—panel, coils, condensers, verniers, grid leak, vernier rheostat, socket, jack, dials, switch, contacts, posts, busbar wire, spaghetti, etc. (no tubes or phones).

Complete for \$11.65

### NEW TYPE COILS

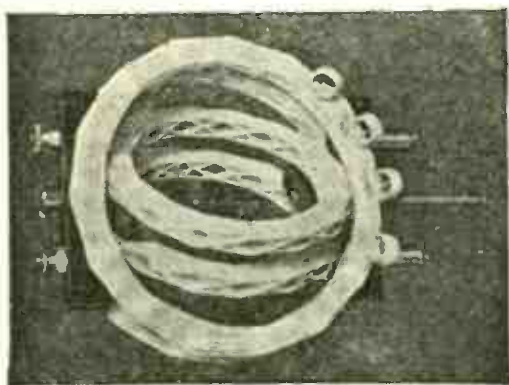
For improved Cockaday Tuner—double silk covered wire wound on hard rubber or bakelite tubes.

**\$4.00**  
per set

Postage additional on all orders

Send no money. Order by post card, pay the postman.

**RADIO SURPLUS STORES**  
HELENA, MONTANA



## Diamond Weave Variocoupler An R. M. C. Product

Seven-eighths of windings are in mid-air, thus reducing dielectric losses to a minimum.

Diamond Weave Construction reduces distributed capacity to a minimum.

The R. M. C. Variocoupler has a wave range of 150 to 600 meters. The Variometer is the same size and general construction as the variocoupler, and has a variance in inductance of 300 meters.

Outside diameter of primary windings is  $4\frac{1}{8}$ "; of secondary,  $3\frac{1}{4}$ "; extreme length  $6\frac{1}{4}$ ".

These R. M. C. products will greatly improve any circuit where a variometer or variocoupler can be used.

Variocoupler.....\$4.50  
Variometer.....\$4.50

**THE RADIO MANUFACTURING COMPANY**  
of Springfield, Massachusetts  
Dept. B 97 Dwight Street



## LEICH RADIO PRODUCTS

### Non-Tune Radio Rectifier

Simple to operate. Needs no attention while charging. Automatically cuts off and on if power stops.

No. 16 for 6 volt battery, \$19.00.

No. 10 for charging storage "B" Batteries, \$12.00.

### LEICH COMFORTABLE HEADPHONES

Clear tone, perfect fitting, most comfortable to wear. Bring in voice or music with volume. Natural and pleasing.

### L'-Radio Plug

for connecting headphones or loud speaker. Sturdy—nicely finished.

No. 60 Single Phone, 90c.

No. 61 Two Phones series, \$1.00.

Ask your dealer to show you Leich Radio Products. Booklet 101-L illustrating complete line on request.

**LEICH ELECTRIC CO.**  
Genoa, Illinois



# From New York to Honolulu With Erla Synchronizing Transformers



Unequaled range and power over a waveband of 200 to 700 meters, is assured by Erla synchronizing reflex transformers. List. \$5 each



Solve crystal troubles by installing an Erla fixed crystal rectifier. Once installed, no attention is required. Jolt and jar proof. List price, \$1



Erla is the only condenser guaranteed to test to the exact capacity for which it is marked. Made in eleven sizes, 30c to 75c each

## "All U. S. Stations on Loud Speaker, Using Only Three Tubes"

Typical of the thousands who have discarded complicated multi-stage receiving units in favor of simple, efficient Erla reflex design, is the experience of J. G. Hamock, 1917 So. Western Avenue, Chicago, who writes:

"During my first week with your three-tube hook-up, tuning through high power Chicago stations, I got Jefferson City, Dallas, Memphis, Atlanta, Omaha, Kansas City, St. Louis, New York, Springfield, Pittsburg, Harrisburg, Louisville, Cincinnati, Fort Worth and Tampa.

"The Sunday following I added Fresno, Denver, Astoria, Los Angeles; Honolulu, Hawaii Naval Maneuvers; and Juneau, Alaska, the Alaska Electric Light and Power Co.

"The United States Stations all were clear on the loud speaker. Also I re-tuned every station by checking them with my twelve-year old son, who would get them on the re-tune, when I would, as required, sharpen the re-tune myself."

Such power, selectivity and ease of control, with three tubes, are attainable only through Erla reflex design, incorporating Erla synchronizing r.f. and a.f. transformers. Guaranteeing the perfect synchronization of received and reflexed currents having the same phase characteristics, Erla transformers enable vacuum tubes to do triple duty as simultaneous amplifiers of received radio frequency, reflexed radio frequency and reflexed audio frequency currents.

For complete details, ask your dealer for Erla Bulletin No. 14, giving Erla one, two and three-tube reflex hook-ups. Or write direct, giving your dealer's name.

Electrical Research Laboratories  
Dept. R 2515 Michigan Avenue' Chicago

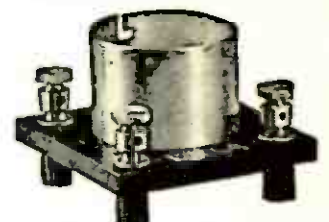
# ERLA



Unduplicated amplification without distortion enables Erla audio transformers to improve any receiving unit. Ratios: 3½ and 6 to 1. \$5



Attractive Erla telescoping bezels, in bright nickel or dull black enamel, fit any ½" to ¾" panel. Made in 1" and 1½" diameter. List. 20c



Mechanically and artistically, Erla sockets occupy first place. Heavy, triple nicked shell on polished Radion base. List price, \$1

## LOUD SPEAKING CRYSTAL SET

Brought in from over 1000 miles and music heard in your room right from your present crystal set with METZ AMPLIFYER. Get our complete catalog. METZ WIRELESS MFG. CO. 5703 Penn Ave., Pittsburg, Pa.

## Make \$120 Weekly!

in your spare time, selling what the public wants—Long Distance Radio Receiving Sets. Two sales weekly nets you \$120 profit! No big investment, no canvassing. Sharpe of Colorado made \$955 in one month. Representatives wanted at once. This plan is sweeping the country. Write or wire us today giving name of your county.

OZARKA, 855 Washington Blvd., Chicago

# SUPERTRAN

The Audio-Frequency Transformer that gives the highest possible amplification on all wave lengths without the slightest loss of tone quality and volume



The F.M.C. SUPERTRAN can be used with any amplifying tube on the market to-day with excellent results.

**Price \$6.00**

At your dealers or by mail postpaid on receipt of purchase price. Write for our free literature.

**FORD MICA CO., INC.**  
14 Christopher St. New York

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## UNIVERSAL VARIOMETER —SPLIT WINDINGS—

The instrument you will NEVER DISCARD for its uses are without number. List \$7.00.  
L & K moulded HARD RUBBER variometers, variocouplers and variotransformers are made in seven styles, an instrument for every standard circuit.

*Descriptive Folder on Request*

**LANGBEIN & KAUFMAN**

654 Grand Ave., NEW HAVEN, CONN.

# FERBEND

TRADE MARK

## Wave Trap

PATENT APPLIED FOR

The  
**Original**  
Wave  
Filter



## Stops Interference!

- Eliminates interfering stations.
- Improves the selectivity of the set.
- Eliminates local broadcasting.
- Selects between conflicting stations.
- Simplifies tuning.
- Often increases signal strength.
- Reduces howling and squealing.

The WAVE TRAP is mounted on a Formica panel in a beautiful mahogany finished cabinet 6x5x6, and is a high-grade instrument throughout enhancing the appearance of the most expensive sets.

**850** Ferbend Electric Co.  
21 E. SOUTH WATER, ST.  
**CHICAGO**  
Circular on request

CHARGES PREPAID

# \$8



A phone plus a  
**FIBERTONE**  
makes a beautiful  
musical instrument

The highest tonal quality undisturbed by either metallic noises or distortion is best obtainable with a fiber horn. This one factor is the reason for Fibertone's popularity. And the low price for such fineness is a sensation of the radio world. The beautiful crystalline finish of the Fibertone fits it for any place where the finer things of the home are seen.

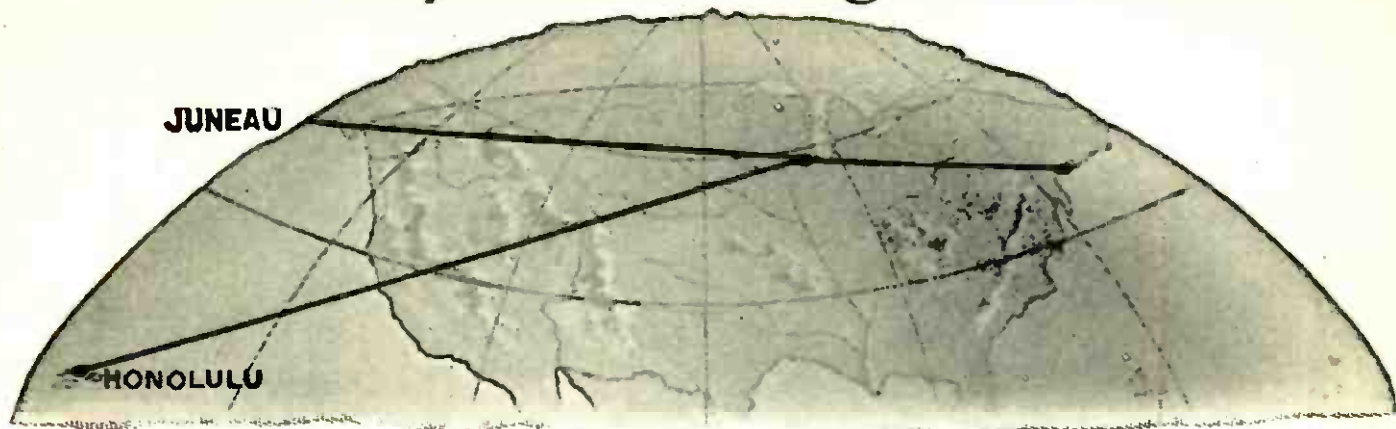
If your dealer cannot supply you write direct.

**FIBER PRODUCTS COMPANY**  
34 Orange St. Bloomfield, N. J.

# FIBERTONE

RADIO HORN

# From New York to Honolulu With Erla Synchronizing Transformers



Unequaled range and power, over a waveband of 200 to 700 meters, is assured by Erla synchronizing reflex transformers. List, \$5 each



Solve crystal troubles by installing an Erla fixed crystal rectifier. Once installed, no attention is required. Jolt and jar proof. List price, \$1



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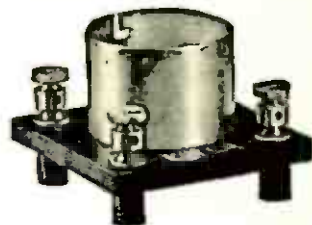
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Mechanically and artistically, Erla sockets occupy first place. Heavy, triple nickered shell on polished Radion base. List price, \$1

## 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 AMPLIFIER. Get our complete catalog.

STEINMETZ WIRELESS MFG. CO.  
5703 Penn Ave., Pittsburg, Pa.

## Make \$120 Weekly!

in your spare time, selling what the public wants—Long Distance Radio Receiving Sets. Two sales weekly nets you \$120 profit! No big investment, no canvassing. Sharpe of Colorado made \$955 in one month. Representatives wanted at once. This plan is sweeping the country. Write or wire us today giving name of your county.

OZARKA, 855 Washington Blvd., Chicago

# SUPERTRAN

The Audio-Frequency Transformer that gives the highest possible amplification on all wave lengths without the slightest loss of tone quality and volume



The F.M.C. SUPERTRAN can be used with any amplifying tube on the market to-day with excellent results.

**Price \$6.00**

At your dealers or by mail postpaid on receipt of purchase price. Write for our free literature.

**FORD MICA CO., INC.**  
14 Christopher St. New York

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## UNIVERSAL VARIOMETER —SPLIT WINDINGS—

The instrument you will NEVER DISCARD for its uses are without number. List \$7.00.  
L & K moulded HARD RUBBER variometers, variocouplers and variotransformers are made in seven styles, an instrument for every standard circuit.

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TRADE MARK  
*Wave Trap*  
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**850** Ferbend Electric Co.  
21 E. SOUTH WATER ST.  
**CHICAGO**  
Circular on request

**850**  
CHARGES  
PREPAID

**\$8**



*A phone plus a  
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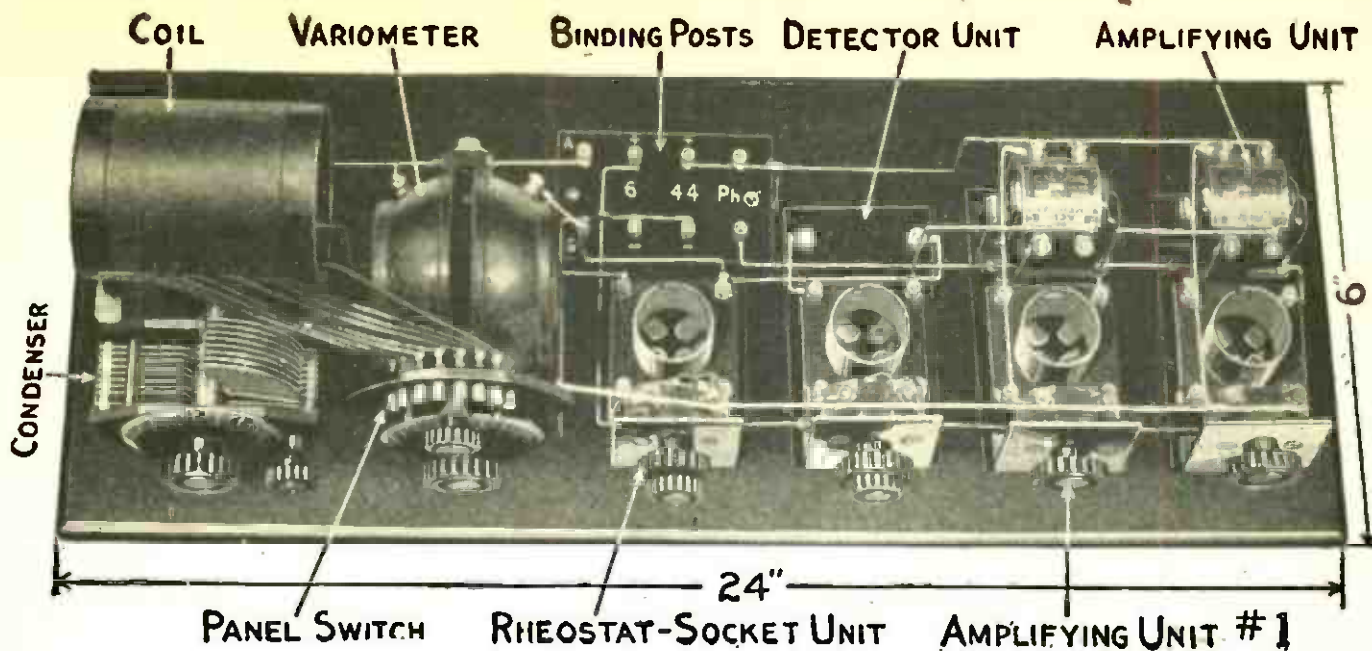
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If your dealer cannot supply you write direct.

**FIBER PRODUCTS COMPANY**  
34 Orange St. Bloomfield, N. J.

**FIBERTONE**  
RADIO HORN

Please mention POPULAR RADIO when answering advertisements.



## Tuned Wave Trap Radio Frequency Receiver

1 Stage Radio-frequency—2 Stages Audio-frequency  
Built on Famous Copp Circuit No. 4

Efficient for all wave-lengths from 200 to 700 meters  
Range up to 2000 miles

Any person can build the above set with A-C DAYTON Complete Units  
**\$43.35**

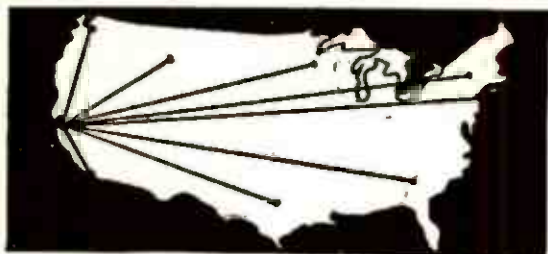
*Units packed complete in one carton with wiring diagrams, photographs, instructions, etc., for complete installation.*

SEE YOUR DEALER OR WRITE US DIRECT

We manufacture a complete line of Radio Parts and Units—Catalog on request

**THE A-C ELECTRICAL MFG. CO., Dayton, Ohio**

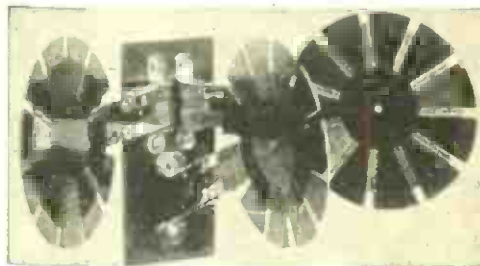
*Makers of Electrical Devices for over 20 Years.*



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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 PERSON can build easily and cheaply. Dry cell tubes used. Complete instructions, Blue print panel layout, Photo, etc., postpaid 25 cents. Stamps accepted.

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Accuracy in your condensers means better results in your receiving. Elgin Precision Condensers are accurate. Permanent accuracy and rigidity are built into them.

**Fully Guaranteed.**

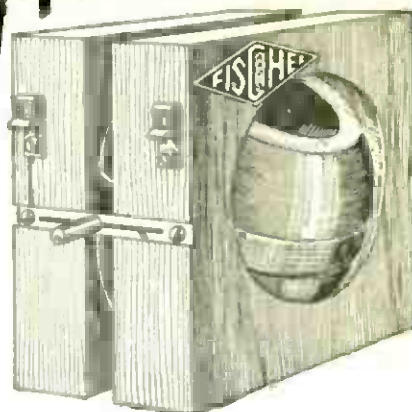
Size	Capacity	Plain	Vernier
3 Plate	.000063 M. F.	\$1.75	\$—
11 Plate	.00025 M. F.	2.40	4.00
17 Plate	.00035 M. F.	2.75	—
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3" diameter composition dials, 50c extra

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### The Champ—VARIOMETER No. 53 Approved as a Record Breaker

- Approved—because it makes 600 Meters.
- Approved—because perfectly constructed.
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- Approved—because of Fahnstock spring clip connections and non-conductive adhesive.
- Approved—because—you'll know why when you

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**20 Diagrams FREE with Each**

For sale at your dealer's—otherwise send the \$3.50 directly to the manufacturer and you will be supplied postpaid.

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Cut 1/4 actual size

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HERE you have it—the smallest Audio-Transformer ever made, and yet the most efficient for volume and tone quality. Think of it! This "Little Wonder" (about the size of an English walnut) gives you maximum reproduction volume with minimum distortion. The secret is in its patented construction. It is 100% shielded against foreign noises. Mounts anywhere—saves space in assembly. Constructed of highest quality material. Made in tube socket types also. We guarantee it unconditionally. Try them in your next "hook-up." You'll be agreeably surprised and pleased.

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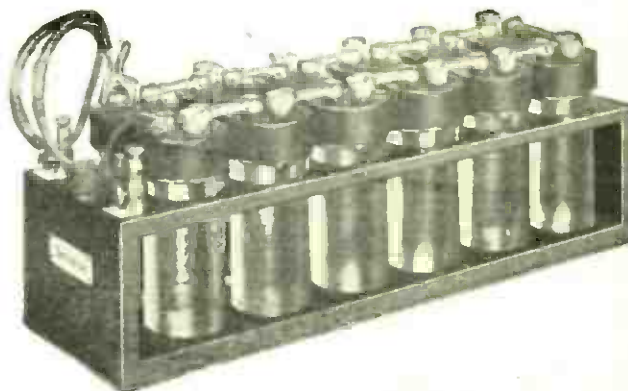
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24 V **\$8.25** RADIO "B"  
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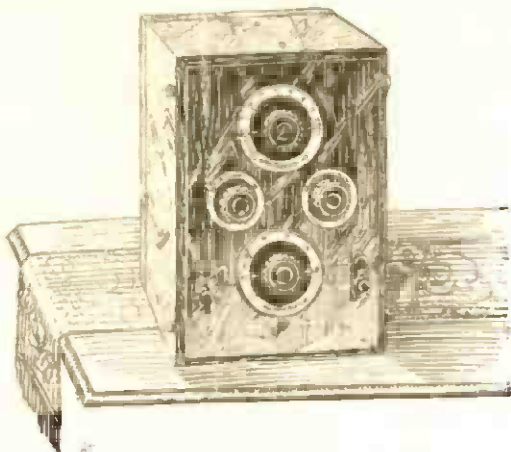
For those who wish to build their own B battery we offer Genuine Seneca Battery Parts at 50c per cell, consisting of one each Pos. and Neg. DRY CHARGED plates, one Separate one Glass Jar, one Cover with Gasket and Vent, and Cell Connector. Shipped via P. P. prepaid upon order of price.

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*New*

# "Town and Country" Set

*By Dr. Fulton Cutting and Mr. Bowden Washington*



At last, a successful all-purpose receiver. Out of the years of experience of Dr. Cutting and Mr. Washington has come this "Town and Country" model—a portable that you can carry with you when and where you wish—yet the perfect set for your home.

In your home, without the carrying handle, "Town and Country" is a handsome 2-tube, *double circuit* cabinet set, highly selective, range up to 1200 miles, capable of operating a loud speaker for local or near-by stations.

*and then, at a turn  
of a switch—*

it becomes a 2-tube, *single circuit* portable set—ready to operate on any sort of *temporary antenna*—a wire around the top of your car—stretched along a tent top—or across the room in the home of a friend.

It's the complete all-purpose set—no compromise. Self-contained—uses dry batteries—**LARGE** dry batteries that last. It's complete with Brandes Head-set—ready for antennae and ground wires when you get it—ready to give you "what's in the air." Price, \$97.50. See it at a C & W Dealer's—or write for literature.

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Operating Station WLAG

For more than 10 years Dr. Fulton Cutting and Mr. Bowden Washington have been designing the highest type of professional radio equipment—U.S. and Foreign Naval Apparatus, Radio for the U. S. Merchant Marine, U. S. and foreign land stations. And now, they have turned their attention to *Radio for the Home*—you can own a genuine C & W Receiver—know the simplicity, ease of operation, sharp selectivity and clear reception that characterize the best professional equipment.

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*Standard of Excellence in Radio Since 1914*

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# The COURT JESTER of TODAY

"No wit to flatter left of all his store,  
No fool to laugh at, which he valued more."  
—Pope

SINCE the earliest days laughter and gaiety have been the most important things in life. In ancient times, when ungentle, courtly knights forgot seriousness, beautiful ladies became more alluring as the clever quips and merry pranks of the court jester brought a sparkle to their eyes and drove dull care away. But they were immune to the clownish antics and slap stick comedy of the jester.

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Let a Crosley Radio Receiver bring fun, laughter and good humor into your home.

**CROSLEY**  
Better - Cost Less  
Radio Products

See the Crosley Line at Good Dealers Everywhere

Write for Free Catalog. This fully describes the Crosley line of Radio receivers which range in price from the Model VI, a 2 tube set at \$30, to the graceful Console Model X-L at \$140. It also shows the complete line of Crosley parts.



Crosley Model X-J—Price \$65

For tuning out local interference and bringing in distant stations this receiver is unexcelled. It is a 4 tube set combining one stage of tuned radio frequency amplification, detector and two stages of audio frequency amplification.

Nowhere can a better set be purchased at any price.  
Cost of necessary accessories \$40.00 and up.

**CROSLEY MANUFACTURING COMPANY**  
Powel Crosley, Jr., President  
116 Alfred Street Cincinnati, Ohio



**CROSLEY** \$ **65**  
Model X-J

The broadcasting station WLW is maintained by the  
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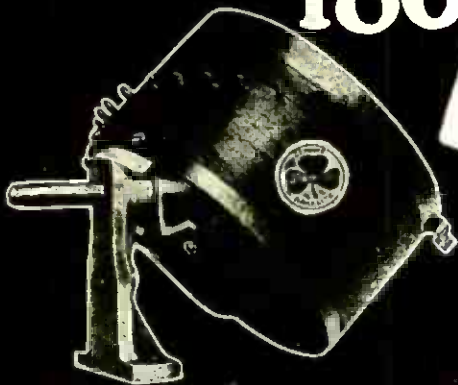
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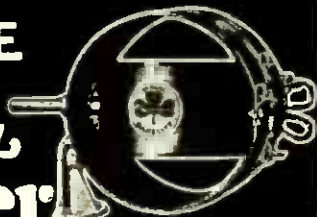
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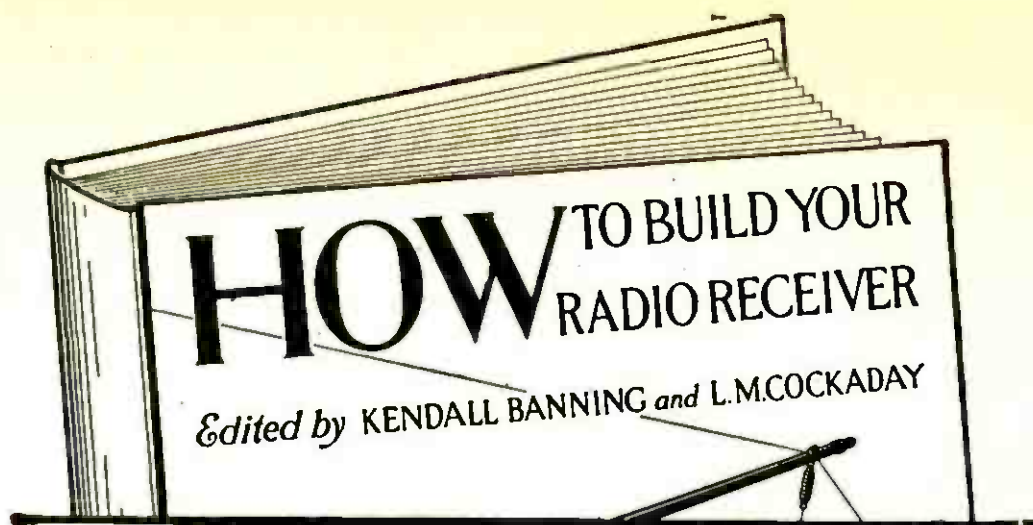


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**Variometer**



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## *Popular Radio Announces*

# A New Book of Supreme Interest and Importance to Radio Enthusiasts

**The most complete and authoritative collection of material yet published in book form on how to build and operate various types of radio receiving sets**

**T**HIS first announcement of a new 96-page book, edited by Kendall Banning and Laurence M. Cockaday, to be published by POPULAR RADIO, will come as a welcome surprise to our half-a-million friends and readers.

There has long been a need for such a book as this, describing fully and completely the several different types of radio receiving sets which have proved most effective, and *how to build them*.

POPULAR RADIO's new book, "How to Build Your Radio Receiver," has been carefully planned to fill this need. No pains have been spared to make this book the most comprehensive and valuable contribution of its kind ever published for the radio enthusiast who, with or without previous technical knowledge or training, wishes to construct a radio receiving set of his own that will meet his every requirement.

"How to Build Your Radio Receiver" gives complete specifications for the construction of *seven* separate and distinct receiving sets—covering the most amazing range and variety of circuits, from the most modern simple crystal set to the famous Super-heterodyne (see opposite page).

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.

Nor have any helpful pointers been omitted. In this new book edited by Mr. Banning and Mr. Cockaday, you will also find scores of valuable hints and suggestions about aerials, how to select your parts, how to install your set, tips on tuning, and how to learn the code.

In all, a book you will not want to be without—one that will be worth many dollars to you. However, no copies are for sale, as yet. The book is not yet off the press. But we want you to have one of the first copies of this new book, as soon as it comes from the press, and we want to *give* it to you *free*.

Here is our offer. For a limited time only, we will *give this book away* with a year's subscription to POPULAR RADIO at \$3.00. If you are already a subscriber, you may renew or extend your subscription for an additional year and still secure one of the first copies of this valuable book *absolutely free*.

The Reservation Coupon printed at the bottom of the opposite page provides a convenient means for you to reserve one of the first copies that come from the press.

# Seven Remarkable Receiving Sets

*Illustrated*

*Diagramed*

*Described*

EACH of the sets described in POPULAR RADIO'S new book 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—the broadest selection anyone could ask for, all clearly illustrated, charted and explained in the simplest possible terms.

Here are the actual receiving sets described in this new book, "How to Build Your Radio Receiver":

## A \$5 Crystal Set

The simplest up-to-date set for local broadcast reception. Approximate range, 15 miles, though distances up to 400 miles are not extraordinary. Gives clear signals on headset without distortion. No operating cost whatever.

## The Haynes Single Tube Receiver

An efficient set that may be made by a novice at an approximate cost of only \$15 for parts. Simple to tune, selective, good audibility. Long distance range up to 1,000 miles on earphones. Six-volt storage battery and 22½ volt "B" battery required, or may be adapted for dry cells and dry cell tubes.

## A Two-Stage Audio-Frequency Amplifier

This instrument may be added to *any* set, crystal or tube, to strengthen the received signals so that they will operate a loud speaker. It is easy to construct, efficient, and costs only about \$15 for parts. Operates on the same "A" battery that is used on the vacuum-tube detector unit.

## The Cockaday 4-Circuit Tuner

A 3-tube set, famous for its high selectivity and beautiful tone. So neat and compact that it may be kept in a bureau drawer. Cost of parts about \$40. Receiving range approximately 1,500 miles on a loud speaker. Operates on 6 volt storage battery and two 45-volt "B" batteries, or may be adapted to dry cells and dry cell tubes.

## A 5-Tube Tuned Radio Frequency Receiver

Two stages of tuned radio-frequency amplification, detector, and two stages of audio-frequency amplification are here employed so that the possibility of "oscillation and re-radiation" is eliminated. The set can be operated on a loop antenna and may be built at a cost of only \$90 for parts. Six-volt storage battery and two 45-volt "B" batteries required. Range about 1,000 miles on loop or indoor antenna, and 2,500 to 3,000 miles on an outdoor antenna.

## The "Improved" Cockaday 4-Circuit Tuner

Probably the most important contribution yet made to the equipment of the radio fan. A compact 5-tube set with a receiving range of over 3,000 miles. Cost of parts about \$95. Wave lengths range from 150 to 675 meters. Automatic tuning and power amplification. Maximum volume of sound, excellent reproduction and no interference. Requires a 6-volt "A" battery, three 45-volt "B" batteries, one 22½-volt "B" battery and a 9-volt "C" battery.

## The Regenerative Super-heterodyne Receiver

More sensitive, more selective and more simple to tune than any other 6-tube receiver yet developed. A three-section, 6-tube set employing the Haynes Single Tube Receiver as tuner. May be further extended to a four-section, 8-tube set by the addition of the two-stage audio-frequency amplifier. The cost of parts approximate \$100. Range of 3,000 to 4,000 miles on a loud speaker. Has been called the "Rolls-Royce" of radio receivers.

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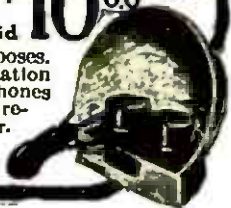
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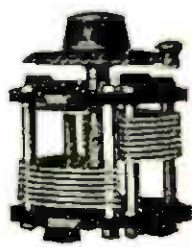
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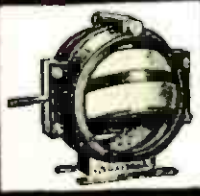
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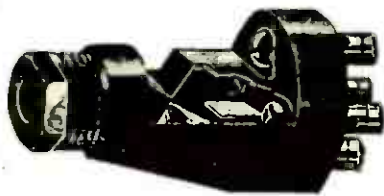
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Established 1889  
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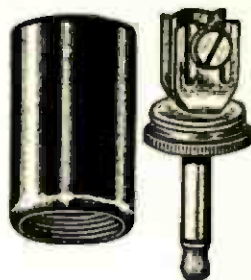
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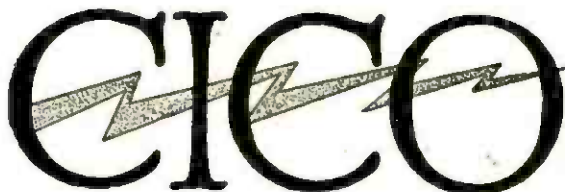


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to replace the Name "Acmedyne"

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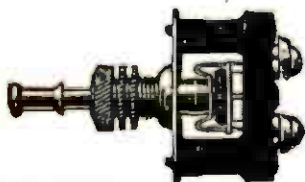
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Press the button—the set is quiet. Pull, and the same program is resumed.



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## Can You Interrupt Reception Without Losing the Station Received?

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With the C-H Radio Switch on your panel in the "A" battery circuit, just a touch of the nicked button and the set is quiet—pull it out and the same program is resumed. It is not necessary to turn back the rheostats and disturb the tuning of the set. You have instant, positive control with a real switch mechanism designed by the C-H Engineers to break up to 3 amperes at 110 volts, yet so precise that no microphonic noises are introduced, even when used in the most delicate circuits.

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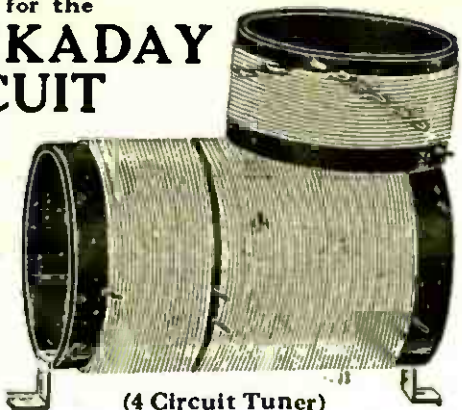
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are now a standard, and in universal use, due to their efficiency in this wonder circuit.

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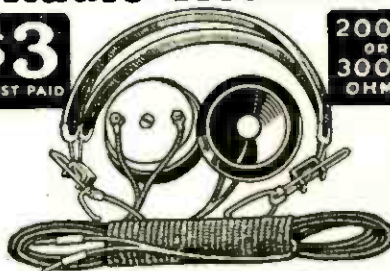
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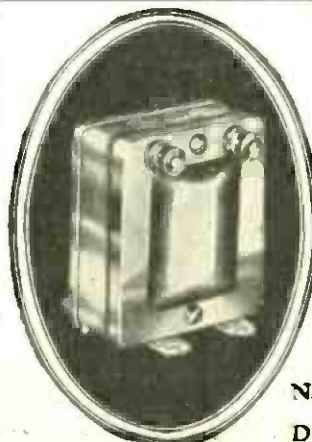
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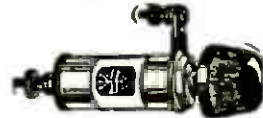
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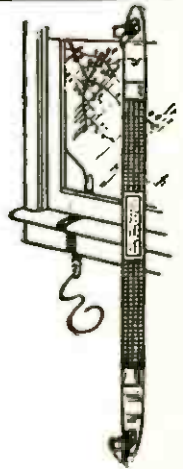


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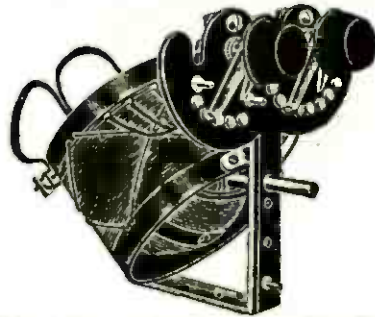
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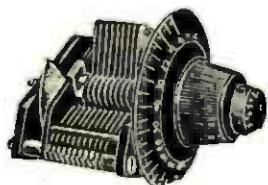
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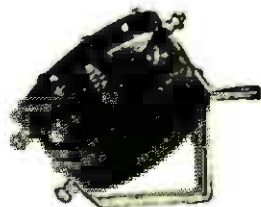
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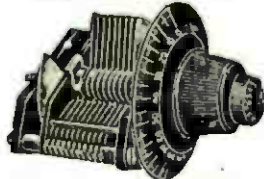
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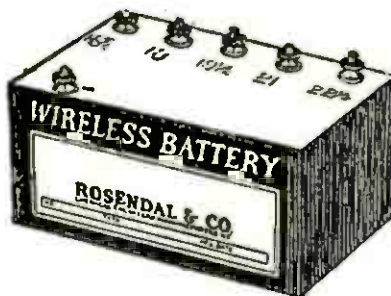
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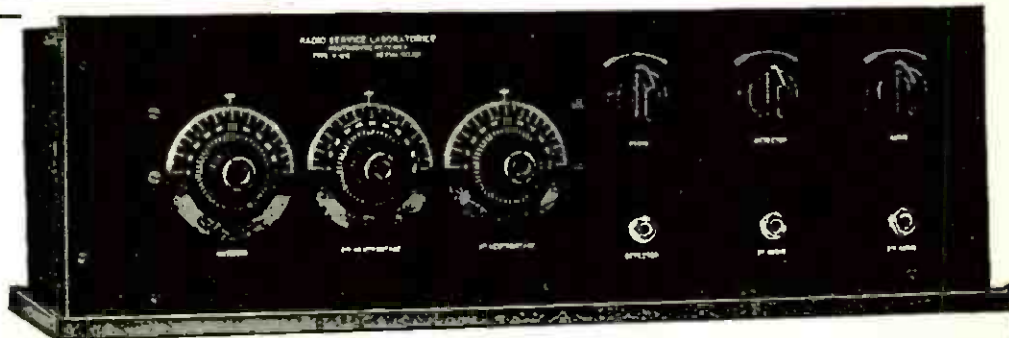
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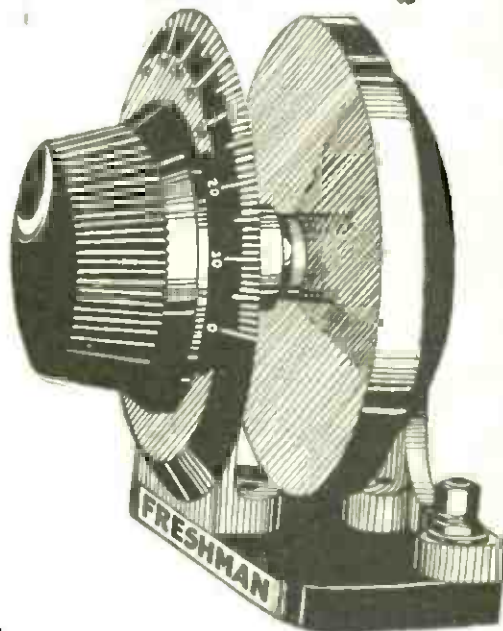
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Enclosed is \$..... Please see that yearly subscriptions are at  
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**FREE**

*Written 2 Year Guarantee  
Your Proof of Satisfaction*

"A" Hydrometer and "B" Battery

## Read Every Word of the Special Christmas Offer—Then Act

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 "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
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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 you pay one penny. Convince yourself you are protected from every angle—that the World battery price saves you 50%. Get the "B" Battery and hydrometer FREE. Order today.



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Clip and mail this ad with your World battery order and get this hydrometer and "B" battery free. 5% disc. for cash in full with order.

**WORLD BATTERY CO.**  
Dept. 3, 1219 So. Wabash Ave., Chicago, Ill.

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## Radio Laboratories and Patent Offices

for the

## Independent Interests

The plant of Francis H. Richards, established in 1875, equipped with separate individual laboratories, where the crude inventive idea may be developed, the experimental models tested out, and the perfected product patented, without first broadcasting the same to possible hostile third parties, has long been a boon to inventors.

To meet the present demands, the establishment is now equipped with laboratories and experienced radio mechanics and patent attorneys, to aid inventors in properly preparing their inventive ideas, either for presentation to the radio interests or to meet the keen competition which is now developing.

**Francis H. Richards**  
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**LOUD SPEAKER**  
\$18.50



**HEAD SET**  
\$4.50

## "ROYALFONE"

KING OF ALL



A complete loud speaker of superior qualities. Will reproduce music or speech with no distortion.

No extra batteries required. Will operate at one or more stages of amplification.

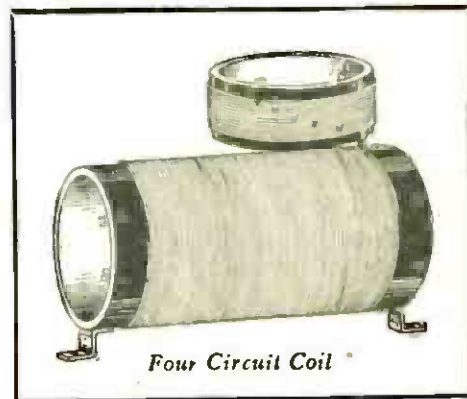
Comes complete with 6 foot cord. 24" high—14" bell—Crystalline Finish

A highly sensitive pair of receivers for the amateur or professional—for long distance or local broadcasting, also very comfortable.



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KING OF ALL



Four Circuit Coil

## Low Losses at High Frequency

This Four Circuit Coil is made in strict accordance with Cockaday's specifications. By actual efficiency tests it is positively the most selective coil made.

Its special construction using hard rubber throughout, precision wound with double silk covered wire, give—

Perfect insulation, less leakage losses, high dielectric, greater selectivity, greater resistivity.

Write for further details. Special proposition to dealers

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**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. This beauty is matched by the efficiency of Na-ald dials. They are moulded of Bakelite and have patented construction.



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**The BATES EAR CUSHION**

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**DEALERS:** Write for special discounts. Fastest moving radio accessory on the market.

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**SHELTONE**  
**LOUD SPEAKER** \$3

Made by Du Pont expressly for us. **WORKS** with any Phones.

Beautiful, transparent, exceptional value. Satisfaction guaranteed.

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**THE NEW SIMPLEX**



**180° Vario-Coupler with Special Spider Web Rotor** will bring in those distant stations you are trying for. An exceedingly efficient and neat coupling device which will cover all broadcast wave lengths up to 600 meters.

Price - - \$3.50

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**TAKE** advantage of this Special Offer! It means a saving to you of a dollar.

You and a friend of yours may have POPULAR RADIO for a whole year, provided you are both *new* subscribers.

Just wrap your check for \$5 around the double coupon and mail it to-day to save money.

Make POPULAR RADIO your New Year's Resolution and profit by all the interesting and helpful articles that are to come during 1924.

(Coupon good until January 20th, 1924)

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Please send POPULAR RADIO for one year to:

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CITY.....STATE.....

And also to this other new subscriber. Here's my cash remittance— (or a check or money order for \$5.00).

NAME.....

ADDRESS.....

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(No extra for Canada. Foreign countries 50 cents extra per subscription.)

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\$2.00 • \$2.00

Should be on every aerial the year 'round. Provides highly efficient lightning and static protection for the home. Fully approved by Fire Underwriters. Can be installed out-doors. Has no vacuum to lose. Install one in your aerial lead now—be safe.

This pioneer radio arrester is backed by 31 years experience in lightning arrester design.

For sale by Dealers everywhere, or sent post-paid for \$2.00. Write for circular.



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## HANDY CHARGER

A Battery Charger that employs no contacts that stick and give trouble, no liquids nor bulks—yet charges 6 volt batteries at 5 to 7 amperes and also charges 12 volt batteries and from 1 to 4 "B" batteries at a time. Beautiful metal case—panel with convenient terminals for each size battery and Weston Ammeter.

If it doesn't charge 'em all, it isn't a

**Handy Charger**

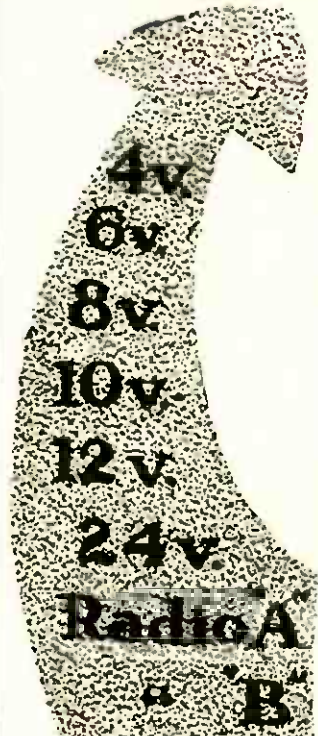
List \$18.00

Simplex model, straight  
6 volt type, \$16.00

**Interstate Electric  
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## COAST TO COAST ON ONE TUBE

E. MacDonald of Bangor, Me., received Winatchee, Wash., on 1 tube Royal Portable Broadcast receiver. One dial Control—Takes all wave lengths.

Royal Portable 1 tube set assembled..... \$10.00

Phones, batteries, tube-Aerial, etc., extra..... 9.75

2 step Amplifier to match, no tubes..... 17.50

Cockaday-Reinartz-Ultra Audion Circuits—Complete parts, panel, tube free with each..... 13.67

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Royaltron Tubes—guaranteed Standard Base—1½ or 6 Volt, detector or Amplifier; specify which one..... 3.95

Write for bargain Catalog 64.

**ROYAL MFG. CO.**

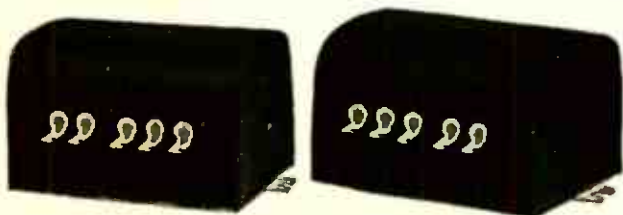
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World Building, New York

## Como Duplex Transformers

(PUSH-PULL)

The COMO DUPLEX SYSTEM of audio-frequency amplification gives the maximum volume without distortion and tube noise.



There is a combined filtering action which assures perfect results when ordinary amplification fails.

It can be added to your present amplifier, giving you power amplification on the weak signals that more of the ordinary amplification would kill.

SOLD IN MATCHED PAIRS

**\$12.50 per pair**

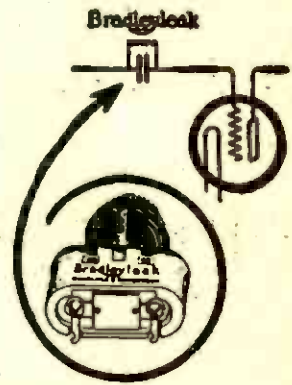
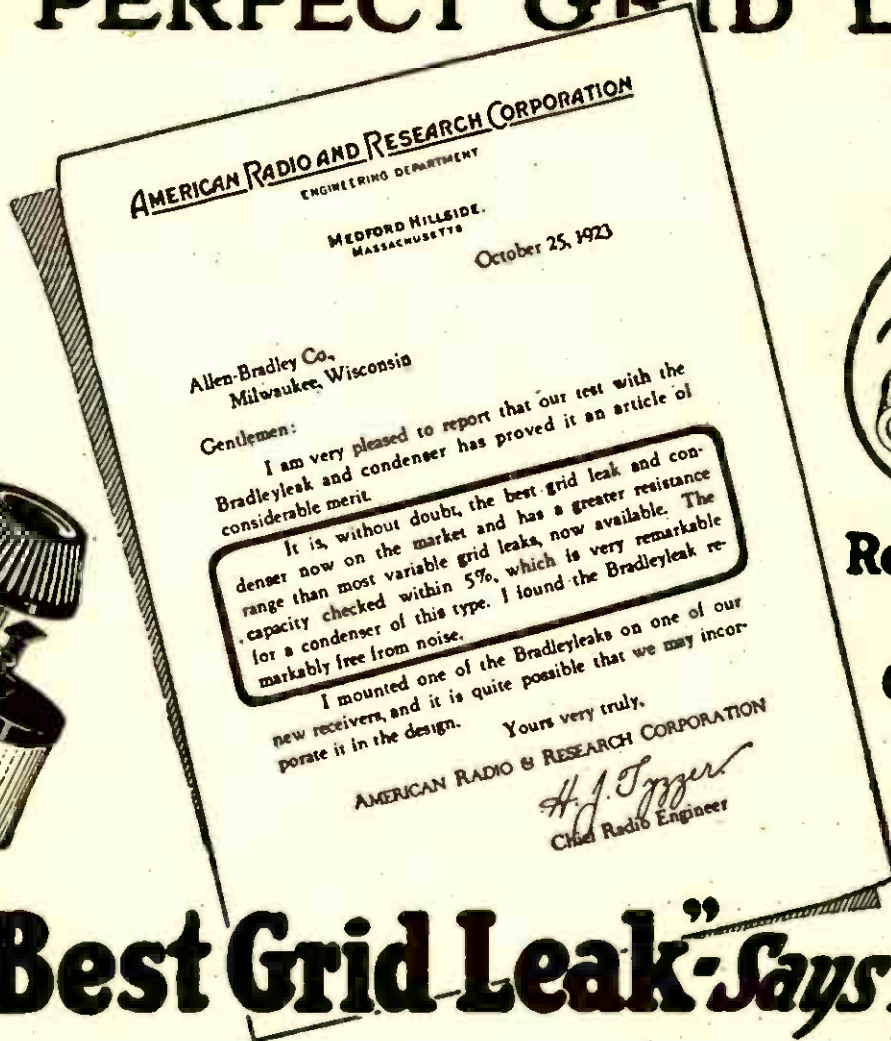
A copy of "HOW TO MAKE A POWER AMPLIFIER" is yours for the asking.

**COMO APPARATUS COMPANY, 446 Tremont Street, Boston, Mass.**

Please mention POPULAR RADIO when answering advertisements.

# Bradleyleak

## THE PERFECT GRID LEAK



**Retail Price**  
**\$1.85**  
**Condenser**  
.00025 MF  
**35¢ Extra**

## "The Best Grid Leak" Says Amrad

Radio has been waiting for an adjustable grid leak which is truly adjustable and reliable. Many attempts have been made to produce such a grid leak, but with little success. It has remained for the Allen-Bradley Co., backed by 20 years' experience with compression disc rheostats, to produce an adjustable grid leak which fulfills all the requirements of a perfect grid leak. To distinguish it from all other grid leaks, it bears the name "Bradleyleak."

The Bradleyleak has been tested by such authorities in radio as Crosley, Kennedy and Amrad. They have all marveled at its noiseless, smooth control, its marvelous range from 1/4 to 10 megohms and also that it is not affected by atmospheric conditions. Radio set builders are using thousands of Bradleyleaks and the demand is increasing at an astounding rate. Your detector will work better if you use the Bradleyleak. Try one on your set, today.

For Special Hook-ups the Bradleyleak is a great favorite and frequently a Bradleyleak makes an obstinate set work perfectly.

**Allen-Bradley Co.**  
Electric Controlling Apparatus

276  
Greenfield  
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Milwaukee,  
Wisconsin

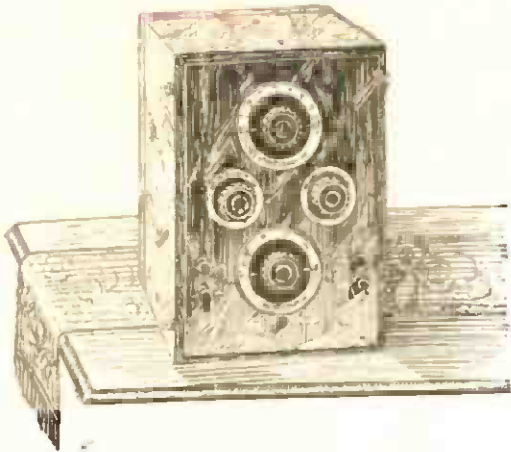
Send for Bulletins and learn the proper value of grid leak resistance for the popular radio tubes. Be sure to write today.

THE ALLEN-BRADLEY CO. HAS BUILT GRAPHITE DISC RHEOSTATS FOR OVER TWENTY YEARS

**New**

# "Town and Country" Set

By Dr. Fulton Cutting and Mr. Bowden Washington



At last, a successful all-purpose receiver. Out of the years of experience of Dr. Cutting and Mr. Washington has come this "Town and Country" model—a portable that you can carry with you when and where you wish—yet the perfect set for your home.

In your home, without the carrying handle, "Town and Country" is a handsome 2-tube, *double circuit* cabinet set, highly selective, range up to 1200 miles, capable of operating a loud speaker for local or near-by stations.



*and then, at a turn  
of a switch—*

it becomes a 2-tube, *single circuit* portable set—ready to operate on any sort of *temporary antenna*—a wire around the top of your car—stretched along a tent top—or across the room in the home of a friend.



It's the complete all-purpose set—no compromise. Self-contained—uses dry batteries—**LARGE** dry batteries that last. It's complete with Brandes Head-set—ready for antennae and ground wires when you get it—ready to give you "what's in the air." Price, \$97.50. See it at a C & W Dealer's—or write for literature.

**Cutting & Washington Radio Corp.**

Minneapolis

Minn.

Operating Station WLAG

For more than 10 years Dr. Fulton Cutting and Mr. Bowden Washington have been designing the highest type of professional radio equipment—U. S. and Foreign Naval Apparatus, Radio for the U. S. Merchant Marine, U. S. and foreign land stations. And now, they have turned their attention to *Radio for the Home*—you can own a genuine C & W Receiver—know the simplicity, ease of operation, sharp selectivity and clear reception that characterize the best professional equipment.

---

## **Cutting and Washington**

*Standard of Excellence in Radio Since 1914*

---

# The COURT JESTER of TODAY

"No wit to flatter left of all his store,  
No fool to laugh at, which he valued more."  
—Pope

SINCE the earliest days laughter and gaiety have been the most important things in life. In ancient times, unbent, courtly knights forgot seriousness; beautiful ladies became more alluring as the clever quips and merry pranks of the court jester brought a sparkle to their eyes and drove dull care away. But they were more to the clownish antics and slap stick comedy of the jester.

Moderns have unlimited sources of amusement. Every broadcasting station has its Jester; its humorous stories, its singing songs and clever comedies. Each night the air is filled with merriment.

With a Crosley Model X-J radio receiver, amusement may be brought clearly and distinctly to your fireside. Sitting comfortably in an easy chair you forget dull care. The magic wand of the radio sends worry scurrying.

The very moderate prices of all Crosley instruments bring radio within the reach of all. No matter which Crosley Model you may select you can be assured of the maximum results at the lowest cost.

Let a Crosley Radio Receiver bring fun, laughter and good humor into your home.



**CROSLEY**  
Better - Cost Less  
Radio Products

See the Crosley Line at Good Dealers Everywhere

Write for Free Catalog. This fully describes the Crosley line of Radio receivers which range in price from the Model VI, a 2 tube set at \$30, to the graceful Consolette Model X-L at \$140. It also shows the complete line of Crosley parts.



Crosley Model X-J—Price \$65

For tuning out local interference and bringing in distant stations this receiver is unexcelled. It is a 4 tube set combining one stage of tuned radio frequency amplification, detector and two stages of audio frequency amplification.

Nowhere can a better set be purchased at any price.  
Cost of necessary accessories \$40.00 and up.

**CROSLEY MANUFACTURING COMPANY**  
Powel Crosley, Jr., President  
116 Alfred Street Cincinnati, Ohio

**CROSLEY** \$  
**65**  
Model X-J

The broadcasting station WLW is maintained by the  
CROSLEY MANUFACTURING COMPANY

MAIL THIS COUPON TODAY

Crosley Manufacturing Co.,  
116 Alfred St., Cincinnati, O.  
Gentlemen: Please mail me free of charge your complete catalog of Crosley instruments and parts together with booklet entitled "The Simplicity of Radio."

Name .....

Address .....