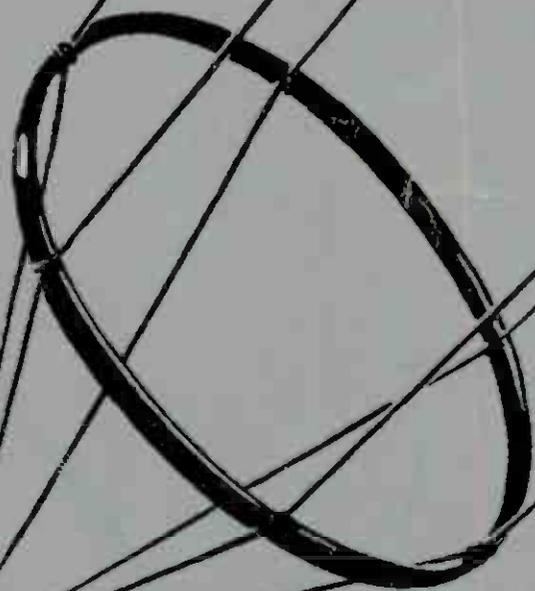


# Popular Radio

Edited by **KENDALL BANNING**

**25¢**

**NOVEMBER  
1923**



*In this Number—*  
**How to Build  
a Super-Heterodyne  
Receiver**



**MORE HOOK-UPS.. MORE ARTICLES..  
..MORE DEPARTMENTS.. MORE PAGES**



**Radiotron  
UV-199**  
For detection or  
amplification  
\$6.50



This symbol  
of quality  
is your pro-  
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*A Small Tube That's a Big Performer*

The new UV-199 is proving a mighty popular member of the Radiotron family, particularly for portable sets.

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# Radiotrons

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*His first taste of music!*

The truly modern young person gets his first taste of music by Radio—and a Brandes. Catchy melodies and charming bed-time stories come to him clearly through a Brandes *Matched Tone* Headset.

NEW PRICES

Superior  
\$6.00

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C. BRANDES, Inc.

237 Lafayette Street, New York City

## *Matched Tone*

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

## Radio Headsets

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# POPULAR RADIO

EDITED by KENDALL BANNING



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(Cover design by Frank B. Masters)

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VOLUME IV

NOVEMBER, 1923

NUMBER 5

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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: 645 North Michigan Ave.

Please mention POPULAR RADIO when answering advertisements.

"The Wise are free from perplexities." Confucius



Perplexity never comes to the owner of a **GREBE** Broadcast Receiver. he is truly a Wise man

Doctor M.H.



**T**HE 20-foot silk-covered wire, supplied with this Receiver, is the only antenna required. You may conceal this wire behind the picture moulding, or run it along the baseboard of your favorite room.

The attractively finished walnut cabinet has compartments for all necessary batteries.

Write for "GREBE Radio in the Well-appointed Home"



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

**GREBE RADIO**



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

# PAGES WITH THE EDITOR

EVERY regular subscriber will find enclosed in his copy of this the November number a green Subscription Order slip that represents a cash value of \$3.00—*provided* that he uses it on or before December 15th, when the new subscription rate goes into effect. The green slip is issued to our subscribers in order to give them the privilege of extending their subscriptions for two years longer at the present low rate.

\* \* \*

AFTER sizing up this November issue, now in your hands, the Editor hopes that you will be so pleased with what POPULAR RADIO promises for the future, that you will wish to take advantage of the special offer of two years for \$3.00.

\* \* \*

HERE is a double-barreled compliment that comes from the professor of English at Indiana University, who comments not only upon the technical excellence of our articles but also upon the style in which they are presented:

\* \* \*

"I happened to pick up the first issue on a newsstand. I became a subscriber and have not missed a copy since.

"I particularly enjoy the articles on how to make instruments and sets. Your directions are more explicit than I find in other magazines, and your recent practice of stipulating the exact make of instrument used is very helpful. I have on several occasions read elsewhere articles covering the same subject matter as articles in POPULAR RADIO. Without exception I have found your treatment clearer and more to the point. I am a professor of English and I know when an article is well written.

\* \* \*

"I USED to buy all the radio magazines that came out. Perhaps the best I can say of yours is that I am constantly buying fewer and fewer of the others."

—PROF. HENRY THEW STEPHENSON

\* \* \*

OUT in Anthony, Kansas, there lives an ardent radio fan, Leroy Hughbanks, who has for several years carried on his experiments despite what would be to most of us an unsurmountable obstacle—total blindness. "People scarcely realize what radio means to the sightless" he bravely comments to the Editor. "The sightless men in particular have not yet realized what they can do in radio."

Nor only does friend Hughbanks keep up with the development of radio but he builds successfully the sets that are described in this magazine—which will give pause to some of our less handicapped readers who sometimes blame the instructions rather than their own oversight when their set does not work properly at the first trial. Mr. Hughbanks writes:

"LET me once again express to you my

great appreciation of that dear old magazine POPULAR RADIO. It is beyond doubt the finest journal on the subject I have found, regardless of price. I have but one criticism; it is by far too small. Make it larger and charge it up to us! We will be glad to pay more for the magazine if you wish to make it bigger and better."

\* \* \*

WE take pleasure in carrying out this reader's suggestion. Beginning with this issue POPULAR RADIO is enlarged by about 56 pages, and the price is 25 cents.

\* \* \*

FROM 'way down east—specifically from Waterville, Maine—comes this gratifying tribute from an ardent reader:

"I am more than pleased with POPULAR RADIO; its pages are filled with information that is priceless to the wide-awake radio amateur. It brings to me the latest news and articles by the best authors who are working to elevate radio in the minds of the general public—and POPULAR RADIO is accomplishing this task with excellent success.

\* \* \*

"To be able to give a concise description of a new circuit or a new piece of apparatus without involving many technicalities, is not a very easy undertaking, but POPULAR RADIO seems to have no great difficulty in doing so."

—D. GILBERT LIBBEY

\* \* \*

CONTRARY to general belief, Brother Libbey, to write and to edit and to illustrate an article so that it will be concise and clear and logical and simple is one of the Editor's most difficult tasks.

\* \* \*

SOMETIMES, when a last-minute rush forces the Editor to send a timely article to the printer without the usual care in preparation, he is prompted to quote the postscript that a famous author once wrote at the bottom of a letter: "Please excuse the length of this message; I hadn't time to make it short."

\* \* \*

WHEN POPULAR RADIO defined its purpose to keep its editorial pages entirely clean and uninfluenced by the business office it merely put into words a policy which the magazine has strictly observed from its very first number. In the protection of its readers no other policy is possible.

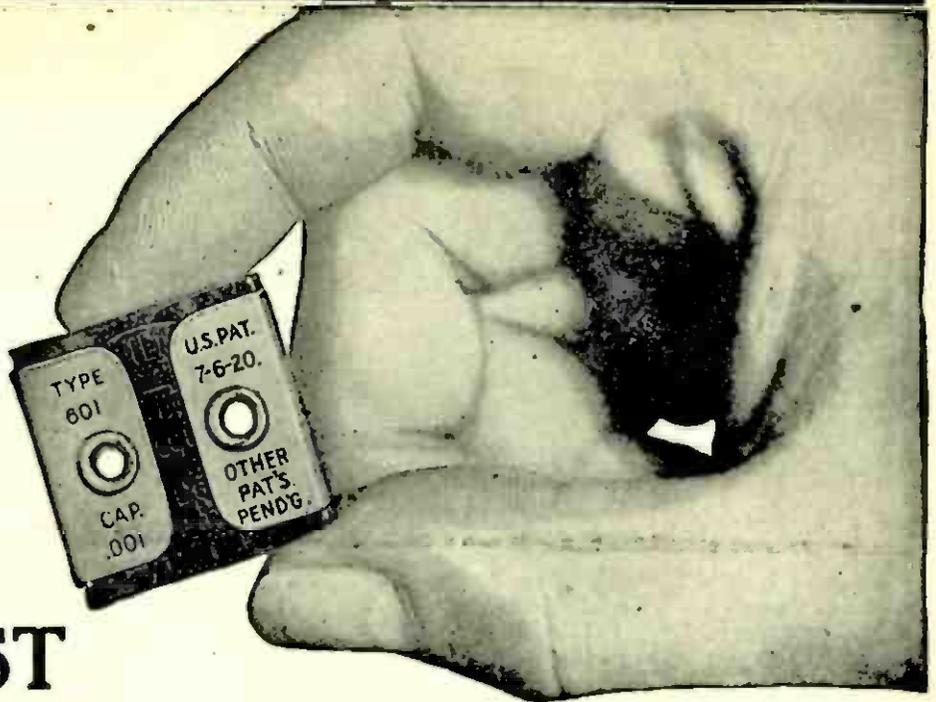
\* \* \*

Nor a single article or statement or picture has yet appeared in this magazine that has been published as the result of pressure from advertisers or prospective advertisers. Nor has any article or statement or picture been held out for a similar reason.

\* \* \*

THE Editor cannot state too clearly or too emphatically the simple fact that "The editorial pages of POPULAR RADIO are not for sale."

(Continued on page 8)



# The BIGGEST LITTLE THING *in radio*

Here is the Dubilier Micadon, Type 601, full size. It is the standard fixed condenser of radio—adopted by nearly all the leading manufacturers of sets and accessories and by discriminating amateurs *because it is permanent-in-capacity.*

Made in many styles and capacities for any circuit.  
Price 35 cents up.  
Look for a Micadon in your set.

Here is a list of well-known manufacturers who are regular customers of ours and who endorse Micadons:

- |                                  |                               |                               |
|----------------------------------|-------------------------------|-------------------------------|
| Adams-Morgan Co.                 | Freed-Eisemann Radio Corp.    | Q.R.S. Music Roll Co.         |
| F. A. D. Andrea, Inc.            | Garod Corporation             | Radio Distributing Co.        |
| Bissell Engineering Co.          | Independent Wireless Tel. Co. | Sec-Tron Radio Co.            |
| Bristol Co.                      | Michigan Radio Corp.          | Signal Electric Co.           |
| Central Radio Laboratories       | Midwest Radio Co.             | Sleeper Radio Corp.           |
| Clapp Eastham Co.                | R. Mitchell & Co.             | Telephone Maintenance Co.     |
| Crosley Mfg. Co.                 | Murad Laboratory, Inc.        | J. S. Timmons                 |
| Cutting & Washington Radio Corp. | National Airphone Co.         | Ware Radio Corporation        |
| De Forest Radio Tel. & Tel. Co.  | O & T Electric Corp.          | Western Coil & Electric Co.   |
| Durham & Co.                     | Operadio Corp.                | Westinghouse Elec. & Mfg. Co. |
| Eagle Radio Co.                  | Pfanstiehl Radio Serv. Co.    | Whiteland Mfg. Co.            |
|                                  |                               | Wireless Improvement Co.      |



Dubilier Duratran (Radio Frequency Transformer)

## DUBILIER CONDENSER AND RADIO CORPORATION

48-50 West Fourth Street  
New York



Dubilier Variadon (Variable Mica Condenser)



Dubilier Ducon Socket-plug

# DUBILIER DEVICES

# PAGES WITH THE EDITOR

(Continued from page 6)

PERHAPS because this policy is so unusual, it has been difficult for an occasional reader to accept or to appreciate its significance. To be specific, two readers—Mr. R. F. Downs of Medford, Wisconsin and Mr. Brentnal G. Worden of Rensselaer, N. Y.—have questioned the sincerity of this magazine in publishing a description of the Haynes DX Receiver (in the September number) and in the same issue publishing an advertisement of the Haynes-Griffin Radio Service in which the "Haynes Coupler" was listed for sale.

\* \* \*

THE Editor welcomes the opportunity of again defining the policy of POPULAR RADIO by quoting from his reply to Mr. Downs:

"I cannot reiterate too clearly or too emphatically the fact that no influence from the business office of this magazine has ever had the slightest effect upon our editorial policy nor will it have as long as I am Editor of this magazine.

\* \* \*

"THE article written by our Technical Editor, descriptive of the Haynes circuit, is *bona fide* and was accepted solely on its merits. It describes a set which has found favor among radio fans and has proven remarkably efficient. Mr. Haynes has no patent on this set or on any part of the set. The article was written, accepted and scheduled without any consideration whatever concerning the advertising.

"Mr. Haynes is in no better position than any dealer or manufacturer to profit from the publication of this article—except insofar as the circuit bears his name as the inventor of it.

\* \* \*

"THE fact that Mr. Haynes has adapted for use in his set a standard type of variocoupler, gives him no advantages that any amateur or any dealer cannot enjoy; how to adapt this standard type of variocoupler was described in detail in the article; you could make the adjustment yourself.

\* \* \*

"FOR your information I may state that I shall continue to edit this magazine entirely regardless of the advertising pages and I shall neither insert nor omit any article or any item or any picture as the result of influence from our business office."

\* \* \*

CAN any policy be more clean-cut or more sane? Or can it be expressed more, clearly?

\* \* \*

RIGHT on the heels of this correspondence, however, comes many letters from readers who not merely endorse POPULAR RADIO's policy but offer sincere congratulations. From Washington, D. C., for example, comes this word of cheer—from a reader who knows POPULAR RADIO long and well:

"I AM very much interested in your *Pages with the Editor*. They read well and convincingly. Apparently yours is one of the few magazines in the world with a conscience as highly developed as you can maintain it. I rather imagine it was a good thing to put the October argument in, in view of the publication in that number of 'How to Build the Haynes DX Receiver' and the simultaneous advertising of the parts. I rather imagine that it will help others to see that you don't intend to keep out excellent hook-ups or improvements merely because they happen to be advertised either in your own publication or elsewhere, but will publish them if you think it is in the interests of your audience.

"Such an attitude is surely, to use your words 'entirely free from the taint of commercialism.'"

—TROY RODLUN

\* \* \*

WITH this number POPULAR RADIO inaugurates a feature for which the Editor has been preparing for months; it is, in effect, an inter-continental radio news department. Everything of importance that happens in radio throughout the world—all the significant discoveries that are announced, all the researches that are being carried on by scientists and experimenters—will be reviewed briefly by our own technical staff. The essence of it all will appear each month in the new department, *In the World's Laboratories*—starting on page 410 of this issue.

\* \* \*

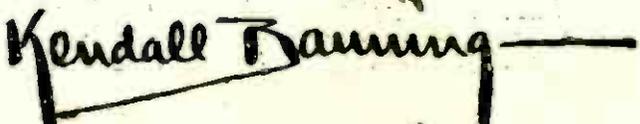
RADIO has already become an inter-continental interest; it is only a matter of time when listeners in the United States will be tuning in on the European broadcast stations, not as a carefully prepared experiment, but as a daily commonplace. Developments in England, France or Germany will soon be as important to us as are the changes on our own continent.

\* \* \*

IN anticipation of this development POPULAR RADIO now has a special agent in Europe. The Editor is now beginning to give our readers the up-to-the-minute radio news of the world—real news, obtained directly and authoritatively from the laboratories where the work is going on.

\* \* \*

If you see it in POPULAR RADIO it's so!

  
Editor, POPULAR RADIO

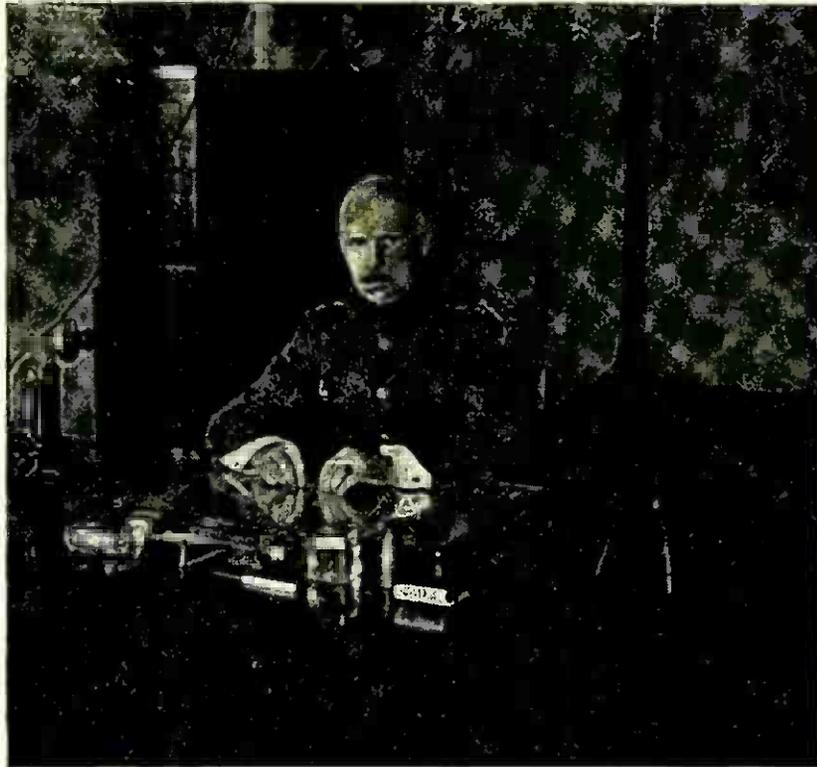
*Please mention POPULAR RADIO when answering advertisements.*

# Sodium



*The Plant Behind It*





TO THE EDITORS OF POPULAR RADIO:

*"I congratulate you on the excellent standing of POPULAR RADIO. You have done wonders with it, and I cannot afford to miss a single number."*

*George O. Spencer*

MAJOR GENERAL, UNITED STATES ARMY



From a photograph made for POPULAR RADIO

### He Transmitted Speech by Radio Twenty-three Years Ago

*Dr. Reginald A. Fessenden, one of the world's foremost scientists, is not only among the very earliest and most successful experimenters with wireless, but has more radio inventions to his credit than anyone else.*



# Popular Radio

VOLUME IV

NOVEMBER, 1923

NUMBER 5



## How Ether Waves Really Move

*The Development of the "Gliding Wave" Theory*

Sir Oliver Lodge, Dr. Elihu Thomson and Major-General George O. Squier have discussed in POPULAR RADIO the movement of ether waves around the earth according to the theory of the Heaviside Layer and the alternative theory of Gliding Waves. In this authoritative article the originator of the Gliding Wave theory explains his own views of the matter.

By REGINALD A. FESSENDEN, Ph.D.

THE sliding wave theory appears to have been somewhat misunderstood both by its advocates and its opponents. The nature of this misunderstanding and how it arose will be better appreciated if we consider the general state of the art at the time the sliding wave theory first appeared, in the Proceedings of the American Institute of Electrical Engineers, November 22, 1899<sup>1</sup>.

Joseph Henry, who was the founder of wireless telegraphy, had discovered electromagnetic induction and invented the induction coil<sup>2</sup>. He had also made the fundamental discovery that the discharge of a condenser was under certain conditions oscillatory, or, as he puts it, consists "of a principal discharge in one direction and then several reflex

actions backward and forward, each more feeble than the preceding until equilibrium is attained." Henry was not only the first to produce high-frequency electric oscillations, he was the first to detect them at a distance, using what was later known as the magnetic detector. The high-frequency oscillations were generated in the upper floor of a building and transmitted to the cellar, where they were received by a receiving coil and utilized to shake out the magnetism from a magnetized needle<sup>3</sup>.

Edison, Elihu Thomson and Houston made many experiments on these transmitted waves, and reports of their experiments will be found in Edison's papers in the technical journals of that



Reprinted from the November, 1922, POPULAR RADIO

#### DIAGRAM OF THE HEAVISIDE LAYER THEORY

According to most scientists, radio waves are reflected from [and transmitted around the earth by] a layer of ionized gas that is suspended high in the atmosphere of the earth. Sir Oliver Lodge is the foremost exponent of this theory.

period and in the paper by Houston and Thomson in *The Journal of the Franklin Institute* for April, 1876<sup>4</sup>. Between 1870 and 1888 von Bezold, Fitzgerald and Hertz had cleared up to a very considerable extent the nature of the phenomena observed, and Hertz's work had shown that the experimenters were dealing with true electrical waves.

Dolbear<sup>5</sup> and Edison had been using vertical grounded antennas for telegraphing wirelessly, though the effects they obtained appear to be mainly electrostatic and only partially true wave transmission.

Crookes in the *Fortnightly Review* for February, 1892, proposed that resonant tuned circuits should be used to select out messages from different stations. Lodge<sup>6</sup> and Popoff<sup>7</sup> had used these waves for signalling, and Popoff, who had used a vertical grounded antenna, coherer and tapper back, pointed out that the apparatus might "be adapted to the transmission of signals to a distance."

Tesla<sup>8</sup>, who had been doing a great



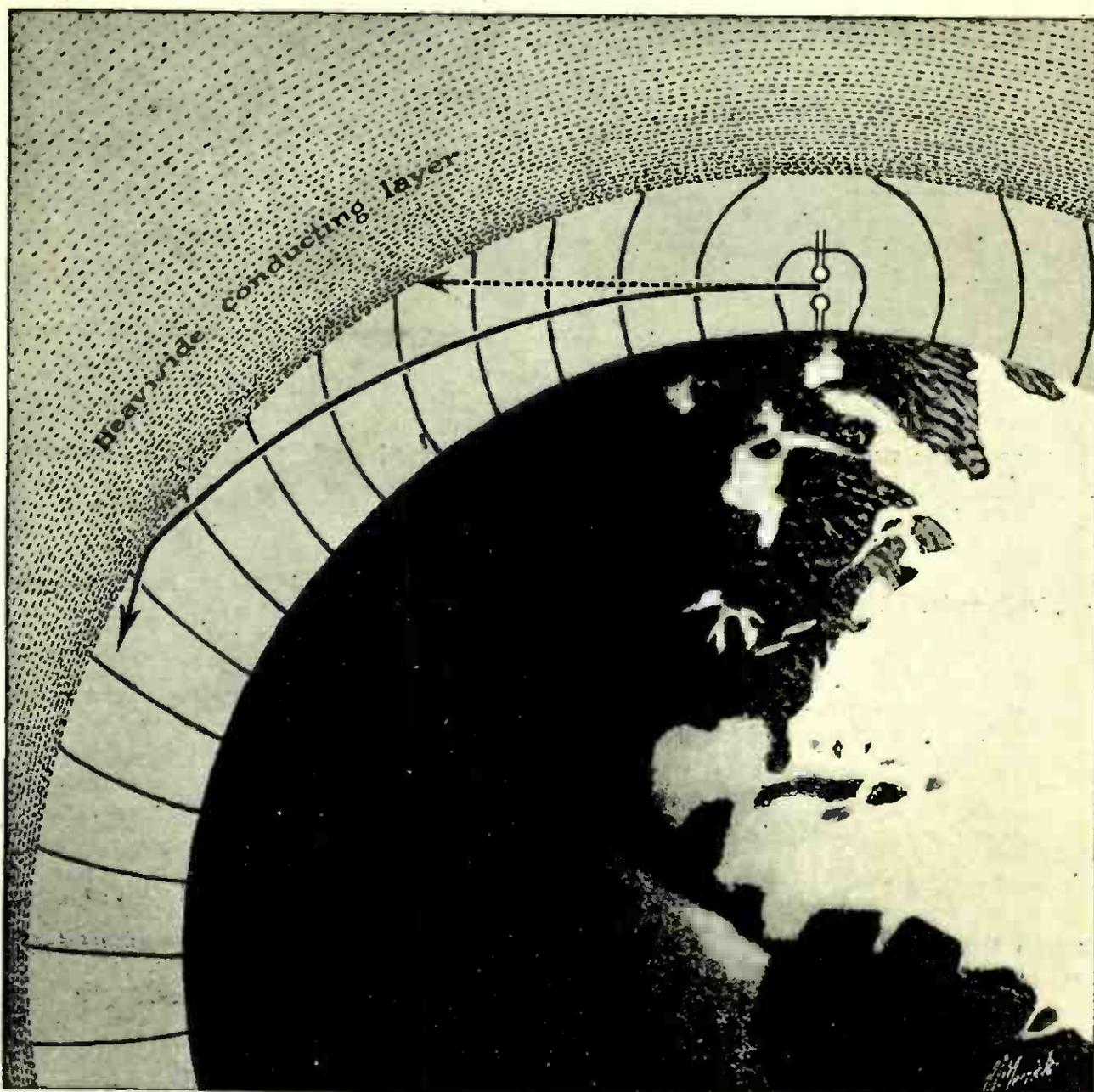
#### DIAGRAM OF THE GLIDING WAVE THEORY

On the other hand, a number of eminent scientists (of which Dr. Elihu Thomson is one) maintain that radio waves are attached to and glide over the earth, following its contour in much the same way as do the radio waves in line radio.

deal of work in high-frequency oscillations, in 1892 proposed a system for transmitting signals wirelessly using the vertical antennas of Dolbear and tuned transformer circuits at the sending and receiving ends.

Edison, in 1884, discovered and invented the hot-cathode vacuum tube<sup>9</sup>, and used it for rectifying high-frequency currents. De Forest's great invention, which consisted of the introduction of a third electrode between the other two, was made about 1907.

Marconi, who had worked under Righi's instructions, had, with the keen eye for commercial opportunity possessed by his race, realized that there was a market for such a telegraphic system, even if working over only short distances, and in July, 1896, gave a demonstration to the English Post Office at Salisbury Plain and succeeded in increasing the range from its previous figure of a half mile obtained by other experimenters to a distance of two miles, using parabolic reflectors and the coherer. In the same year Captain



From a drawing made for POPULAR RADIO

#### DIAGRAM OF DR. FESSENDEN'S THEORY

*Instead of moving in straight lines outward from the source, as shown by the dotted line, the waves really move in a curve like that shown by the solid line. But this curve tends to bend away from the earth's surface and reflection from the Heaviside Layer is necessary to bring it back again.*

Jackson (now Admiral) of the British Navy found that considerably greater distance could be obtained by using the Dolbear-Edison-Tesla arrangement of vertical antennas and tuned sending and receiving transformers at both transmitting and receiving ends.

Such was the state of the art in 1899. Henry had discovered the method of producing high-frequency oscillations and of detecting them at a distance, utilizing his other inventions, the induc-

tion coil and the magnetic detector, for this purpose. Dolbear had invented the vertical antenna. Edison had invented the hot-cathode vacuum tube detector. Tesla had invented the tuned sending transformer and tuned receiving transformer, connecting to the vertical antennas. Marconi, Samuels and Isaacs had undertaken the commercial exploitation of the field. De Forest was about to begin the work which resulted in his invention of the audion.

But even then the nature of the phenomena involved were not clearly understood. Possibly influenced to some extent by patent reasons there was a strong effort made to show that there was something radically new and strange in the systems which were being commercially exploited. It was stated by a number of authorities that the phenomena were *not* due to high-frequency alternating currents, but that some peculiar "whip-crack" was necessary in the ether. A few quotations will illustrate this point<sup>10</sup>.

Professor Cross stated that "alternating currents in the vertical wire will not produce Hertzian waves in the ether, as such waves are produced only by the disruptive discharge. Probably a crude mechanical illustration would be the case of a whip-lash—motions of some kind would be produced, but they would be of a quite different character." Fleming stated that "although in the third claim the patent speaks of employing rapidly recurring or alternating electric impulses, unless some form of a condenser is discharged to cross the spark gap there cannot be any production of Hertzian waves—the disruptive discharge is the one essential condition for the production of Hertzian waves."

Marconi stated that "the difference between Hertzian oscillations and ordinary alternating currents is most certainly *not one of degree*. An analogy may be found in the case of a sound wave in air. The swinging of a bell in a church steeple to and fro will produce no wave, and further, no sound, but if the rim of the bell is struck soundly with a hammer, it effects the air with sufficient suddenness. Hence it appears absolutely clear to me that there is no Hertzian wave telegraphy without the essential feature for producing Hertzian waves, which is the Hertzian spark."

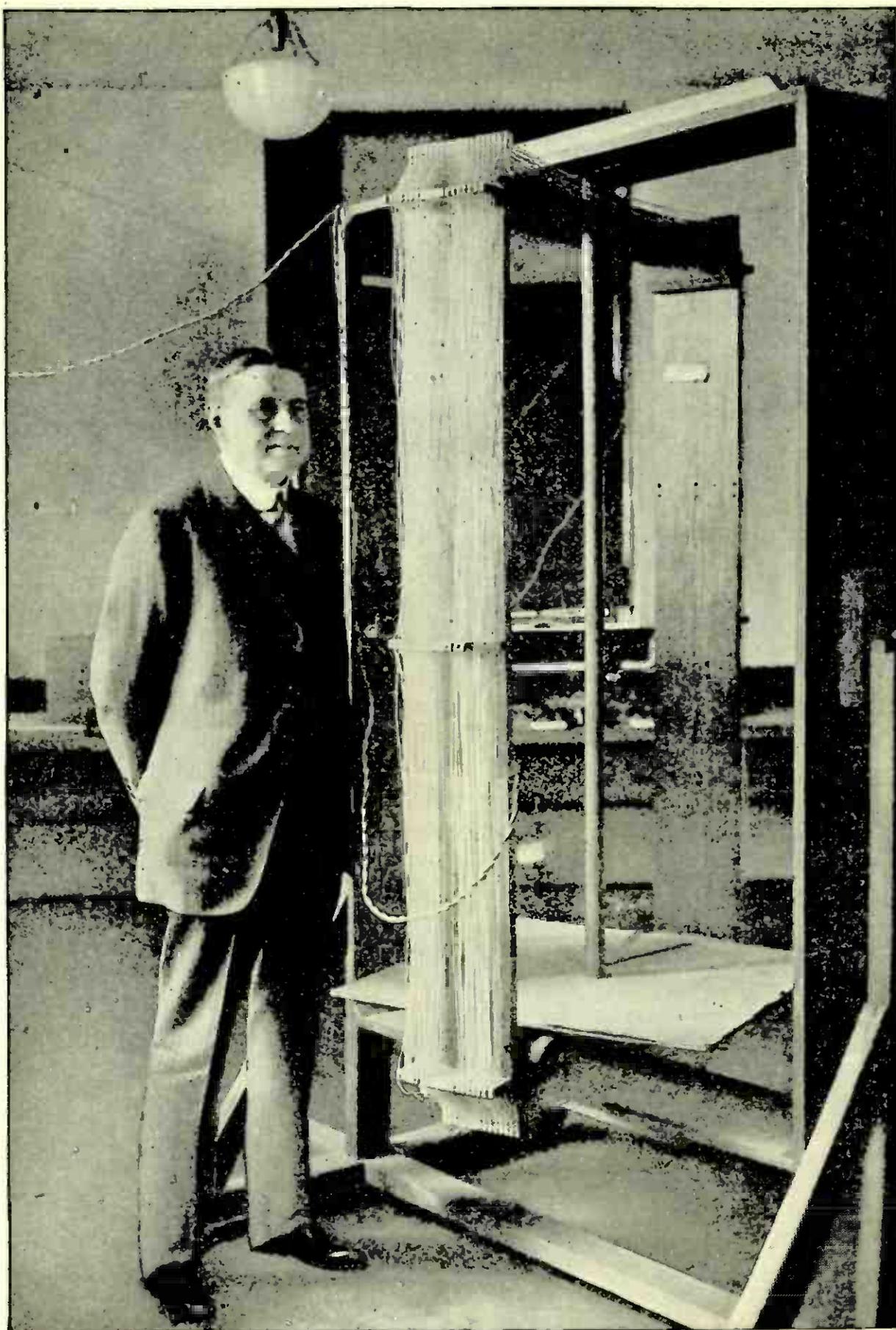
The writer had been lecturing and experimenting on the production and detection of Hertzian waves for a

number of years<sup>11</sup>, and was convinced that there was no essential distinction between the Henry high-frequency oscillations and Hertzian waves. With the object of demonstrating this a considerable number of experiments were made in 1899, with the assistance of one of the writer's former students, Dr. Kintner, and the results published in the American Institute paper above referred to, that is of November 22, 1899, in which the sliding wave theory referred to by Professor Elihu Thomson<sup>12</sup> was fully explained and illustrated.

It will be seen that this paper on the sliding wave theory was written for a specific purpose, i. e., to show that there was no mysterious "whip-crack of the ether" involved in wireless telegraphy, but merely the well-known high-frequency currents, and though it led to important developments, for instance, the wave chute, the use of the magnetic component of the wave, the loop antenna, the pelorus or wireless compass, continuous wave generation, the wireless telephone and the heterodyne, it was never intended as a presentation of the complete theory.

This has resulted in the theory being misunderstood to some extent. Professor Thomson has supposed, it would appear from his article, that the waves are *entirely* guided by the surface of the conductor and follow the earth around. Eckersley<sup>13</sup>, on the other hand, states that the transmission of the half waves is not influenced *at all* by the conductor but "the energy is propagated in straight lines."

The correct theory lies between these two opinions. The original mathematical investigation made by the writer in 1900 shows that the sliding waves are guided by the earth's surface to a quite considerable extent near the origin, but that the effect rapidly falls off. The amount of the bending is expressed by a series formula, the first term of which is an angle equal to half the angle between a tangent to the source and a straight line



© Harris & Ewing

**HOW UNCLE SAM STUDIES ATMOSPHERIC  
DISTURBANCES WITH A LOOP AERIAL**

*Dr. L. W. Austin of the Bureau of Standards, with the apparatus used for investigating the effects of the ionized clouds described in this article.*

joining the surface of the conductor at a distance of a quarter wavelength from the source, and the source. The effect of this series falls off very rapidly with the distance. For transatlantic distances it is negligible, but for the distances dealt with in my original paper it is quite appreciable.

The reception of waves across the Atlantic cannot, therefore, be due to guiding of the sliding waves by the conductor and must be due to some conducting layer in the upper portion of the earth's atmosphere.

Writers on the subject of the Heavyside Layer seem to assume that this layer is more or less hypothetical and are apparently not aware that it was investigated fully prior to 1907.

The investigation was begun by the writer in 1900 at Cobb Point, Maryland<sup>14</sup>, where two masts were erected one mile apart and by means of hot wire barreters and ring receivers, the exact method of transmission of the waves was experimentally determined<sup>15</sup>. By means of ladders placed at varying distances from the antennas the course of the waves in the air was fully mapped out up to distances of several hundred yards from and to the antennas, and by burying the receivers at different depths in the ground and immersing them to different depths in the sea water, the rate of decay below the surface and the strength of the currents flowing in the surface were accurately determined. The results appeared in papers published by the writer some twenty years ago, where, for example, the figure is given that with a certain amount of salt in the sea water and with a certain wavelength the strength of the high-frequency currents falls off to the fraction  $1/e$  of its former value at a depth of 18 inches. Figures are also given of change intensity in going up and down sloping ground. Later, in 1906, while operating across the Atlantic between Brant Park in Massachusetts and Machrihanish in Scotland extensive

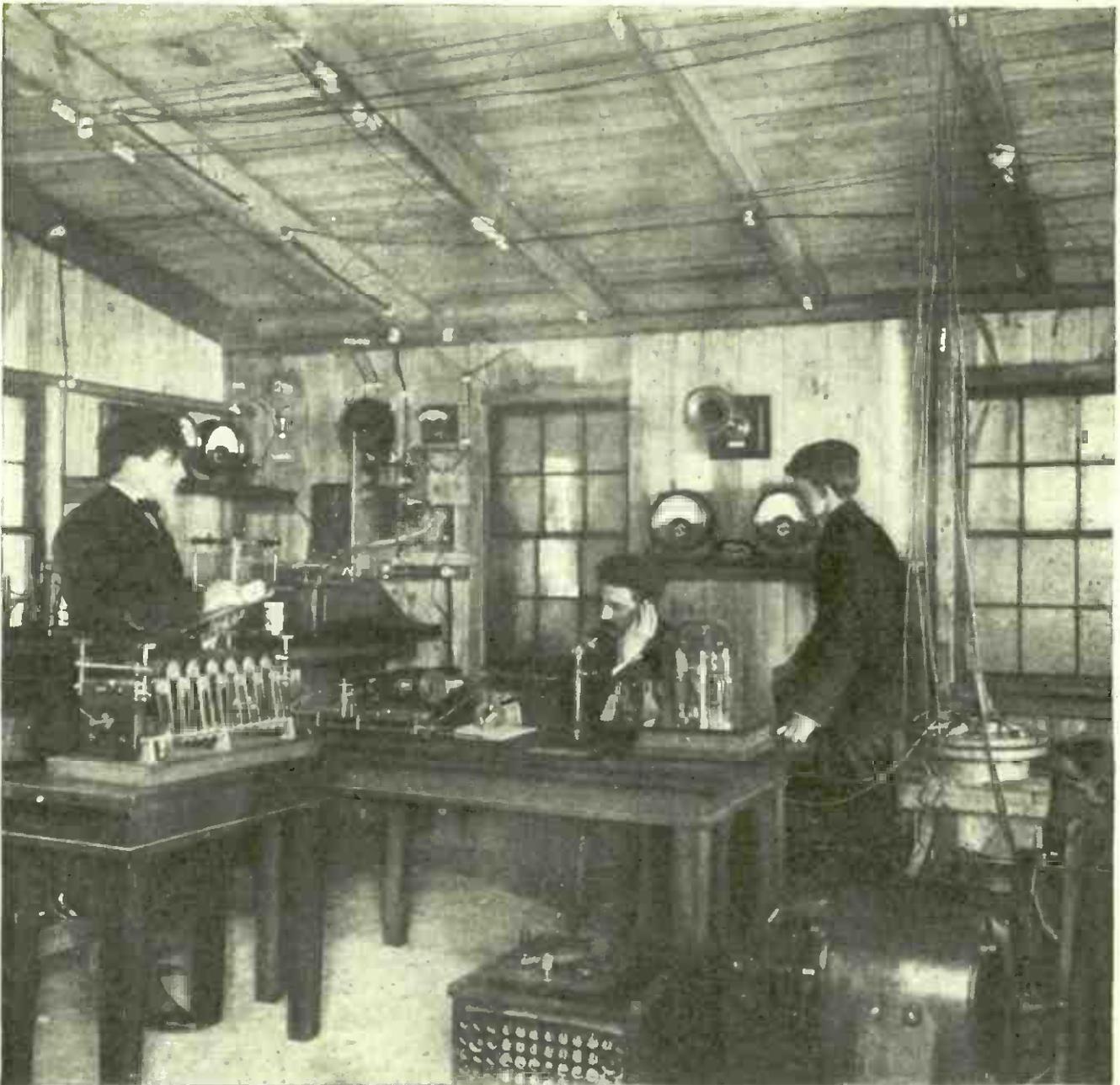
measurements were made on the efficiency of transmission of different wavelengths at different hours during the day and night. A curve showing the results was published in 1906<sup>16</sup> and again in 1908<sup>14</sup>.

The first point determined, as will be seen from these articles, was that the failure in transmission during daylight was not, as Dr. Fleming had stated and attempted to show mathematically<sup>17</sup>, due to absorption in the neighborhood of the sending station. This was determined by measuring accurately and simultaneously the difference in intensity between the daytime and nighttime reception of signals at six different stations at distances of 200 yards, 30 miles, 170 miles, 270 miles, 400 miles and 3,000 miles from the sending station. It was found that there was no difference in the daytime and nighttime transmission for nearby stations, and that the difference increased rapidly with the distance.

A second point determined was the efficiency of different wavelengths for transmission during daytime and nighttime. From the curves given in the papers referred to it will be seen that the absorption increased slightly as the wavelength increased, up to a frequency of 70,000 and then fell off with extreme rapidity. It was for this reason that long wavelength was adopted by the writer for transatlantic working in January, 1906. Up to this time short waves had been used in the attempts to work across the Atlantic, under the impression that they gave a sharper "whip-crack," but as the result of these experiments and the publication of these curves it became generally known that long waves should be used for successful operation.

The third result was the determination of the height of the conducting layer. This is given in section 10 of the article of May 18, 1906<sup>16</sup>, as follows:

"The height above the earth at which marked absorption begins to take place may be roughly estimated as about 300



From a photograph in the collection of Dr. R. A. Fessenden

#### DR. FESSENDEN'S BROADCASTING EXPERIMENTS SEVENTEEN YEARS AGO

*As far back as November, 1906, this station was in operation at Brant Rock, Mass. Gramophone music was broadcast from the machine shown in the left corner. This historic picture shows three of Dr. Fessenden's assistants (left to right), Mr. Stein, Mr. Mansbendal and Mr. Guy Hill.*

miles at nighttime and 100 miles during daytime."

It will be noticed that the height of this reflecting layer as determined in 1906 from transatlantic wireless experiments agrees almost exactly with the height at which aurora are formed, as determined ten years later by trigonometrical photographic measurements.

The fourth point determined was that the Heaviside Layer was not a smooth

surface but was broken up into clouds of ionized air, "ioneph's," as the writer has termed them. To quote from the paper referred to, "these masses of ionized air are not continuous but somewhat resemble clouds."

The fifth point determined was the size of these clouds, which is given in the article referred to as varying in diameter from 150 feet to two miles and more.

The sixth result was the discovery of aeolotropic absorption or the variation in intensity in different directions on different nights.

The seventh point referred to in the paper is the discovery of diffraction effects.

The eighth result was the discovery of a relation between the efficiency of transatlantic transmission on different nights and the curves of variation in the earth's magnetism. The two sets of curves were found to be substantially identical in character.

The ninth point was the discovery of what were called "echo signals." To quote from the article: "On certain nights there appeared to be indications at the Boston station that a double set of impulses were being received, one about a fifth of a second later than the other. It is too early yet to make any definite statement in regard to the matter, but there is some reason for thinking that the second set of signals arrived at the station after going the longer way round. To take an actual numerical example, the strength of signals received at Boston from Machrihanish on the night of January 30 was 480 times that of audibility. If the second set of signals went around the other way, their intensities, according to the square law, would be as 1 is to 70. Hence signals that had gone the other way round would have an intensity of 480 divided by 70, or 7 times audibility. As a matter of fact, the second set of signals, which we may call the echo signals, were really nearly twice as strong. This, of course, might be taken as an argument against their having come that way, but I am not disposed to consider it as a conclusive one. If, however, they did come round the other way, it is evident that the rate of absorption must become uniform after a certain distance."

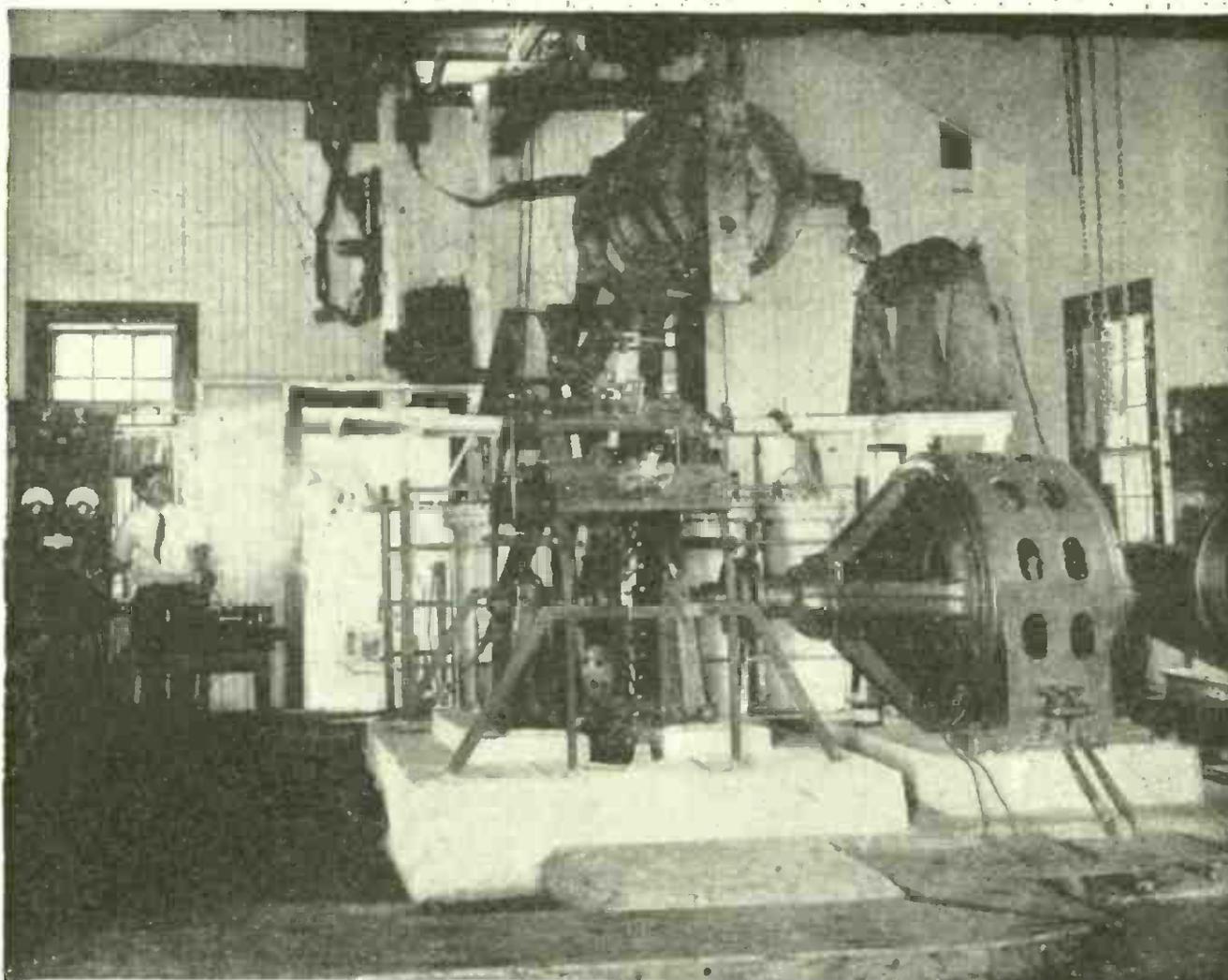
Though the statement was severely commented upon at the time (May 18, 1906), the existence of these echo

signals has since been confirmed. In the January, 1922, issue of the "Monthly Notices of the Royal Astronomical Society," from the Greenwich, Poulka, Uccle and Edinburgh Observatories, Professor Sampson gives curves of "the error in wireless time signals which demonstrate the curious fact that each observatory is liable to be in error by 0.2 second, and that the error frequently persists for some weeks in the same direction. The cause is obscure; lateral refraction due to dissymmetry in the distribution of atmospheric pressure is examined, but is insufficient to explain the whole anomaly."

It will be seen that a quite considerable amount of experimental work had been done on the Heaviside Layer as far back as May, 1906, and it is hoped that someone else may take up work along the lines indicated. Some additional information will be found in a paper on the pelorus published in 1919<sup>18</sup>.

Dr. Elihu Thomson and Sir Oliver Lodge have referred to the "scepticism" concerning Marconi's first attempt to transmit wireless signals across the ocean to Newfoundland. This is really a commercial and not a scientific matter.

The reference is, of course, to the disclosures of fact which appeared in the *London Electrician* for November 22, 1907<sup>19</sup>; to the fact that three dots were used as a signal letter; the fact that the receiver used (a carbon-mercury coherer) can be made to give a succession of three dots followed by a period of silence by adjusting the electrodes to the right distance; the fact that no one was allowed to listen in to the signals except Marconi and a single assistant who had no knowledge of electric circuits; the fact that the experiments were abruptly discontinued in spite of the very generous offer of the cable companies to waive their monopoly so far as experimental work was concerned and not only to permit but to assist Mr. Marconi in making any further tests; the fact that we now



From a photograph in the collection of Dr. R. A. Fessenden

#### MEASURING THE HEIGHT OF THE HEAVISIDE LAYER

*By means of this elaborate transmitter Dr. Fessenden carried on experiments in 1906. The operator, Guy Hill, has since become known to radio fans everywhere as Captain Hill, for several years associated with Major General George O. Squier.*

know that with the short wavelength used and with the single, kite-supported wire at the receiving end, the small amount of power and no amplification, no signals could possibly have been received over that distance with that apparatus; the fact that even with the much more highly powered stations subsequently built at Cape Cod it was found necessary to first send the Roosevelt message by cable from the Holland House, New York, and then, after it had been sent out from the Cape Cod station wirelessly, to send a second cable message by the Duxbury cable directing the release of the message cabled from the Holland House; the circumstances connected with the Glace Bay tests as discussed in *The London Electrician* of

the date referred to, and the fact that a considerable amount of cable stock had been sold shortly prior to the announcement of the Newfoundland tests. These facts have undoubtedly influenced public opinion to scepticism. But this is a matter on which everyone must form his own opinion, and those who may be inclined to pass harsh judgment should remember that the standard of commercial ethics is not quite the same as that of abstract science.

To conclude, I think that perhaps the most striking evidence of the reality of the Heaviside Layer is the close agreement of the results of the tests made to determine the height of this layer (as given in the paper in *The Electrical Review* for May 18, 1906, cited above)

with the determinations of the height of the aurora borealis made in 1920. The fact that these two heights agree almost exactly is pretty conclusive evidence of the existence of such a layer. At first sight the aeolotropic transmission referred to in the paper of May 11, 1906, cited above, might be considered as equally conclusive evidence, but it will be seen from the paper of 1919 in *The Electrician* (also cited) that such a deviation would still exist even though there were no Heaviside Layer.

<sup>1</sup>Reginald A. Fessenden, "The Possibilities of Wireless Telegraphy." (A discussion). *Trans. Amer. Inst. Elec. Engs.*, volume 16, mail edition pages 635-642, regular edition pages 607-614 (1899).

<sup>2</sup>Joseph Henry, "On the Production of Currents and Sparks of Electricity from Magnetism." *Amer. Jour. Science.*, volume 22 (appendix), pages 403-408 (1832).

<sup>3</sup>"The Scientific Writings of Joseph Henry," 1832-1848. The Smithsonian Institution, Washington, D. C. Henry's important papers on electromagnetic induction are reprinted in "The Discovery of Induced Electric Currents," edited by J. S. Ames, volume 1, 107 pages, The American Book Company, New York, 1900.

<sup>4</sup>Edwin J. Houston and Elihu Thomson, "The Alleged Etheric Force. Test Experiments as to its Identity with Induced Electricity." *Jour. Franklin Inst.*, volume 101, pages 270-274 (April, 1876).

<sup>5</sup>U. S. Patent No. 350,299, issued October 5, 1886.

<sup>6</sup>Sir Oliver Lodge, "The Work of Hertz." *Proc.*

*Royal Institution* (London), volume 14, page 321, June 1, 1894.

<sup>7</sup>Popoff, *Jour. Russian Phys. Chem. Soc.*, April 25, 1895.

<sup>8</sup>Nikola Tesla, "Experiments with Alternate Currents of High Potential and Frequency." *Jour. Institution Elec. Engs.* (London), volume 21, pages 51-163 (1892).

<sup>9</sup>U. S. Patent No. 307,031, issued October 21, 1884. See also Edwin J. Houston, "Notes on Phenomena in Incandescent Lamps," *Trans. Amer. Inst. Elec. Engs.*, volume 1, first paper, 8 pages, October, 1884.

<sup>10</sup>Court reports in Marconi vs. De Forest, Southern District of New York. Proceedings Electrical Congress at St. Louis; Discussions *Inst. of Elect. Eng.* (England) and "Principles of Electric Wave Telegraphy."

<sup>11</sup>Purdue University catalogue for 1892-93. Thesis, Bennet and Bradshaw, Western University of Pennsylvania, 1895.

<sup>12</sup>POPULAR RADIO, volume 2, pages 231-235, (December, 1922). See also Elihu Thomson, "A Short Story in Wireless," *The Electrician* (London), volume 89, page 148 (August 11, 1922).

<sup>13</sup>T. H. Eckersley, "A Short Story in Wireless" (letter to the editor). *The Electrician* (London), volume 89, pages 242-243 (September 1, 1922).

<sup>14</sup>Where speech was first transmitted wirelessly, December, 1900. See Reginald A. Fessenden, "Wireless Telephony." *Trans. Amer. Inst. Elec. Engs.* volume 27, pages 553-629 (1909).

<sup>15</sup>A. Frederick Collins, "Fessenden's Work in Wireless Telegraphy." *Electrical World*, volume 42, pages 474-476 (September 19, 1903).

<sup>16</sup>Reginald A. Fessenden, "Wireless Telegraphy," *Electrical Review* (London), volume 58, pages 744-746 (May 11, 1906) and 788-789 (May 18, 1906).

<sup>17</sup>J. A. Fleming, "Principles of Electric Wave Telegraphy," pages 617 and 618.

<sup>18</sup>Reginald A. Fessenden, "The Fessenden Pelorus (Wireless Compass); a Caution as to Its Use." *The Electrician* (London), volume 83, pages 719-721 (December 19, 1919).

<sup>19</sup>Reginald A. Fessenden, "A Regular Wireless Telegraph Service Between America and Europe." *The Electrician* (London), volume 60, pages 200-203 (November 22, 1907).



Kadci & Herbert

#### BROADCASTING A CONCERT FROM A LINER'S DOCK

In the foreground may be seen the microphone that transmitted the jazz of Paul Whiteman's orchestra just before the sailing of the steamship LEVIATHAN from New York. The innovation made a hit with the radio fans.



From a photograph made for POPULAR RADIO

#### THE HEAD OF UNCLE SAM'S DETECTIVES

*Although officially known as chief of the Bureau of Investigation of the Department of Justice in Washington, the author of this article, William J. Burns, is perhaps more widely known because of his career as a sleuth in many important criminal cases.*

## Radio Puts on Gum Shoes

The applications of radio to police work are limitless. How the Department of Justice, in co-operation with the police departments, is preparing to create a nationwide radio net for locating and catching criminals is here told by—

WILLIAM J. BURNS

**A** YOUNG man in a certain city recently called on a large dealer in radio equipment and selected a high-priced receiving set. He claimed to be representing a public school. He took the set away, saying that the money for it "would be brought in later."

When the dealer found that he had been deceived he placed the case in the hands of the Burns Detective Agency. This agency's operators decided to give

the case what we call "absent treatment."

That night there went out from a local broadcasting station, a message, somewhat as follows:

"Wanted: A youth, about 18 years old, 5 feet 7 inches tall, weight about 135 pounds, light hair and eyes, affable, small scar on cheek. He is wanted for procuring illegally a radio receiving set (fully described). A reward of \$50 will be paid for information leading to his arrest."

It happened, as was expected, that at the time the youth was entertaining a group of friends with the outfit which thus poured into their ears the account of his misdoing. They recognized him at once, but with quick wit he warded off embarrassment by saying:

"It's only a chum of mine pulling off what he thinks is a good joke."

But on the next day the youth's mother went to the dealer's store and paid in full for the outfit.

The case, though a minor one, shows how the radio may be used in subtle way for detecting crime. In truth, I believe it will prove to be our single best medium for pursuing criminals in many kinds of difficult cases. It will thus rank among the best of crime preventives.

That is the thought that we, who plan to nationalize this new instrument of crime detection, have of the radio as an arm of law and order.

It is to be a first feature in the operation of the National Bureau of Identification and Information hereafter to be carried on by the Bureau of Investigation, U. S. Department of Justice.

The new bureau is to be taken over rather than set up. For nearly twenty-five years it has been operated in Washington, D. C., by the National Association of Chiefs of Police. To it have come copies of identification material collected by the police of large cities—material that consists of photographs, fingerprints, Bertillon measurements and records of individual offenders of the more or less professional class of criminals. It now has on file probably a million items of information relating to several hundred thousand criminals. New items reach it now at the rate of perhaps 40,000 a month.

Through it large police departments and detective agencies exchange data that are of mutual value. Its biggest service has been in making identifications.

Although of much value, this bureau has not been adequate to the need for a national clearing house on crime for various reasons.

One reason is, that because of its semi-private nature, there are facilities which it could not use to the fullest extent. There is the radio, for instance, but this can be used with fullest effect only through some form of broadcasting service.

In order that it be able to make use of such a service as well as many other things now beyond its range, the Department of Justice has agreed to take over the activities of the bureau and hereafter operate it. This move is in furtherance also of a policy laid down, upon his taking office, by Attorney General Daugherty with reference to the Department of Justice's investigating bureau. It was to make this bureau an all-round agency for public service, especially in the prevention of all crime. Through it we have tried to bring all the crime detecting agencies of the country into a form of co-operation that will enable them to work as a single unit in protecting the public from the criminal, and in detecting crime.

This aim will be greatly advanced by the National Bureau of Identification and Information, for under government operation the bureau will be of service to peace officers of all kinds, the rural county sheriff as well as the big city chief of police, the village constable as well as the large private-detective agency. In fact, we hope to get them all to supply it with as well as to draw upon it for information.

We expect also to make it an all-round storehouse as well as clearing house for crime data. There will be a statistical office—the first of national scope, to collect regularly numerical data, such as used to be gathered periodically by the Census Bureau; however, the data will be more up to date and more inclusive. There also will be a library where we expect to keep on



From a photograph made for POPULAR RADIO

### The Radio Detective Who Unfathomed the Famous "Nauen Buzz"

*During the early days of the World War the incredibly rapid and undecipherable radio signals between the most powerful broadcasting station in Germany and the station of the "Telefunken Company" at Sayville, Long Island, N. Y., aroused the attention of the U. S. officials. But it was a radio amateur, Charles E. Apgar of Westfield, N. J., who finally found the solution by means of amplifiers that recorded these signals on wax phonograph cylinders. By this means the messages were de-coded—and the Long Island station was promptly seized. This picture shows Mr. Apgar operating the same apparatus which he used on that historic occasion.*



**AS THE PICTURE WAS SENT—**

*The Jenkins apparatus for transmitting and receiving pictures by radio (as described in POPULAR RADIO for April, 1923), is already being used for sending motion pictures in the same way.*



**—AND AS IT WAS RECEIVED**

*The device, in effect, "draws pictures with pencils of refracted light." Note the steel engraving-like quality of the received portrait.*

file every book, report or other published item of material having to do with crime. We hope to make it so complete that even any general student of crime may go there and get full and accurate information having to do with all phases of the subject.

But the big function of the Bureau of Identification and Information will be the quick dispatch of information respecting crime and the pursuit of criminals. In that purpose radio will be used on a national scale, and it will thus be made available to all peace officers. In many cases it will greatly expedite pursuit and speed up interchange of information to a degree beyond what is now possible through any other medium of communication.

A serious crime, let us say, is committed in Massachusetts or Texas. The offender drops seemingly, as the reporters often say, "out of existence." With the bureau in full operation and the government's radio facilities at its command, all space may cry out for his apprehension. No matter how fast or how far he may go, the radio will dog his footsteps—it, indeed, may pour into his own ears an inescapable harbinger of discovery.

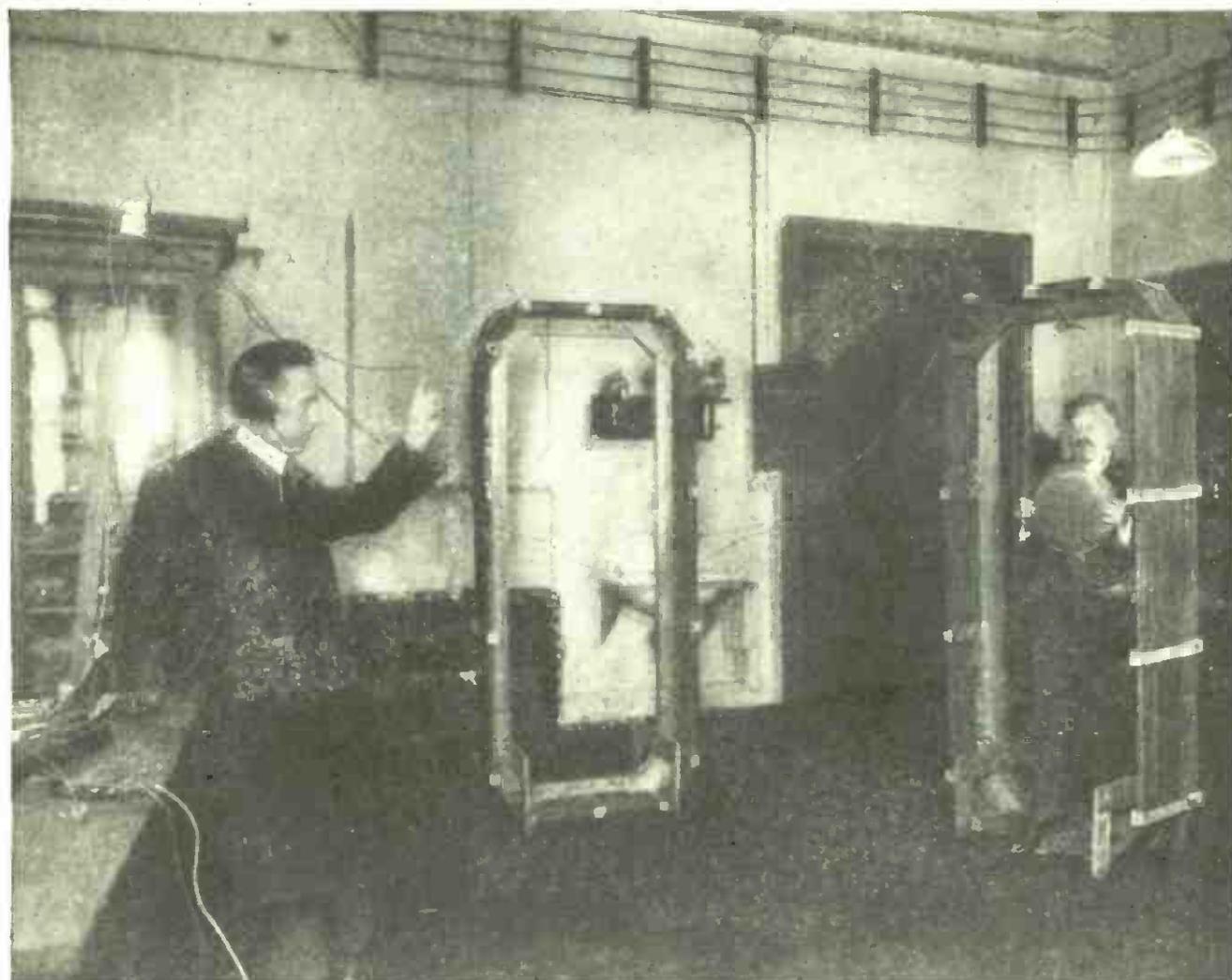
For a flash by radio from an officer of the law anywhere in the country may rally against the fugitive every pursuing agency in the country, and do it almost instantaneously.

In many cases the radio will be able to send forth much more than general descriptions of the fugitive. If he happens, for example, to be recorded in the official archives of crime, his fingerprints and even his photograph may be broadcast, by a single operation, throughout the country.

In that case the officers of the law at the scene of the crime would need only to file a simple telegram to Washington, saying, for instance, no more than the following:

"We want No. 1162. Broadcast."

A clerk in the Washington bureau,



Courtesy of Perry Armstrong

#### HOW RADIO WAVES TRAP THIEVES OF COPPER

*Coils of wire, concealed behind the casings of the doorways of an Austrian factory and connected with similar coils at the door of the watchman, tuned to resonance by the use of inductance and capacity in variable units, permits the detection of a piece of copper as small as four square inches.*

with nothing but the number as guide, could turn to a file and get all information needed for broadcasting full data regarding the criminal to all parts of the country.

The information will include fingerprints and photographs and histories of every important criminal arrested anywhere in the country.

It is now possible to transmit fingerprints by either telegraph or radio. Among the several recently invented methods of doing this is a process recently devised by Hakon Jørgenson of the University of Denmark. It consists of a system for reducing fingerprints to numerical formulas. By means of it a fingerprint at one place may

be sent to another place in some such formula as the following:

" $14 \times 6 - 5 - 8 \times 10 - 142 \times 152$ ."

With such formulas at hand, the expert can construct the essential parts of the print. Hitherto, fingerprints could be transmitted from one place to another only by mail or in person. This often caused serious delays in carrying on investigations. A suspect would be arrested, say, in San Francisco. The only way to determine positively whether he was the person wanted would be by comparing his fingerprints with ones on file, say, in New York. Thus a week or more would elapse before duplicates could be transmitted from the one place to the other.



Courtesy *The Tribune*, N. Y.

#### A POLICE PORTRAIT TRANSMITTED BY RADIO OR WIRE

*With the aid of the geometric chart shown on the page facing, portraits are broadcast by the Italian Home Office in Rome; a special staff of men are employed for sending and receiving not only portraits but fingerprints.*

In international cases there often is several weeks' delay. Now, however, a fingerprint may be transmitted by radio or telegraph in an hour's time. Indeed, by means of radio it may be broadcast to all the ends of the earth.

The same may soon be done, also, with photographs—thanks to the invention made by C. Francis Jenkins of Washington, D. C.\* By means of the Jenkins machine the actual portrait may be transmitted. This will vastly expedite identifications when the system is applied to police methods, as it will insure quick and wide distribution to the means by which fugitives may be recognized at sight.

By means of radio photography it may be possible, for example, to have

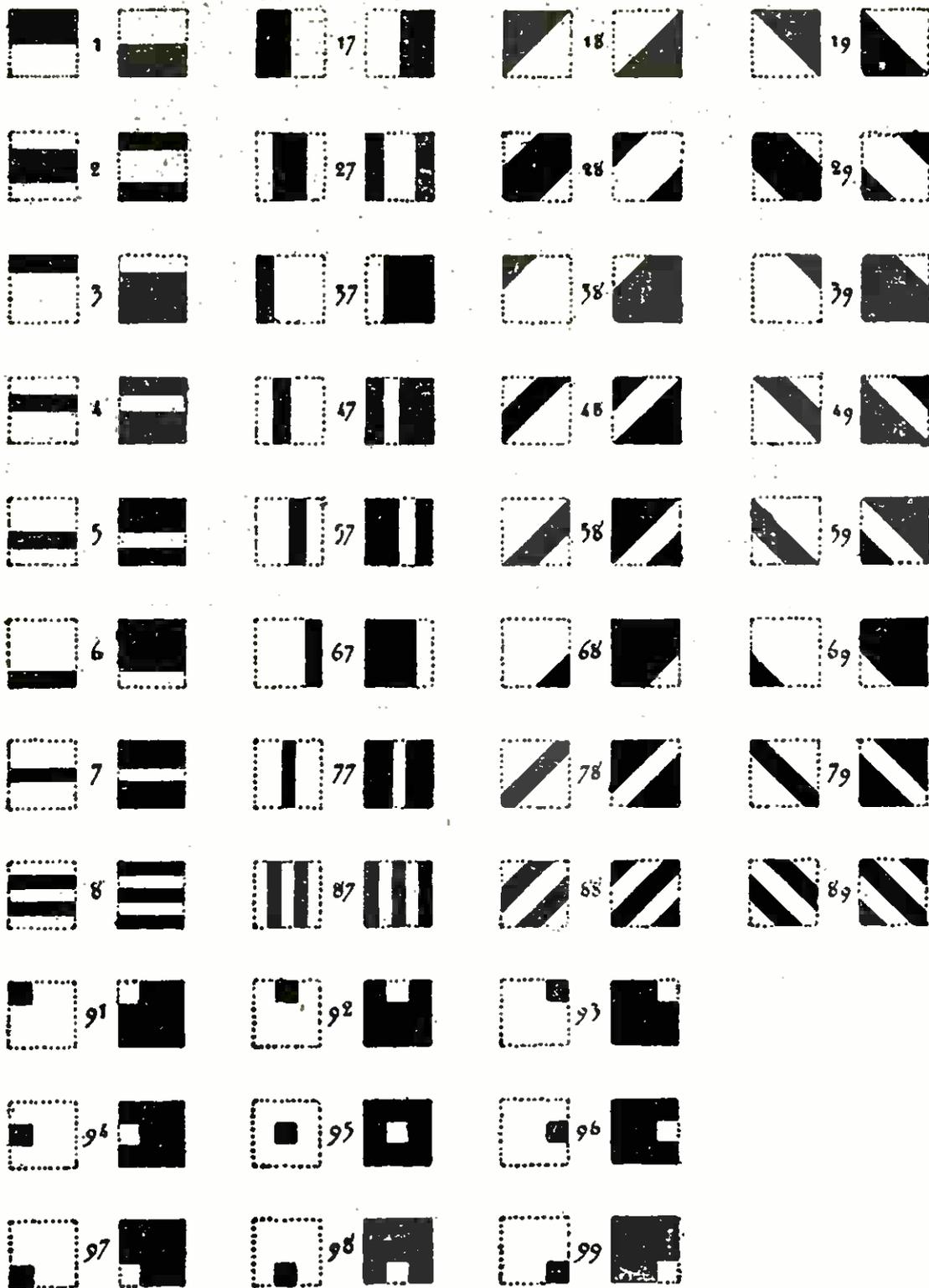
\*See POPULAR RADIO for April, 1923.

posters containing a photograph of a fugitive on display in every locality of the country within a few hours after a crime is committed.

The essence of strategy in fighting crime, as in war, is speed. As a famous general once put it, success depends on "getting there furthest with the most men." The essence of crime prevention is certainty of apprehension and punishment—but the criminal must be caught before he can be punished.

Both prevention and apprehension will be aided by the radio, once it is applied in the full, as by no other system or device yet invented.

One may telephone or telegraph by one operation in a single direction only. Despite the vast network of wires that now stretch over the country there are



**THIS CODE CHART IS THE BASIS OF THE "ELLERO SYSTEM"**

*By means of these shaded squares, designated by numbers, a picture may be literally dissected into units similar to the units of a halftone screen, and re-assembled by numbers transmitted by wire or radio. This system was invented by an Italian code expert, Commendatore Ellero.*

many spaces only sparsely touched or not at all by them. The police of New York and Philadelphia, for instance, may "burn" the wires in making a joint pursuit of a fugitive while the criminal drops into some isolated community

between those cities and lets the winds of pursuit blow harmlessly by. With the radio every locality wherein the criminal possibly could take refuge would be reached at the same time with calls for his arrest.

This is now being demonstrated locally by several city police departments, notably those of Chicago and Detroit. In the first city, I am informed, the scout cars of detectives are equipped with receiving sets through which the operators can be reached from headquarters at any time, and be kept informed with developments as they work.

In both cities the radio is being used with particular success in the matter of automobile thievery. Every day names and numbers and descriptions of stolen cars are broadcast into all surrounding country, with the result that thousands of eyes are put on the watch for these cars.

Incidentally, it should be possible,

through the radio to reduce to *nil* automobile thievery, which as a rule depends for success on quick get-aways over open roads. With officers and garages and the great number of amateur radio fans, whose aid could be secured quickly, kept informed along the highways of escape, it should become well-nigh impossible for a thief to make his escape with a stolen automobile.

The automobile as a means for the quick pursuit of criminals is offset to a great degree by the fact that it can be used almost as well by fugitives themselves. Indeed the criminal, I have no doubt, will learn to make use of the radio, not only in making escapes but also in accomplishing crimes.

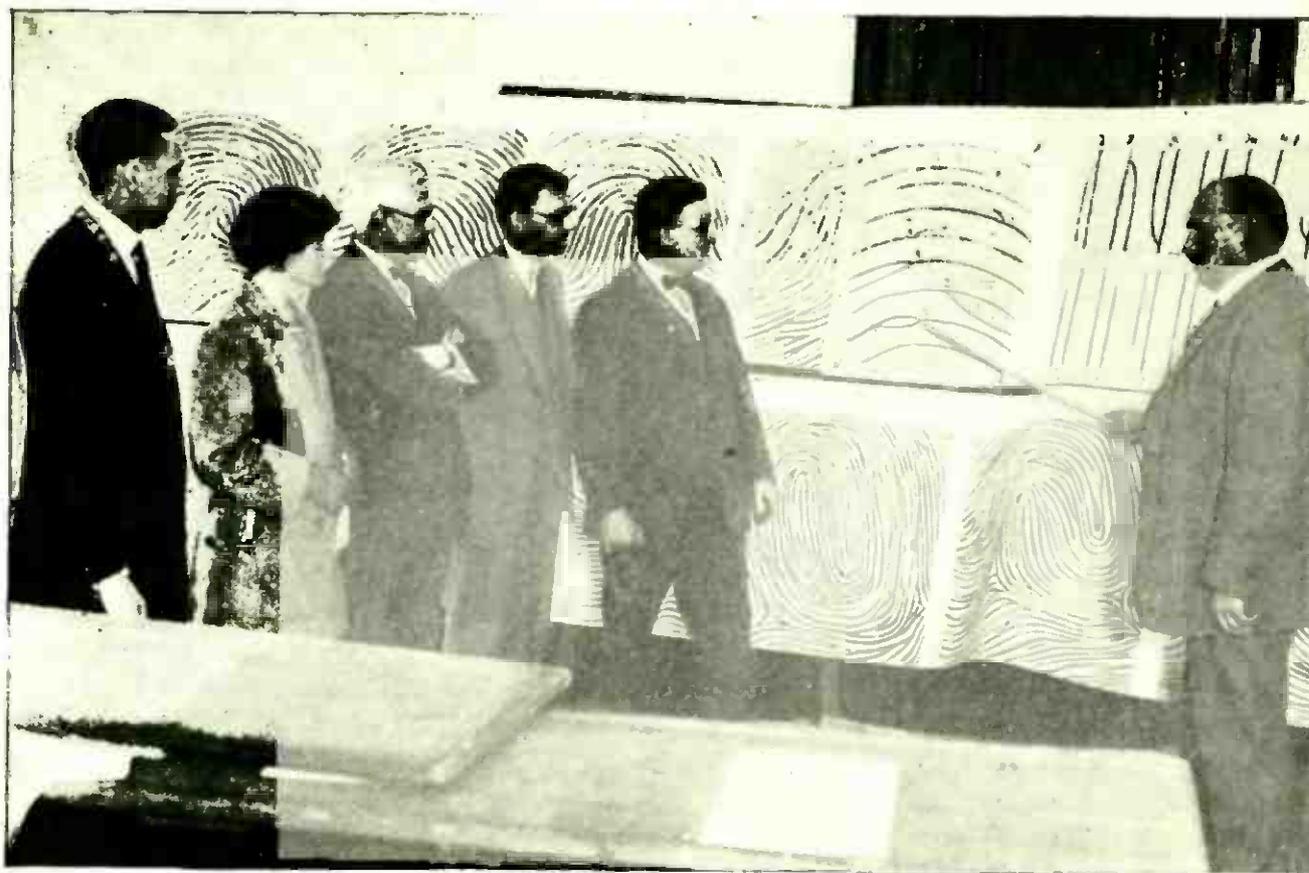
This latter is made difficult by the



From a photograph made for POPULAR RADIO

#### WHERE THE RECORDS OF LAW-BREAKERS ARE KEPT

*Into these files of the National Bureau of Identification and Information at Washington pour monthly about 40,000 items of information about criminals. Radio will play an increasingly important part in both collecting and disseminating this data for police uses.*



Pacific &amp; Atlantic

#### FINGER PRINTS BY RADIO

*Hakon Jorgenson, sub-director of the Copenhagen police and inventor of a fingerprint classification system that permits the transmission of these identification marks by radio, is demonstrating his invention to the New York police experts. The plan is based upon numbers for curves, valleys and whorls.*

fact that track of stations can be kept, but it will be relatively easy for the fugitive to carry his own receiving set and by means of it keep reasonably well informed as to what is done *via* radio by those in pursuit of him. But again, as illustrated by the case of the youth who stole the receiving set, this very fact may be turned upon and used against the fugitive. In truth, the "psychological" possibilities along this line are limitless.

These lines of development will cause the radio to serve as a great crime preventive. The very knowledge that radio is available for full use in pursuit, that it can reach him no matter where he may go, should have and must eventually have a restraining influence upon the criminal.

And it is the prevention of crime which is the prime aim of every conscientious peace officer. And it is crime

prevention that we hope for most through the work of the Bureau of Identification and Information and its chief arm, the radio.

It will give us something we have long needed and under our system of government cannot have except by voluntary action—a central establishment through which all crime-pursuing agencies may work together, particularly in the matter of crime prevention.

In European countries all policing activities generally are directed by national bureaus or departments. That is probably why several of them already have gone further than we have done with the radio as a policing agency. In France it has been in general use for some time, and it has been successful.

Among the more striking examples of the use of radio in detecting crime may be included the following report from Mr. Armstrong Perry, who has been



Keystone

#### IN THE BROADCASTING ROOM AT POLICE HEADQUARTERS

*New York City owns one of the most efficient radio stations in the country, WLAW; the uses of it, however, have not begun to be realized. Receiving apparatus has been installed at headquarters of each of the five boroughs.*

touring Europe and picking up items of interest for the readers of POPULAR RADIO. He writes as follows concerning the illustration published on page 351:

By the guilty expression on the face of Hofrat Dr. Max Reithoffer as he steps through a suppositious doorway with a theoretically stolen plate of copper and by the reproving attitude of Ingenieur Einil Wolf, his assistant, it is easy to see that the apparatus shown in this picture is the latest thing in radio thief-catchers.

Morals in Austria were not much after the war. Theft and pilferage became almost as common as in the United States, where they drove to the wall several of the leading insurance companies that guaranteed policyholders against such risks. Dr. Reithoffer, at the head of the government technical institute's radio department, was besought by numerous manufacturers, tradesmen and building contractors to devise some means for detecting pieces of copper that were being carried away from the premises where they belonged by workmen who did thieving as a

side-line. He responded by inventing the system shown in the picture.

It is simple, now that the problems involved have been solved. Any doorway used by departing workmen is supplied with a coil such as that through which Dr. Reithoffer is seen stepping. The wires are concealed behind the casing, of course. From this coil wires lead to a similar one at the door of the watchman or detective who may be near or several hundred yards away. The two coils are tuned to resonance by the use of inductance and capacity in variable units. So delicately is the apparatus adjusted that four square inches of copper concealed in the pocket of a light-fingered workman will disturb the balance and signal the watchman, who, thus warned, loses no time in apprehending the guilty one. The large plate carried by the inventor was used only because it would show up well in the photograph; it is several times the size of the smallest plate to which the apparatus will respond.

One of the difficulties encountered in perfecting the device was that it persisted in sounding alarms for watches, pocket knives and other metal articles that the workers had

a perfect right to own and carry. Adjustment had to be made so that it would signal: "watch and knife plus stolen copper."

The photograph was taken at *Das Elektrotechnische Institut der K.K. Technischen Hochschule* in Vienna, where Dr. Reithoffer has been a professor for twenty years. He prefers not to give fuller details at present as he has no attachment for signalling to Vienna when ambitious imitators try to get away with valuable ideas pilfered from others.

In this country radio can be used with fullest efficiency only when main reliance is placed on the facilities possessed by the Federal Government. The big broadcasting stations of the army and navy may thus be utilized to serve all the peace officers of the country, and in so doing will bring all of them into closer working harmony. This also will be voluntary, thus giving us the benefits without the risks attaching to a national department of police.

We hope also to develop the idea internationally. The bureau we are to operate will be at least the nucleus of

an international clearing house on crime—something which (as recently pointed out by Sir Basil Thomson, late of Scotland Yard) is a vital need. This will be facilitated by radio, and especially by the numerous stations abroad already owned and operated by our government.

Many details bearing upon our plans are yet to be worked out. But I see no obstacle in the way of solving them.

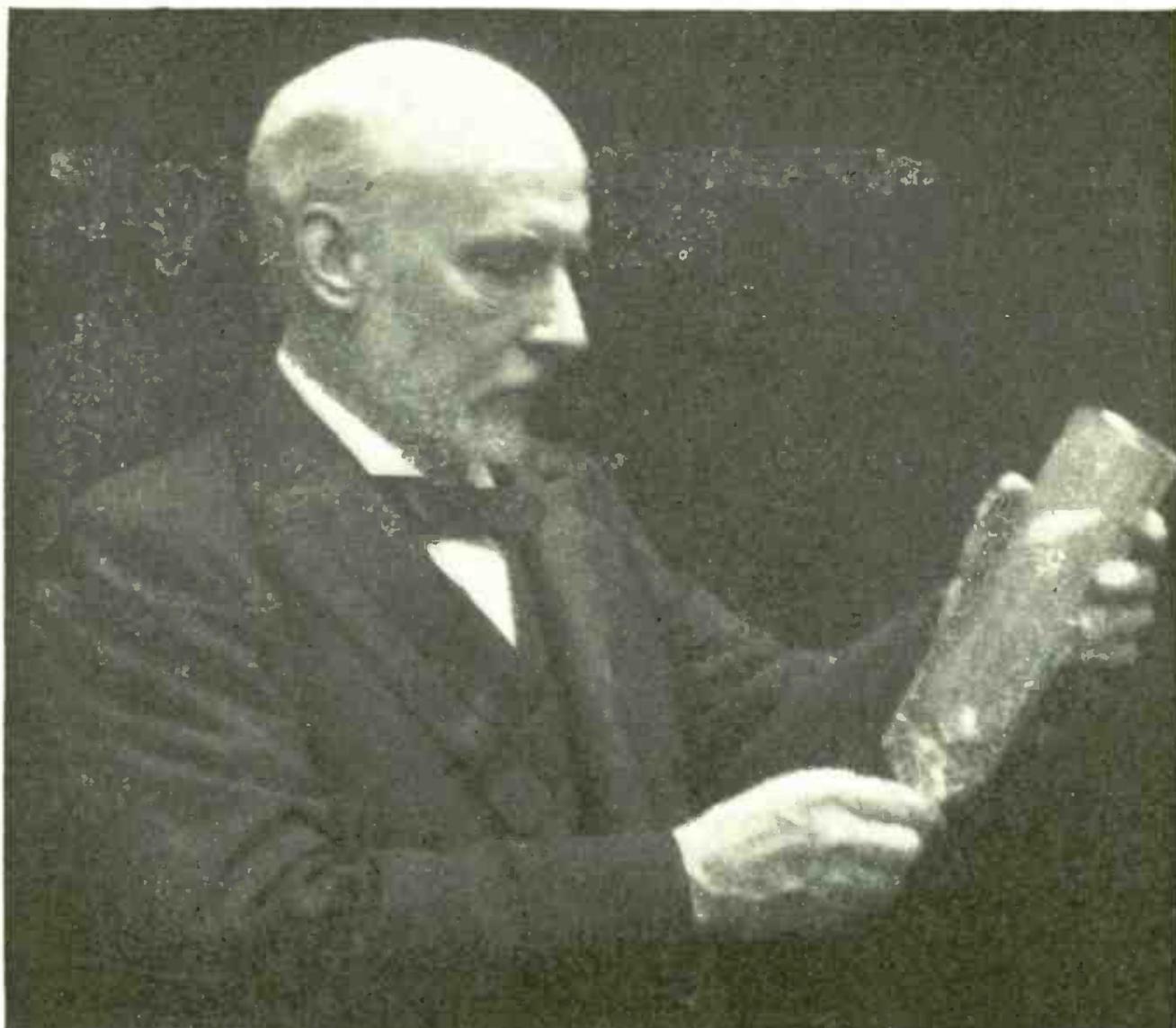
When they are fully applied a tremendous force will have been brought to bear against the world of crime. Already, I understand, more than a million and a half amateur radio fans operate receiving sets in this country. In certain situations they can be of inestimable service in fighting crime. This can be done through the aid they can give in distributing information quickly and widely and also in keeping eyes out for fugitives from justice.



Photonews

#### AN AERIAL IN YOUR WINDOW SHADE

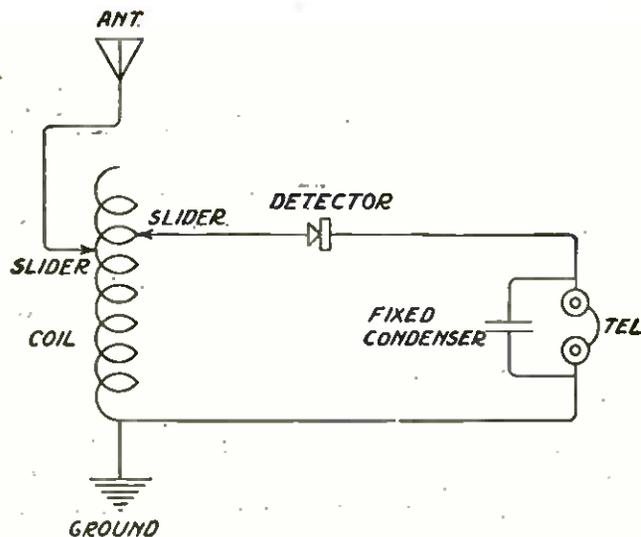
*Wires running around just an ordinary roller window shade is the novel device worked out by W. H. Bullock of New York. "Tuning is accomplished by pulling the shade up or down" is the report that accompanies the picture.*



From a photograph by Hoppé, London

### The Inventor of the Superfreeze

THE manufacture of vacuum tubes for radio use owes much to Sir James Dewar, Ph.D., LL.D., F.R.S., F.I.C., F.R.C.S., who was a pioneer investigator of the properties and uses of liquid air. By a series of new methods and devices which he invented Sir James succeeded in liquefying not only air but hydrogen, oxygen and several other gases. These novel liquids, never before seen by man, were intensely cold. Some of them reached temperatures as low as 450 degrees below zero, Fahrenheit. In order to keep these liquids and use them in experimental work it was necessary to invent a new kind of cold-proof container, and Sir James produced the double-walled vacuum flask, now familiar as the household thermos bottle. This conquest of extreme cold, so that it can be used in the laboratory as easily as any other reagent, has been an important item in the production of the nearly perfect vacuum which is necessary in some kinds of radio vacuum tubes, as was described in POPULAR RADIO for October, 1922.



### THE CONDUCTIVELY-COUPLED CRYSTAL CIRCUIT

*Cost of parts:* Not more than \$10.00.

*Selectivity:* Fairly good.

*Operation:* Very simple. Only two controls are used; a primary and a secondary slider.

*Ease of construction:* No technical knowledge necessary.

*Approximate range:* 15 miles.

*Outstanding features:* This circuit is especially suitable for the beginner who wants to start out by building the simplest set that will give him clear reception of local signals at the smallest cost.

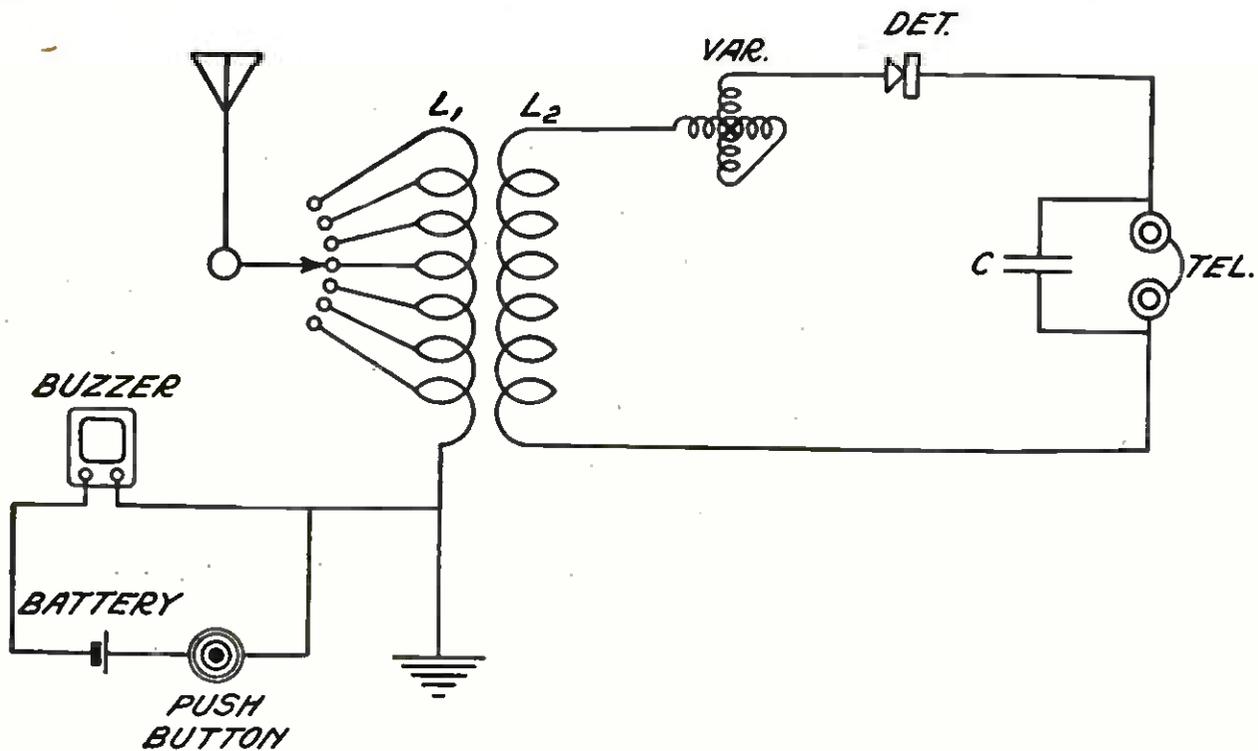
## The 100 BEST HOOK-UPS

### INSTALLMENT NO. 1

*A carefully compiled list of the most efficient receiving sets and the approximate costs, range and peculiarities of each; selected for the practical guidance of the radio novice*

**I**N choosing these circuits, careful consideration has been given to the various uses to which the apparatus may be put. The circuits have been rated under six different classifications which, it is believed, will enable the radio fan to pick out the one that is most suitable for his own particular needs. One hundred picked and tested radio receiving circuits, each one of which is best for its own particular field of usefulness, will be included in this hook-up series for the special benefit of the man who is undecided as to just what he wants. In his selection he will be influenced by (1) *the cost* of the parts; (2) *the selectivity* of the set—particularly if the experimenter is near numerous stations; (3) *the ease of operation*; (4) *the ease of construction*; (5) *the approximate range*, and (6) *the outstanding features* of the set.

The approximate ranges here given are yearly averages on actual records made with receiving sets throughout the country. During the summer the actual ranges may fall to 50 percent of the value given, while in the winter, under the best of conditions, the actual ranges have been known to exceed the values given by as much as 500 percent.



THE INDUCTIVELY-TUNED CRYSTAL CIRCUIT

*Cost of parts:* Not more than \$15.00.

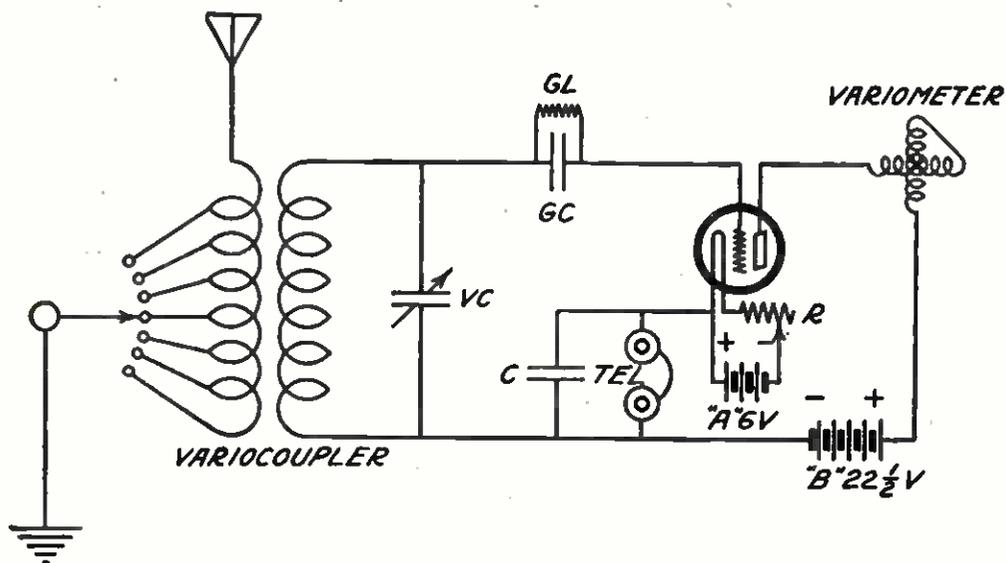
*Selectivity:* Good.

*Operation:* Fairly simple. The antenna circuit is tuned by a tapped switch, the secondary by a variometer and the coupling is varied by rotating the secondary coil of the variocoupler.

*Ease of construction:* Easy to build.

*Approximate range:* 15 miles.

*Outstanding features:* The set is sharp to tune on account of the loose coupling that can be employed, and it has a test buzzer which is a great help in setting the crystal in adjustment.



THE COMBINATION TUNED-PLATE, ULTRA-AUDION CIRCUIT

*Cost of parts:* Not more than \$25.00. (Note: The cost of tubes and batteries is considered "extra," and is not included in the costs given in these descriptions).

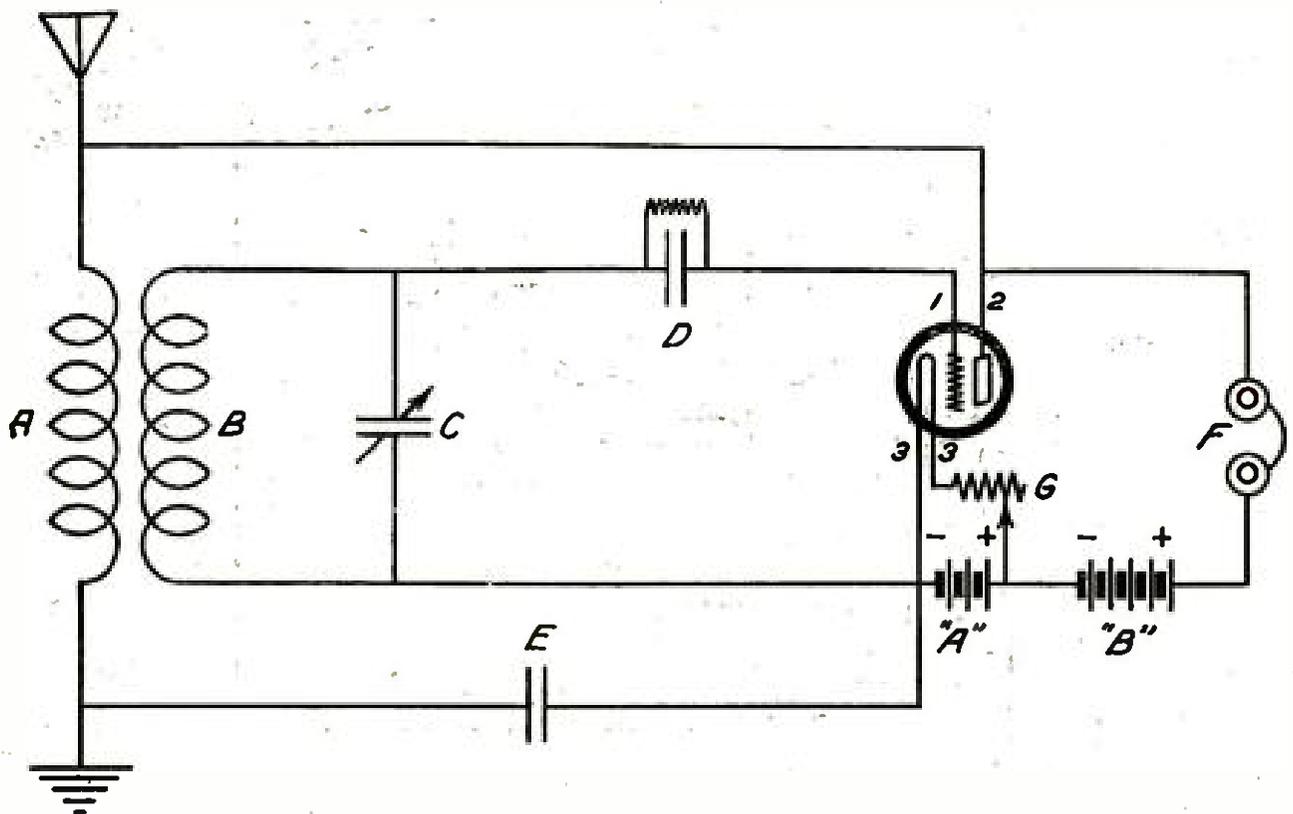
*Selectivity:* Excellent.

*Operation:* Requires considerable skill which can be acquired in a couple of months of experimenting with the tuning.

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

*Approximate range:* 500 miles.

*Outstanding features:* Exceptionally suitable for DX amateur work on CW. Tuning is very sharp and easy when it is learned correctly.



THE MAN-DAY SINGLE-CONTROL REGENERATIVE CIRCUIT

*Cost of parts:* Not more than \$12.00.

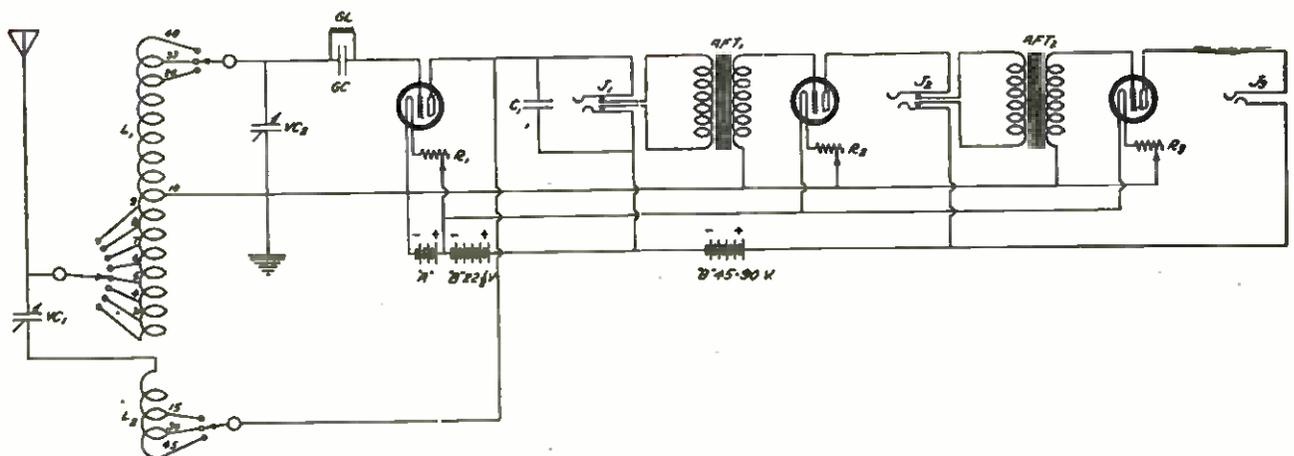
*Selectivity:* Excellent.

*Operation:* Very easy. Only one control for wavelength. Regeneration is adjusted with the filament rheostat.

*Ease of construction:* Simple.

*Approximate range:* 500 miles.

*Outstanding features:* This is the simplest regenerative circuit to tune. It is very selective and costs but little.



THE REINARTZ CIRCUIT, WITH 2 STAGES OF AUDIO AMPLIFICATION

*Cost of parts:* Not more than \$35.00.

*Selectivity:* Excellent on amateur wavelengths, very good on broadcasting wavelengths.

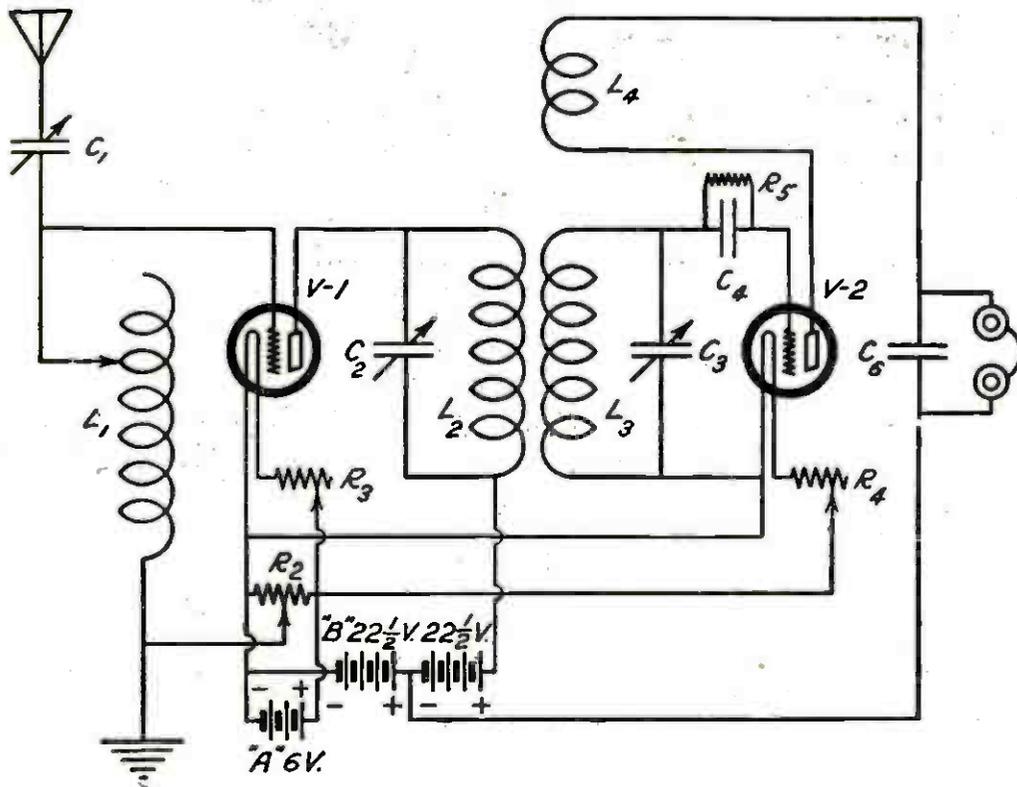
*Operation:* Easy when mastered; about a month's practice should suffice to become

well enough acquainted with the peculiarities of the tuning.

*Ease of construction:* Simple.

*Approximate range:* 1,500 miles.

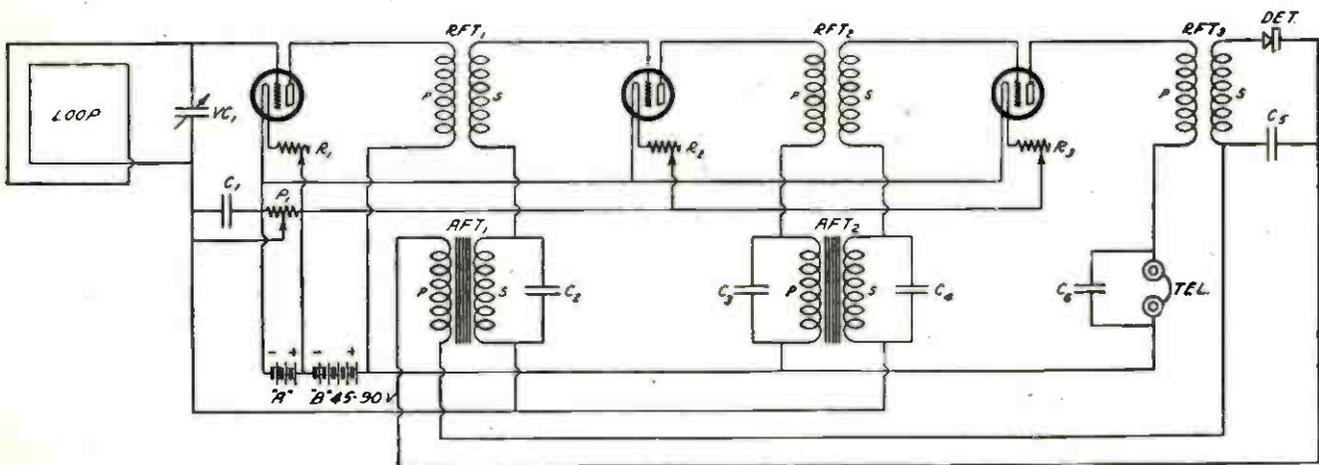
*Outstanding features:* It is noted for its DX amateur reception and its low cost.



**TUNED RADIO-FREQUENCY AND REGENERATIVE-DETECTOR CIRCUIT**

*Cost of parts:* Not more than \$28.00.  
*Selectivity:* Good.  
*Operation:* Rather complicated for a beginner.  
*Ease of construction:* Easy.  
*Approximate range:* 500 miles.  
*Outstanding features:* May be used with short

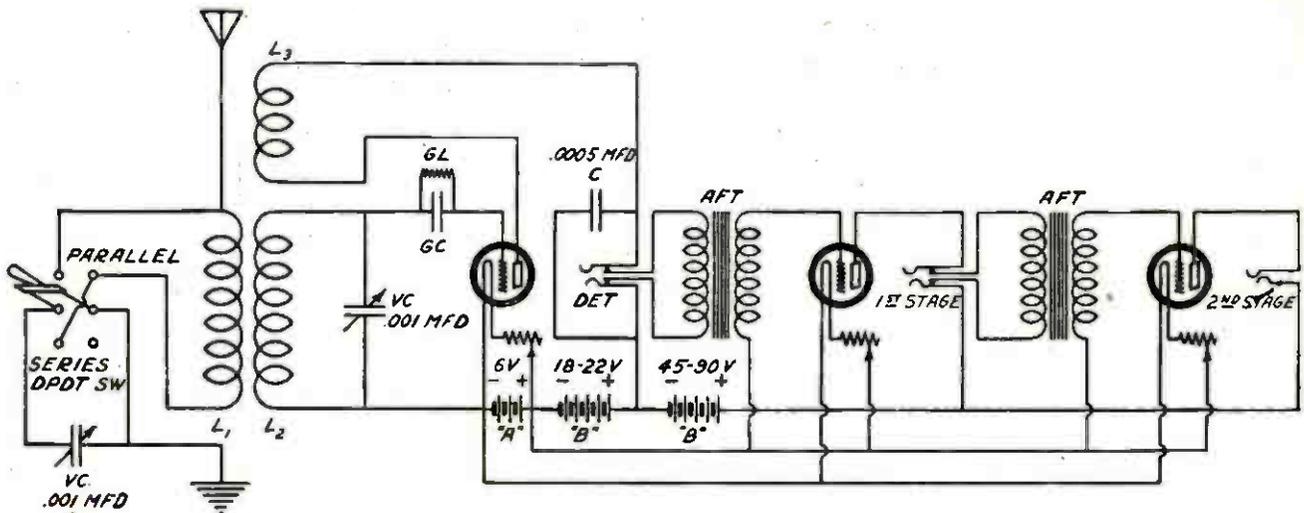
indoor antenna. It may be made from a single-circuit, honeycomb set to stop re-radiation, and may be used to give the builder a good idea of radio-frequency amplification before he tries out the more complicated circuits.



**THE SQUIRE REFLEX CIRCUIT**

*Cost of parts:* Not more than \$50.00.  
*Selectivity:* Excellent.  
*Operation:* Very simple. One control for wavelength and one control for regeneration; the only other adjustment that must be made is the setting of the crystal detector.  
*Ease of construction:* More or less compli-

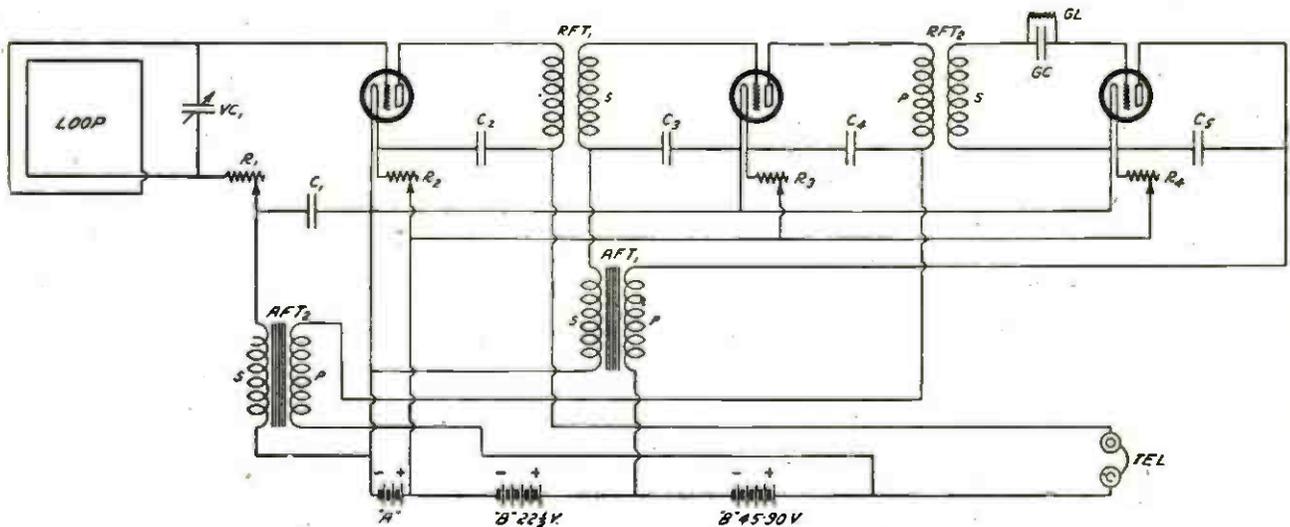
cated. There are a number of precautions that must be taken to get the circuit to operate at highest efficiency.  
*Approximate range:* 500 miles (with the loop antenna).  
*Outstanding features:* No outdoor antenna is needed for DX reception. Simplicity of tuning.



**TRIPLE-COIL, HONEYCOMB REGENERATIVE CIRCUIT WITH TWO STAGES OF AMPLIFICATION**

*Cost of parts:* Not more than \$35.00.  
*Selectivity:* Good.  
*Operation:* Rather complicated.  
*Ease of construction:* Not hard to make.  
*Approximate range:* 1,000 miles on the low broadcasting and amateur wavelengths and

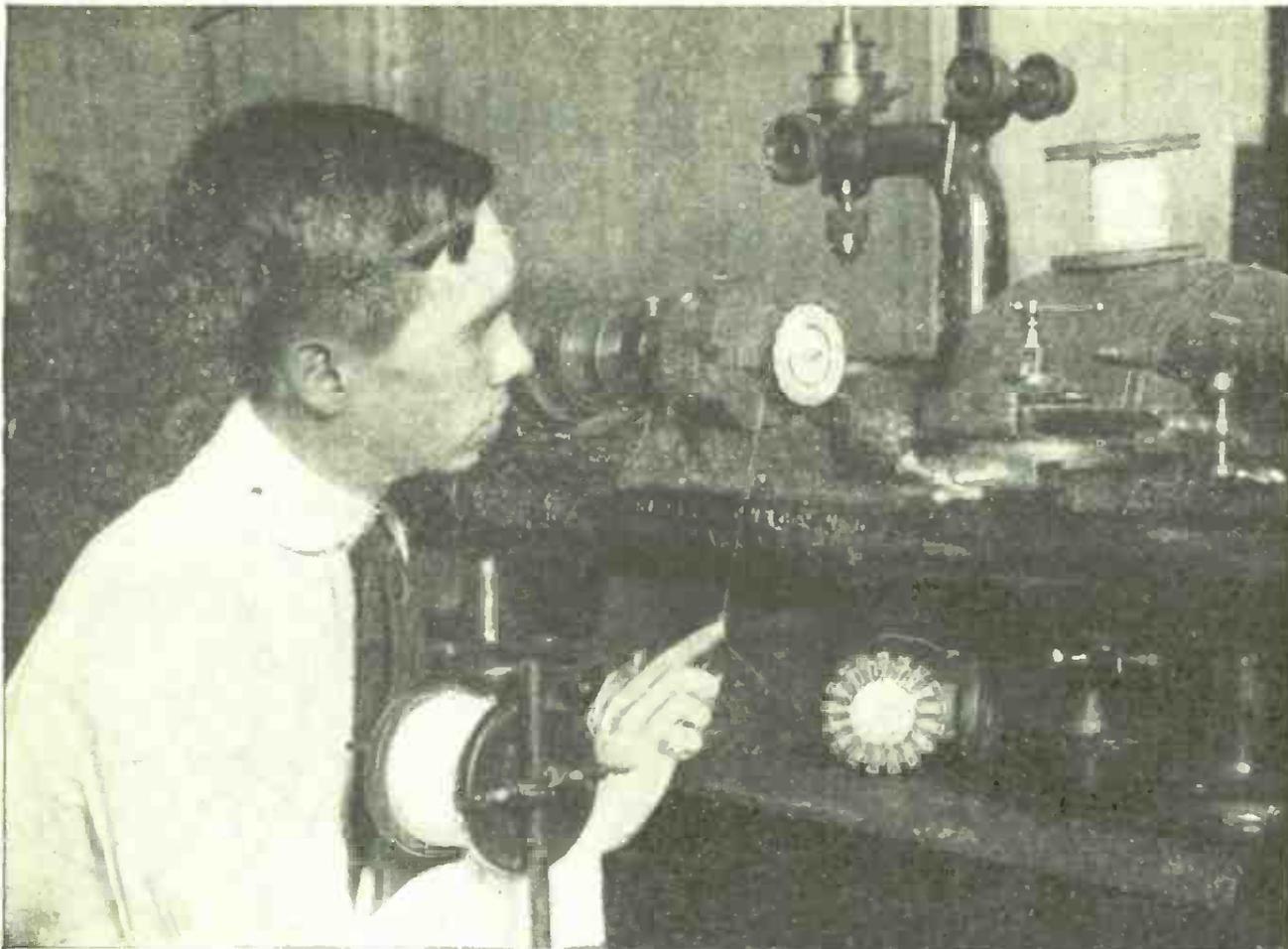
3,000 miles on the extreme high wavelengths.  
*Outstanding features:* It may be made to cover all wavelengths by interchanging coils. The coils may be plugged into sockets at will, thus making the set into a high or low wave receptor which is regenerative.



**THE GRIMES REFLEX CIRCUIT**

*Cost of parts:* Not more than \$40.00.  
*Selectivity:* Excellent.  
*Operation:* Extremely simple. Only one control for wavelength needed and one control for regeneration.  
*Ease of construction:* This is a quite complicated circuit to follow out and to get in operation. There are a number of details that will give the beginner trouble when he

first tries to make this set, but they can be overcome.  
*Approximate range:* 500 miles (with loop antenna).  
*Outstanding features:* No outdoor antenna is needed for DX reception. Simplicity of tuning. No crystal detector to bother with. The audio-frequency amplification is fed back to the next preceding tube in each stage.



Kadel & Herbert

#### WINDING A SPIDERWEB COIL

*For calculating the inductance for the various shaped coils, used in radio for reception, there are numerous formulas which are applicable to only one of the types or shapes of coils.*

## HOW TO CALCULATE The Inductance of Your Coils

No. 6 of a series written especially for POPULAR RADIO

For this kind of mathematical foretelling of the electrical characteristics of coils, a number of standard formulas have been developed, but for a given type of coil a given formula must be used, if accuracy is to be attained. Some interesting formulas and helpful information on how to use them are brought out in this article.

By SIR OLIVER LODGE, F.R.S., D.Sc., LL.D.

THE expression given by Maxwell for the inductance of any compactly wound coil whose diameter is considerably greater than its width, is the following:

$$L = 4\pi n^2 r \left( \text{Log}_e \frac{8r}{R} - 2 \right)$$

Where  $r$  = the mean radius of the coil,  $n$  = the number of turns of wire,

$R$  = the geometric mean distance of the points in the section of its winding.  $R$  = one-quarter of the width and depth of the wound channel, added together.\*

In applying this formula it is neces-

\*This is sufficiently accurate for ordinary purposes. Thus, suppose the width was half an inch and the depth a quarter of an inch, the value of  $R$  would be a quarter of three-quarters, or three-sixteenths of an inch.

sary to remember that the numerator of the fraction inside the brackets, whose natural logarithm is to be taken, must be decidedly bigger than the denominator—at least ten times greater—otherwise the 2 cannot be subtracted from it without causing error or even absurdity. For  $\log_e 10 = 2.3$ , and the balance is dangerously small, even then. It is necessary, therefore, that the radius  $r$  be itself at least double or treble the greatest sectional dimension, for then the margin is adequate and the formula applicable.

A much more elaborate expression to cover any case, is given by Maxwell, and simpler ones have now been invented and may be cited in due course.

Meanwhile we may examine the above expression to see when it is a maximum for a given length of wire. It is plain that the length of wire wound on the coil will be the number of turns multiplied by the average length of a turn, namely  $2 \pi r$ ; or  $l = 2 \pi n r$ . So the expression is:

$$L = 2 n l \left( \log \frac{8 r}{R} - 2 \right)$$

Having decided on the *shape* of the section or channel for the winding (say square), it is plain that  $R$  varies with its linear dimensions, and that therefore,  $n$  varies as  $R^2$ . It also varies inversely as  $r$ , for a given length of wire. Putting these things together, it follows that  $L$  is a maximum when

$$\log \frac{8 r}{R} = 3\frac{1}{2}$$

and that accordingly the maximum value of  $L$  is  $3 n l$ , which is the same as  $6 \pi n^2 r$ .

We will return to this extremely simple expression for maximum inductance,  $L = 3 n l$ , shortly. If  $T$  is the thickness of the covered wire, and  $b$  is the side of the square in which it is wound, it is obvious that

$$n T^2 = b^2$$

Hence the maximum self-inductance is

$$L = \frac{6 \pi r b^4}{T^4}$$

But the condition

$$\log \frac{8 r}{R} = 3\frac{1}{2}$$

gives us

$$\frac{8 r}{R} = e^{3\frac{1}{2}} = \sqrt{e^7} = \sqrt{(1096 \cdot 6)} = 33 \cdot 11$$

Or

$$\frac{r}{R} = 4.14$$

Whence, for a square section,

$$\begin{aligned} r &= 4.14 \times .45 b \\ &= 1.863 b \end{aligned}$$

The outside diameter is

$$2 r + b = 4.726 b$$

The inside diameter is

$$2 r - b = 2.726 b;$$

so that

$$D = 1.734 d.$$

Now since  $r = 1.863 b$ , the maximum  $L$  may be written

$$\begin{aligned} 6 \pi \times 1.863 \times \frac{b^5}{T^4} \\ = 35.1 b^5 \\ T^4 \end{aligned}$$

### The Preceding Articles of This Series by Sir Oliver Lodge—

1. HOW TO GET THE GREATEST EFFICIENCY OUT OF YOUR RADIO  
CIRCUITS ..... *March, 1923*
2. HOW TO GET THE MAXIMUM INDUCTANCE IN YOUR COILS..... *May, 1923*
3. THE RATIO IN SIZE BETWEEN YOUR ANTENNA AND YOUR COIL..... *July, 1923*
4. HELPFUL FORMULAS FOR DESIGNING YOUR COIL..... *September, 1923*
5. PRACTICAL HINTS FOR COIL CALCULATION..... *October, 1923*



Kadel &amp; Herbert

### WINDING AN ORDINARY SOLENOID COIL ON A LATHE

*This is the most used type of coil in this country, for reception below 600 meters. The wire is usually wound on a composition tube and the turns run in a single layer, each turn lying beside the preceding turn.*

or, using  $n$ , to express the number of turns per unit breadth,

$$L_m = 35 \cdot 1 n^4 b^5 *$$

Given the inductance required, and also the thickness of covered wire to be used, this determines  $b$  the size of the groove which is to be filled with wire.

$$b = \frac{1}{2} \sqrt[5]{L T^4}$$

We know that the mean radius of the bobbin is  $r = 1.863 b$ , so the external diameter of the bobbin is  $\frac{14}{8} b$ , while the internal diameter is  $\frac{8}{8} b$ .

(More exactly, of course, the fifth root of 35.1 is not 2 but 2.04.)

*Example:*

Let the inductance required be 1,600

\*Only simple arithmetic is needed to convert this into the formula previously given:  $66.6 L = D^5 T^4$ .

meters, and the thickness of covered wire half a millimeter. Then

$$L T^4 = \frac{1,600,000}{16} = 10^5$$

So approximately we get for breadth and depth of section,  $b = \frac{10}{2.40} = 4.9$  millimeters.

For external diameter  $D = 23$  millimeters.

For internal diameter  $d = 13$  millimeters.

For mean radius  $r = 1.863 b = 9.13$  millimeters.

For number of turns

$$n = \frac{b^2}{T^2} = 96$$

For length of wire

$$l = 2 \pi n r = 5,520 \text{ millimeters} \\ = 5\frac{1}{2} \text{ meters}$$

If we check this by reckoning back to the inductance as  $3 n l$ , an expression as obtained a few paragraphs above, we shall find it about right. This extremely simple expression,  $3 n l$ , for maximum inductance, when the proper conditions are satisfied, is perhaps not of much use for predetermination, but it is handy for checking. It is worth considering, moreover, whether its simplicity does not make it useful even for the beginning of predetermination; and this we will do in another article.

If we need to know the inductance, or the resistance, or any other feature, of a coil extremely accurately we must determine it by direct experiment. Its estimated value can only be a first approximation, unless excessive precautions are taken and an elaborate calculation made.

But it may be asked, "Is no notice to be taken of the thickness of the uncovered wire—the conductor itself?" We always seem to attend to the thickness of the covered wire instead of to the bare copper. Well, there is a small correction to represent the concentration of the current in the core of the wire sheath. It takes the form of a small addition to the inductance, and Maxwell's complete expression for a ring-shaped compactly wound coil of large diameter is not merely what is quoted above, but has an additional term, so that it may be re-written thus:

$$L = 4 \pi n^2 r \left\{ \log_e \frac{8r}{R} - 2 + \frac{1}{n} \left( \log_e \frac{T}{t} + .12 \right) \right\}$$

where  $\frac{T}{t}$  means the ratio of the thicknesses of the covered to the bare wire.

The fact that the logarithm of this ratio has to be divided by the number of turns, before using it as a correction inside the bracket, shows that it is but a small correction, even when the covering of the wire is thick.

We will only attend to it for a coil shaped so as to give maximum inductance, and in that case the formula becomes

$$L = 3 n l + 2 l \left( \log_e \frac{T}{t} + .12 \right)$$

Or practically

$$\frac{L}{l} = 3 n + \log \left( \frac{T}{t} \right)^2$$

So for a coil of many turns the correction is small, but it always tends in the direction of increase.

Taking an extreme case, in which the covering is so thick that  $T = 10 t$ , then for a coil of 100 turns the factor with which to multiply  $l$  is not 300 but 305, when the correction is applied

### Coils of Other Shapes

For the calculation of the inductance of coils in general several formulas have been elaborated by the mathematicians. Some of these are appropriate for one shape, some for another.

For compact coils, of which the dimensions of the wound channel are small compared with the diameter of the whole coil, the fundamental formula of Clerk Maxwell is probably the best. But for elongated or spread out coils—those in the shape of a long cylinder, for instance—a quite different formula is more serviceable. The Maxwellian one would then be unwieldy, and in its simple form altogether inapplicable.

For elongated or cylindrical coils an expression was worked out by Cohen.\*

It applies to a single-layer coil whose length is not less than four times its diameter, and runs thus:

$$L = 4 \pi^2 n_1^2 r^2 \left( \frac{2r^2 + b^2}{\sqrt{(4r^2 + b^2)}} - \frac{8r}{3\pi} \right)$$

where  $b$  is the length of the helix (i.e., the breadth of the coil),  $r$  its radius, and  $n_1$  the number of turns per unit length.

Neglecting  $r^4/b^4$ , that is, taking the ratio  $r:b$  as moderately small, this can be simplified down to the following very handy formula, with  $n_1 b$  replaced

\*See the *Bulletin of the Bureau of Standards*, U. S. A., Volume 4, page 385, for 1907-8.

\*See also *The Appendix to Professor Pierce's "Principles of Wireless Telegraphy,"* page 341.



Bureau of Standards

## A U. S. STANDARD OF INDUCTANCE

*This is one of the standard inductance coils, used by the Bureau of Standards at Washington, D. C., for actual inductance measurements of other coils. The standards are matched up with other coils of unknown inductance in a bridge-circuit and their inductance is thus determined.*

by  $n$  the total number of turns of wire,

$$L = \frac{4\pi^2 n^2 r^2}{b} \left( 1 - \frac{8}{3\pi} \cdot \frac{r}{b} \right)$$

Or in other words,

$$L = \frac{\text{square of total length of wire}}{\text{length of coil}} \left( 1 - \frac{8}{3\pi} \cdot \frac{r}{b} \right)$$

where the correction factor in brackets is of less and less importance as the helix is longer and narrower.

Example: Take a coil 1 meter long, wound with covered wire 1 millimeter thick, the diameter of the coil being 20 centimeters, so that  $\frac{r}{b} = \frac{1}{100}$ . The number of turns will be 1,000, and the

total length of wire 20,000  $\pi$  centimeters. So

$$L = \frac{(\text{Length of wire})^2}{\text{length of coil}} \left( 1 - \frac{8}{3\pi} \frac{r}{b} \right) \\ = \frac{4 \times 10^8 \pi^2}{100} \left( 1 - \frac{8}{30\pi} \right)$$

$$= 36.6 \times 10^8 \text{ centimeters} = 366 \text{ kilometers.}$$

If the coil is only fairly long, and the ratio of its radius to its length be called  $x$ , then a few additional correcting terms, due to Dr. A. Russell, can be added, so that it becomes:

$$L = \frac{\text{square of total length of wire}}{\text{length of coil}} \\ \left( 1 - \frac{8x}{3\pi} + \frac{1}{2}x^2 - \frac{1}{4}x^4 \right)$$

All expressions for  $L$  inevitably involve the square of the number of turns and the linear dimensions of the coil, so that the answer comes out as a length. All the rest of the formula consists of ratios of similar quantities, that is to say, of mere numbers. All such formulas, provided there is no error, will give the right order of magnitude for the inductance; on the assumption, of course, that the core is air, and not iron. But there will usually be some corrections to apply if accuracy is wanted. More accurate formulas are given in Eccles' Handbook to Wireless; but usually the accurate value is best obtained by experiment.

#### Disc Coil

The value of  $L$  for a disc coil of large aperture can be reckoned from Maxwell's formula.

Or we may re-write it in terms of external and internal diameter of the disc coil thus:

$$L = \pi n^2 (D+d) \left\{ \log_e \left( 16 \frac{D+d}{D-d} \right) - 2 \right\}$$

Let us apply this to a disc spiral of

external diameter 6 inches and internal diameter 2 inches.

$$L = 8 \pi n^2 (\log_e 32 - 2) \text{ inches}$$

Or if there are 10 turns in the spiral,

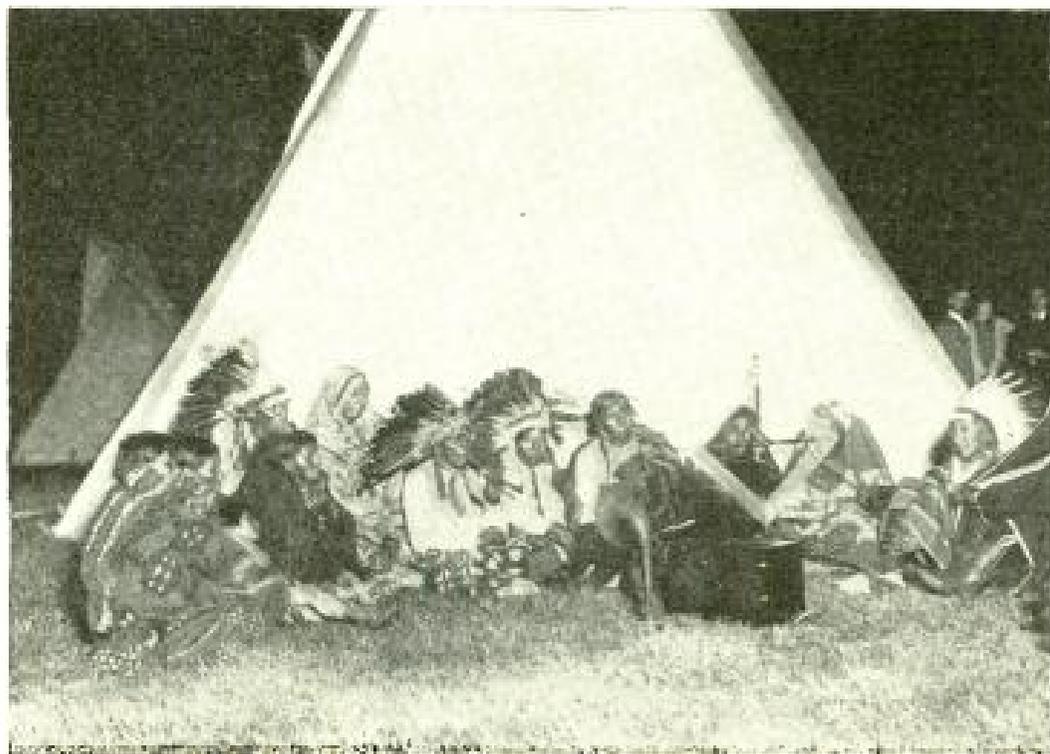
$$L = 2,500 \times 1.466 = 3,700 \text{ inches}$$

or about 100 yards.

It is remarkable how nearly the simple expression  $3 n l$  happens to agree with this. But it won't apply at all to the case of a long cylindrical coil or solenoid. It would give a result much too big for such a coil; though it is nearly right for a disc.

A long coil may be convenient for sliding contact purposes, but it does not give maximum induction. A disc coil on the other hand is not usually so far away; and indeed a properly shaped coil can be built up of disc coils.

The close addition of one disc coil to another similar one will practically quadruple the inductance, and therefore double the wavelength to be dealt with. A third coil will approximately treble the wavelength, the antenna or condenser capacity remaining the same.



Kadel & Herbert

*A group of Arapahoe Indians from Wyoming, camping in New York while on their way to England, get their introduction to radio.*



From a photograph  
made for  
POPULAR RADIO

THE ORIGINATOR OF THE FAMOUS SHORT-WAVE RECEIVER  
*Paul F. Godley, one of the most capable radio experts in the world, demonstrates  
a new method for picking up radio signals.*

## Receiving Without Antennas

How to use the ordinary regenerative set efficiently and economically without an outside antenna, without expensive radio-frequency amplifiers and without a complicated circuit

By PAUL GODLEY

**T**HERE is an increasing desire on the part of radio folks and would-be fans to receive without using an antenna. The usual excuse is that someone in the household is in fear of the effects of lightning when any overhead conductors run to the home.

Fears such as these are groundless. There is no more danger from an antenna than from electric light and telephone service, which have running to them overhead conductors elevated to practically the same extent that an an-

tenna needs to be elevated. The mystery which is wrapped up in radio seems to carry with it, for many, some of this unfounded fear. Thus it is we find experimenters, writers, and manufacturers trying to cater to this demand.

Circuits of one sort or another have been devised which enable broadcast reception without the use of an antenna. Mainly these have been comprised of multi-stage amplifiers of the radio-frequency type; so far as the writer knows, no general attempts have been

made to take advantage of the inherent sensitivity of regenerative circuits in conjunction with "antenna-less" outfits.

In passing, two interesting facts might be observed. (1) The cheapest and most effective form of radio amplification which has ever been devised for use in conjunction with an antenna-less radio receiver may be constructed at a cost of a few dollars. In effect it will equal or surpass three stages of the best radio-frequency amplification which the writer has ever seen. It is comprised of an average-sized antenna and a good earth connection.

(2) As compared to hazards involved by telephone and electric light connection due to lightning or other cause, the lightning hazard of an antenna is, at least, small.

Multi-stage radio-frequency units depend as a rule for excitation upon the energy collected by a loop antenna consisting of a few turns of wire on a square frame, two feet or so on a side, and almost invariably the circuits call for a ground connection. Upon trying circuits of this sort, it is immediately

learned by the experimenter that if the ground connection is left off the strength of the received signal is materially weakened. From this it must be assumed that all of the energy which excites the outfit does not come to it through the loop antenna; that the ground connection in itself is in some manner acting as an antenna; that currents are being generated in the earth and fed up to the receiver through the ground connection.

It takes but a moment for even the uninitiated experimenter to prove to his own satisfaction that the currents generated in the loop antenna, such as that described briefly above, are small indeed as compared to those generated in an overhead antenna of average dimensions. In other words, the difference of potential which exists between the points A, and B, in the antenna circuit of Figure 1-A are quite large as compared to those differences in potential existing between points A, and B, in Figure 1-B. The ratio of those potentials will run somewhere in the neighborhood of one hundred to one. If the ground connection is run directly to

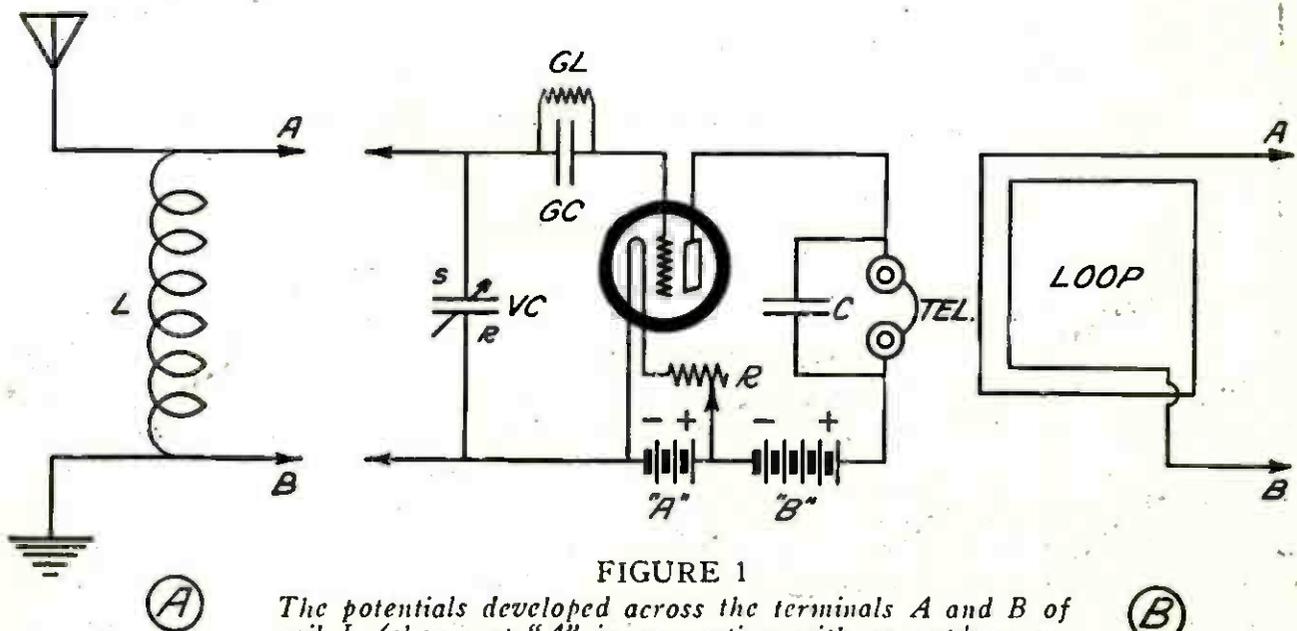


FIGURE 1

The potentials developed across the terminals A and B of coil L (shown at "A" in connection with an outdoor antenna) are of enormously greater amplitudes than those developed across A and B of the loop antenna (shown at "B"). If either of these two pick-up systems were used with the vacuum-tube detector circuit (shown in the middle of the diagram), scheme "A" would therefore be immeasurably better.

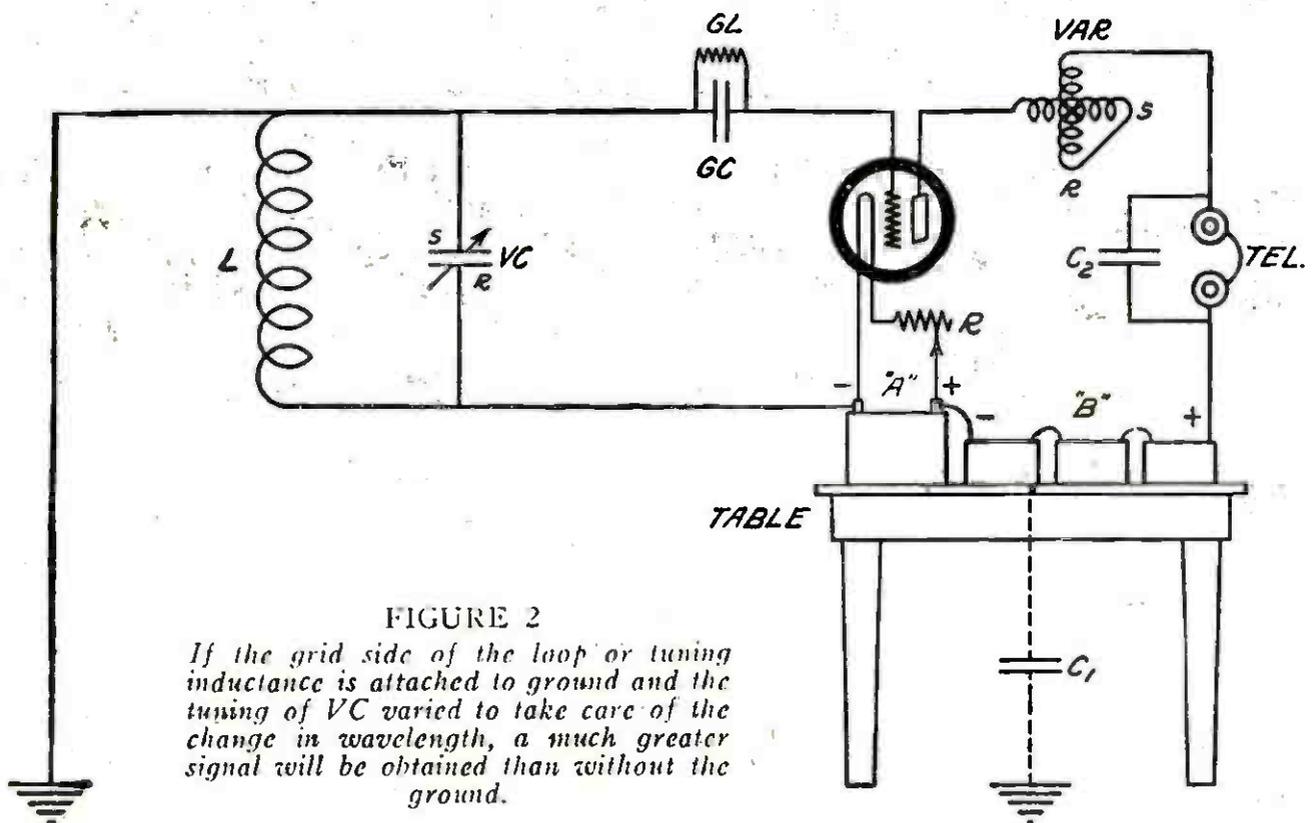


FIGURE 2

If the grid side of the loop or tuning inductance is attached to ground and the tuning of VC varied to take care of the change in wavelength, a much greater signal will be obtained than without the ground.

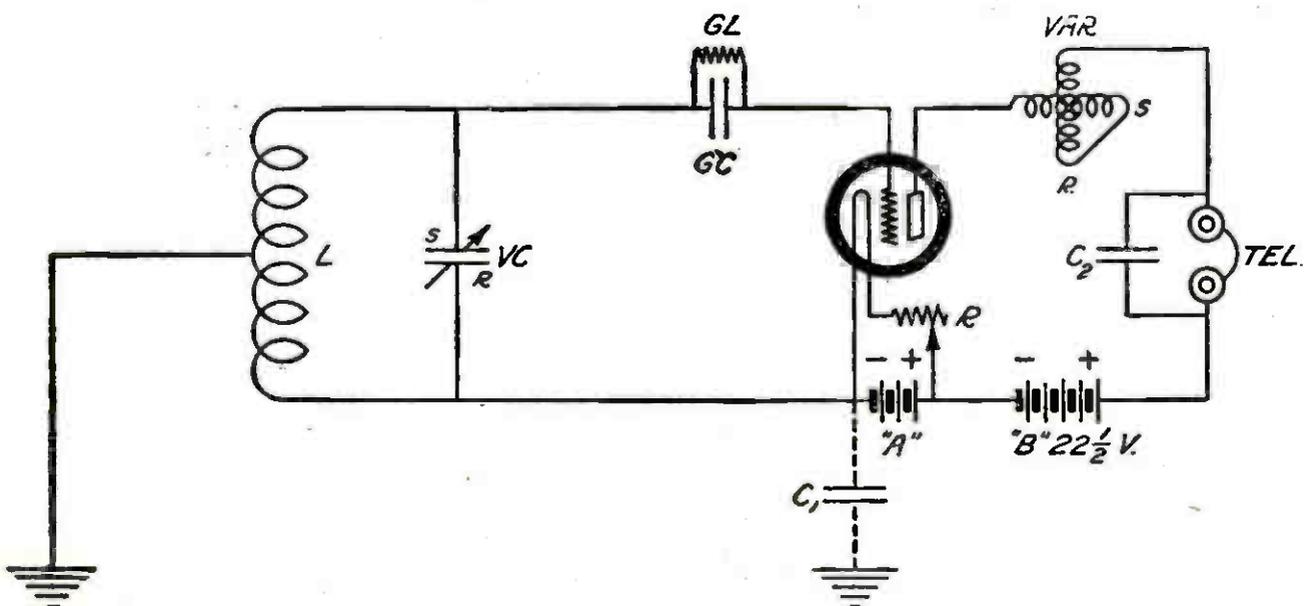


FIGURE 3

A still greater signal may be obtained by this method of grounding in which the ground is taken off somewhere in the middle of the loop or tuning inductance.

the grid of the vacuum tube (as shown in Figure 2) and if proper compensation is made in the tuning element of Figure 2 so as to allow for the change in wavelength which results, surprisingly large values of signal will be fed into the outfit as compared to those fed into it by the loop alone. The ratio of the signal potentials picked up on the

average ground connection, as compared to those picked up by the average antenna, is about twenty to one in favor of the antenna. This ratio will vary a great deal, however, depending upon the type of ground connection. Where the ground connection is a long one, the energy picked up will be greater; if the ground connection is a

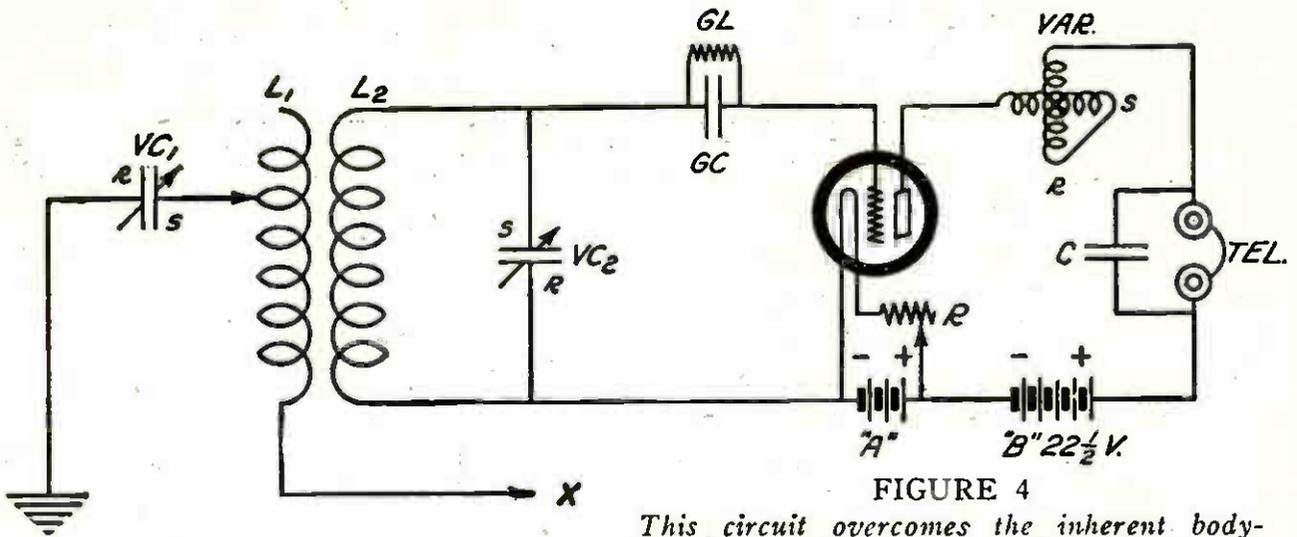


FIGURE 4

This circuit overcomes the inherent body-capacity troubles encountered in the circuits of Figures 2 and 3.

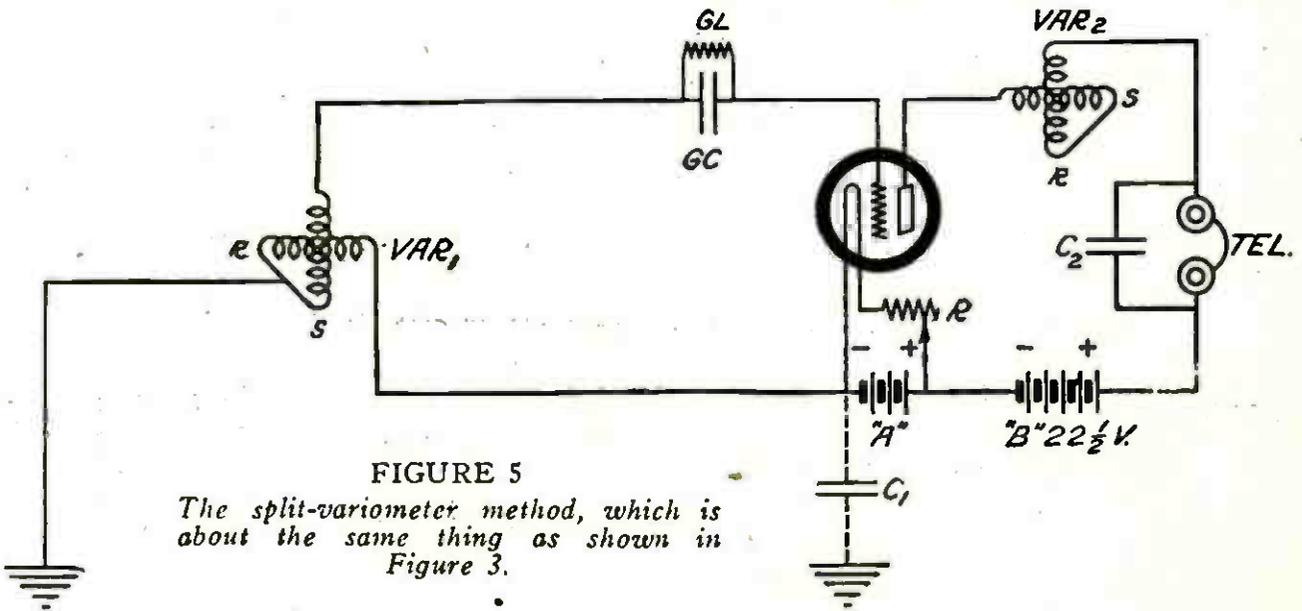


FIGURE 5

The split-variometer method, which is about the same thing as shown in Figure 3.

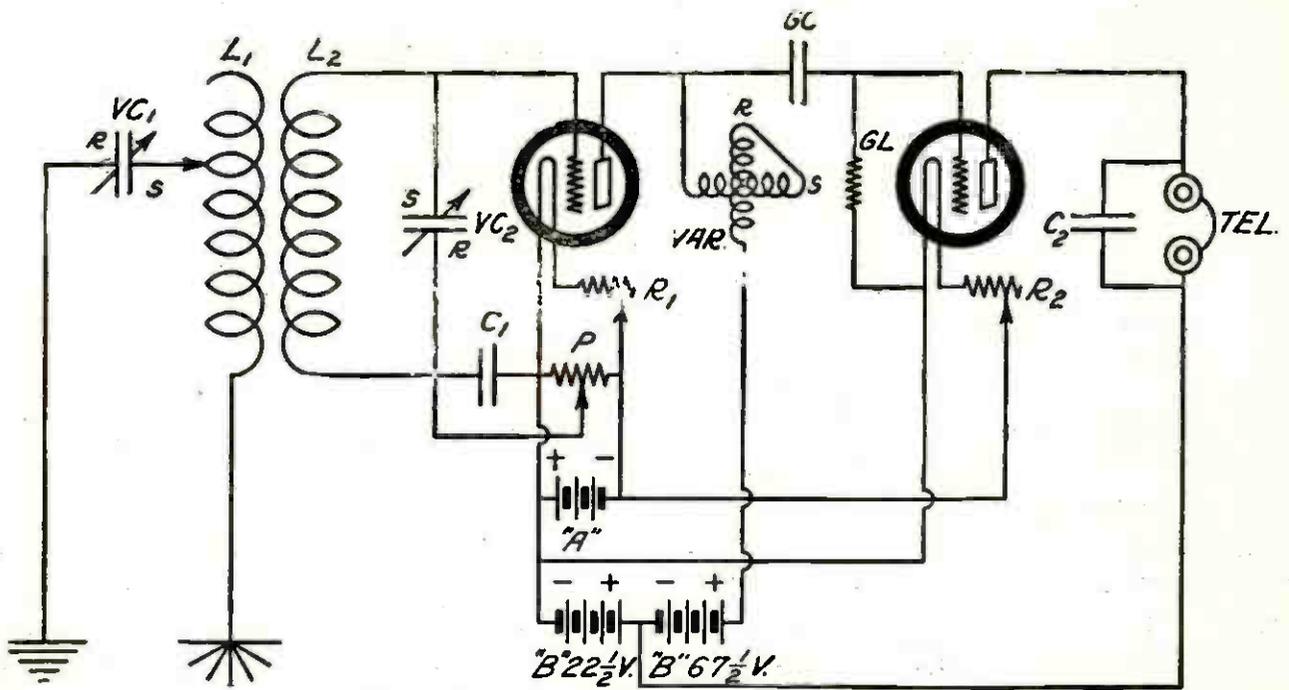


FIGURE 6

One stage of tuned, regenerative, radio-frequency amplification added to Figure 4.

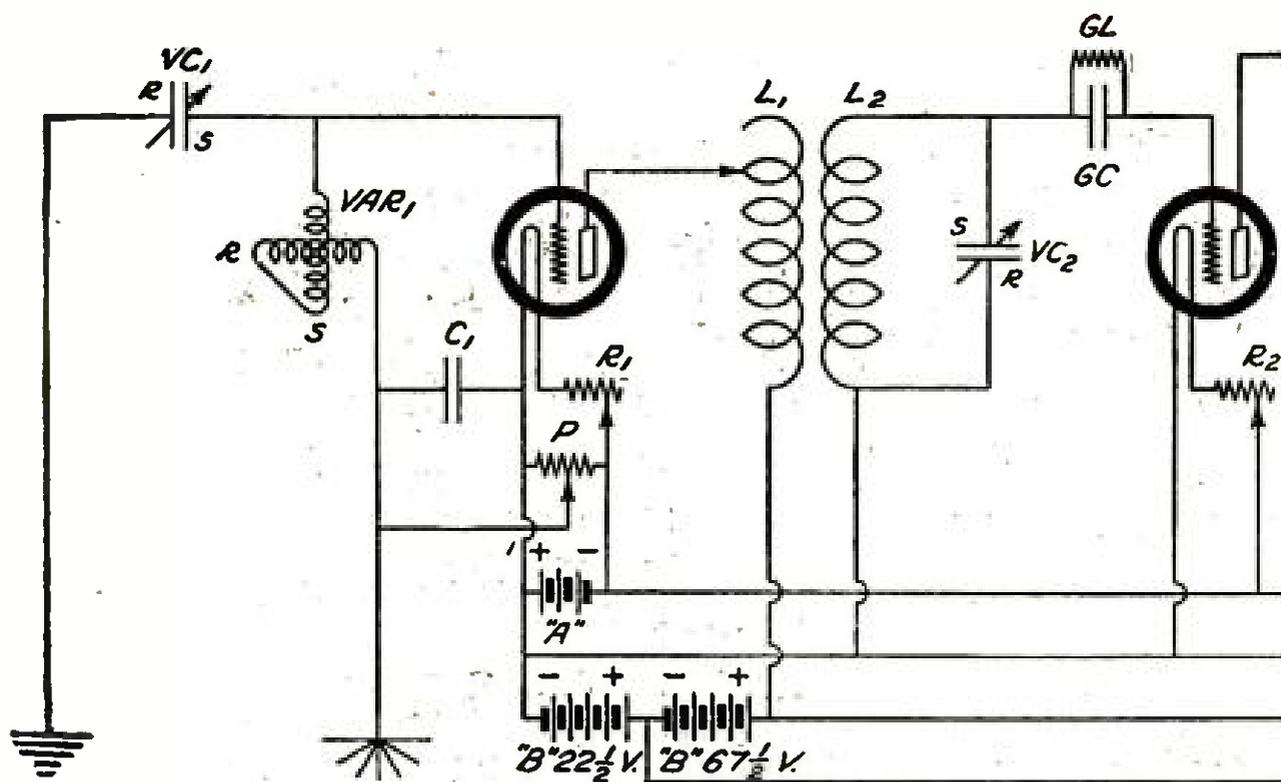


FIGURE 7

The best circuit arrangement of all to use. This is a standard three-circuit regenerative receiver, with the tuned ground circuit, one stage of radio-frequency amplification and two stages of audio-frequency amplification.

short one, it will be *less*. In the average home, however, this ratio of approximately twenty to one will hold true.

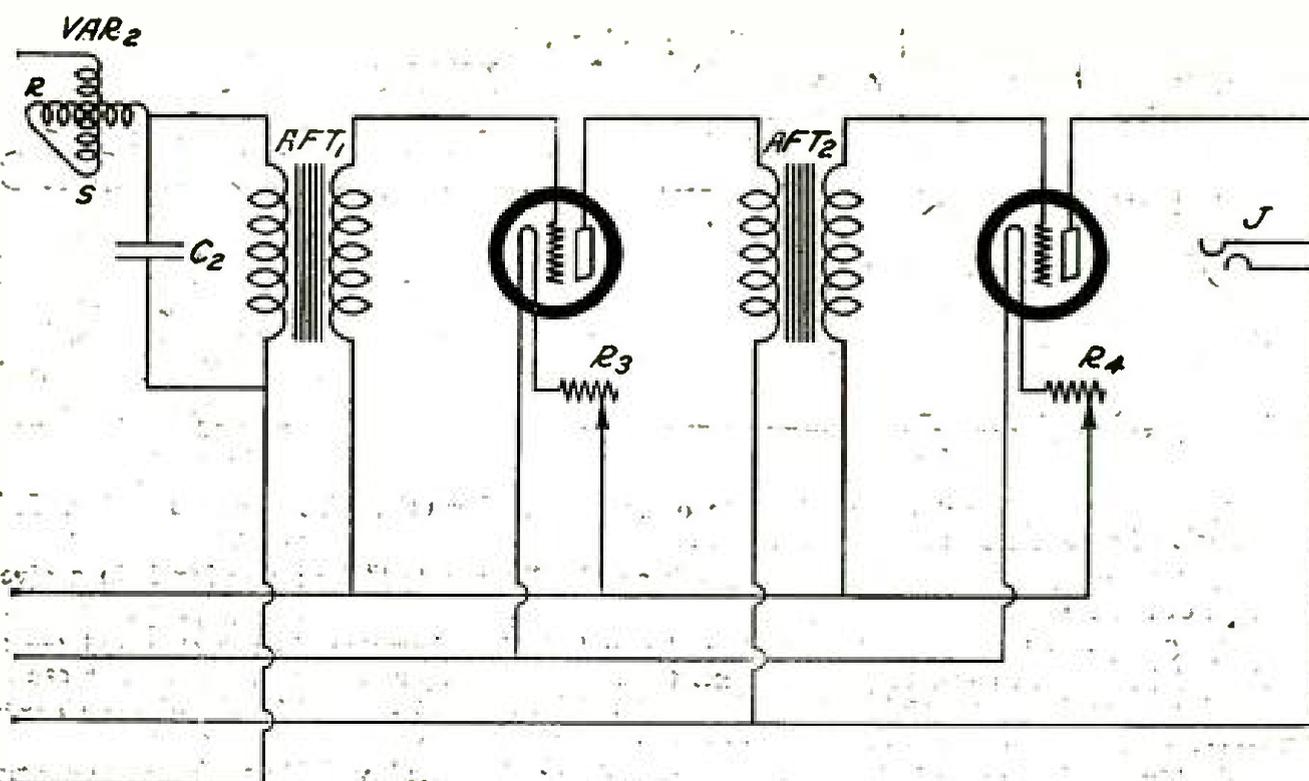
Connecting the ground to the grid of the vacuum tube is *not* desirable, however, for the reason that the size of the capacity C-1, is large. (This capacity C-1, is formed by the receiver and its battery which go to make up one plate of a condenser, and the ground which forms the other plate. The insulating material, air, or whatever it may be, between the receiver and the earth, forms the dielectric. Its value will, of course, vary, depending upon the location of the receiver with respect to the earth.)

A better method of connection is that shown in Figure 3, where a tap is taken out of the center of the grid inductance and grounded. This, however, has not completely eliminated the difficulty of the shunt capacity; furthermore, both the methods of Figure 2 and Figure 3 place the filament circuit of the receiver at a potential considerably above earth

potential, which results in serious difficulties as soon as one attempts to tune the outfit, as the operator's body in approaching the receiver will alter the value of the capacity C-1, in either case, with the usual baffling result.

The circuit shown in Figure 4 overcomes these difficulties and results in the same signal strength. Figure 4 is easily arranged in conjunction with any standard three-circuit receiver and may be set up without any great amount of difficulty when using a single-circuit receiver (merely by supplying and coupling an extra inductance L-1).

Figure 5 indicates a method of utilizing the earth pick-up where the receiver is comprised of two variometers, one in the grid circuit and one in the plate circuit. In this case, the earth is connected to the mid-point of the grid variometer. On account of this connection and that shown in Figure 3, circuits of this type have been classed as "split circuits," although reference to Figure 3 will indicate that there is noth-



ing particularly novel about the arrangement.

Figure 6 shows the circuit of Figure 4 except that the vacuum tube coupled directly to the pick-up connection (ground) acts as a tuned regenerative, radio-frequency amplifier. Difficulty will be had with this circuit due to its persistent tendency toward oscillation unless some method is used to control the oscillations. A potentiometer may be connected as shown in Figure 6 so as to throw *positive* potentials upon the grid of the radio amplifier. Or resistance may be placed in the grid circuit of the radio-frequency amplifier tube, but, this broadens the tuning to a marked degree unless the circuits are on the verge of oscillation at all times, and is, for this reason, undesirable. It is far better to use the potentiometer method shown or to regulate the amount of potential fed to the plate circuit of the radio-frequency tube.

Figure 7 is perhaps the best circuit of all; in this a single stage of tuned-radio-frequency amplification is employed. Here a standard three-circuit, regenerative receiver is connected with the radio-frequency amplifier as shown.

The variable coupling between the output circuit of the radio-frequency amplifier and the input circuit of the detector in the regenerative receiver will provide complete control over the tendency toward oscillation in the radio-frequency circuit. Tuning the pick-up circuit may best be accomplished by utilization of a variable condenser as shown, or by the substitution of a variometer for the inductance  $L$ , in this circuit.

Using the combination shown, it is usually possible, either in the city or the country, to pick up signal strength of sufficient order to operate a loud-speaker satisfactorily from a two-stage amplifier at distances of twenty-five or thirty miles from the broadcasting stations. This is particularly true when the tuned-radio-frequency unit is used.

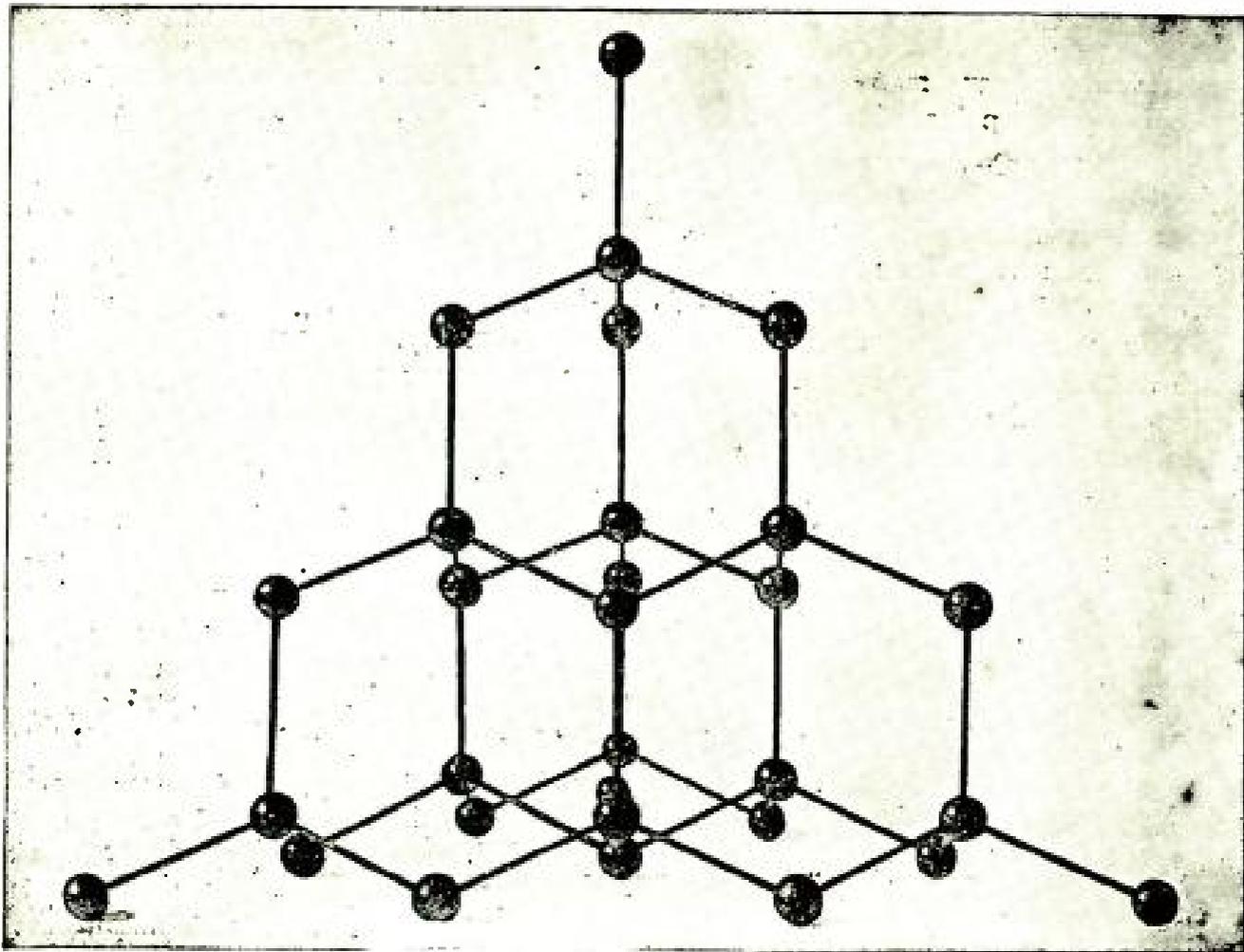
Those who are in the habit of carrying radio receivers to remote places will find it easy indeed by substituting a wire fence for the ground connection, to pick up distant stations. Railway tracks, exposed water lines, wires thrown into the bed of a brook or small stream, and other similar connections have been used with remarkable success in just this way.



## HINTS FOR Learning the Code

By EDWARD R. LEIGHT

1. Do not let your thoughts divert to other things. Form the habit of concentrating. It is the basis of all success in learning the code.
2. WHEN you memorize the code, make it an "intelligence test" by mastering it in a given length of time.
3. ONCE you have learned the code and you "miss" a character, do not stop and try to think of it. It will come to you the next time. If the group is a word, the character can be filled in; otherwise you have lost the entire group. The habit of holding on to characters, temporarily forgotten, retards the progress in speed.
4. THE beginner who insists on counting the dots and dashes invariably confuses one character with another, particularly when trying to copy speed.
5. Go over the characters in your mind in between times; not by so many dots and dashes but by the sound. For instance Y is—dah-dit-dah-dah.
6. EACH code character is a musical sound. Memorize it in that way. If you must begin by counting the dots and dashes, do so. But save time and acquire speed by reverting to the sound method as soon as possible.
7. Do not attempt to put a character down before it has been completed. Read ahead and write at least one or two characters behind the key.
8. IN copying well behind the key there is ample time to determine doubtful characters before you come to them, to space the groups or words properly and to make a neat copy.
9. THE habit of writing two or more characters behind the sender comes from retaining groups or words in the mind; that is, by having someone send press, word at a time, which must not be written down but connected in the mind and called off as completed. Begin with short words, sent slowly, and increase in length and gradually in speed.
10. THE habit of trying to guess the words and attempting to write them down before they have been completed is a bad one. In many instances the word turns out to be other than that expected and the result is that you become disconcerted and lose the rest of the message.
11. MAKE the characters legible. I's and E's, T's and L's and K's and H's, for instance, should not resemble each other. Dot the I's and J's, cross the T's and distinguish M's, N's and U's from each other.
12. WHEN you send, round out the characters properly. Make the dashes of equal length, the dots in proportion, and evenly and equally spaced.
13. DON'T try to send fast at first. Learn to form the characters correctly; then send slowly and work up in speed as you grow in proficiency.
14. AVOID jerky sending. This is generally the result of holding the muscles stiff. Let the forearm rest on the table; let the muscles relax and put the movement in the wrist. This rests the arm and makes it easier to form the characters correctly.
15. To send fast is one thing; to send fast correctly is another. Become known for having a good "fist" by first practicing slowly and carefully.
16. THE habit of letting the fingers come in contact with the metal of the key while sending is a bad one. It will eventually result in a shock.
17. WHEN you make an error in transmission make two interrogation marks, instead of a series of dots, and then begin the word anew.
18. SEPARATE the heading of the message from its body by a break or double dash; likewise the body and signature.



From a photograph made for POPULAR RADIO by Hoppé, London

### HOW THE ATOMS OF CARBON ARE ARRANGED INSIDE OF A CRYSTAL OF DIAMOND

*As they would look if they were magnified several million times. The model was made by Sir William H. Bragg.*

## The Crystal Houses that Atoms Build

By WALDEMAR KAEMPFERT

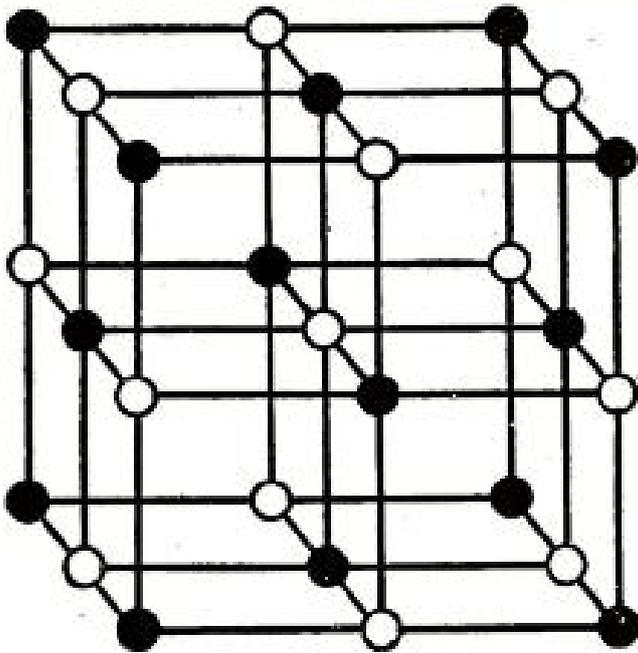
PICK up a brick. How heavy, how solid and substantial it seems. Look at the heavens above you—at the distant moon, at the still more distant stars. How empty seems the sky for all the myriad twinkling suns and planets in that vast black canopy. Yet the brick in your hand is relatively no more solid than the immense expanse above you. If you could but magnify it to the dimensions of the solar system the atoms of the brick would be millions of miles apart.

Any solid, a chair, a table, the flesh of your body is emptier than it seems—an aggregation of countless atoms, but atoms separated from one another by distances that are comparatively as awe-inspiring as those that greet the astronomer's eye. Hundreds of comets have swept through space without colliding with planets or suns, and a comet far smaller than an atom might theoretically swim through a seemingly dense brick just as readily.

Medieval churchmen were given to

speculating how many angels could stand on the point of a needle. The modern conception of a solid's spaciousness of structure is not to be classed with similar idle vaporings. It would take a million million million atoms to fill the head of a pin, but the positions of atoms in many substances are as definitely known as those of the blocks of stone and of the steel beams and girders that compose the Woolworth Building. Physicists and chemists used to *guess* at the internal arrangement of atoms in an element or its compounds. Now they *know* how they are grouped because they have actually seen the groupings.

Two brilliant, painstaking, thorough scientists discovered a method of making the infinitely small atom tell the story of the part that it plays in chemical architecture. They have worked in such harmony that the one can hardly be mentioned alone. This follows not only because they are father and son, but because they have experimented together, reasoned together and written



THE SKELETON OF  
COMMON SALT

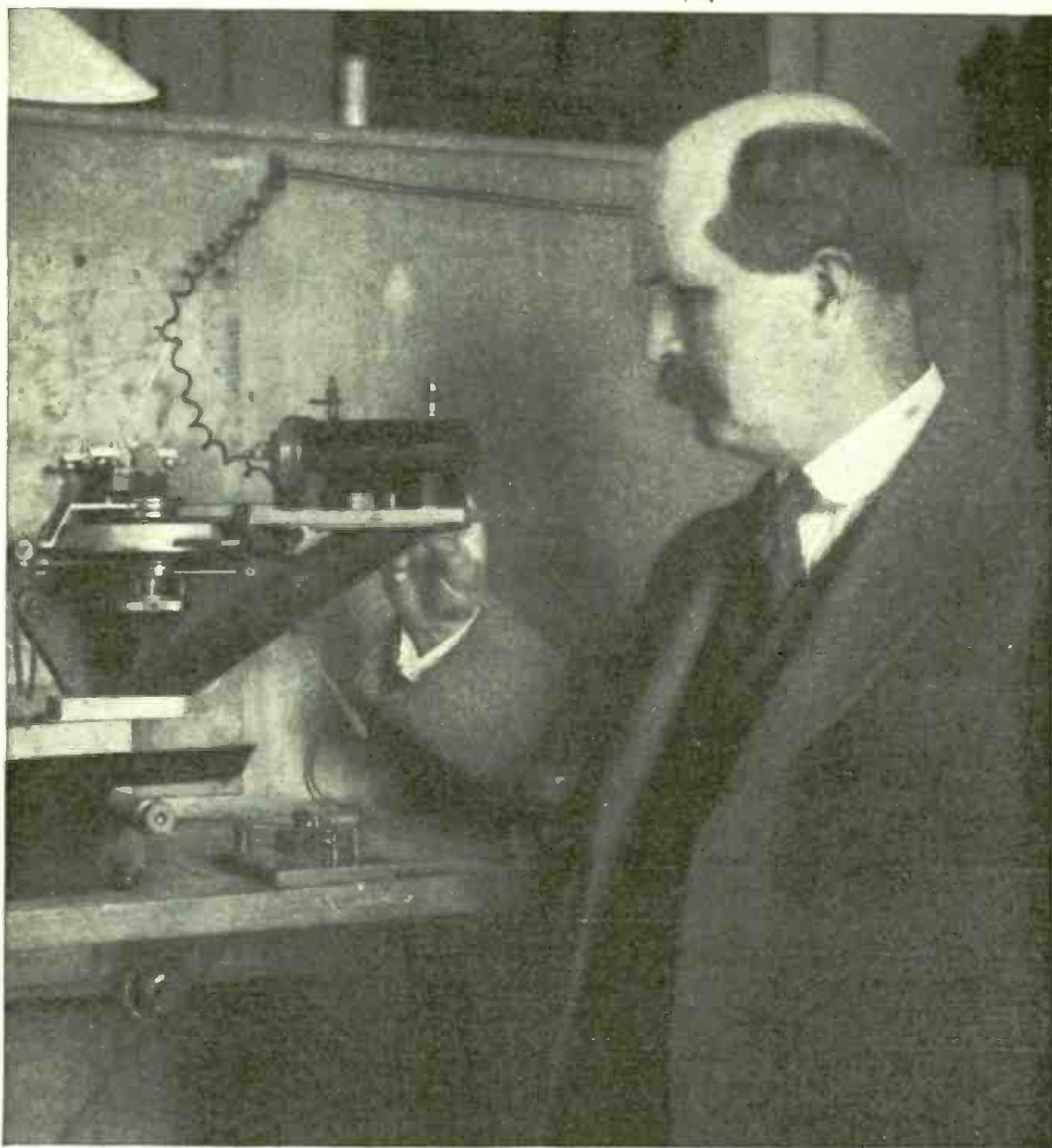
*The black spots represent atoms of sodium and the white spots atoms of chlorine, as they are arranged inside a crystal of sodium chloride which is the chemist's name for common salt.*

together about their investigations. Bragg is their name. Professor Sir William H. Bragg is the father; Professor W. L. Bragg is the son. Talk to the son about atoms and he will refer you to his father; talk about them to Sir William, and he will refer you to his son. When the Nobel prize for physics was awarded a few years ago it was divided between them. There are two Braggs in the flesh, but scientists generally speak of the work of "Bragg" when they discuss atoms and their architectural arrangement in matter.

These extraordinary Braggs, like generations of scientists that preceded them, were struck by the amazing and obvious uniformity of crystal structure. Always crystals of the same composition are alike so far as the angles formed by corresponding faces are concerned. Diamonds may differ in size, but not in these angles. And so sugar, common table salt, and hundreds of other crystals, invariably present the same angular uniformity. It was evident long ago that a crystal must be built somewhat like a skyscraper and that some unit-pattern or floor-plan must be repeated over and over again.

Now it happens that most of the solids that we know are crystalline in nature. Hence the man who can make a crystal reveal the secret of its structure so that we can draw a plan of it as we can of a house, must go far toward answering such age-old questions: What is matter? Why is iron iron and gold gold? Why is an element what it is and not something else? What holds a lump of matter together? Why is it different from a liquid or a gas? Why doesn't it fly apart?

While it was apparent that a crystal must be built according to some definite unit-pattern or floor-plan, there were long only shrewd guesses as to what the unit-pattern or floor-plan must be. The trouble was that no microscope could possibly be invented which would magnify the infinitely small atoms and show



From a photograph by Hoppé, London

#### AN EXPLORER IN THE REALMS OF THE ATOM

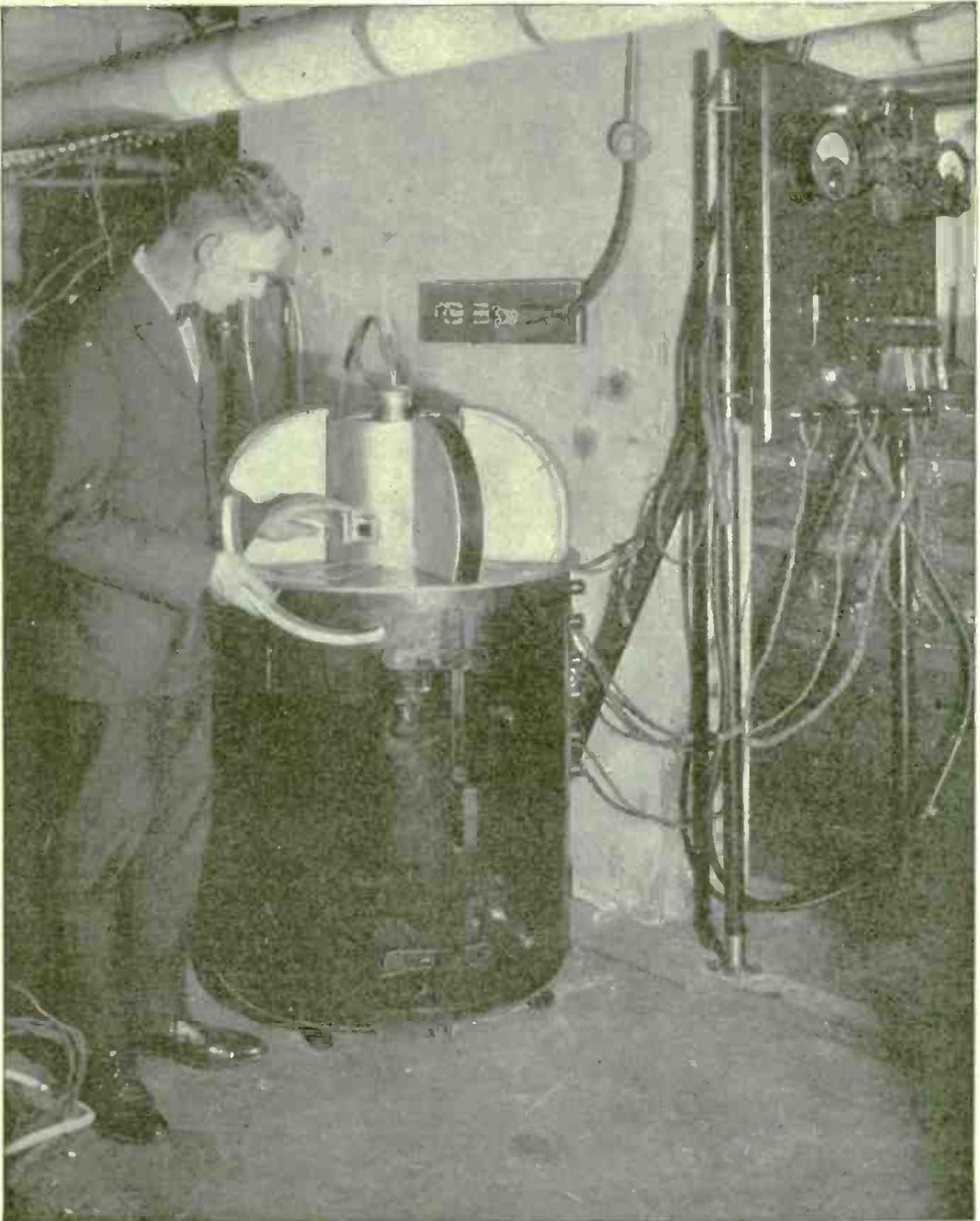
*Sir William H. Bragg (together with his son, Prof. W. L. Bragg) has supplied most of our knowledge of how the atoms inside of crystals are put together. The instrument shown above is the identical X-ray spectrometer with which were made many of Sir William's explorations into the realm of these tiniest of dimensions.*

us exactly how they are grouped. Lenses are themselves composed of atoms. To see atoms in a crystal the lenses themselves would have to become granular or atomic.

In 1912, Laue, a Swiss physicist, made this startling suggestion: Turn the X rays on crystals. Two discoveries might be made. In the first place, the

true nature of X rays might be revealed, about which there was no unanimity of opinion at that time. In the second place the atomic structure of a given crystal might be disclosed.

To understand why Laue made this suggestion and carried it out himself we must grasp the nature of light and of the many other waves that undulate



General Electric

#### A NOVEL DEVICE FOR STUDYING ATOMS BY X-RAY PHOTOGRAPHY

*An American student of crystals, Dr. A. W. Hull of Schenectady, and the apparatus developed by him for examining how the atoms are arranged inside the fragments of a crystalline powder. Strips of photographic film inside the quarter-round boxes on the top of the apparatus permit the making of four X-ray crystal photographs simultaneously.*

through the ether. That energy is transmitted in waves every radio amateur knows. His waves are like light waves, only longer—so long, in fact, that his eyes cannot see them.

When we say that we "see" a light we mean that our eyes have been affected by waves of a certain size and frequency. A musical note may be deep or shrill; it has what we call a certain "pitch." Light has its pitches, too; only we call them "colors" in the vernacular, while the scientist speaks of wavelengths, just as amateurs do in radio parlance. A radio set can be tuned to receive music and speech on a certain wavelength band. When we look at the world around us through a piece of red glass we have tuned in to red; we have excluded all other wavelengths of light. Like any radio set the eye has its limitations so far as this tuning process is concerned. Our visible wavelength band extends from deep red to deep violet. The red waves are the longest which we can see or to which we can tune in, and the violet the shortest. An ordinary camera is a far better receiver of light waves than our eyes. It can photograph the invisible. It can "see" or be attuned to waves that are much shorter than those that lie beyond the violet end of the spectrum—waves that are called ultra-violet.

The only difference between radio waves and light waves is one of wavelength. A radio wave may measure twenty miles from crest to crest when it is sent half around the world by some powerful trans-oceanic station. Visible light waves have an average wavelength of only one fifty-thousandth of an inch. Still shorter are the X rays.

It follows that an ordinary light wave is huge compared with an X-ray wave. That was one reason why scientists were at first not sure whether or not X rays should be classed as light waves. For example, they could not reflect X rays. Now we know the reason. Mirrors reflect light because they are very smooth

surfaces. A rough surface scarcely reflects light. The smoothest surface that human skill could produce is rougher than sandpaper to the X rays. For this reason X rays cannot be reflected by any smooth man-made surface. But the atoms of crystals (not the actual surfaces) are so much finer than X rays that they can act as reflectors. Knowing this, Laue proposed that they be used as little mirrors. When a crystal of mica was broken and subjected to test a beautiful X-ray reflection was obtained. X rays were thus proved to be a finer kind of light.

At this point the Braggs appeared. Laue had a rather cumbrous apparatus which, however successful it was in enabling him to prove that X rays are light waves, was not simple or effective enough to penetrate deep into the heart of a crystal. That there was a regular arrangement of the atoms was clear, but the exact structure was not readily determined. The Braggs devised a simple instrument which they called an "X-ray spectrometer," and with it they tore aside the veil of mystery and conjecture in which the atoms had so long been shrouded.

They knew that they could never hope to see an atom; there was no way of magnifying it the necessary one hundred million times. But they could make it reflect X rays, and they could note the points of reflection and thus locate the atoms.

This can be made still clearer if we imagine that we had to study water waves by the action of corks thrown upon the ocean. The corks have no effect whatever on the large waves (the equivalent of ordinary light waves). But if the surface of the water is disturbed only by the smallest perceptible ripples (the equivalent of X rays), they have a very marked effect. As the fine ripples strike a cork they are broken; there are ripple reflections and scatterings. If the corks were invisible a clear-headed, straight-thinking scientist

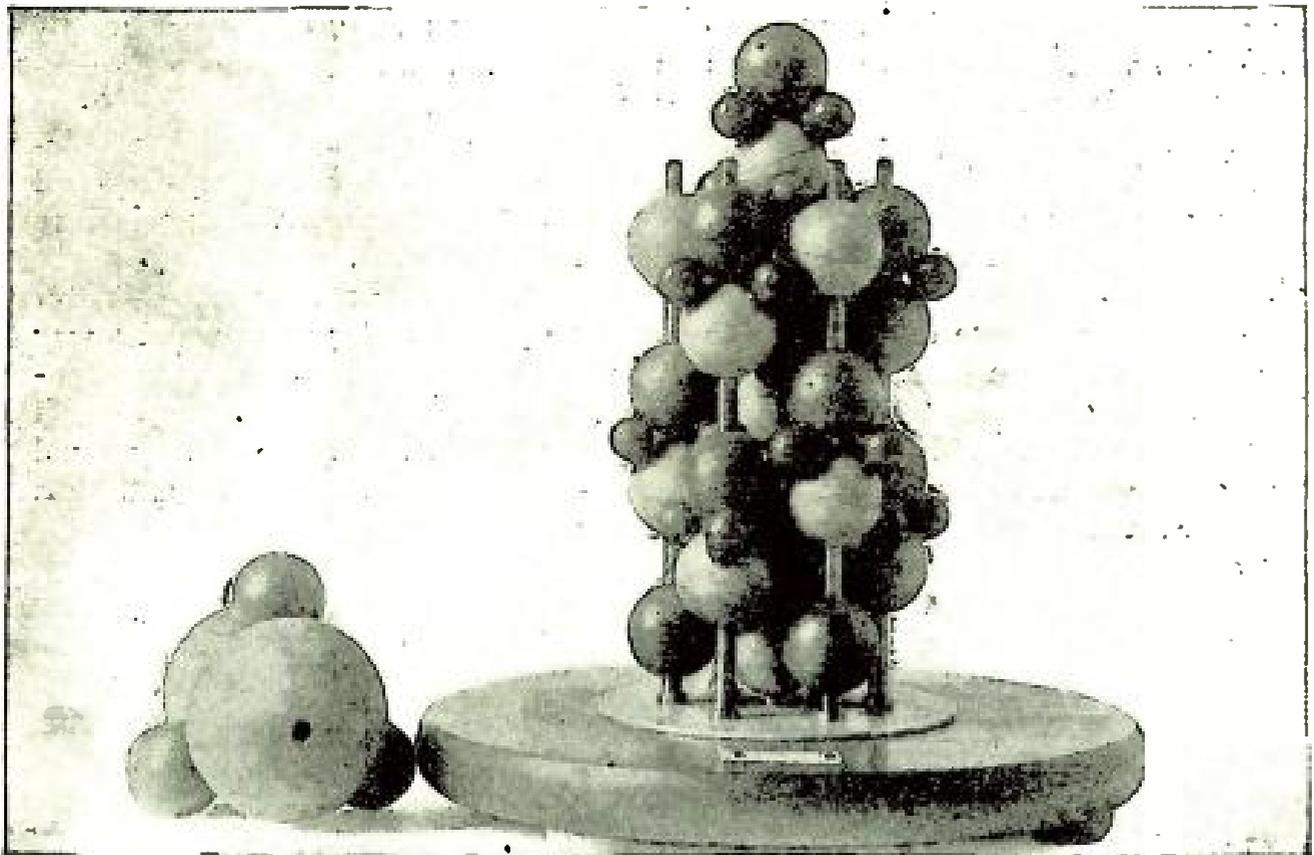
could form a very good picture of their size and spacing simply by watching the way in which the ripples were broken.

So the Braggs turn the X rays on a crystal and note with their spectrometer the manner in which they are scattered by the invisible atoms. A photograph is taken. To one who knows nothing about light, X rays, wave motion, and atoms, it is meaningless—a blur of lines. To the Braggs and to scientists who have repeated their experiments it is as clear as the blueprint of a complicated machine is to an engineer.

What is it that is so startling? You have seen a field of corn planted in regular rows. Look down one row and you see an almost endless line of stalks. Looks down another, and you see a second line. In whichever direction you look there is this regular, pre-

cise array. So the Braggs, in a sense, look down the avenues of a crystal from end to end. They do more than look; they actually measure the intervals between the atoms. Mind you, these atoms are so small that billions of them are clustered in the smallest visible speck of dust. Yet these two indefatigable men have measured the spacings with such accuracy that the error cannot be more than one in one thousand.

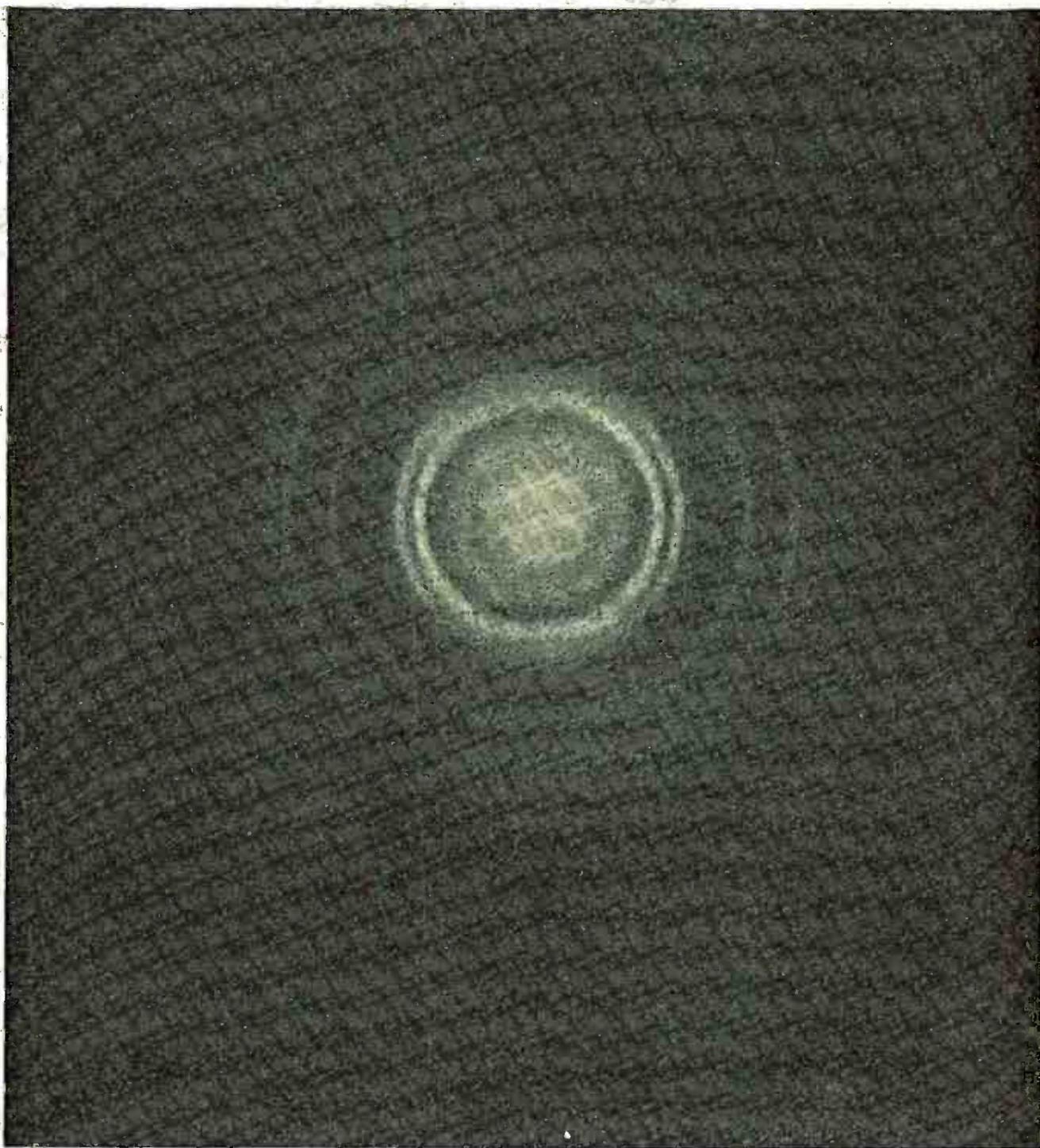
The stalks in a corn field have been regularly planted in two dimensions only—according to the length and breadth of the field. Atoms in a crystal are located in avenues that spread out in three directions. This makes it possible for them to distribute themselves in many very regular ways, but nature seems to content herself with not more than four or five.



From a photograph made for POPULAR RADIO by Hoppé, London

#### A STILL LIFE STUDY OF ALUMINUM AND OXYGEN ATOMS

*How the atoms of aluminum (represented by the large balls at the left) and of oxygen (the small balls) are arranged inside the crystal of a gem ruby. This, like the diamond model reproduced on the first page of this article, is from the collection of crystal models prepared by Sir William H. Bragg.*



#### AN X-RAY PHOTOGRAPH OF A CRYSTAL

*This ring pattern was produced by the bending of X-rays on passing through a thin sheet of aluminum. From the relative diameters of the different rings it is possible to calculate the arrangement and distance of separation of the atoms in the tiny invisible crystals of aluminum.*

Take the diamond, for example. Each atom has four neighbors regularly disposed about it. A group is formed which has the shape of a tetrahedron. Why is a diamond hard? Because of this very tetrahedron arrangement of its atoms. A diamond is pure carbon. So is graphite. Why is graphite black and greasy to the touch and the diamond

brilliantly transparent and hard? Graphite atoms are arranged in hexagonal columns which split with the greatest ease into thin leaves that slide easily on one another. It is this slipperiness of the leaves that makes graphite such a good lubricant. As for the difference between the diamond and graphite in color and brilliancy—that is due to the

internal structure of the atom itself.

Potassium chloride is a familiar chemical compound. As its name indicates, it is composed of potassium and chlorine. The Braggs have shown that in a crystal of potassium chloride each potassium atom is surrounded by six chlorine atoms and each chlorine atom by six potassium atoms. In the ruby the unit consists of a pair of aluminum atoms surrounded symmetrically by three oxygen atoms.

Napthalene is familiar to us in the form of moth balls. Why is it so light? Because the internal structure of the napthalene crystal is so lace-like, so empty.

This study of crystals is not easy. The atoms are arranged in planes behind one another, and the Braggs must distinguish the reflections from one plane from those of others. This is somewhat like trying to pick out the features of a single man who has been photographed with half a dozen other men to make a composite portrait.

So the Braggs consider crystal after crystal. They plot the location of the atoms. They construct models of the different atomic arrangements that they have studied, and each model is an accurate plan of the crystal whose structure it represents. The crystal proves to be a kind of lattice. Each lattice is known by a special name. There is the simple "cube lattice," the "centered cube lattice," the "face-centered cube lattice," and a few more. The different lattices constitute what may be regarded as styles of crystal architecture. They are identified by the skillful Braggs because nature never displays bad taste in mixing her architectural styles. She may superpose two

face-centered lattices to form the characteristic tetrahedron of the diamond, but the tetrahedon structure is always recognizable.

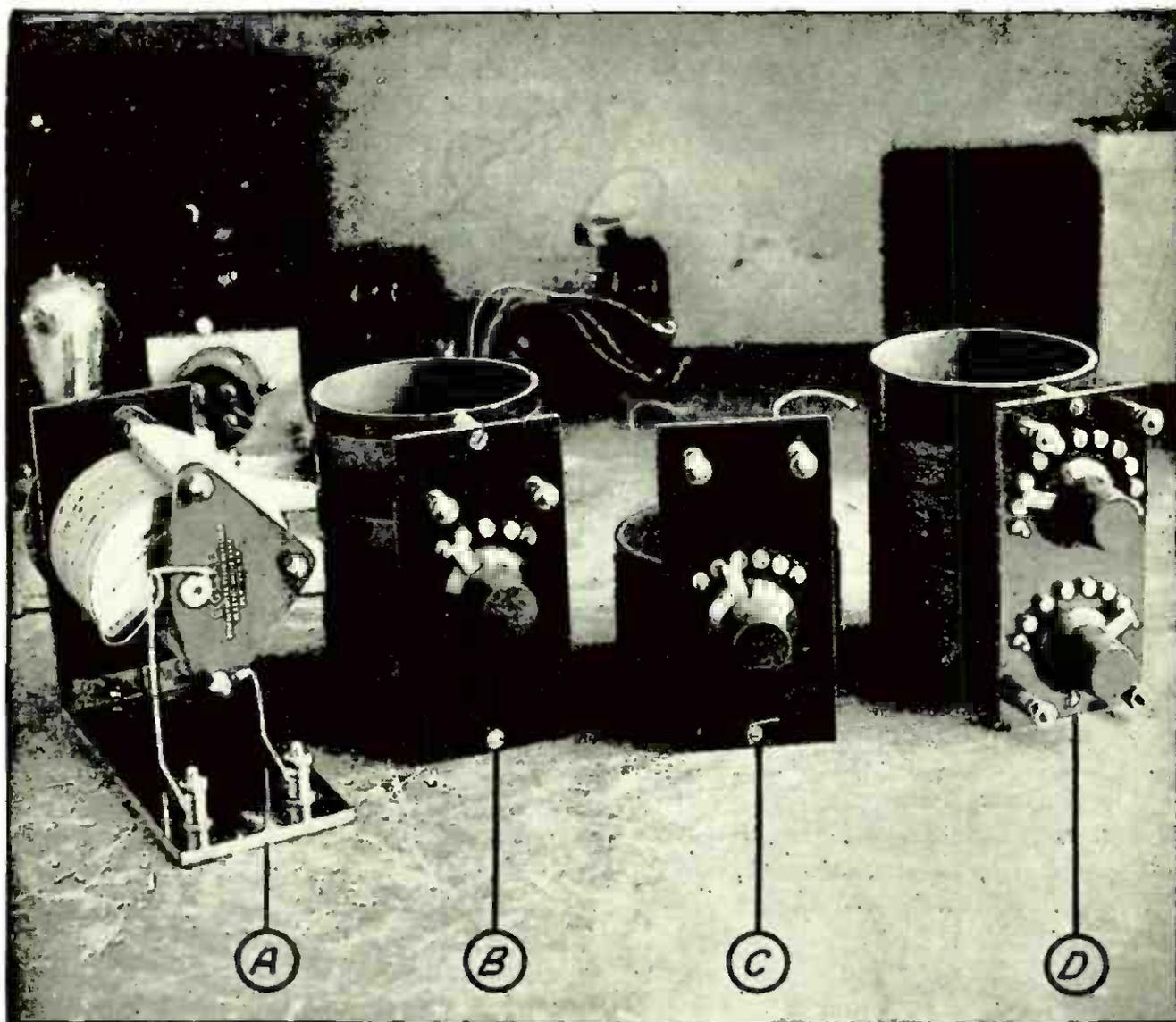
The lattice arrangement of the atoms is not real, like the girders of a building or the wires of a suspension bridge. Only the atoms are real. Probably they are round—bullet-like. What holds them in place? Forces of which we know only too little as yet, but which are the equivalents of very substantial ties and rods. No doubt they are electrical in character. Theoretically, it is possible to hold steel girders together by electromagnetic attraction. In some such manner are the atoms of a crystal held together.

Twenty years ago the atom was "the hypothetical smallest subdivision of matter" as the text-books phrased it. It has ceased to be either hypothetical or the smallest possible particle of matter. It is as real as a rock. It has a definite size, a definite shape, a definite weight and a definite place in a solid body. The Braggs have told us so much about it that it is almost possible to explain why iron is iron and gold is gold. The properties of a substance prove to be due to the peculiar way in which atoms are architecturally grouped. So, the strength and elasticity of metals, their power of conducting electricity and heat can be explained in terms of their structure as it is revealed by the X rays. The Braggs are not concerned with practical or engineering applications of their discoveries, but it is safe to predict that the day is at hand when the hired chemists and physicists of steel works will find the X rays as useful to them in producing a desired alloy as the crucible or the cupola.

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### How to Increase the Selectivity of Your Receiver

*In the next number of POPULAR RADIO—for December—one of the foremost radio experts in the world, John V. L. Hogan, will tell the amateur and the novice how to reduce interference by sharpening his tuning.*



*The following panel-mounted units will be found useful additions to any radio experimenter's equipment; A, .001 mfd. variable condenser, B, variable coupling unit, C, short wave tapped tuning coil, and D, a long wave inductance tapped in tens and units.*

## Handy Units for the Radio Laboratory

By M. B. SLEEPER

**I**N laying out a radio set the wise experimenter does not proceed with the construction of a finished outfit—unless he is working from drawings—without first laying out a test circuit on the laboratory bench. Under such circumstances it is not always practical to build complete tuning units, and for that very reason the testing instruments shown in the accompanying photograph are extremely convenient.

At the left is a 43-plate condenser mounted on a vertical panel, to which,

in turn, is bolted a base panel secured in position by short lengths of angle brass. Binding posts are arranged in the rear for connections to the test circuit. Three experimental inductances also are shown.

The type shown at the left is divided into three sections that are separated considerably in order to reduce the coupling between them. This coil was employed in tests for a wide wavelength range. The center coil was constructed for a short-wave receiver.

The unit at the right was also made for a long-wave set in which the primary coil was adjusted by means of units and tens switches.

Although the coils were originally built for particular sets, they have come in handy for all kinds of work. Now when an experimental circuit is to be set up it is seldom necessary to wind additional coils. This type of mounting

is much easier to handle than plain round coils, the tubes of which must be adjusted by means of loose clips. Moreover, for coupling, they can be moved together or separated.

When fairly tight coupling is required one coil can be set directly on top of the other, either above or below, according to the end of the coil to which coupling is required.

## A Home-Made Variometer

### —That Can Be Built at a Cost of 30 Cents

By DAVID LAY

THE tuning instrument shown in Figure 1 can be made at home with a little care and patience. Inserted directly in a standard aerial, it will cover a range of from 200-600 meters without the use of a condenser.

A disc five inches in diameter is cut out of a piece of "fiber" or cardboard, and the periphery or outer edge is divided into any odd number of parts. Twenty-one divisions are shown in the illustration, but seven, eleven, fifteen, or any other uneven number will serve equally well. Lines should be drawn radially outwards from the center to the marked points, these being afterwards cut out so as to form slots in which the wire is wound.

Before making the slots, however, an inner circle, three inches in diameter, is first drawn, and then cut out to form the "rotor" part of the tuner, the outer annulus or ring forming the stator or stationary part.

Both parts are then cut out with a sharp knife along the radial lines, the slots in the stator being made somewhat wider than those in the rotor. A core one inch in diameter is left at the center of the rotor, as shown.

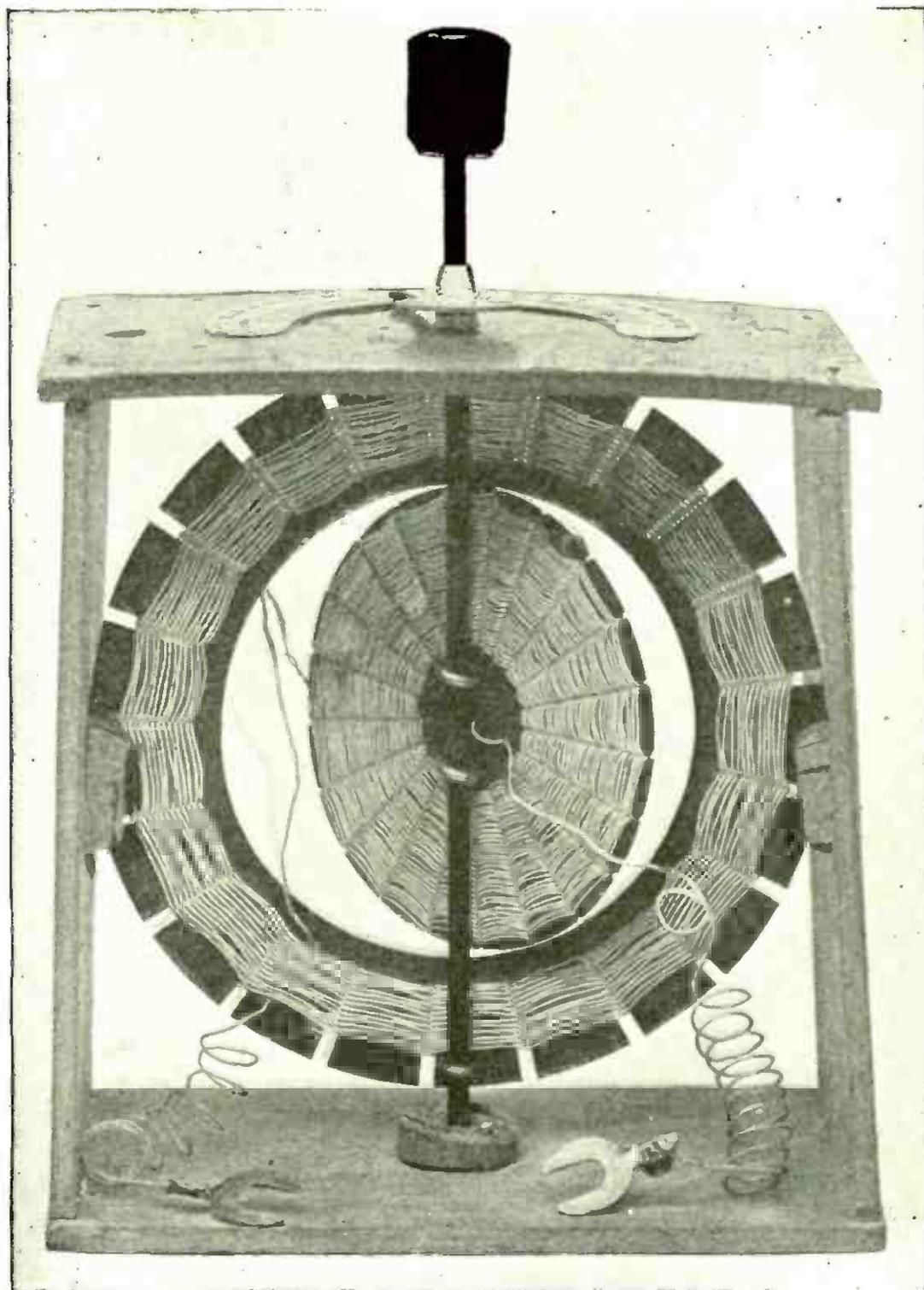
The outer ring is wound with 24 turns of No. 28 D.C.C. wire, and 60 turns of the same wire are coiled around

the inner disc in the well-known basket weave fashion. The inside end of the stator winding is joined to the outside end of the rotor winding, so that the coils run in sequence, a sufficient length of wire being left to allow of relative movement between the two parts. It is also advisable, when cutting out the inner disc, to take off a shaving of about  $\frac{1}{8}$  inch. This will give a sufficient clearance to allow the inner disc to be rotated.

The two ends for connection to the antenna and ground terminals of the set are taken from the center of the inner disc and from the outside of the ring respectively, and are preferably fitted with "spade" terminals, as shown. The remaining two terminals of the stator and rotor are connected together.

Small brass eyelets are inserted at the top and bottom of the stator to form bearings for the turning spindle, which is fastened in turn to the center disc or rotor by two center eyelets, as shown. The two central eyelets are somewhat smaller than the others, in order to grip the spindle firmly; or a simple lashing of wire may be found more convenient.

The variometer may be mounted in a casing built up from the parts of an old cigar box, as shown. Two pieces of cork are tacked at each side to se-



#### THE SPIDERWEB VARIOMETER

*Although this instrument was made by an amateur, out of odds and ends of materials, it proved to be a really efficient variometer. It may be used to tune the antenna circuit or the plate circuit of a regenerative receiver. The frame was made out of the wood from an old cigar box.*

cure the outer ringcoil and prevent it from turning, whilst a third piece of cork, tacked to the bottom, serves as a friction bearing for the spindle. Finally a turning knob, pointer, and scale are added.

The instrument gives remarkably good

results with an ordinary crystal set, and is sufficiently elastic to pick up amateur telephony, broadcasting, and commercial ships traffic.

It will also serve as a variable inductance for tuning the plate circuit of a regenerative vacuum-tube receiver.



From a photograph  
made for  
POPULAR RADIO

#### A "TALKING" FIXED CONDENSER

*The author listens to music which is reproduced by a poor condenser in which the plates are so loose that they vibrate in unison with the currents that flow through them.*

## THE TRUTH ABOUT FIXED CONDENSERS

By RAYMOND FRANCIS YATES, R.E.

IT has been said that "upon trifles the greatest gifts of the Gods often hang." So it is with long distance radio—upon trifles the best DX records often hang.

Not the least among these trifles is the little fixed condenser, which is so sadly ignored and neglected by those in whom the temperature of the DX fever runs highest.

Too many fans make the mistake of believing that a fixed condenser should simply consist of a few sheets of tinfoil, separated by greased paper and stored away in a cigarette box filled with wax. But the wise radio

man has grown to respect the little fixed condenser and consequently he attaches the greatest importance to it. But what can possibly be wrong with a fixed condenser? No matter how crudely it is made it will "condense." What more is to be expected? We shall see.

A moment's reflection on the history of the condenser will be interesting. It was on October 11, 1745, that old Dean von Kleist, of the Cathedral of Camin, Germany, made an experiment. It was an important experiment, but von Kleist did not realize it. That he was amazed and mystified, however;

is proven by his letter to Dr. Leberkuhn which follows:

"When a nail or a piece of brass wire is put into a small apothecaries' vial and electrified, remarkable effects follow; but the vial must be *very dry and warm*. I commonly rub it over beforehand with a finger on which I put some powdered chalk. If a little mercury or a few drops of spirits of wine can be put into it the experiment succeeds the better. As soon as this vial and nail are removed from the electrifying glass, or the prime conductor to which it hath been exposed is taken away, it throws out a pencil of flame so long that with this burning machine in my hand I have taken about sixty steps in walking about my room; when it is electrified strongly I can take it into another room, and then fire spirits of wine with it. If while it is electrifying I put my finger or a piece of gold which I hold in my hand, to the nail, I receive a shock which stuns my arms and shoulders."

This was the birth of the Leyden jar. In January, 1746, Peter Van Musschembroeck made the same discovery in the University of Leyden, hence the term "Leyden jar."

The Abbé Mollet in France later played with Leyden jars or condensers, and killed small birds with a discharge in order to entertain the ladies of the French court. Another experimenter tried to emulate him but did not succeed until he struck upon the happy thought of grouping the jars together and in this way obtaining a more powerful discharge.

Like the storage battery, a condenser is called upon to hold electricity. This is a crude comparison, however, as the storage battery does not actually hold electricity but keeps it stored in the form of chemical energy which is released as electrical energy. There is only one true container of electricity; only one device that can be "filled" with it. It is the condenser. Each condenser has a certain capacity to hold electricity. We measure liquids in quarts and the capacity of condensers in microfarads. The term "farad" is taken from the first five letters of the name Faraday, in honor of Michael Faraday. Now, a condenser with a capacity of one farad would be as big as a house, and so it is necessary to

measure the capacity of condensers in microfarads. (A microfarad is one-millionth of a farad). Even a condenser of one microfarad capacity is too large for general use in radio measurements. Fixed condensers used in radio-frequency circuits usually extend from .0001 microfarad to .0025 microfarad.

We have probably been told many times that a condenser is made up of two conducting surfaces separated by a dielectric. The word dielectric is one of those high-sounding words used by the electrical expert to denote an electrically non-conducting medium. Therefore, we find dielectrics in condensers consist of paper, glass, oil, air or mica. The two last named substances are by all means the best as we shall later discover.

The capacity of a container depends entirely upon its dimensions. This is partly true of condensers—the larger their surfaces and the greater the number of plates, the higher the capacity will be. There is also two other factors which help to determine the capacity of a condenser. These are the thickness of the dielectric and also what is known as the "dielectric constant." The closer the conducting plates of a condenser, the higher the capacity will be. This means that we must place between them a dielectric as thin as possible and yet with a high insulating strength. A poor dielectric, however, no matter how thin it may be, will not give us an efficient, high-capacity condenser. These requirements make mica the ideal dielectric for fixed condensers, and tinfoil the universally used conducting medium. Mica can be split into sheets with a thickness of only a few thousandths of an inch. This makes it possible to build up a condenser of high electrical capacity, of high insulation strength and small dimensions.

When a condenser is charged (filled), static electrical pressure is stored between the metal sheets. In the case of radio-frequency currents this process



From a photograph made for POPULAR RADIO

#### THE "SQUEEZE" METHOD OF TUNING

*This ingenious fan tunes his set by means of a cheap paper condenser which is connected in series with his single-circuit set. When he wants to listen to one station he holds it loosely, but when he wants to hear another station, he pinches it between his thumb and forefinger. This changes the capacity of the condenser and tunes either station in or out.*

takes place with lightning-like rapidity. Like a quart measure, when the condenser becomes filled or charged it runs over and discharges. With a liquid stream of given force, it would require longer to fill a two-quart measure than it would a one-quart measure, and likewise with a given electrical pressure it would take longer to fill a 1-microfarad condenser than it would a  $\frac{1}{2}$ -microfarad condenser. The same holds true in the case of discharge. One would take twice as long to discharge as the other.

The character of a condenser discharge is oscillatory in nature; that is, it dashes back and forth alternately and dies out. If we place one end of a steel strip in a vice, pull it back and release it it will vibrate, and the amplitude of these vibrations will gradually diminish until the strip is at rest. A condenser discharges in simi-

lar fashion. The released currents dash back and forth from one side to the other, charging and discharging and recharging and redischarging the device until it is "empty." The time occupied by the twinkling of an eye is long compared with the time required for the discharging of a small condenser. Small condensers may be charged and discharged millions of times in a single second, larger ones, of course, require more time.

What has all of this to do with the use of fixed condensers in receiving sets? This is the interesting question that we will now consider.

When a condenser is being charged the negative and positive impulses of the charging current exert an actual physical pressure upon the plates of the condenser. This pressure is due to the electrical repulsion and attraction which

tends to tear the conducting medium away from the surface of the dielectric. This is *not* theoretical. It is a known and observed fact which every radio fan may verify for himself if he wishes. The phenomenon is not noticeable when radio-frequency currents pass through a condenser, as the frequency of these currents is so high that the inertia of the tinfoil plates will not allow them to respond to it. In the case of audio-frequency currents, and condensers in audio-frequency circuits, the result is different. These currents are able to cause the plates of a condenser to vibrate, and for this reason condensers that do not have a permanent capacity and that are not built to withstand this action are a constant source of trouble. They develop circuit noises and produce howling that is often laid to other causes. This is especially true, of course, in connection with vacuum-tube circuits. When the plates of a condenser vibrate they affect the capacity of the whole circuit, as this movement causes the capacity of the condenser to fluctuate within comparatively wide limits although the plates may move only a microscopic distance. These small changes are magnified by the vacuum tubes, and many a hectic noisy set can be brought into the pink of condition by using better condensers.

There are a number of experiments that can be made to demonstrate this point. Under certain conditions the writer had heard speech from a broadcasting station reproduced with an ordinary paper condenser. The reproduction was rather faint, to be sure, but nevertheless it was audible. The plates vibrated in exact sympathy with the audio-frequency currents, and if higher amplification had been used, the reproduction could have been heard at a considerable distance from the condenser.

We have all heard of the "condenser microphone" which is used in many of the modern broadcasting stations. Here we have two plates sepa-

rated by air. The device is really a simple condenser, and the sound waves impinge upon one of the plates causing it to vibrate. This vibration is sufficient to cause variations in the capacity of the device, and in this way the sound is impressed upon the electrical circuit.

If a carelessly constructed paper condenser is placed in a 500-cycle circuit the thing will emit a humming noise that will exactly correspond to this frequency. The loudness will depend upon the strength of the current.

While the writer was editing the radio columns of a New York newspaper one of his readers wrote in and told how he was using a so-called "fixed condenser" to tune with. When the condenser was left undisturbed he could hear WEA. When he pressed the condenser tightly between his fingers he was able to change the capacity sufficiently to hear WJZ. Being an ingenious sort of a chap, he connected the condenser to a long wire where it was in reach of his easy-chair. Then he sat there and listened to either of the two stations at will; he pinched the condenser or he let it loose!

From our discourse here it is evident that we should use only such condensers as are of permanent capacity.

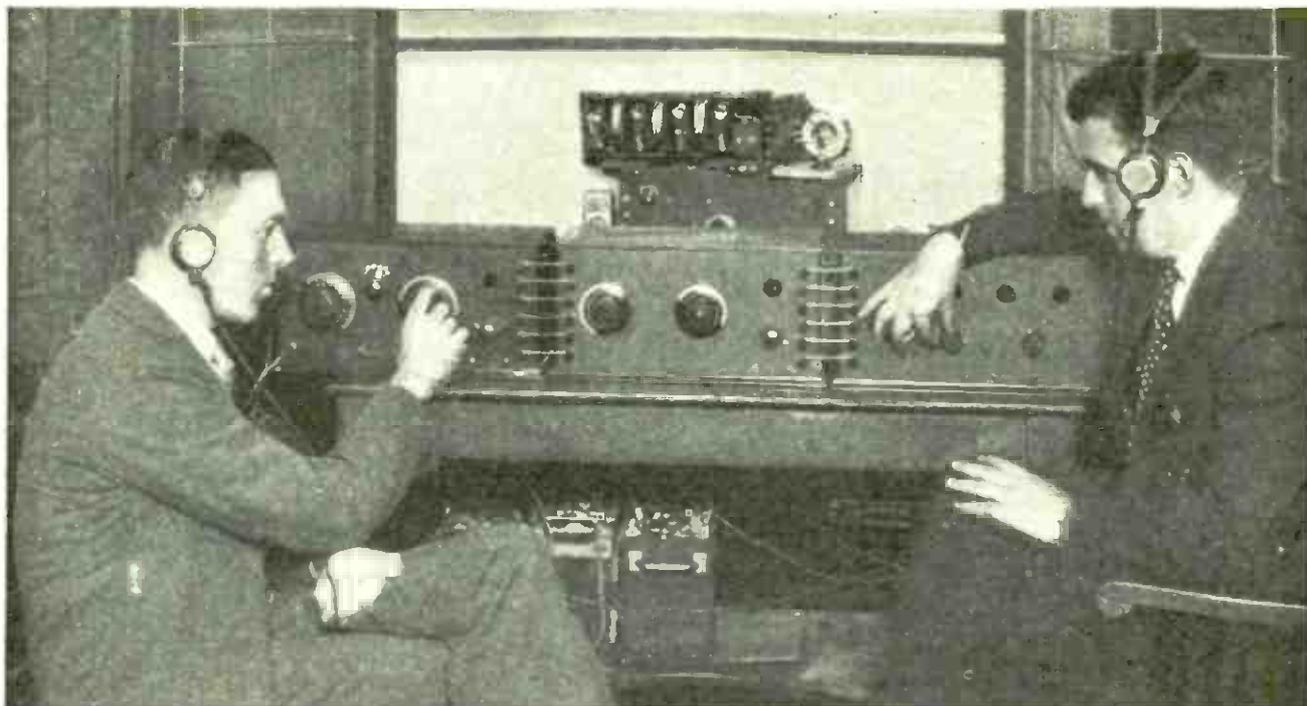
Condensers, like batteries, may be connected together in series or in parallel if we wish to arrive at different capacities. If we had three condensers of .001 mfd. capacity and wished to use them as a single condenser of .003 mfd. capacity, we would simply connect them in parallel. We must always remember then that we add the capacities of the condensers when we connect them in parallel. The following simple formula expresses this:

$$\text{Capacity } .001 + .001 + .001 = .003 \text{ mfd.}$$

If the condensers are connected in series the formula becomes:

$$1/c = \frac{1}{.001} + \frac{1}{.001} + \frac{1}{.001}$$

$$1/c = \frac{3}{.001} \text{ or } 3C = .001 \text{ or } C = .00033 \text{ mfd.}$$



From a photograph made for POPULAR RADIO

### THE TWO DESIGNERS DEMONSTRATE THEIR EXPERIMENTAL SET

*The new receiver consists of three parts in separate cabinets. The tuner at the left is being operated by Mr. Haynes, the builder of the set; the oscillator is in the center and the amplifier at the right is being adjusted by Mr. Cockaday.*

## HOW TO BUILD THE NEW REGENERATIVE Super-heterodyne Receiver

### PART I

Here is a new and remarkable type of super-heterodyne which is more sensitive, more selective and more simple to tune than any other kind of multi-tube receiver yet developed. The costs of the parts approximate \$100, and anyone who can build and operate an ordinary regenerative set can build and operate this one. While the principle of the super-heterodyne receiver is patented, this set is not on the market, and the following description of it is published for research and experimental purposes only.

By LAURENCE M. COCKADAY, R. E.

THE super-heterodyne receiver is the most *sensitive* receiver yet developed. If it is properly designed it is also the most *selective*. Its one drawback, heretofore, has been its *complexity*—complexity of construction and operation. This and the fact that the amateur and broadcast listener cannot afford such a costly piece of apparatus as it has been up to this time has kept the super-heterodyne from gaining the popularity that it justly should have received.

However, the super-heterodyne (or any other type of set) must have the following qualities before it can ever be acclaimed by the multitude as a really popular circuit.

1. *It must be selective.*
2. *It must be sensitive.*
3. *It must be easy to construct.*
4. *It must be inexpensive.*
5. *It must be easy to operate.*
6. *It must be economical from an "A" battery standpoint.*

Although the super-heterodyne meets

the first two points better than any other known type, it has always been termed the "Rolls-Royce" of radio. But, beside being the most selective and sensitive it was also complicated, expensive, and could not be built by any but the most experienced engineers. It has always imposed a heavy strain on the "A" battery on account of the large number of tubes necessary to take advantage of its extraordinary amplifying powers. These factors have kept it, up to the present time, as the "lord of all radio receivers," but unfortunately they have also limited its use to a chosen few who have had the price, the ability and the patience to master its complications.

The authors of this article have long realized the possibilities of this wonderful circuit and they have, during the last six months, devoted much time to research for the purpose of developing a simplified super-heterodyne that is worthy of the name.

Of course, with the new low-filament-consumption vacuum tube such as the

C-301-A and the UV-201-A, the set can now be made efficient as far as "A" battery loading is concerned.

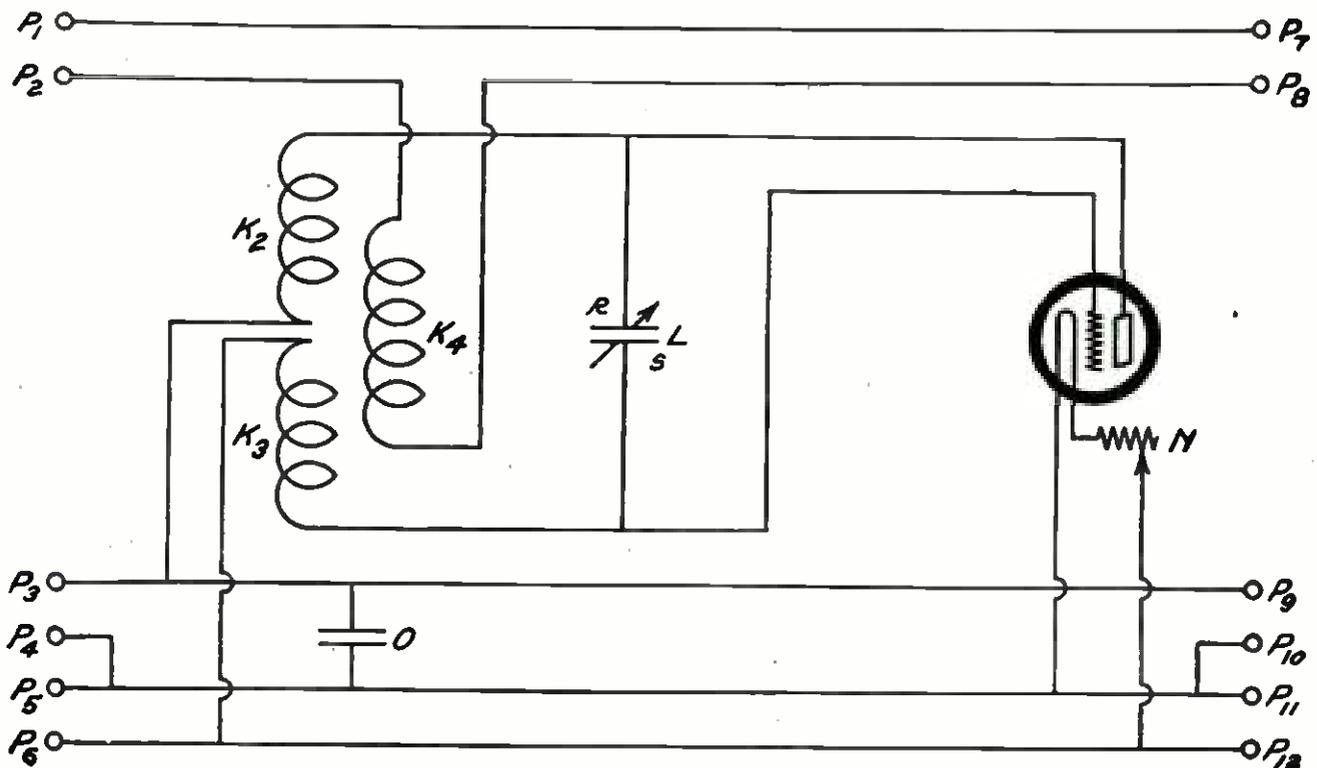
*It is now possible to burn four tubes with less filament current than one tube would have taken a year ago.*

This fact covers the point raised in the 6th requirement specified at the head of this article.

The circuit as finally evolved (and as will be described in this article) has only two operating controls; for this reason it really is simple to operate. (Point No. 5.)

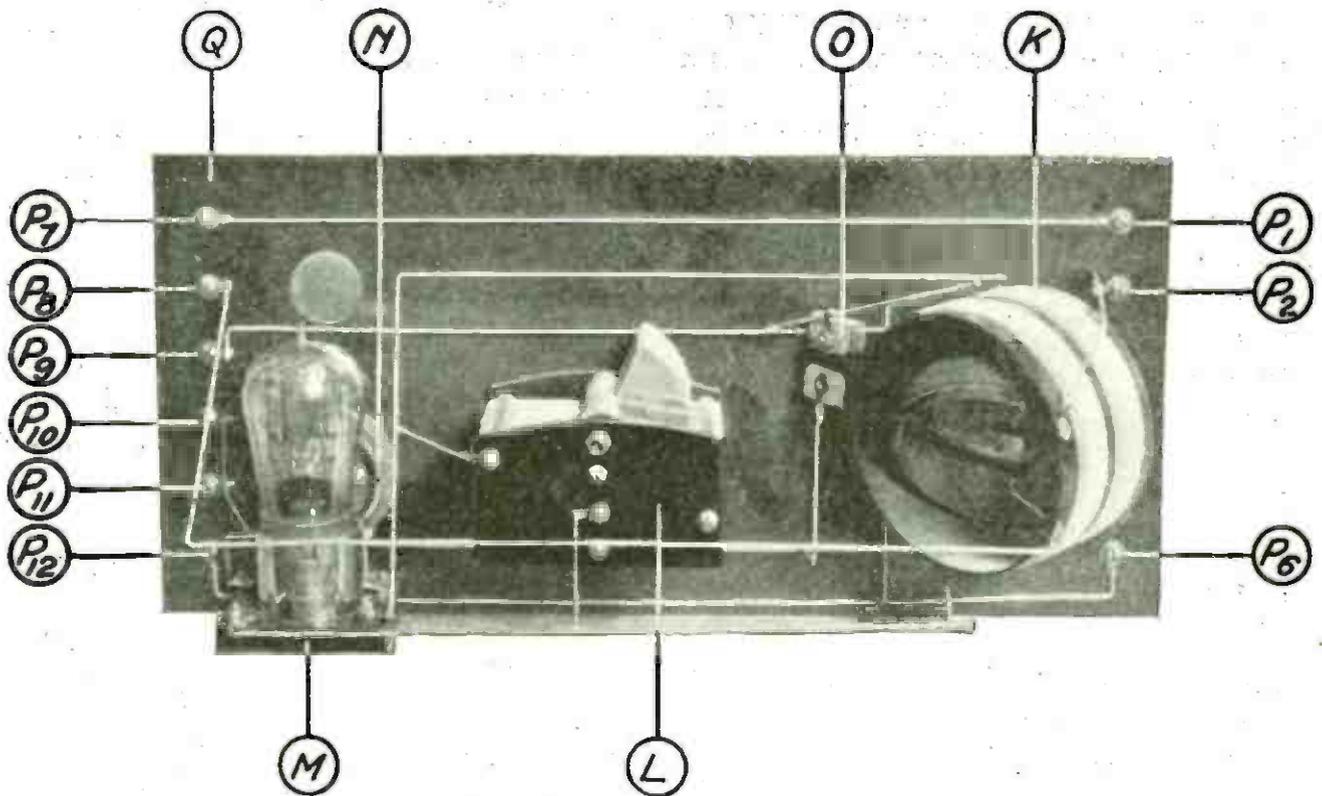
The circuit has been so simplified and the parts used so reduced to essentials, that it is relatively inexpensive. (Point No. 4.)

In its final form the set is really simple to construct. (Point 3.) It can be built in units. This places the super-heterodyne right where it ought to be as the ultimate in radio-reception apparatus but within the reach of anyone who is ordinarily handy with tools and who can afford to experiment with radio at all.

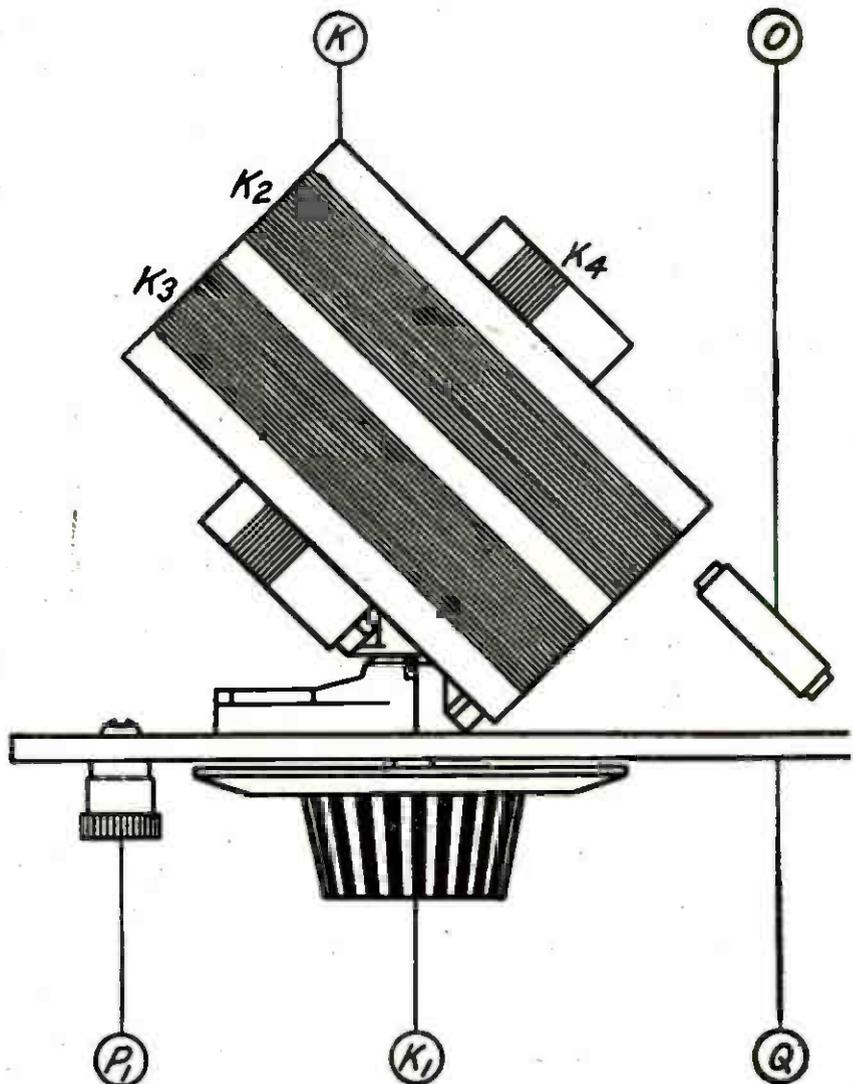


THE EXACT WIRING DIAGRAM FOR THE OSCILLATOR

FIGURE 1: This diagram shows how to wire up the oscillator panel including the special oscillator coupler, the heterodyne condenser, the tube and the fixed condenser. The binding posts are numbered so that the experimenter will have no trouble in connecting up.



**THE INTERIOR OF THE OSCILLATOR**  
 FIGURE 2: (Above). The parts are designated by letters which reappear in the text and in the other diagrams and drawings. This actual photograph of the instruments indicates the simplicity of the set and should dispel any fears the prospective experimenter may have that its construction is difficult.



**HOW THE PARTS ARE ASSEMBLED**

FIGURE 3: (At right). The diagram extending across the bottom of these two facing pages is a working drawing of the oscillator; it shows the general arrangement of the parts as they are viewed from above.

Some of the new features incorporated into the design of the set which make it so suitable for DX reception over wavelengths between 180 and 600 meters are:

The use of the first tube as a *radio-frequency amplifier*.

The use of a heterodyne oscillator coupled to the *plate circuit* of the first tube (instead of to the grid circuit as is usual).

The use of a new type of air-core, radio-frequency transformer which is *sharply tuned to a wavelength of 3,000 meters*.\*

The use of *regeneration* in the radio-frequency amplifier (which greatly boosts up signal strength without complicating the control).

The *elimination of the variable-tuned*

\*The authors wish to thank Mr. McMurdo Silver for the important work that he has contributed toward the perfection of the radio-frequency transformers.

*circuits* at the input of the radio-frequency amplifier.

The *reduction of the tuning controls to two knobs*, one for the wavelength and one for the heterodyne oscillator.

The successful use of *regeneration* in the first-tube circuit.

The use of the Haynes circuit *for tuning*.

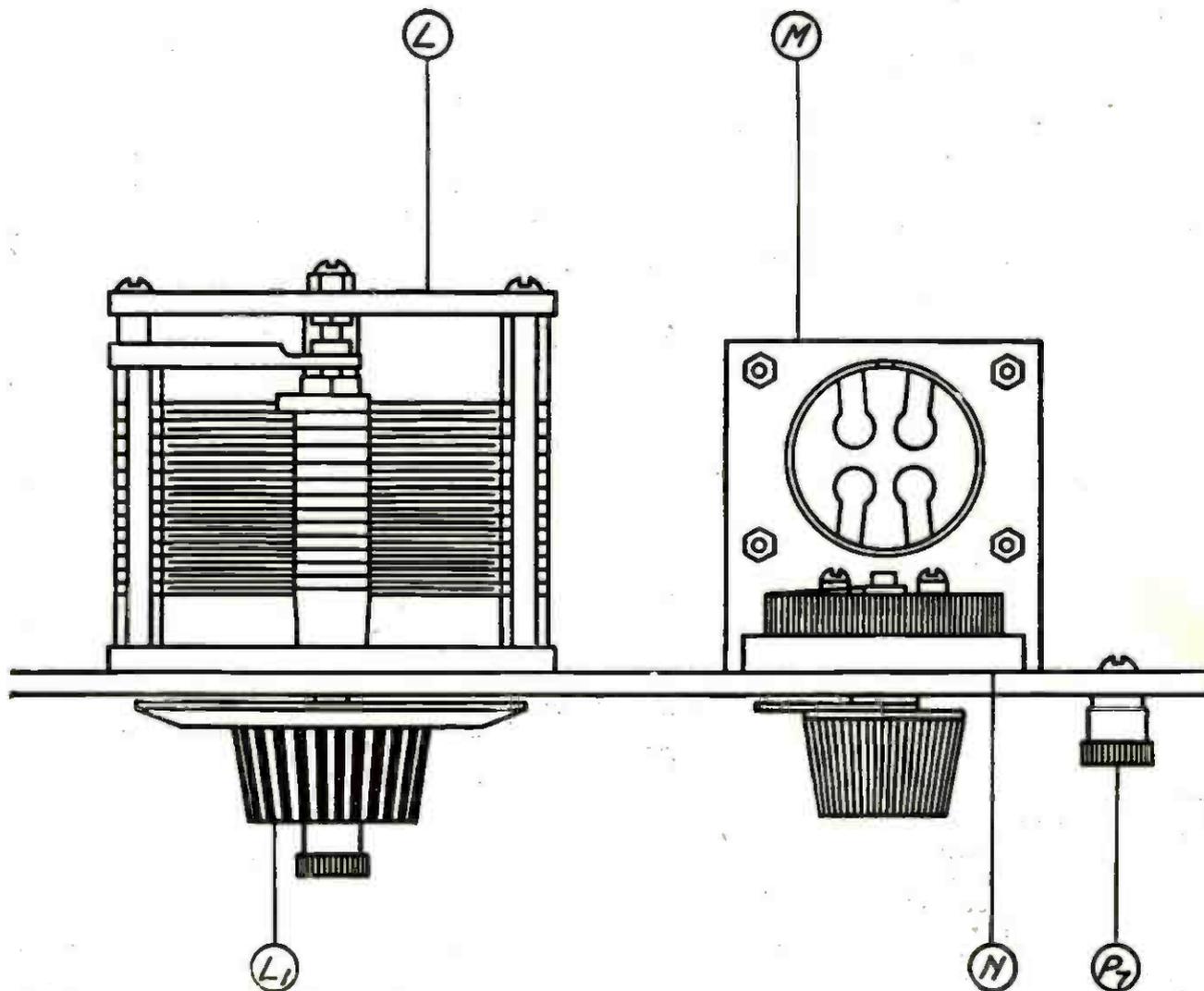
The use of the *new thoriated-flament vacuum tubes throughout* (six tubes).

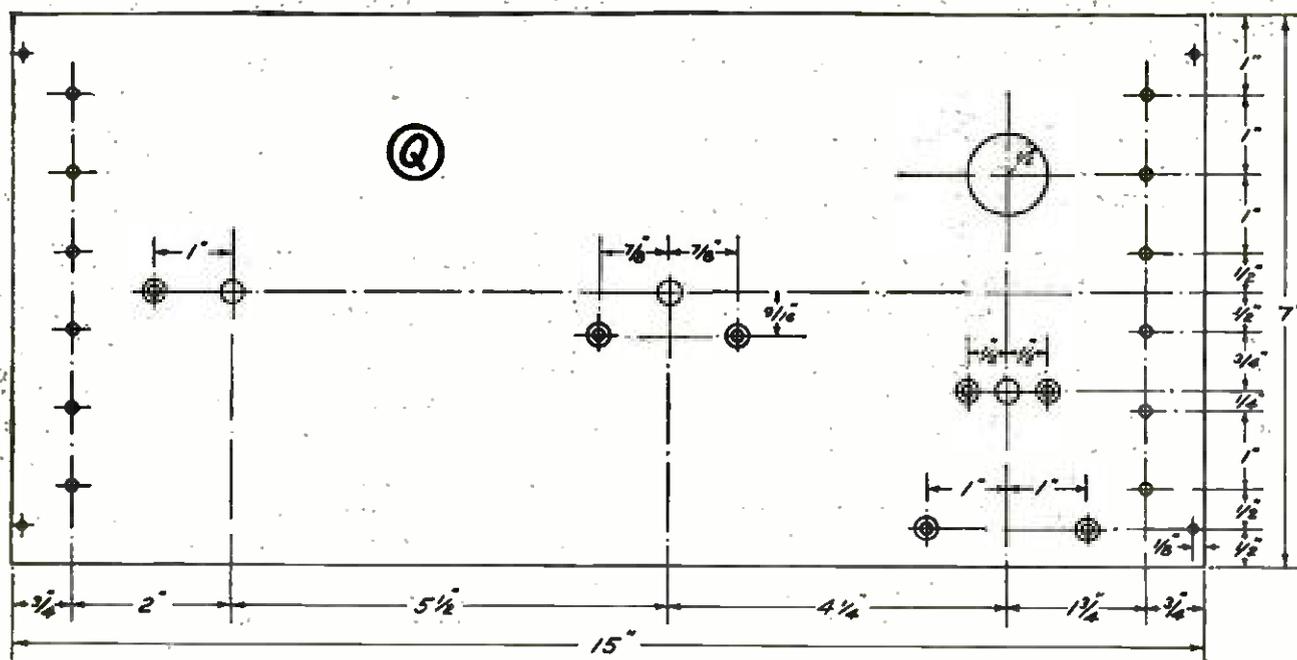
The use of a *new oscillation coupler* for the oscillator.

The set is constructed in three parts; the *tuner*, the *oscillator*, and the *radio-frequency amplifier*.

The tuner was described in the September, 1923, issue of POPULAR RADIO.

The oscillator will be described in this article. The radio-frequency amplifier will be described in the December issue of POPULAR RADIO along with a





#### THE DRILLING PLAN FOR THE PANEL

FIGURE 4: This drawing shows where to drill the holes in the panel for mounting the instruments and attaching the binding posts. The correct spacings are given for the holes. The holes outlined with a double circle should be countersunk.

full, detailed description of the proper way to set up the complete receiver, and how to adjust and tune it. Although the receiver will bring (in New York City) all the western broadcasting stations and DX amateur transmitters throughout the country, on a loudspeaker, without any audio-frequency amplification, if the builder so desires he may use the two-stage amplifier described in the October issue of POPULAR RADIO. This will produce too much volume on almost any signals for the ordinary home, but there are some folks who like a lot of volume, and this will give it to them.

All of the units described here are mounted in standard-sized cabinets, and the binding posts are arranged so that they may be simply bridged across from one unit to another when the cabinets are arranged side by side. The batteries are connected to the end unit and the other units are fed through the bridging binding posts. This does away with any unsightly, sprawling connections. The general appearance of the complete set (without the audio-frequency amplifier) is shown in the photograph on page 392.

The actual wiring diagram for the oscillator is shown in Figure 1.

#### The Parts Used in Building the Oscillator

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 electrical circuit. The same designating letters are used in the text and the list of parts below.



The list of parts here 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.

- (K2, K3, and K4)—Haynes-Griffin special oscillator coupler;
- K1—knob and dial, 3 inch;
- L—Fett and Kimmel Micro-tune variable condenser, .0005 mfd.;
- L1—knob and dial, 3 inch;
- M—Fada panel mounting socket;
- N—filament rheostat, 20-30 ohms;
- O—Micadon fixed condenser, .005 mfd.;
- P1 to P12—binding posts;
- Q—composition panel;
- R—cabinet.

#### How to Construct the Oscillator

After procuring all the instruments and materials for building the set, the amateur should

set about preparing the panel Q, (shown in Figures 2, 3, 4 and 5).

First of all the panel should be cut to the correct size, 7 by 15 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 4.

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

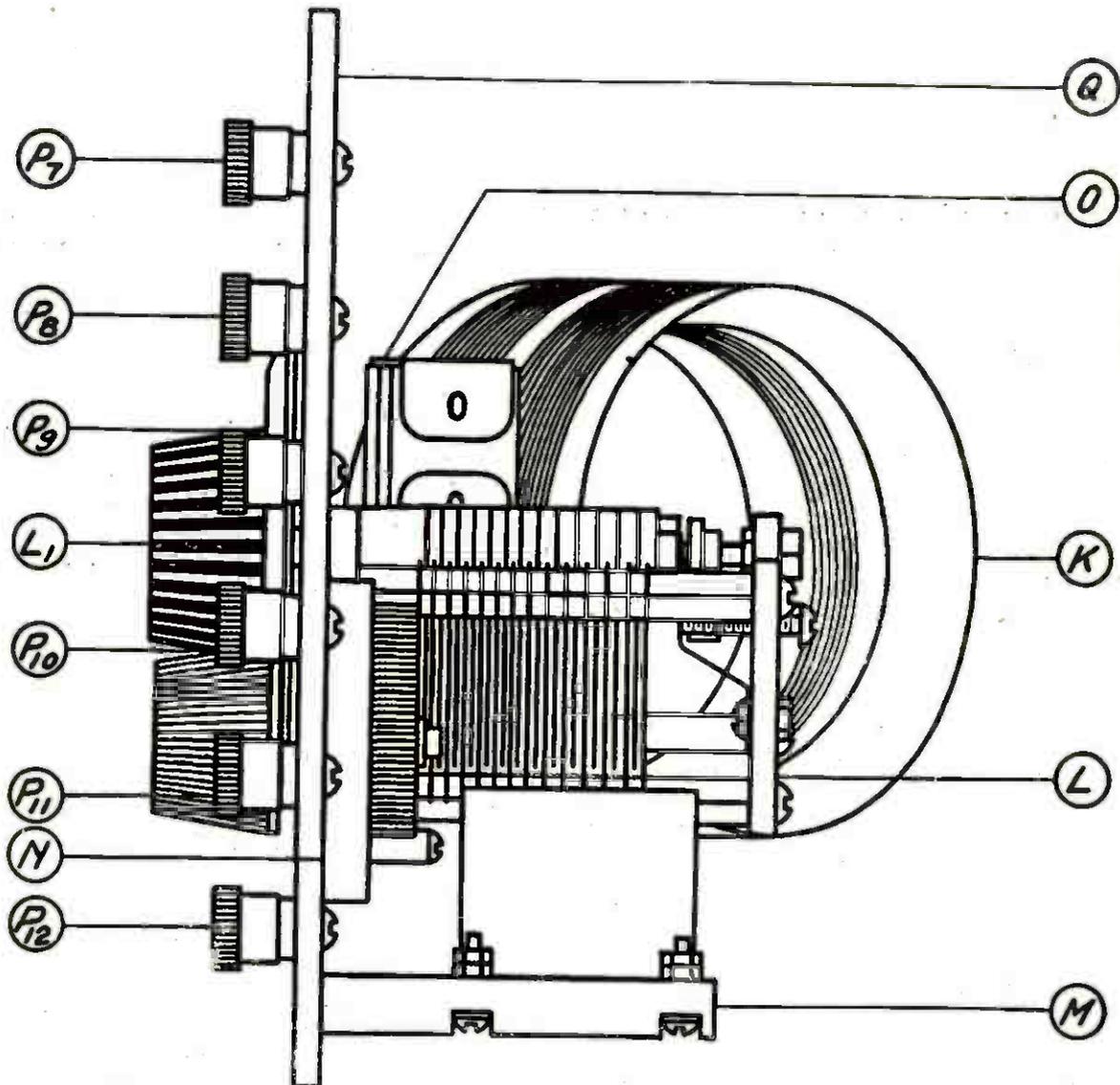
When the panel is drilled, it may be given a dull finish by rubbing lengthwise with smooth sandpaper until the surface is smooth, then the same process should be repeated except

that light machine oil should be applied during the rubbing. The panel should then be rubbed dry with a piece of cheese-cloth, and a dull permanent finish will be the result. Or the panel may be left with its original shiny-black finish, if care is exercised so that it is not scratched during drilling.

Next, mount the variable condenser L, by means of two screws inserted through the panel as shown in Figures 2, 3, and 5. The dial L1, should then be fastened to the shaft of the condenser by means of a set-screw.

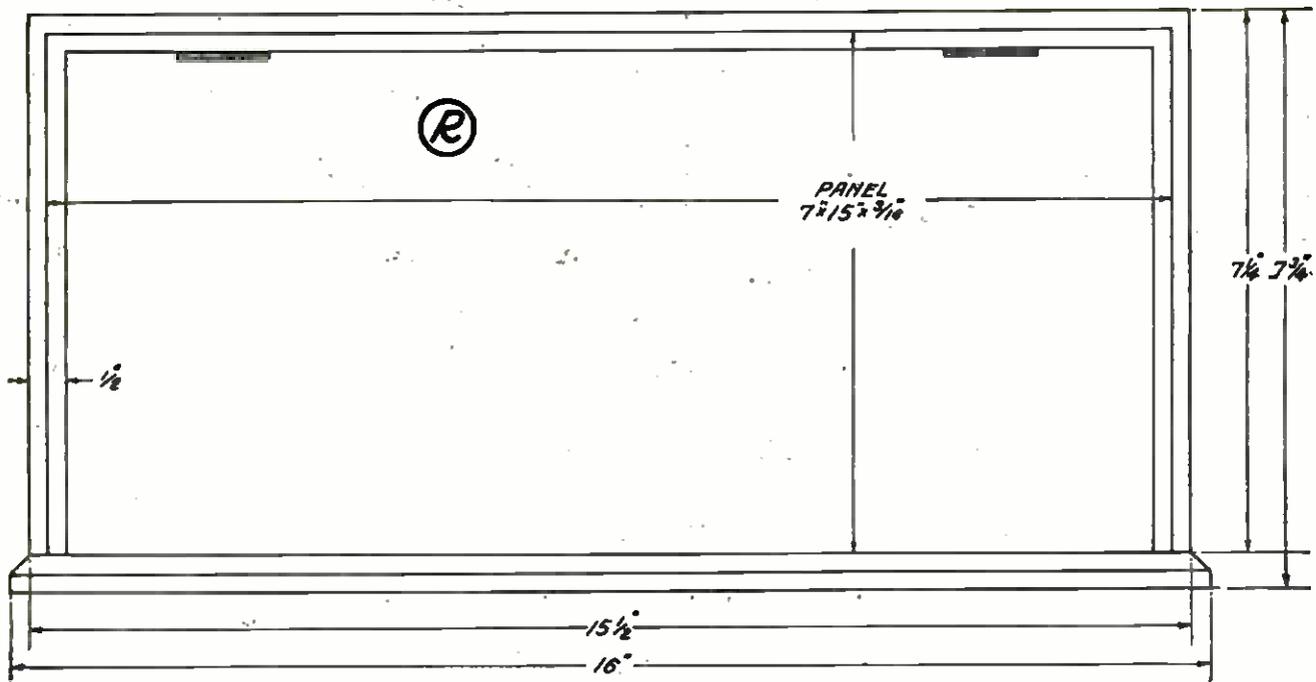
Now, fasten the oscillator coupler K, in its correct place (Figures 2, 3, and 5) by a single screw and attach the knob and dial K1. The three windings of the coupler are designated as K2, K3, and K4, but these designations are for wiring up and will be considered later.

When this is done, mount the socket M, by two screws fastened through the panel, and mount the rheostat N, just above the socket. The arrangement of these two parts is clearly shown in Figures 2, 3, and 5.



THE SIDE VIEW OF THE OSCILLATOR

FIGURE 5: This mechanical drawing gives the side elevation of the instruments as they should be fastened to the panel. The binding posts are mounted in a vertical line at each end of the panel.



#### THE DIMENSIONS FOR THE CABINET

FIGURE 6: This diagram (which contains the front and side measurements for the hardwood cabinet) may be turned over for construction to the cabinet maker or a cabinet of this size may be obtained from almost any radio supply store.

The fixed condenser O, can be left until the wiring is done as it is to be supported by the connecting wires and does not need to be mounted on the panel.

Now fasten on the binding posts P, as indicated in Figures 2, 3, and 5 by inserting a screw through the panel for each one. The various binding posts are designated in the diagrams by numbers from 1 to 12 but these are only given for ease of identification in wiring. All the binding posts are exactly alike.

The dimensions for the cabinet are given in Figure 6. This cabinet may be made by anyone who is handy with carpenter tools, or, the drawing in Figure 6 may be turned over to a cabinet maker. It should be made of hardwood finished to suit the owner's taste. However, as the cabinet for this set is a standard size, it may be procured from almost any radio store; merely ask for a cabinet for a 7 by 10-inch panel.

#### How to Wire the Oscillator

The oscillator should be connected up with bus wire in the following manner:

Run a straight piece of tinned copper bus wire from the binding post marked P1, to the post marked P7, as shown in Figure 1. P1, is the top binding post on the left hand side of the panel (looking from the front). P7, is the top binding post on the right side of the panel (also looking from the front of the panel).

Next, connect binding post P2, with one end of the rotor winding K4, (of the oscillation coupler K,) with a wire and connect the other end of the winding K4, with the binding post P8.

Now run a wire from P3, to P9, and also

connect another wire to this piece and run it to the inside end of the stator winding K2, (of the coupler K). From the outside end of the winding K2, run a wire direct to the plate terminal of the socket M.

Then run a wire from binding post P4, direct to P5, and from there over to P11, and on to P10. The condenser should now be connected by two bits of wire between P3, and P5.

When this has been done, run a wire from P11, to one filament terminal of the socket M, and from the other filament terminal connect a wire to the rheostat N. From the other side of the rheostat a wire should be connected direct to P12.

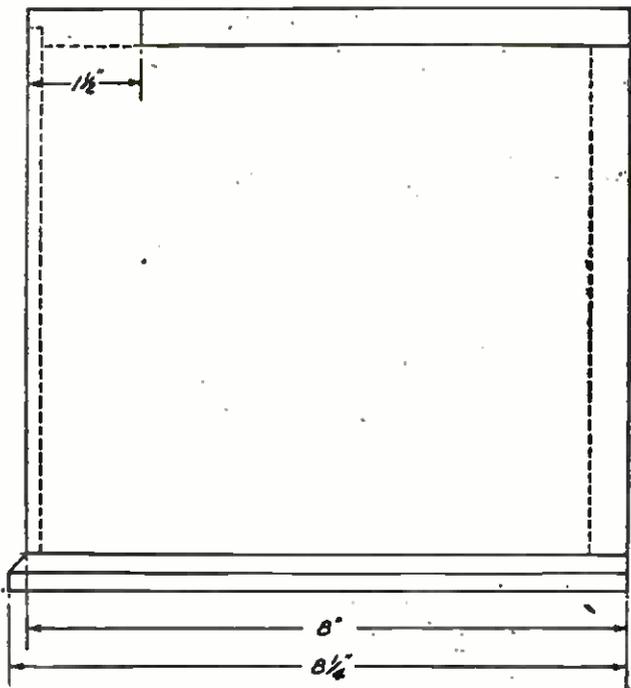
Now, connect binding posts P6, and P12, with a wire, and run a connection from P6, up to the inside end of the winding K3, (of the coupler K). The other end of the winding K3, should be run to the grid terminal of the socket M.

Finally connect the variable condenser L, between the plate and grid leads (from the socket M), being sure that the rotor plates of the condenser are connected to the plate lead and the stator plates of the condenser are connected to the grid lead as indicated in the wiring diagram in Figure 1.

This completes the wiring.

#### What the Oscillator Does

Almost every radio fan who operates a regenerative set is familiar with the whistle accompanying reception of a radio-broadcast signal when the detector is oscillating. We know that this is caused by the incoming radio-frequency current combining with the radio-frequency current generated by the vacuum tube when it is allowed to oscillate. However,



when the wavelength of the oscillating receiving circuit is varied slightly off the wavelength of the incoming signal, the whistling note heard in the receivers goes up in pitch. In other words, when the frequency of the local oscillations (generated in the receiver) is identical with the frequency of the signals being received, the whistle is *not* heard. The two sets of oscillations are then in synchronism or in phase with each other.

When the frequency of the local oscillations is varied either up or down, slower or faster than the frequency of the received oscillations, a whistle is heard which starts with a low pitch and gradually increases till it goes way up and up above audibility. The greater the difference in frequency between the local oscillations and the received oscillations, the higher the "beat note" will be. As stated before if we further increase the difference in frequency the note will become inaudible and if it is increased sufficiently a *beat will be produced which will have a radio-frequency wavelength of its own*. The oscillator (or heterodyne as it is more widely known) does this when used for this purpose. It generates an oscillating, radio-frequency current, the frequency of which can be varied at will, so that it will heterodyne or beat with

the incoming signals and produce another signal like the incoming signal, only on a higher wavelength!

In this way the incoming signal can be *re-produced* on a higher wavelength, in this case 3,000 meters, at which wavelength, radio-frequency amplification can be carried on with enormously greater efficiency than on the original wavelength!

This is the secret of the super-heterodyne; it permits of super-amplification at a radio-frequency by means of a heterodyne.

In the oscillator, just described, the frequency of the local oscillations is varied by rotating the condenser  $\cdot L$ , by means of the knob  $L1$ .

For those who want to own a receiver that will literally reach out to the corners of the earth and pick out a whisper to recreate it into a mighty shout, here is the set to make. Contrary to belief, it really is a simple set to tune.

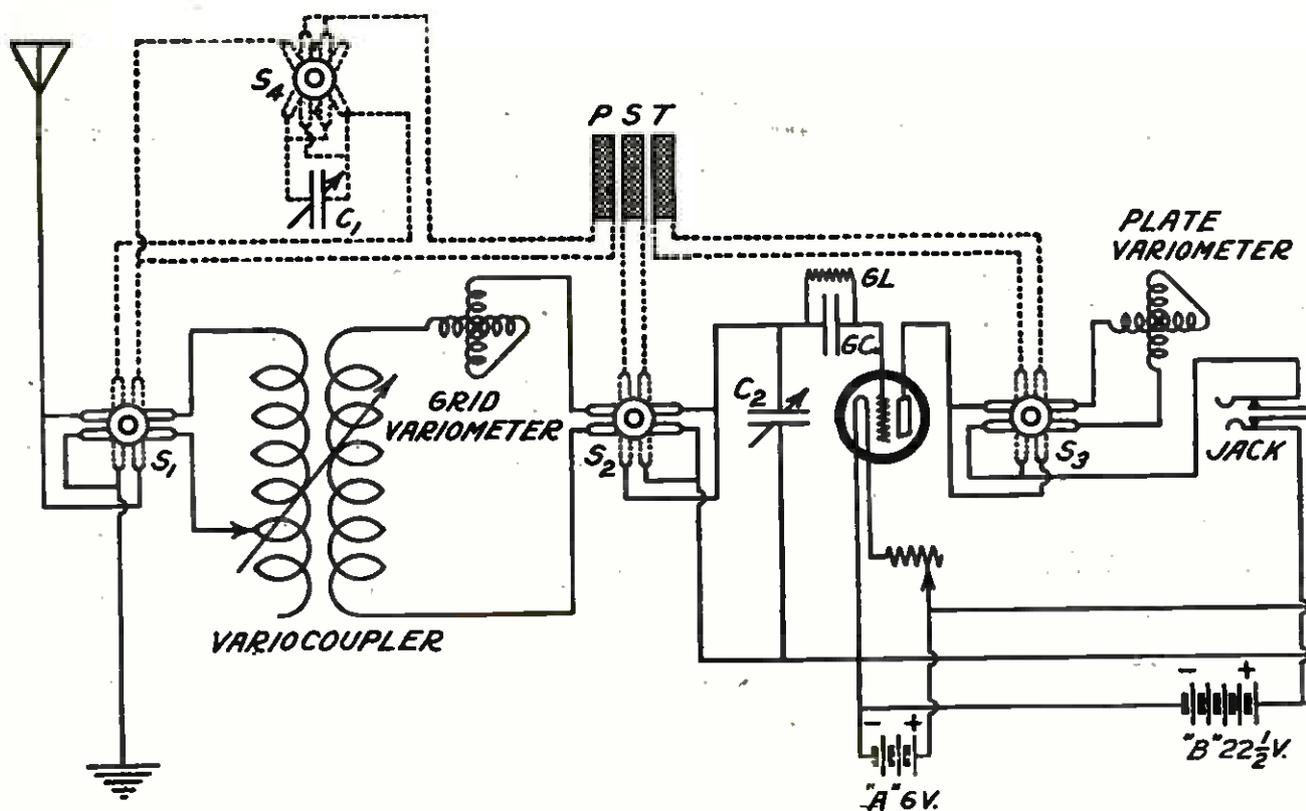
For those who decide to build it we recommend starting work on the tuner described on page 222 in the September issue. Then build the oscillator described here, and next month in the December issue we will describe the radio-frequency amplifier unit. This will be the complete set, unless you want to use audio-frequency amplification, which really is not necessary unless a terrific signal from a loudspeaker is desired. You may get the information on the audio amplifier from the October issue.

The second part of this article—which will appear in the December number—will also tell all about connecting up and tuning the complete super-heterodyne receiver, and will be accompanied with full operating data.

### The "University of the Ether"

*THE wonderful field that radio is opening up in the province of education is so vast that it is not inconceivable that our whole conception of education may be revolutionized. Some vision of what the future holds will be set forth in POPULAR RADIO by one of America's most imaginative authors—Percy Mackaye.*





## HOW TO BUILD A COMBINATION SHORT AND LONG-WAVE REGENERATIVE RECEIVER

This set combines the advantages of the three-coil honeycomb tuner for receiving long waves with the advantages of the variocoupler two-variometer regenerative receiver for receiving short waves. The changeover may be made at will by the operator by means of a clever series of simple switches.

By LESTER A. TWIGG

**T**HE modern radio enthusiast wants a receiving outfit with which he can listen in to a large number of distant as well as nearby broadcasting stations. He wants efficiency in his set, which means not only that it must possess sensitiveness, stability and selectivity, but that it must cover a wide range of wavelengths. And he wants all this at the lowest possible cost.

The present-day short-wave receiving sets are designed to give the best results on wavelengths of 200 to 600 meters. While these short-wave sets can be loaded so as to receive messages on longer waves, it is generally conceded that the spiderweb coils, or coils of similar windings, give better results in the

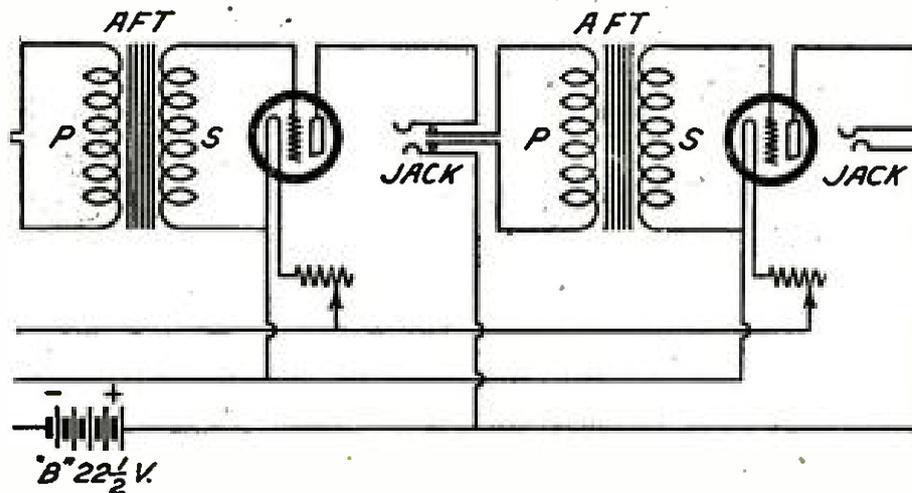
reception of long-wave signals. A combination, then, of a short-wave set and a long-wave set is the answer to the demand for efficiency in both short and long-wave reception.

Such a combination, which I shall call an ideal set, can be constructed from standard parts at a cost of about \$110, but if the windings are home-made and the cabinet and panel omitted it can be constructed for much less. Properly constructed it will compare favorably with any two-stage set on the market selling for two or three times the cost, and if carefully operated it will give surprising results.

One feature which materially lowers the cost of this set is the elimination of

FIGURE 1

This diagram shows the circuit connections for the two tuning units and the detector and two stages of audio-frequency amplification. When either tuner is in use, the other tuner is entirely disconnected and does not interfere with the proper functioning of the one that is being operated.



the double-pole, double-throw switches, substituting series-parallel switches and taps. Four of these switches, shown in Figure 1 as S1, S2, S3 and S4, can be purchased with the necessary taps for less than four dollars; this is less than some shops charge for a one-panel mounted double-pole, double-throw switch. Another feature which lowers the cost is the compactness of the set. All the apparatus, except the batteries, are contained in a cabinet 21 inches long, 12 inches wide and 10 inches deep. This makes all connections comparatively short and adds efficiency to the outfit.

The arrangement of the parts can best be understood by referring to the diagram, Figure 3. A small shelf is fastened to the panel directly under the rheostats, upon which is fastened the two audio-frequency amplifying transformers and the three tube sockets. By extending the shelf to the back of the cabinet, ample room is provided for adding one or two stages of radio-frequency amplification, which today is a very necessary part of the outfit of a wide-awake experimenter.

The duo-lateral, or spiderweb, coils are mounted on the panel and can easily be changed and adjusted to vary the wavelength and tuning as desired. When radiophone messages, or other messages

below the 600-meter wavelength are to be received, the switches are turned horizontally to the short-wave set; when signals above the 600-meter wavelength are to be received the proper coils are selected according to the table accompanying Figure 1, and the switches turned longitudinally to the long-wave set.

The variable condenser, C-1, used in the long-wave set, is controlled by switch S-4, as shown in Figure 2-A, and this condenser is shifted to the different positions as shown in B, C and D of Figure 2. This condenser is of the 43-plate type with a capacity of about .001 microfarad. The variable C-2 is a 23-plate condenser with a capacity of .0005 microfarad.

In constructing a set such as has been described the different parts I used were all of standard make. The material used and the costs of the various items are listed as follows:

1 variocoupler with dial.....	\$ 6.00
2 variometers with dials.....	12.00
3 porcelain tube sockets.....	1.65
3 filament rheostats .....	2.25
2 audio-frequency amplifying transformers .....	7.00
2 double-circuit phone jacks.....	1.50
1 open-circuit phone jack.....	.50
7 binding posts .....	.35
1 grid condenser (.00025 mfd.).....	.30
1 grid leak (2 megohms).....	.50

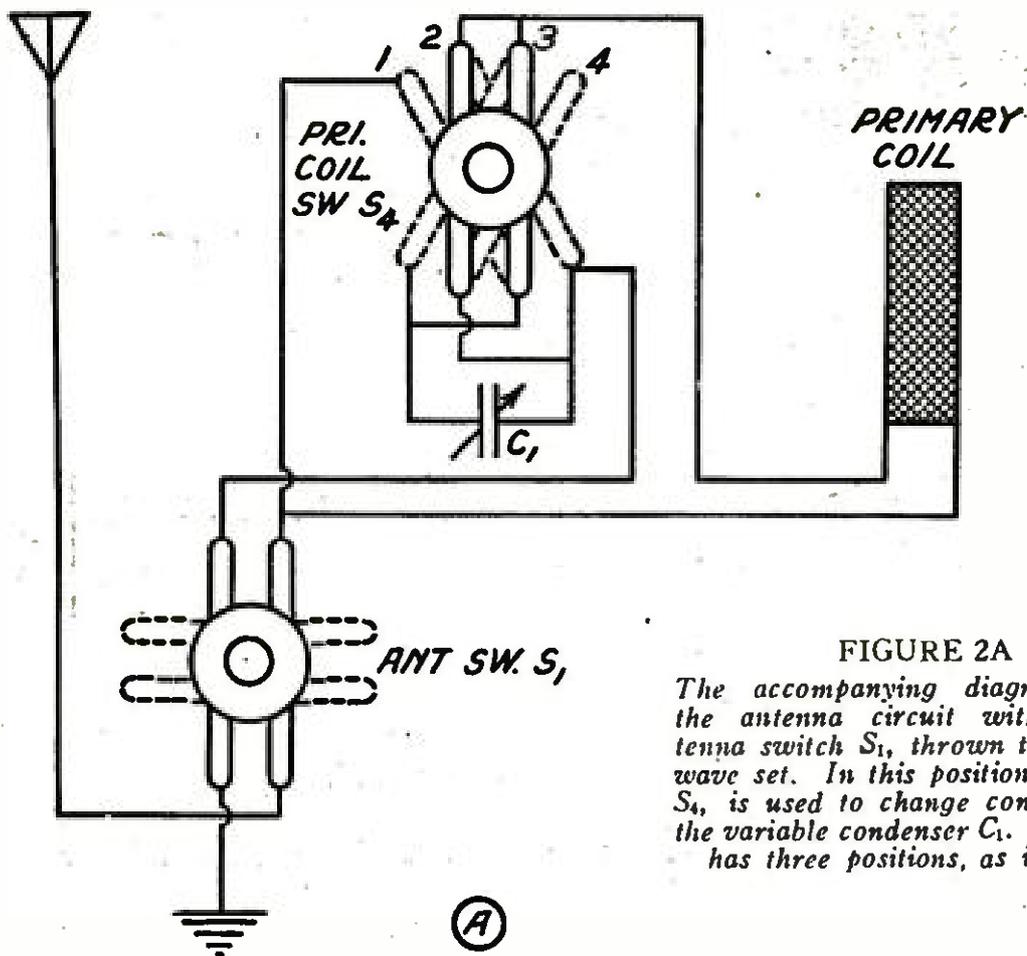
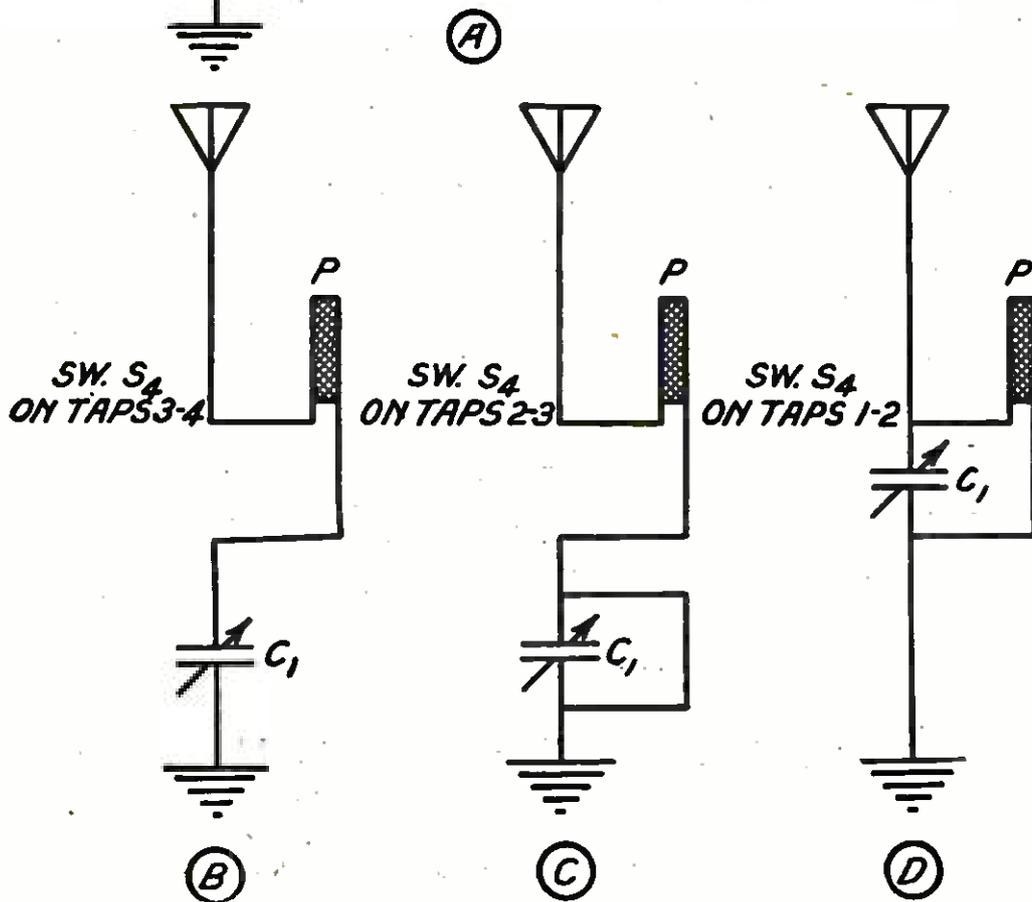


FIGURE 2A

The accompanying diagram shows the antenna circuit with the antenna switch  $S_1$ , thrown to the high-wave set. In this position the switch  $S_4$ , is used to change connections to the variable condenser  $C_1$ . The switch has three positions, as indicated.



FIGURES 2B, 2C AND 2D

In the diagram 2B the switch levers are on 3 and 4 (condenser in series with coil); in the diagram 2C the switch levers are on 2 and 3 (condenser short-circuited) and in the diagram 2D, the levers are on 1 and 2 (condenser shunted across the coil). By this means the wavelength of the antenna circuit may be varied over a wide band of wavelengths.

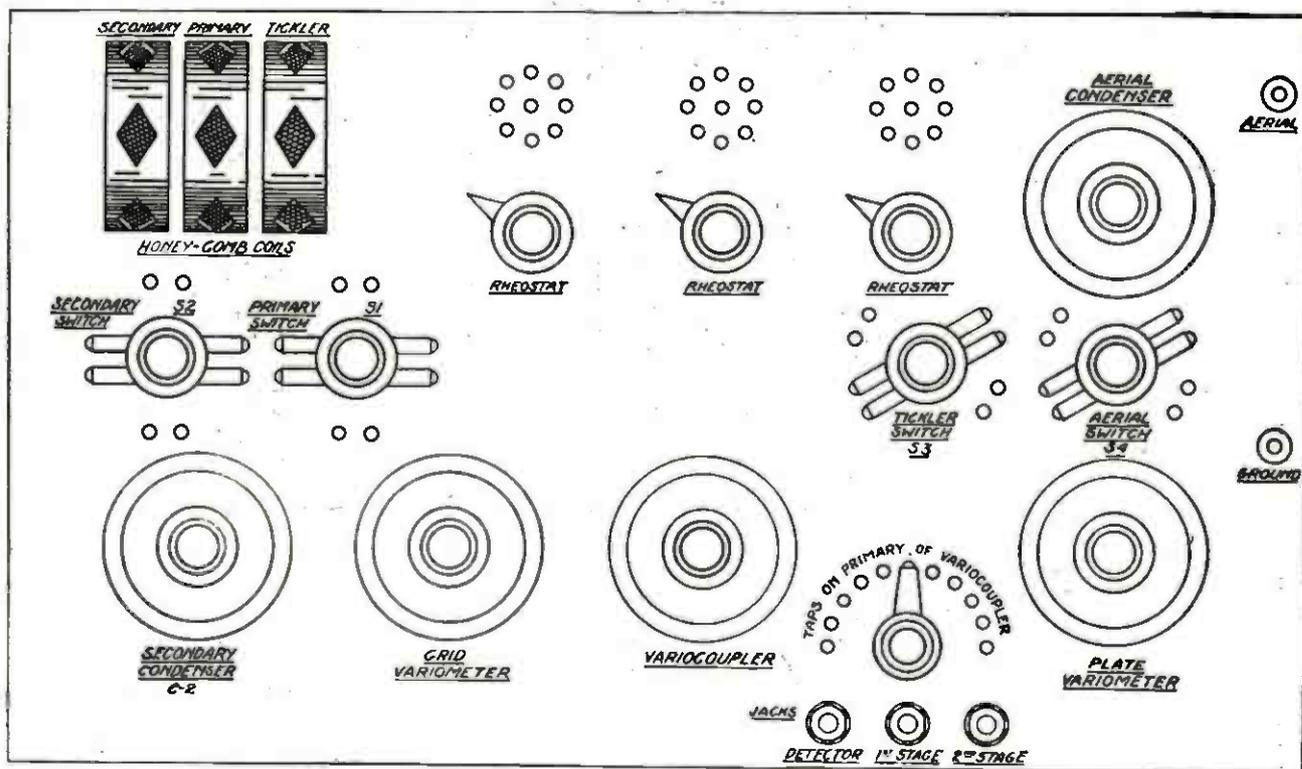


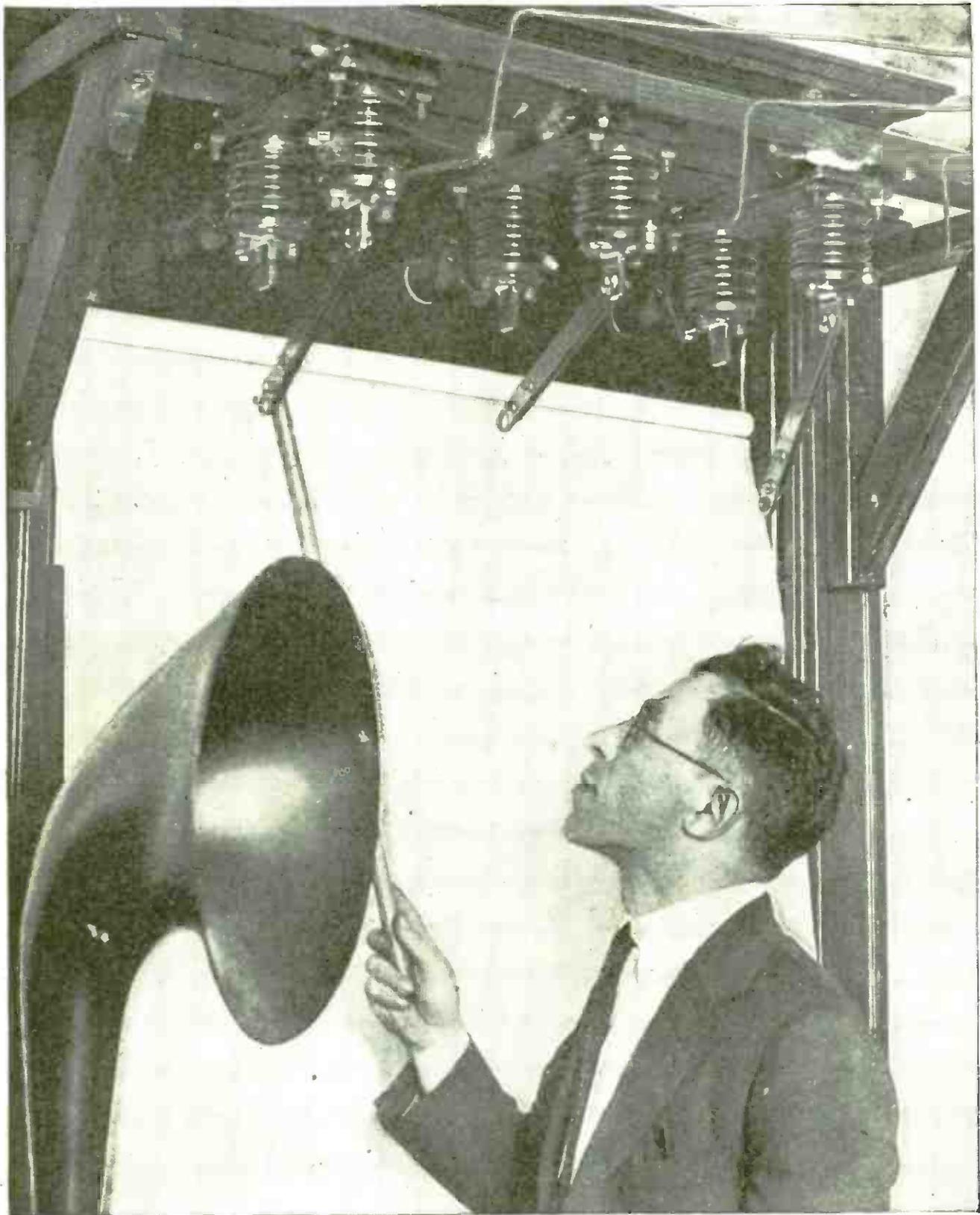
FIGURE 3

A diagram for laying out the instruments on the panel, showing how to put the set into a cabinet.

2 amplifying tubes .....	12.68	2 pinioned coil mountings.....	2.20
1 detector tube .....	4.84	1 variable condenser (.001 mfd.)....	4.00
2 "B" batteries (22½ volts each)....	2.00	1 variable condenser (.0005 mfd.)....	3.00
1 "A" battery (6 volts, 60 ampere hour capacity) .....	14.00	1 coil each of the following sizes: L-75, L-100, L-150, L-200, L-250, L-300, L-400, L-500, L-1,000, L-1,250.	15.00
1 set head phones (2,000 ohms).....	5.00		
1 phone plug for jacks.....	1.00		
1 switch lever (1¼ inch radius).....	.25		
1 100-foot length No. 14 antenna wire .....	1.00		
1 switch (porcelain base S.P.D.T.)....	.35		
1 piece 50-foot length aluminum wire No. 14, for ground and for wiring outfit .....	.26		
1 cabinet (12 x 21 x 10 inches).....	3.25		
1 panel (12 x 21 x 3/16 inches).....	3.50		
1 dozen contact points.....	.40		
ADDITIONAL FOR LONG-WAVE SET			
3 dozen contact points.....	1.20		
4 series-parallel switches .....	3.16		
1 stationary coil mounting.....	.70		
		Total cost.....	\$109.84

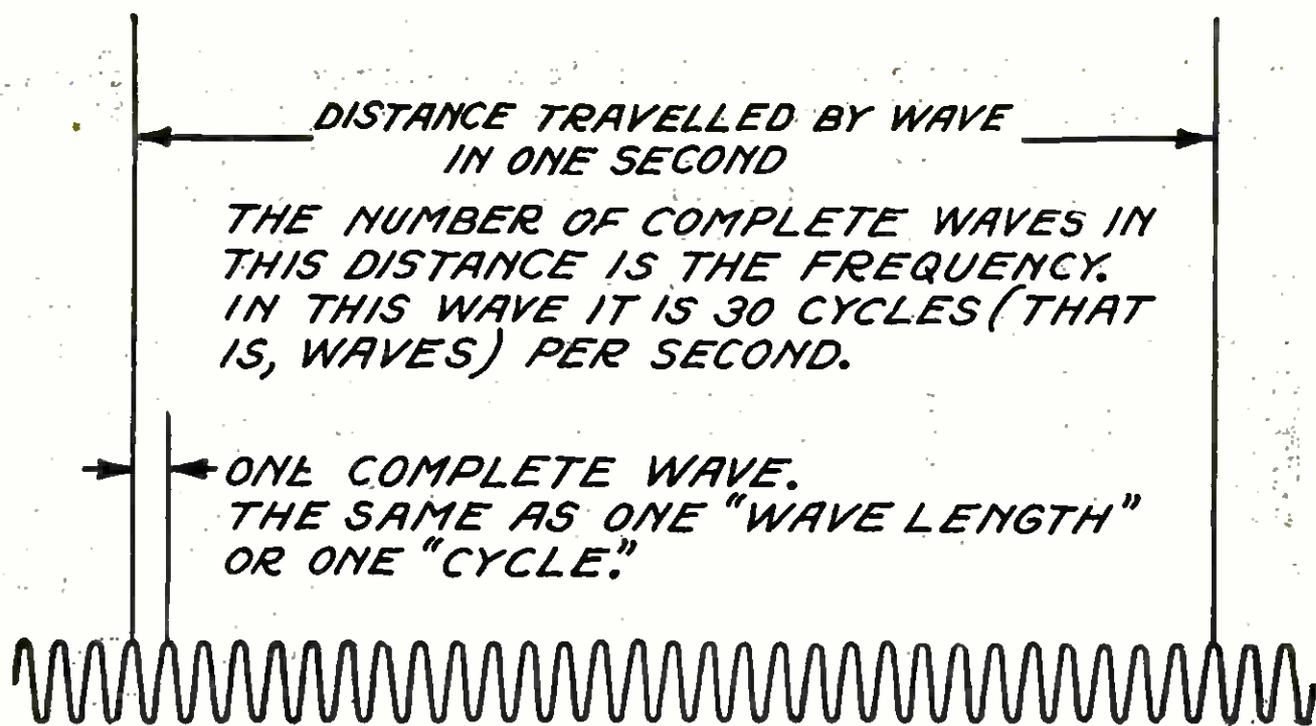
With this set, located in Washington, D. C., I have regularly heard concerts from Pittsburgh, Indianapolis, Detroit, Cleveland, Newark and Schenectady, besides a number of stations within a radius of 300 miles. Any number of telegraph stations, from almost any distance, may be heard on the long-wave set.

Number of Turns in			=	Wavelength in Meters	
Primary	Secondary	Tickler			
35	25	35	=	145	— 350
75	50	35	=	305	— 710
150	100	75	=	635	— 1,660
200	150	100	=	845	— 1,970
300	250	150	=	1,420	— 2,850
500	300	200	=	2,550	— 4,250
500	400	200	=	4,200	— 6,300
1,250	1,000	400	=	6,250	— 14,500
1,500	1,250	500	=	13,600	— 21,000



#### BUYING HOME AMUSEMENT WITH YOUR ELECTRIC LIGHT

*This is a part of the system recently installed on Staten Island, one of the boroughs of New York City, by which regular programs of music and other interesting material will be supplied to subscribers over the power lines of the local electric service company. The methods of "wired wireless" as developed by General Squier are used. The insulators shown at the top of this photograph carry the high-tension power-distributing wires to which the radio-frequency currents carrying the broadcast material are supplied. A full description of the apparatus used will appear in an early number of POPULAR RADIO.*



*This diagram shows clearly the relation between wavelength and frequency for the specific wave pictured at the bottom—in this instance the wave produced by the note of a flute.*

## HOW TO CONVERT Wavelengths Into Kilocycles

ARTICLE NO. 1 OF A NEW SERIES

Useful facts about ether waves—condensed  
for your notebook

By E. E. FREE, Ph D.

**WHAT** is a kilocycle? Why are radio waves now being measured in this new unit instead of the familiar wavelengths? What is frequency?

Of these questions let us take first what frequency is and what is its relation to wavelength.

Any wave whatsoever, a radio wave in the ether, a sound wave in the air, a water ripple on the surface of a pond, consists of a succession of pulses moving along one after another. Most waves have a succession of *regular* crests and troughs like ocean waves or like the electric wave, a picture of which is shown in Figure 1.

The part of the wave between one crest and the next following crest is called one complete wave. Its length—that is the distance between successive wave crests—is one wavelength. This is the familiar radio unit.

The *frequency* is merely the number of such complete waves that pass in one second (or what is the same thing) the number of wavelengths in the distance the wave moves in one second.

Consider the arrival of a moving wave at some fixed point; for example, the arrival of a sound wave at your ear.

The wave appears to your ear as a succession of regularly timed pulses,

one pulse for each wave crest. Each pulse pushes a little against your ear. This sets the drum of the ear to vibrating; inward for each pulse, outward again during each time between pulses. The number of these back-and-forth vibrations of the drum a second is the same as the number of pulses of the wave that arrive a second; it is the same; that is, as the frequency of the wave. The higher this frequency, the shriller the sound seems to your ear.

What you really hear, then, is the frequency, not the wavelength. Frequency, indeed, is always a more characteristic property of waves than length is. Wavelength depends on the *speed* of the wave, and the speed depends not only on the kind of wave but on the medium in which the wave is traveling. Sound waves, for example, move faster in water than they do in air. The wavelength of a sound wave will be greater in water than in air. But its frequency will be the same. It is frequency, not wavelength that is the constant property.

Similarly when you modulate a sound wave onto a radio wave the wavelengths of the two waves do not matter. The sound wave is a slow wave in air. Its single waves are very short. The radio wave on the other hand, is a fast wave in the ether. Its wavelength is relatively very long. The factors that really determine the relation of the two waves, the factors that you need to take account of in modulation calculations, are the respective frequencies of the two waves.

This is one reason why frequencies are coming to be used instead of wavelengths. The use of frequencies makes all kinds of waves comparable directly. Modulation calculations are easier. Interference, harmonics and all other mutual relations of waves are more directly discoverable.

The *kilocycle* is merely a unit of frequency, just as the meter is a unit of wavelength. In electrical terminology

a "cycle" means one complete wave, measured, as usual, from one crest to the next following one. (See Figure 1.) The frequency may be expressed, therefore, in cycles. It is the number of cycles a second. An alternating current, for example, may have 60 cycles a second, which means the same as a frequency of 60 cycles.

The kilocycle is merely 1,000 cycles, just as a kilometer is 1,000 meters or a kilowatt is 1,000 watts. To say that a wave has 500 kilocycles a second means that it has 500,000 cycles (that is, complete waves) a second.

To convert frequencies and wavelengths into each other requires knowledge of the speed of the wave. Radio waves move with the speed of light. According to the most accurate experimental determinations this speed (in vacuum) is 186,326 miles a second, or 299,860,000 meters a second. For ordinary calculations radio engineers use a round number of 300,000,000 meters a second.

A wave that has 500 kilocycles (which is the same as 500,000 complete waves) a second, will move in that second 300,000,000 meters. The length of each single wave will be, therefore, 300,000,000 divided by 500,000, or 600 meters. This wave will have a wavelength (in vacuum) of 600 meters.

Here are the rules for conversion:

*To convert the wavelength (in meters) into the frequency (in kilocycles) divide it into 300,000.*

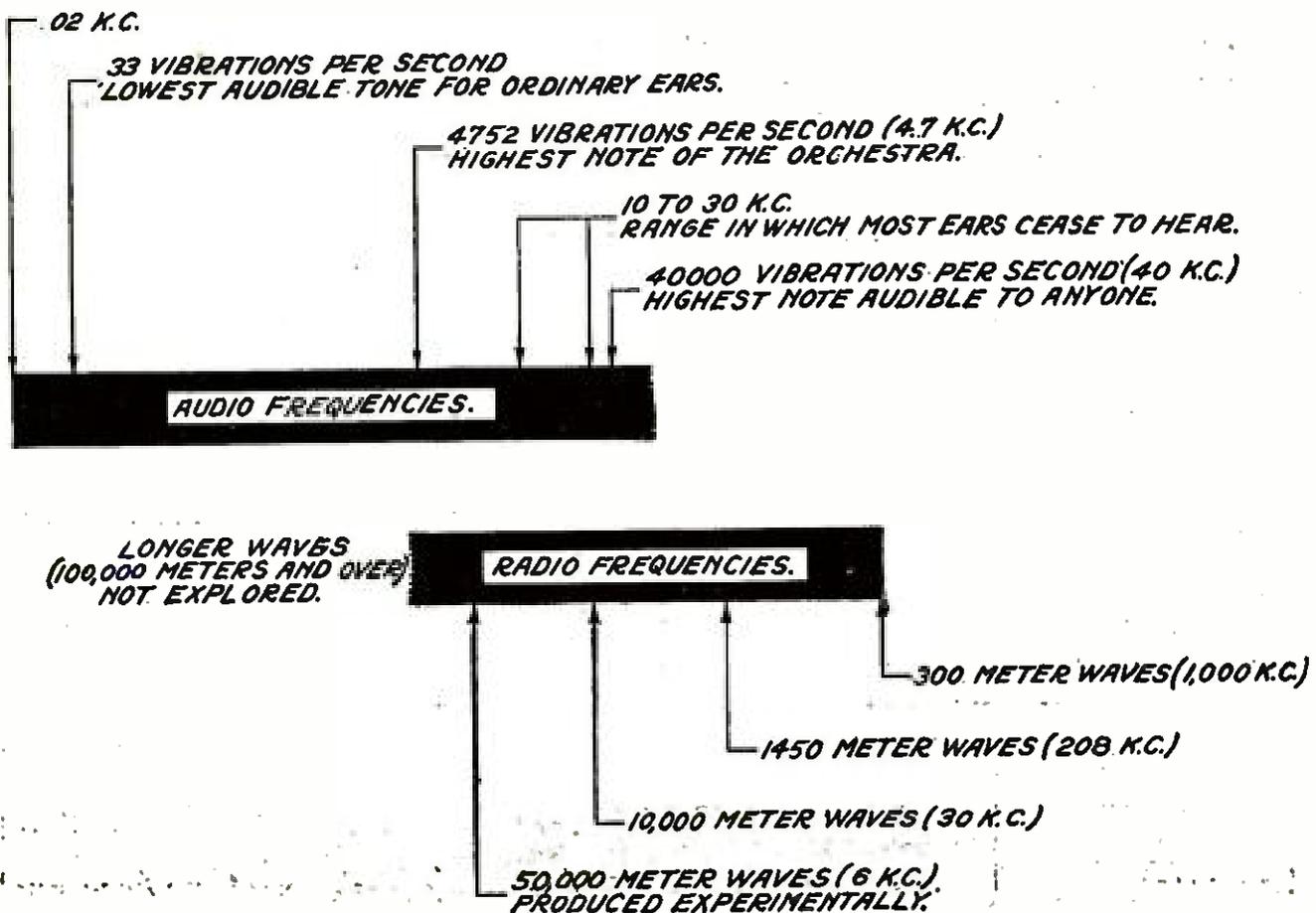
The reverse rule is the same:

*To convert the frequency (in kilocycles) into the wavelength (in meters) divide it into 300,000.*

The speed of radio waves in air and in non-conducting materials is nearly the same as in vacuum. These rules hold, therefore, for all ordinary calculations.

By way of comparison, the speed of sound waves in ordinary air is about 1,150 feet a second (350 meters a second), not much over one millionth

		FREQUENCY	WAVE LENGTH
AUDIO FREQUENCY VIBRATIONS	} 10.6 OCTAVES	.02 KILOCYCLE (20 VIBRATIONS PER SECOND)	15,000,000 METERS
		<i>THE AUDIO FREQUENCY AND THE RADIO FREQUENCY OVERLAP AS SHOWN IN ANOTHER DIAGRAM HEREWITH.</i>	
USUAL RADIO WAVES	} 6.7 OCTAVES	30 KILOCYCLES	10,000 METERS
		<i>HERE BELONG ALL ORDINARY RADIO WAVES.</i>	
SHORT ELECTRIC WAVES	} 16.7 OCTAVES	3,000 KILOCYCLES	100 METERS
		<i>THESE WAVES HAVE BEEN USED ONLY EXPERIMENTALLY. HERE BELONG, ALSO, THE RADIO HEAT WAVES RECENTLY DISCOVERED BY DR. E. H. NICHOLS. ALL THESE WAVES WILL PROBABLY BE QUITE IMPORTANT IN THE FUTURE.</i>	
HEAT WAVES	} 10.3 OCTAVES	300,000,000 KILOCYCLES	.001 METER (10,000,000 ANGSTROM UNITS)
		<i>ALSO CALLED THE INFRA-RED RAYS.</i>	
LIGHT WAVES	} 1 OCTAVE	387,000,000,000 K.C.	7750 ANGSTROM UNITS
		759,000,000,000 K.C.	3900 ANGSTROM UNITS
ULTRA- VIOLET LIGHT	} 3.7 OCTAVES	10,000,000,000,000 K.C.	300 ANGSTROM UNITS
		<i>RAY'S THAT PENETRATE MOST KINDS OF MATTER.</i>	
X-RAYS	} 11.6 OCTAVES	30,000,000,000,000,000 K.C.	.1 ANGSTROM UNIT
		<i>FROM RADIUM</i>	
GAMMA RAYS	} 3.3 OCTAVES	300,000,000,000,000,000 K.C.	.01 ANGSTROM UNIT
		<i>UNEXPLORED REGION, WAVES STILL SHORTER THAN GAMMA RAYS</i>	



#### RADIO FREQUENCIES THAT WE CAN HEAR

The longer waves of radio overlap into the range of audio frequencies, as is shown in this diagram.

of the speed of radio waves. The speed of sound in water is about 1,500 meters a second. The fastest known speed for sound is in steel; it is about 5,300 meters a second.

Not only radio waves but all kinds of ether waves are designated most conveniently by their frequencies. The table on page 407 gives in form convenient for reference all the ether waves now known with their frequencies and the corresponding wavelengths in vacuum. The term "octave" is borrowed from music. One octave means all the waves between any particular frequency and a frequency twice as great. For example, the first octave of the table includes all the waves between a frequency of 20 cycles a second and a frequency of 40 cycles a second; the second octave is from 40 to 80 octaves a second, and so on.

The entire series of ether waves,

from the longest radio waves to the shortest gamma rays, is now known without gaps. There was formerly a gap between the ultra-violet waves and the X rays, but this has been filled by the discovery of some very long X rays lying well within the ultra-violet range. The other former gap, between the heat waves and radio waves, was filled recently by the work of Nichols and Tear (POPULAR RADIO for July, 1923).

The divisions of the waves into radio waves, heat waves and light waves, are made merely for convenience. All the waves belong, really, to one unbroken series. Many of the divisions are overlapped, just as the heat waves overlap the short radio waves and the X rays overlap into the ultra-violet. A similar overlap of the audio frequencies and the radio frequencies is shown in the illustration on this page.

The ether waves that have been most

studied by scientists are those of light. These differ from the longer and shorter waves only in that they happen to be perceived by the human eye. Physically all the waves are the same. The *color* of light depends upon its frequency, or, what is the same thing, upon its wavelength. The band of color in a rainbow, which scientists call the spectrum, is as follows:

	Angstrom Units
Heat waves (invisible).....	longer than 7,750
Red light.....	7,750 to 6,460
Orange light.....	6,460 to 5,900
Yellow light.....	5,900 to 5,600
Green light.....	5,600 to 4,900
Blue light.....	4,900 to 4,500
Violet light.....	4,500 to 3,900
Ultra-violet rays (invisible)	shorter than 3,900

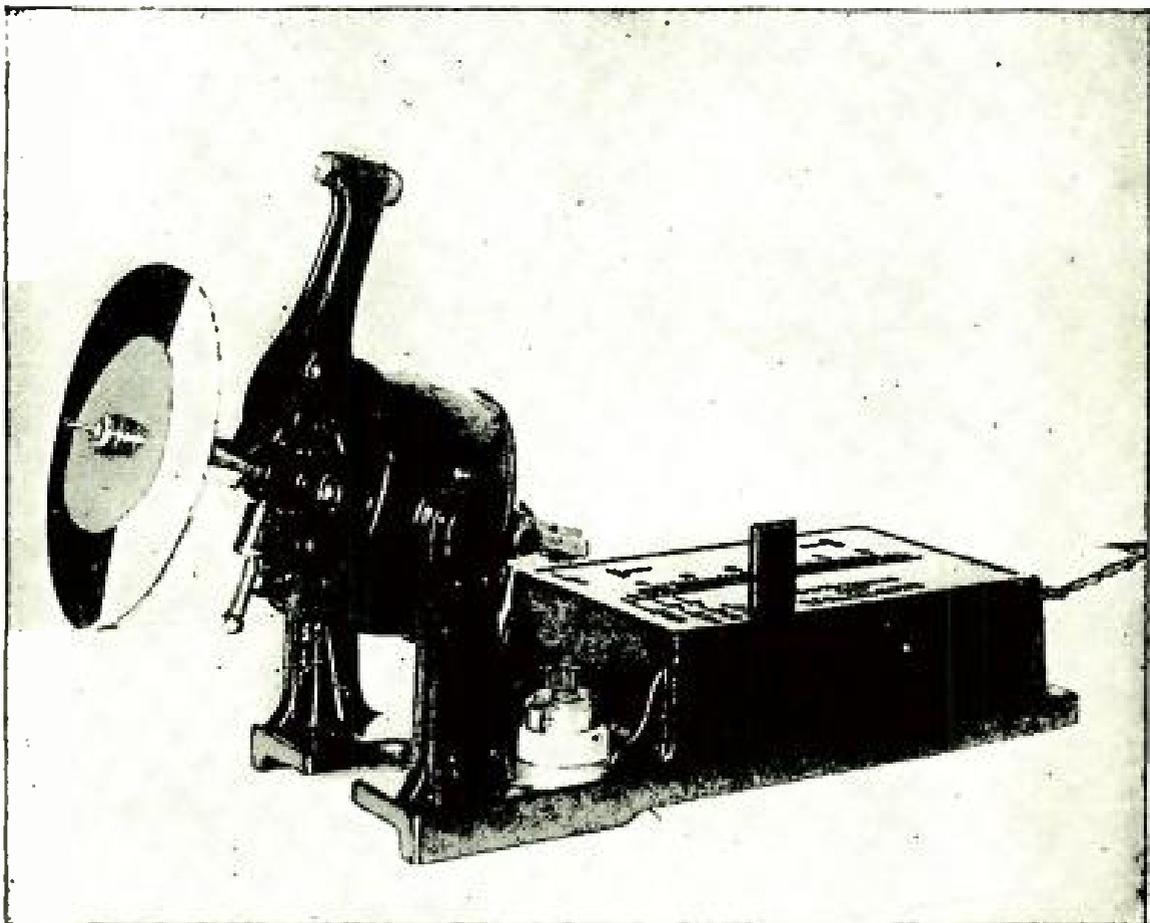
The Angstrom unit used in this table and which is the common unit for the

length of light waves, equals one ten-billionth of a meter. It is named after the celebrated Swedish scientist Dr. K. A. Angstrom, who was the first to study and chart the spectrum of sunlight.

Other units of length sometimes used in designating the wavelengths of ether waves, are the following:

1 meter.....	equals 1,000 millimeters
1 millimeter....	equals 1,000 microns
1 micron.....	equals 1,000 double microns
1 double micron	equals 10 Angstrom Units

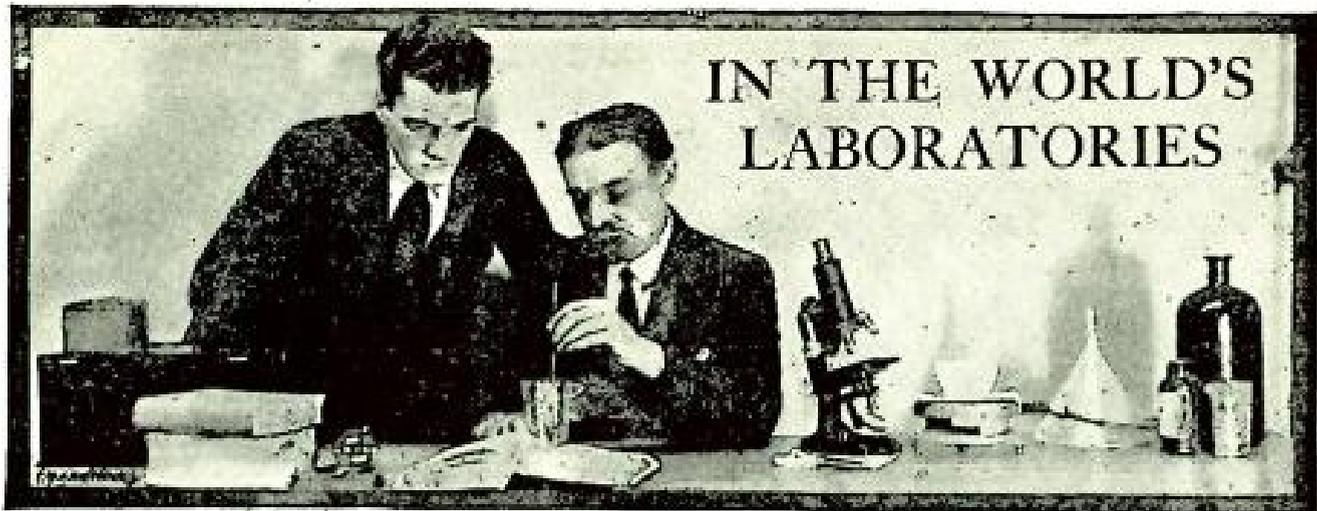
The abbreviation for micron is the Greek letter mu ( $\mu$ ), that for the double micron is ( $\mu\mu$ ); that for the Angstrom Unit is A. U. or sometimes merely A. A double micron is sometimes called a "micro-micron" or a "mille-micron."



Brown Bros.

#### HOW COLORED LIGHT WAVES ARE MIXED AND JUDGED

One half of the colored rim on the edge of the disk is red, the other half is white. When the disk is rapidly revolved by the attached electric motor the light waves from the two portions of the disk blend in the eye, producing a shade of pink. In the same way the color-blends necessary to produce any desired shade of any color can be worked out in the laboratory. Psychologists also use this same instrument to study the way in which the human eye sees various mixtures of light of different colors.



### *Einstein May Be Wrong After All*

HAS the Einstein Theory been proved right, finally and certainly, by the photographs taken last year in Australia during the eclipse of the sun and recently announced by Dr. Campbell?\*

Many scientists would be inclined to answer yes. But Professor William H. Pickering, distinguished student of the moon and of Mars and one of the most famous of American astronomers, is still disposed to be sceptical. In an article in *Popular Astronomy* for June-July, 1923, he reviews the attempts that have been made recently to check Einstein's famous three proofs of his theory, with results not entirely favorable to the completeness and accuracy of the theory itself.

These three proofs, you remember, were the following:

*First*, the light from a distant star ought to be bent a trifle as it passes close to the edge of the sun. The exact amount of this bending was calculated from the theory, and it was this amount which was confirmed by the Australian photographs.

*Second*, some of the dark lines across the rainbow band or spectrum of sunlight ought to be displaced a little in position when compared with the corresponding lines in the spectrum of light produced here on earth.

*Third*, the Einstein Theory explained,

according to its advocates, the slight error long known to exist in the annual motion of the orbit of the planet Mercury.

The predicted bending of the light ray from a star appears to have been confirmed with reasonable exactness. This Dr. Pickering admits. The second proof, the displacement of the solar spectrum lines, has not yet been brought to exact test because of the tremendous experimental difficulties involved in work of this sort. The scientists of the Mount Wilson Observatory, who are admittedly the world experts in this field and who have unsurpassed instrumental equipment for it, are not yet willing to announce any result either for Einstein or against him.

The third proof—with reference to the error in the orbit of Mercury—has usually been considered fully favorable to the theory. Indeed it was the ability of the theory to explain this well-known discrepancy that first recommended it to the serious attention of astronomers. But recent recalculations of the motions of this planet are not, Dr. Pickering points out, quite so much on Einstein's side as has been supposed. The Einstein Theory explains the error in the orbit not only sufficiently, but too much. It accounts for more error than exists.

When all known corrections are applied to the figures, including a correction for the polar flattening of the sun, which seems to have been forgotten in

\*See POPULAR RADIO for October, pages 284-285.

the first calculations, the error in Mercury's orbit works out, Dr. Pickering writes, as 38.1 seconds of arc. Einstein's equations account for an error of 42.9 seconds: over ten percent more, that is, than exists.

This does not disprove the Einstein Theory, but it does mean, Dr. Pickering implies, that we should go a little slow in accepting it as complete and final. Perhaps some modification of it may prove to be necessary.

Even the proof from the bending of starlight, while it seems undoubtedly to be a *fact*, may not constitute such a real proof of the theory as it has been thought. Dr. Einstein, to be fair to him, never called any of these three things a *proof*. He said merely that they were *consequences* of his theory; that they would be true if it was, and assuming, of course, the usual other theories as to the nature of light and the like. In

recent years it has begun to seem as if this last assumption might be a rather unsecure one. We begin to suspect that our usual theories of light are not quite perfect. Some facts about X-rays, for example, do not fit into them very well. We may have to modify these theories, and this may change somewhat our interpretation of the supposed Einstein proof.

All this makes it increasingly desirable to secure accurate information about the second proof, the predicted shift of the spectrum lines. Many scientists are working on this, and early results are probable. It is possible, also, that the eclipse of the sun that is occurring in Southern California while this number of POPULAR RADIO is being written, may yield information of importance. No total eclipse of recent years has been so readily accessible to centers of population and none in the



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#### DOES THE EINSTEIN THEORY EXPLAIN ERRORS THAT DO NOT EXIST?

*Possibly, thinks Prof. William H. Pickering, the distinguished American astronomer, who questions whether the "proof" with reference to the error in the orbit of Mercury does not prove too much.*



International

THE "ELECTRICAL DOG" AND ITS INVENTOR,  
JOHN HAYS HAMMOND, JR.

*This little car, propelled by battery-driven electric motors, contains an arrangement of selenium cells which directs its movement. It follows a light, turning when the light turns, as a dog follows his master.*

history of the world has been attacked by such an assemblage of scientists as have gathered in California and Mexico for this one.

*Machines That Operate by Light Waves*

THE extraordinary property of the metal selenium by which it changes in electrical conductivity whenever light falls on it has been for years an incentive to inventors. Devices employing it have ranged from machines to open window shades when the sun rises in the morning to automatic dogs that will follow you about if you hold up a lamp in front of them. The newest one, of which we read in a recent number of the *Wireless Review* (London), is a device that dims automatically the headlights of your automobile whenever another car approaches yours on the same road.

A selenium cell fixed to the front of your car receives the light rays from the approaching headlights. This changes the resistance of the selenium and actuates a relay which inserts a dimming resistance into your headlight circuit.

So passes a test of road courtesy. When you see the other fellow's lights grow pleasantly dim as you approach, you will not know any more whether it is because he is a member of the fellowship of friendly drivers or whether it is merely because he has money enough to buy a selenium cell.

*French Time Signals Are Late*

THE report of the British official astronomical observatory at Greenwich indicates that during 1922 the daily time signals sent out by the French radio station at Paris were, on the

average, .04 second later than the British signals. The signals from the Bordeaux station showed an even greater lag, the average discrepancy being .08 second. Both of these figures indicate the final unexplained discrepancy after all known corrections have been applied.

During the year the American signals averaged .03 second behind the British ones, but this is explained by the British authorities as being due to the time required for the wave to cover the long distance separating the two stations. The German signals from Nauen coincided exactly with the British ones.

More interesting, really, than speculation about the possible cause of the lag in the French signals is the fact that this lag was discovered at all. Such precision in the comparing of times between two distant stations would have been absolutely unobtain-

able before the development of radio. This is only one of the many ways, as pointed out by General Ferrié in his article in POPULAR RADIO for October, in which radio is proving of assistance to other sciences.

### *The Future of the Airplane Controlled by Radio*

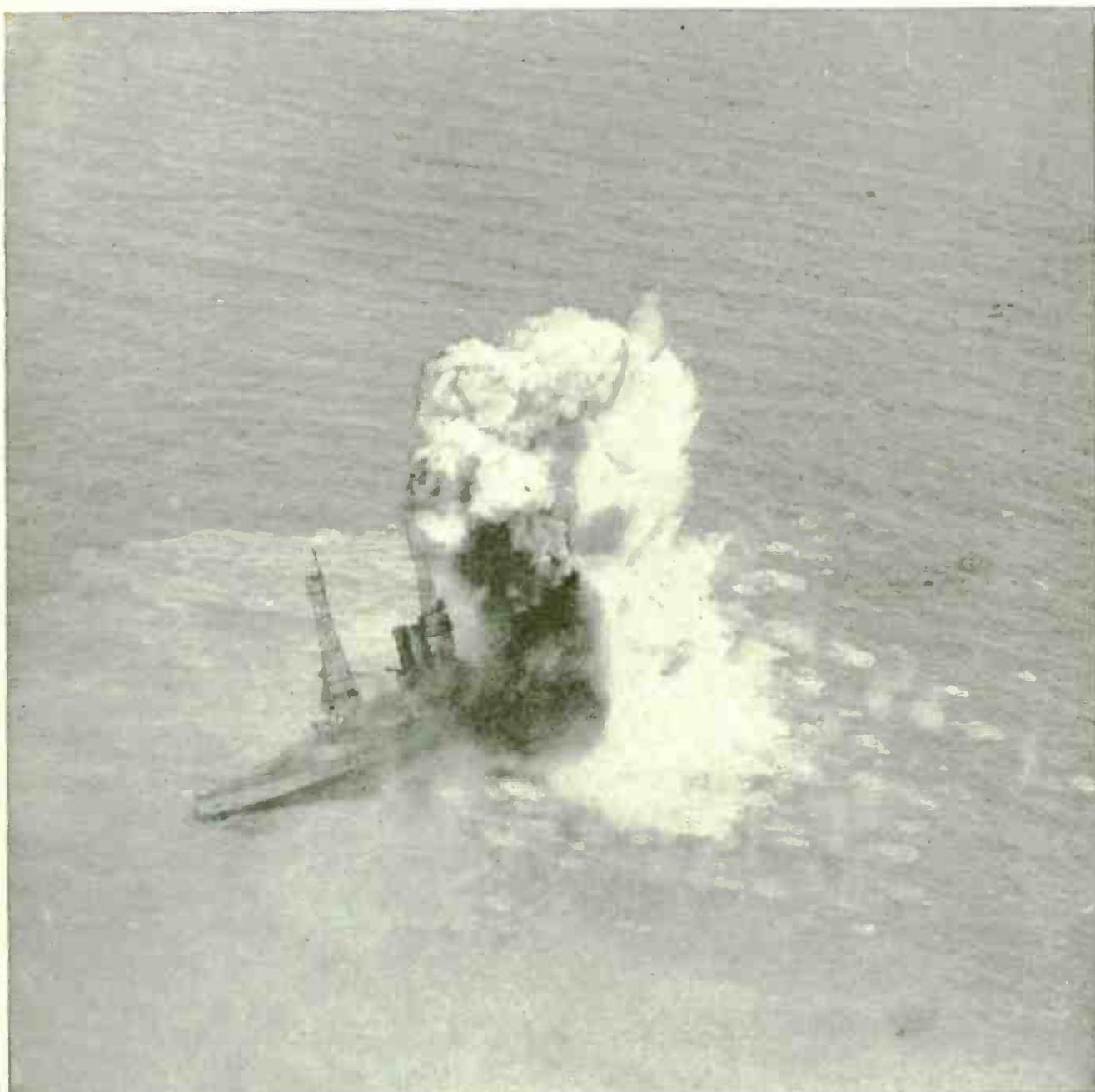
WILL one of the gifts of radio to the world be a mail route encircling the globe in a score or two of hours; moving, that is, as fast as the sun itself? Will we ship freight to Europe overnight? Will the thousand or so men who are necessary to man and operate an ocean liner be replaced by three or four radio operators bending over their keys somewhere in a seaport city?

None of these things is impossible if we are to share the enthusiasm of the



#### A MAIL CARRIER OF THE FUTURE

*A radio-controlled airship recently exhibited in London and said to be capable of making long flights without either passengers or pilot.*



U. S. Army Air Service

**RADIO-CONTROLLED SHIPS MAY BE DESTROYED BY  
RADIO-CONTROLLED AIRCRAFT.**

*In trials by the United States Navy, the battleship Iowa, with no one on board, was steered and controlled by radio while aircraft attacked the moving ship with full-sized bombs, simulating the conditions of actual warfare.*

scientists and engineers who gathered recently at the jubilee meeting of the French Society of Civil Engineers to hear and discuss the paper of M. Percheron on the possibilities of the pilotless, radio-directed airplane. In the presence of General Ferrié, the head of the French radio service, of M. Soreau, the expert on commercial aviation, and of many other distinguished members of the Society, M. Percheron described some of the French experiments, mili-

tary and otherwise, in which automatic devices controlled the flight of planes; some of them carrying pilots who acted merely as observers and never found it necessary to touch the controls, others entirely without human passengers and dependent for their control altogether upon the radio signals sent out from ground stations.

The fact that such devices were developed in the latter days of the war by most of the allied nations is common

knowledge, but they have been thought of in the main as having military value rather than as being useful in time of peace. But it is evident, M. Perchiron said, that a perfected man-less plane will make available for ordinary use the higher regions of the atmosphere where the air is thinner and the speed attainable by a plane is correspondingly greater. Mail planes cannot now fly at these great elevations because of the discomfort to the pilot. If there is no pilot this limit disappears.

That our own aviation authorities are not unmindful of these possibilities is evidenced by a recent statement made by General Mitchell, of the Air Service, U. S. A., in the course of an interview predicting that airplanes could probably rise without great difficulty to 55,000 feet above the earth, nearly four miles above the present record. At such a height, the general said, planes might be flown to Europe in a few hours. Automatic machinery in the plane would send out radio signals at regular intervals. These signals, picked up by properly placed direction-finders on shore would enable the operators here to keep in constant touch with the position of the plane and to send out from time to time the necessary control signals to direct its flight.

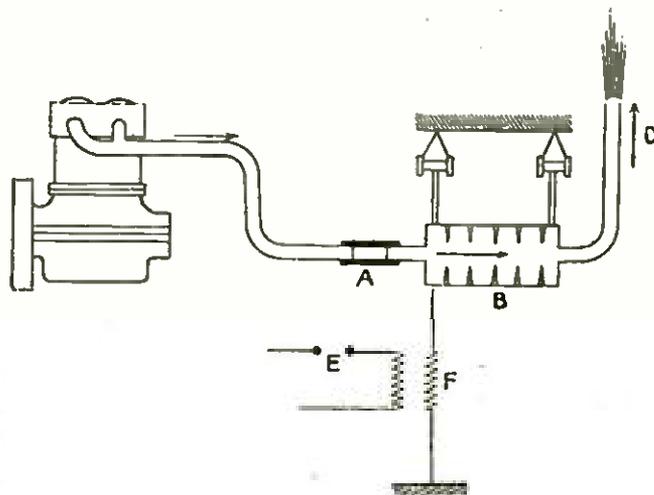
All this is wonderful enough, but a suggestion may be added. If radio movies prove possible, as it now seems almost certain that they will, such a machine placed in the plane would enable the operator at home actually to see out from the plane at all times and to control its flight visually, just as a living pilot would do. Think of the possibilities for military observation during war, of exploration over unknown country, of stay-at-home travel! One could actually send an eye out anywhere in the world to look at things and to report instant by instant whatever was visible from where it happened to be. The traditional magic carpet, gives place to the radio eye.

### *Exhaust Gases Used as an Antenna*

ACCORDING to a note in *La Nature* (Paris) Mr. A. M. Low has patented a novel and surprising method of doing away with metallic antennas, either for reception or transmission. He uses the exhaust gases of his automobile or of any other internal combustion engine. These gases, of course, are discharged from the engine in a highly ionized condition so that they form a conducting cloud extending some distance into the air, just as a cloud of smoke or steam rises some feet above a smoke-stack. If an alternating potential is communicated to such a cloud a wave will be propagated from it much as from a metallic antenna.

The arrangement of the apparatus is shown in the accompanying illustration. The muffler is insulated from the body of the engine and is connected to the exhaust line by means of an insulating coupling. The radio signal wave is fed into the muffler, the internal points serving for the more perfect communication of the impulses to the ionized gas.

The invention is expected to have its main use in airplane radio where it may result, experts believe, in doing away with the trailing wire and other forms of metallic antenna.



*La Nature, Paris*

### THE EXHAUST-GAS ANTENNA

*B*, is the muffler, insulated from the engine by a non-conducting suspension and by the insulating coupling *A*. Radio impulses enter the muffler by way of *F*, and are communicated to the exhaust, *D*.

## WHAT READERS ASK



THIS department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask the SERVICE BUREAU.

THE flood of inquiries that has poured in upon the Service Bureau has not only furnished evidence of the need of this department, it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to co-oper-

ate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do not ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

**Q** In justice to our regular subscribers, the Service Bureau is compelled to restrict this special service to those whose names appear on our subscription list. A nominal fee of 50 cents is charged to non-subscribers to cover the costs of this service and this sum must be enclosed with the letter of inquiry. No inquiries can be answered personally or by telephone.

**QUESTION:** Can spider-web coils be substituted for honeycomb coils in a triple-coil honeycomb circuit?

BREWSTER JENKINS

**ANSWER:** Yes. These two types are often employed interchangeably in the same circuit using a primary coil, a secondary coil, and a tickler coil.

\* \* \*

**QUESTION:** What is the average plate current of an ordinary six-volt detector tube? I get a reading of only about  $\frac{3}{4}$  to  $1\frac{1}{2}$  milliamperes, and I was given to understand that the tube should have a much greater plate current.

A. MILLER-ROBERTS

**ANSWER:** In order to work on the proper part of the curve (of grid voltage plotted against plate current) to obtain detection, the tube's plate current will be small. The values you have given are representative of the values ordinarily found. However, if the tube were used as an amplifier the plate current may be raised to several times that value.

**QUESTION:** Why is it that when I change wavelength on my one-tube, crystal-detector reflex receiver, I also have to change the adjustment of the crystal detector? If I do not, the set oscillates. Why is this?

ORVILLE F. ROGERS

**ANSWER:** If you tune the set to any given wavelength and then lift the crystal adjustment spring off the crystal you will immediately hear the set commence to oscillate. When you adjust the crystal for that wavelength you also are adjusting the resistance of the secondary circuit of the radio-frequency transformer to a certain critical value that stops the set from oscillating. It is really a transfer of effective resistance from the crystal circuit through to the grid circuit of the first tube that controls regeneration in this type of receiver.

When you change wavelength, however, you need a different resistance in the crystal circuit to keep the radio-frequency circuit stable, and so you have to readjust the crystal until you have obtained this value to get the best results.

QUESTION: What is the best test for deciding what kind of horn to buy for a loudspeaker? Sometimes the dealers do not have a set going and one has to take their word for it that the type they offer is as good as they say. Can you tell me of any precautions or hints that might help me to pick out a good one?

REYNOLD FENNER

ANSWER: The best test of a loudspeaker is to listen to it in operation. However, you may be helped by the following suggestions:

1. Try tapping the horn with the finger; if it rings with a high tinny note it will reproduce with a twangy sound and will probably rattle on some of the higher tones. It should give off a dull, low thud, if it is to operate satisfactorily.
2. Composition fibre horns are usually less resonant than thin metallic horns.
3. The better type of energizing unit has a moving element that is not in torsion when no signals are being received. That is, they are usually not affected by the magnetic pull of the magnets when signals are not passing through the coils.
4. The base of the instrument should be solid and heavy.
5. The horn should have as few sharp curves or corners as possible.
6. If you take the horn off and sing the musical scale into it with as near equal intensity as you can, each note should be of approximately the same strength and no particular note should stand out above the rest.

QUESTION: Is there any difference between the operating principle of the Fleming valve and the new diode tube?

J. C. D.

ANSWER: They both work on the same principle as an electron-discharge valve. The last mentioned tube is a recent development of the Fleming valve. They may both be used as a detector but neither of them will operate as an amplifier.

\* \* \*

QUESTION: Please let me have a diagram of the triple-coil honeycomb outfit for one tube. I was told that this is a good regenerative circuit for a beginner to start with. I want to build it myself.

ALAN BRENT

ANSWER: You will find the hook-up in Figure 1. The instruments necessary to include in the circuit are the following:

- L1—honeycomb or duolateral coil, L-35 or L-50;
- L2—honeycomb or duolateral coil, L-50;
- L3—honeycomb or duolateral coil, L-75;
- VC1—variable condenser, .001 mfd.;
- VC2—variable condenser (vernier), .0005 mfd.;
- GL—grid leak, 1 or 2 megohms;
- GC—grid condenser, .0005 mfd.;
- C—mica fixed condenser, .0005 mfd.;
- R—filament rheostat.

If a dry-cell tube is used, the filament rheostat should be suitable for the tube; ask the dealer. If a regular 6-volt detector tube is used, use a 6-ohm rheostat.

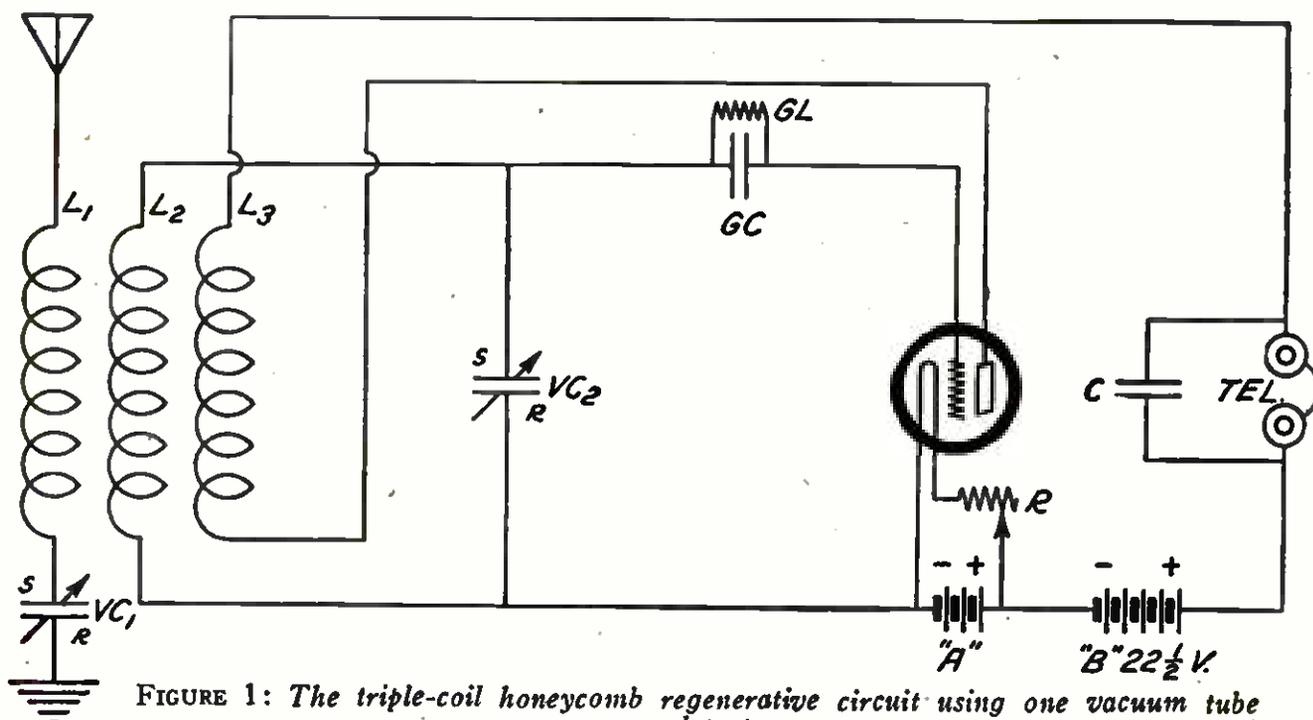


FIGURE 1: The triple-coil honeycomb regenerative circuit using one vacuum tube as a detector.

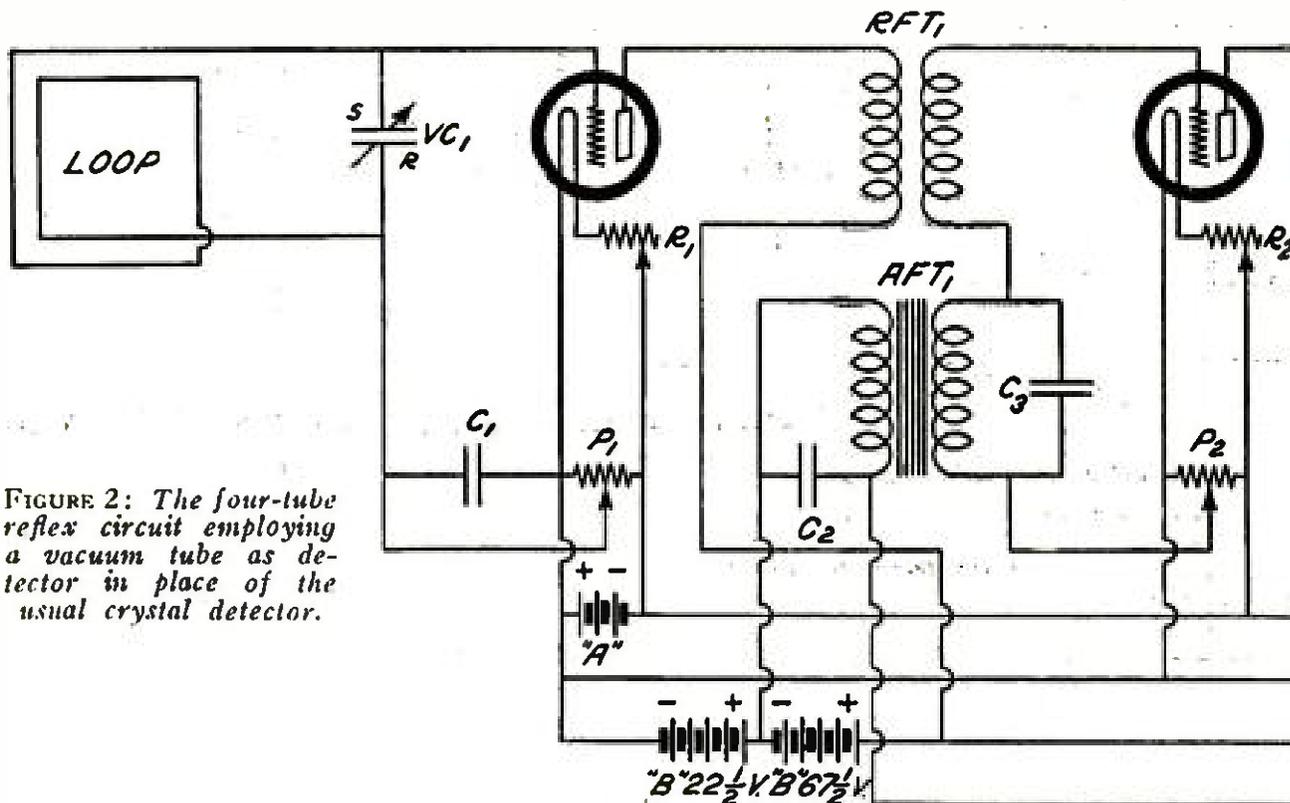


FIGURE 2: The four-tube reflex circuit employing a vacuum tube as detector in place of the usual crystal detector.

**QUESTION:** In the July issue of POPULAR RADIO you printed a circuit (Figure 4, page 78) showing three stages of radio, two stages of audio-frequency amplification, and a crystal detector, with three vacuum tubes. This reflex circuit works fine on a loop antenna, but I don't like the bother of "setting" the crystal detector in adjustment all the time. Will you please show me how to add a vacuum-tube detector in place of the crystal? I have tried it but have had no success, so I thought I had better come to headquarters and get the correct information.

ROWLAND BATES

**ANSWER:** The four-tube reflex circuit shown in the diagram in Figure 2 gives you the information that you require. Exactly the same parts are used that were contained in the old crystal circuit, except for the vacuum tube, which replaces the crystal, and a grid leak GL, of 2 megohms resistance, a grid condenser GC, of .00025 mfd. capacity, and an additional rheostat. Four C-301-A tubes or UV-201-A tubes, or DV-6-A tubes may be used with good results.

**QUESTION:** Is a power amplifier much different from an audio-frequency amplifier?

JACK ROCHE

**ANSWER:** Both of the types of amplifiers known by the popular names you mention are really audio-frequency amplifiers. The power amplifier is an audio-frequency amplifier that uses larger tubes than ordinarily used in the regular audio-frequency amplifiers attached to a radio receiving set. This means that it is necessary to employ higher plate voltages and also a "C" battery to keep the grids of the tubes at the correct free potential for proper operation.

Some types of power amplifiers use two tubes for each stage. These are connected "back-to-back" with a special split-winding transformer so that the cores of the transformers are not saturated when no signal is being received.

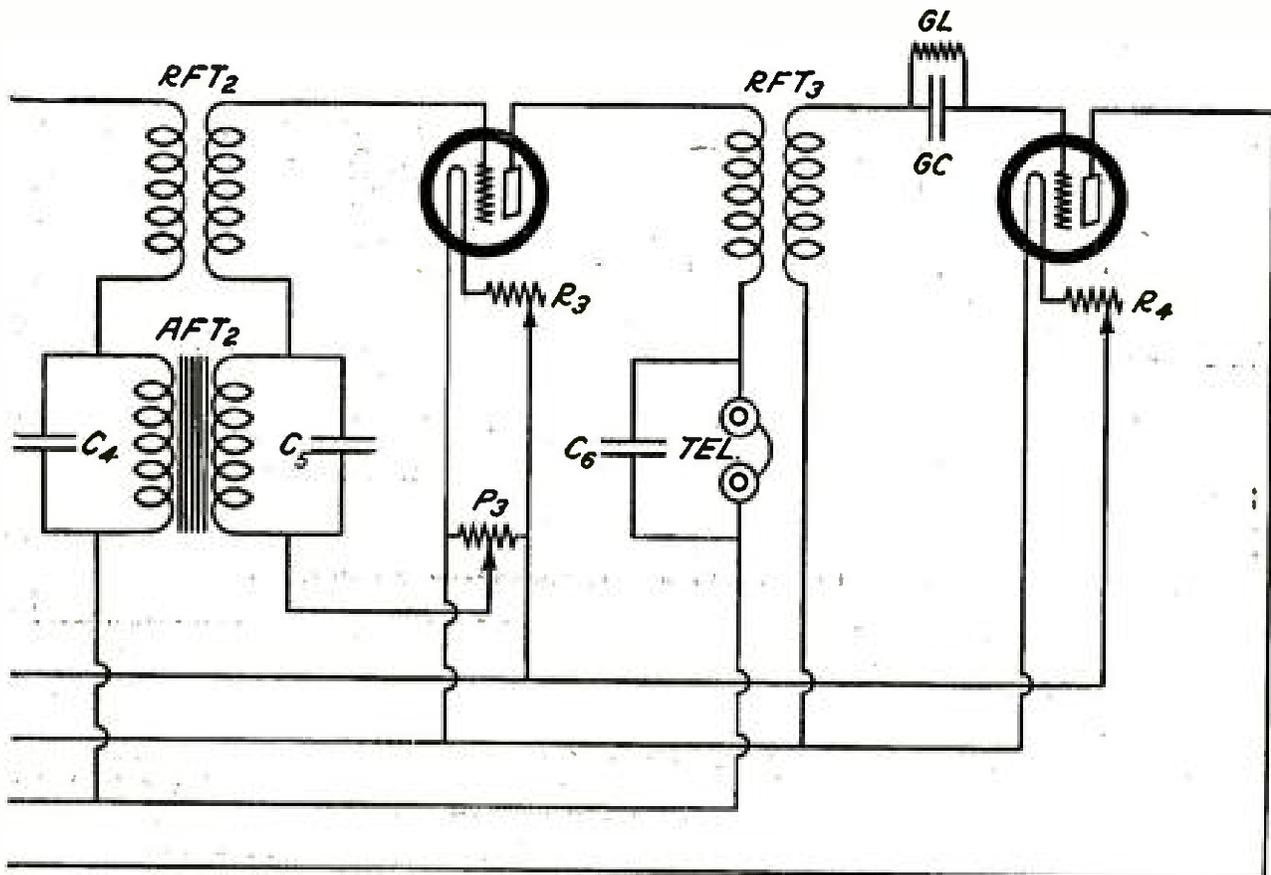
\* \* \*

**QUESTION:** I want to use the electric light lines for an antenna as I cannot put up an outdoor installation. What kind of a device or instrument is used for connecting to the electric lamp sockets? Do they work well?

S. N. SMITH

**ANSWER:** The part you must ask the dealer for is an electric light adapter. There are a number of these devices on the market with various trade names, but the dealer will understand if you ask him for an adapter to use the electric light circuit for an antenna.

These devices do not work with the same efficiency in all locations. In some houses they will not work at all. However, it is worth trying if you can not put up any other kind of antenna.



QUESTION: What sized motor generator should I buy to operate two 250-watt G. E. transmitting tubes, one as an oscillator and one as a modulator with a 50-watt speech amplifier?

R. M. H.

ANSWER: You will need a one-kw. machine at least.

\* \* \*

QUESTION: Which is the best for local reception, a crystal set or a vacuum-tube set?

THOS. J. GREGG

ANSWER: They both have their advantages and disadvantages. The crystal is the simplest and the cheapest but it will not bring in the signals as loud as the vacuum-tube set. Although the vacuum-tube set is more expensive, it will be found to be more reliable and the detector action is permanent; there is no adjustment of the vacuum tube to sensitivity as in the case of the crystal and it is not knocked out of adjustment. For all around use the vacuum-tube set furnishes the more reliable and efficient service.

\* \* \*

QUESTION: Will it be feasible to use a gas pipe as a ground for my receiver? I will have to run a wire about fifteen feet if I use a water pipe.

JAMES CULBERT

ANSWER: The gas pipe will not be good. Use the water pipe even if you have to run fifty feet to get to it.

\* \* \*

QUESTION: What is the best way to control the regeneration in an ordinary ultra-audion circuit? Should I use a variable grid condenser or would a variable bypass condenser across the telephones and "B" batteries be better? Or should I use both? I know that the filament rheostat plays an important part in the proper control of this simple circuit but I want to get your views on the subject.

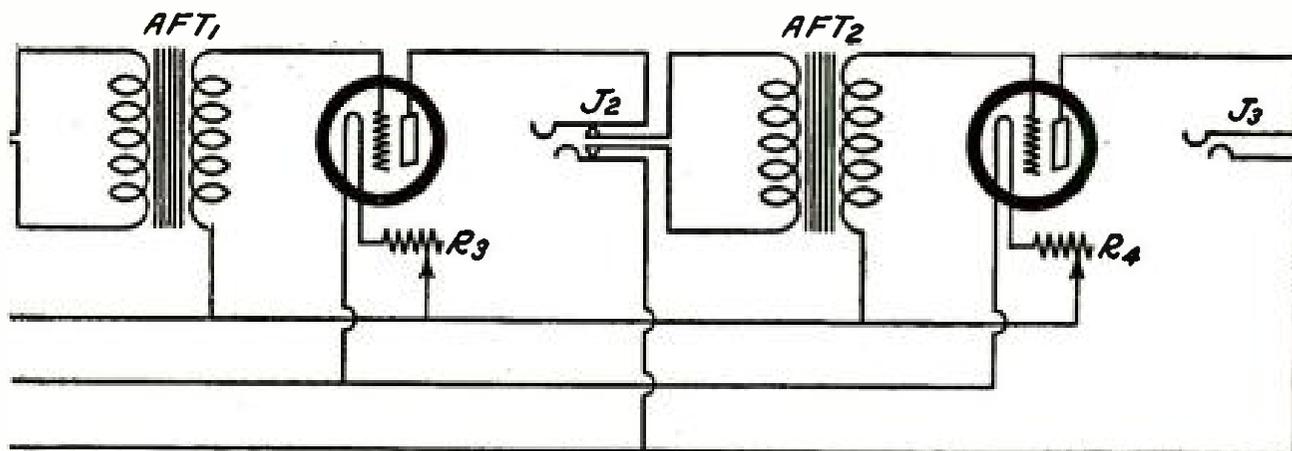
RAYMOND NILES

ANSWER: With a fixed condenser in the grid circuit and a variable condenser used in the plate circuit as a bypass across the telephones, you should get the best results. Varying the grid condenser will also do the same thing but when the grid condenser is varied to a rather high capacity, the tuning may become broadened and at the same time the regenerative control will become "sticky;" that is, it will burst into oscillation and you will have to reduce the capacity of the condenser to a low value and work up again. The variable plate bypass condenser is much the better of the two.

The filament need only be set at approximately the right value and all the control work done with the variable.



FIGURE 3: One stage of tuned radio-frequency amplification, detector and two stages of audio-frequency amplification. This is a real reliable distance getter.



generative circuits that employ looser coupling and simpler regenerative control go a long way to overcome these difficulties while at the same time retaining all the good advantages of the older circuit arrangements, and in some cases they produce even better results.

Radio-frequency amplification, however, although more tubes are used and although it is harder to tune, has its own advantages, especially the newer types of inductively tuned radio-frequency circuits employing compensating condensers which keep the circuits from falling into oscillation by preventing any feedback of high-frequency energy through the capacity of the tubes themselves. These newer circuits are extremely favorable to long-distance reception on a loop antenna, and the signal-static ratio on such a receiver is considerably increased.

For a given number of tubes, the regenerative method is undoubtedly the peer, but where unlimited radio-frequency amplification is necessary, there is no other way out but to use cascade radio-frequency amplification at the wavelength of transmission; or by some method similar to the super-heterodyne in which the signal is changed to a lower frequency and then amplified with greater efficiency than is now possible at the higher frequencies.

\* \* \*

QUESTION: I am located among the tall buildings of a large city, and am only one half mile from the largest broadcasting station in this section of the country. When this station is working I am, at present, unable to hear anything else. And yet I am using the regular regenerative circuit with a variocoupler and two variometers, which, I was given to understand would tune out anything.

At any rate I am unable to do it, so will you kindly let me know of some circuit, reflex, neutrodyne, Flewelling,

four-circuit, or anything, which should enable me to get some of the other local stations, at least.

I can hear the other stations with my present set, but they are "in the background and always overpowered by the station first spoken of.

Would the four-circuit tuner be the right thing to use? The circuit appeals to me.

HARRY Z. MENDEL

ANSWER: The four-circuit tuner will do the work you require. This is because of the extremely low decrement of the circuits used and the loose coupling employed. Be sure to use coils which are wound on composition tubing of good quality and be sure that there is no shellac or any other kind of insulating paint used on the windings; otherwise even this circuit will tune too broadly.

\* \* \*

QUESTION: How many volts should be used on the plates of the C-301-A tubes when they are used as amplifiers?

S. BENNINGTON

ANSWER: Not more than 90 volts, unless "C" batteries are used. You may use up to 120 volts if you use a "C" battery of 9 volts on the grids of the amplifiers.

\* \* \*

QUESTION: What capacity of condenser is used in the secondary circuit of the Haynes type receiver? I want to get a Cardwell condenser for this set and I do not know what size to ask for.

ALLEN AIRES

ANSWER: The correct capacity is .00025 mfd.



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.

### Radio Renders Heroic Service to Humanity

No more impressive evidence of the inestimable value of radio in the hour of emergency for summoning aid when moments were priceless and in broadcasting warnings when those warnings saved human life, can be offered than in the earthquake calamity in Japan early in September. A part of this service is told here:

The calamity which practically wiped out Tokyo and Yokohama and broke the Pacific cable, gave radio another opportunity to demonstrate to the world its value in international communication, especially in emergencies when land lines and cables fail. Without the single radio communication link left at Iwaki the world might have been without details of the Japanese disaster for as long as a week. Bits of news and imperative information would have been put through by cable, but radio is said by Secretary Hoover to have literally saved the day in bringing in relief as well as in carrying out the news.

To be sure, the first brief message of the disaster came to the Japanese Ambassador at Washington by cable from Nagasaki *via* London—out of the back door of the East, as it were, and over cables estimated 15,000 miles long. The commercial cable from Japan to Bonin Island (reported submerged) and thence to Guam, was put out of service by the earthquake, so that messages were routed east by way of Manila, Shanghai and Nagasaki, or west by way of London.

It remained for radio to carry most of the official dispatches and news reports across the Pacific to North America, and radio, aided by the remaining cable connection of Nagasaki handled a tremendous amount of traffic. The Japanese government station at Iwaki, or

Tomioka, stepped into the breach and the world now knows of the excellent service rendered by the Japanese operator who stood a long watch alone. His call and messages on the disaster were picked up by the Radio Corporation's station at Bolinas, California, and were relayed to all points in the United States. Iwaki, which is about 144 miles from the stricken cities, for some time had no means of communication inland; at the suggestion of the Japanese Ambassador at Washington, however, a courier service was established to Tokyo and a regular schedule was put in operation. A statement that "communication was open to Tokyo" by the State Department, led some to believe that line wire communication between the station and Tokyo was established, yet no wires had been re-established. Since the advent of radio, it seems that a new word must be substituted for "communication" when referring to roads and other lines of transportation.

Radio was the means of getting the first authentic account of the disaster to the new world on September 4, when the master of the *S. S. President Jefferson* radioed to his Shanghai office from the port of Yokohama direct. The American Consul put the message on the cable for Secretary Hughes in Washington, where facts relating the unsafe condition of the harbor at Yokohama were immediately broadcast by the Naval Hydrographic Office, so that all ships might be warned of the hidden dangers there owing to the absence of lights.

The U. S. Naval forces in Japanese waters also rendered official emergency service by radio. The American Asiatic fleet was at Yokohama and the Destroyer *Borie* was stationed at Nagasaki as a radio relay ship. Messages from the American flagship were picked up by the *Borie*, relayed to the Naval radio station at Cavite and thence to the Naval station at San Francisco. Government west-bound messages were sent from Washington *via* the Annapolis radio station or commercial land lines to San Francisco, where they were relayed *via* Honolulu, Guam and Cavite to the *Borie*

and thence to the American fleet off Yokohama. The *U. S. S. Sacramento* was stationed at Woosung, China, to relay radio messages. The naval service delivered official dispatches to Yokohama within twenty-four hours.

Many radio experts feel that the terrible disaster and the severing of communication out of Japan will aid materially in establishing better radio service between Nippon and the world. The policy of the Japanese government has been to control radio, although American commercial companies have been endeavoring to provide better stations and transmission for some time. It is now hoped that American radio interests will be given the opportunity to establish high-powered stations in Japan.

—CARL H. BUTMAN

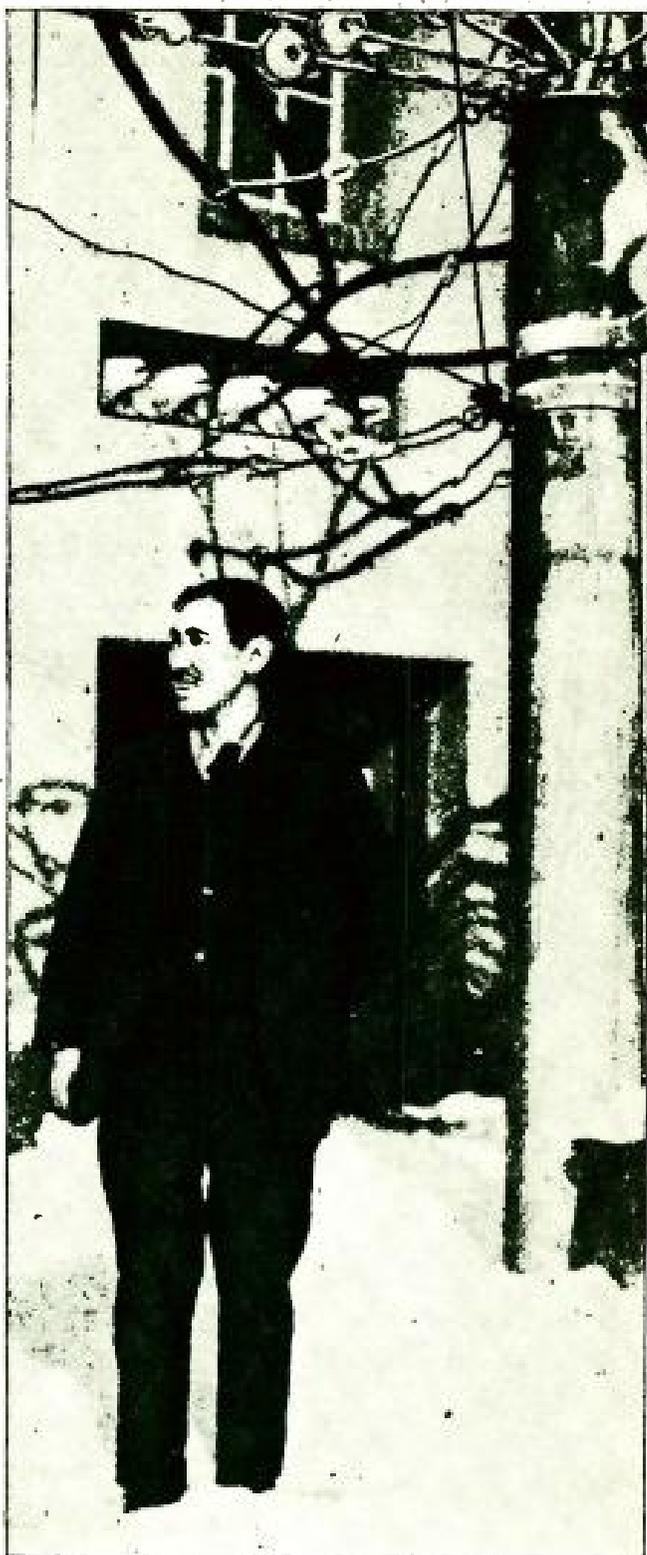
### The Bureau of Standards to Transmit Radio-Frequency Signals

THE Department of Commerce has announced a schedule of standard frequency radio signals to be transmitted by the Bureau of Standards for the months of October, November and December. These signals should be of interest to all transmitting station operators in checking wavemeters and adjusting transmitting and receiving apparatus; their accuracy is better than three-tenths of one percent. The full announcement follows:

Commercial and ship operators should be especially interested in the transmission of October 20. The signals of November 20 cover approximately the same band as those of October 20; the signals of November 5 cover the frequency band used by "Class B" broadcasting stations. The frequencies transmitted on December 5 cover those used by all broadcasting stations as well as some used by amateurs.

Measurements made at the bureau of the frequencies on which broadcasting stations are operated indicate that some stations are not remaining on their assigned frequencies, hence are causing interference with programs from their own as well as other broadcasting stations.

The schedule followed in these transmissions will be slightly different from that followed in the past. All transmissions will be by unmodulated continuous-wave telegraphy and no announcement will be made by voice. This considerably reduces the time of transmitting any one frequency. The signals will in other respects be similar to those transmitted in the past. A complete frequency transmission will include a "general call," a "standard frequency signal" and "announcements." The "general call" will be given at the beginning of the eight-minute period and will continue for about two minutes. This will include a statement of the frequency. The "standard frequency signal" will be a series of very long dashes



International

### THE RADIO ENGINEER WHOSE STATION SUMMONED AID TO JAPAN

*Mr. Wakamatsu was the radio expert in charge of the Haranomacki branch of the Tomoka radio station that for a few fateful hours was the only link between the devastated areas and the rest of civilization. The remarkable concrete antenna towers, 660 feet high, were designed by the Japanese scientist F. Omori for the express purpose of withstanding earthquake shocks; to his genius is largely due the help that was summoned in time to save countless human lives.*

with the call letters WWV intervening. This signal will continue for about four minutes. The "announcements" will be on the same frequency as the "standard frequency signal" just transmitted, and will contain a statement of the measured frequency. An announcement of the next frequency to be transmitted will then be given. There will then be a four-minute interval while the transmitting set is adjusted for the next frequency.

The complete schedule has been so planned that a wavemeter may be accurately calibrated over a range of from 150 to 1,700 kilocycles, if all of the transmissions are received. With sensitive receiving apparatus it should be possible to receive these signals anywhere east of the Mississippi River.

The complete schedule of standard frequency signals to be transmitted follows:

*Schedule of Standard Frequency Transmission from WWV*

Wavelength in meters is given in parentheses.

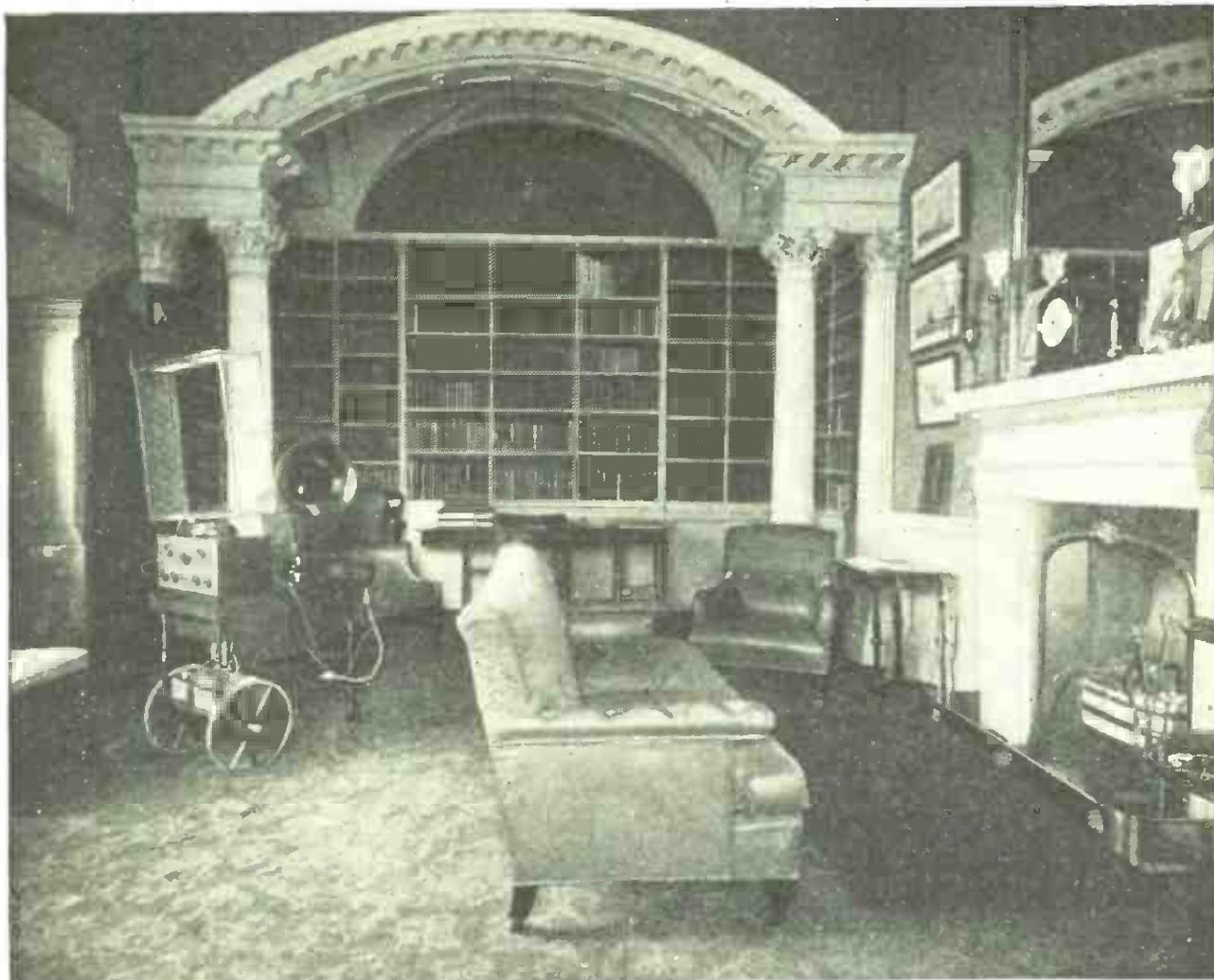
	OCT. 20	NOV. 5	NOV. 20	DEC. 5
Eastern Standard Time	Kilocycles			
11.00 to 11.08 P.M....	166.5 (1800) 220	500 (600) 580	150 (1999) 190	500 (600) 700

11.12 to 11.20 P.M....	(1363) 275	(517) 640	(1578) 240	(438) 900
11.24 to 11.32 P.M....	(1090) 315	(468) 700	(1249) 290	(333) 1100
11.36 to 11.44 P.M....	(952) 375	(428) 760	(1034) 360	(273) 1300
11.48 to 11.56 P.M....	(800) 425	(394) 833	(833) 430	(231) 1500
12.00 to 12.08 A.M....	(705) 500	(360) 920	(697) 500	(200) 1600
12.12 to 12.20 A.M....	(600) 666	(326) 1,000	(600) 570	(187) 1700
12.24 to 12.32 A.M....	(450)	(300)	(526)	(176)

**A Long-distance Watch Tick**

AUDIENCES that have been held so spellbound in the theater that they could "hear the ticking of a watch" may have to change a time-worn expression that is being made obsolete by radio. Here is an account of a watch tick that was heard hundreds of miles:

Listeners-in had a new and odd experience recently when they heard the ticking of a



© Vandyck, London

**WHERE ROYALTY LISTENS IN**

*When His Royal Highness, the Duke of York, democratically wants to join the growing army of radio "hams" in England, he merely directs his butler to wheel in his portable radio set—shown above in the duke's sitting room.*



Gilliams Service

#### AN EXTRAORDINARY MECHANICAL CODE WRITER

*This machine, invented by Dr. Scherbius, a noted Austrian electrical expert, is capable of 22,000,000,000 code combinations. It may be operated by any typewriter and is capable of writing code messages as they are received by wire or radio and deciphering them automatically.*

watch that was held near one of the microphones on the stage of the Municipal Theater in Forest Park, St. Louis, while the operetta *Die Fledermaus* was being broadcast by station KSD. The watch episode was in the second act. Craig Campbell, in the rôle of Eisenstein, exhibits a lady's watch to a masked woman whom he meets at a gay party. She is his wife, but he does not know it. He playfully counts her pulse while timing the beats with his watch. While doing this Campbell held the watch close to the microphone. Several St. Louisans reported that they distinctly heard the ticking of the watch over their sets and there is no reason to doubt that it was heard at more distant points.

—EDWARD O'CONNOR

#### A Radio Net Around the Arctic Circle

SOME idea of what the long arm of radio may mean to the out-of-the-way places of the world which have been deprived in a large measure of

the benefits of civilization, may be derived from this brief description of the extending use of wireless into the waste lands of the far north:

A plan has been adopted by the Canadian government by which Dawson City, of Klondike fame, is to be linked with civilization by radio. Stations will be established at Dawson City, Fort Simpson, and Fort McMurray, constituting yet another step in the taming of the far north. Some idea of the distances involved will be had when it is noted that Dawson is only three hundred miles from the Arctic circle. Heretofore the only electric connection that Dawson City has had with the south, has been by telegraph with Ashcroft, British Columbia. The first of the connecting stations, Fort Simpson, is on the Mackenzie River, in the Northwest Territories; the second, and most southerly, is in the province of Alberta, on the Athabasca River. These stations will be installed this summer.

Next year stations will probably be established at Forts Smith, Resolution, Norman, and Aklavik, thus completing the chain of communication in northwestern Canada.

—K. H. BROADUS



DON'T skip any articles in this magazine. They have all been carefully chosen to give the reader the proper perspective of the radio art, and to keep him well informed not only of new scientific developments that mean progress, but of new problems and conditions that confront the radio world, and how they are being solved and overcome.

So, just because you do not have as much of an interest in one subject as in another, do not skip. You will really be missing something that will help you to the right viewpoint. If you do not agree with the other fellow on a certain subject, by reading his argument or discussion you will at least be able to understand how he thinks, while at the same time making your own logical conclusions. Some of the ideas may seem too deep for you, just as some of them may seem too simple, but if you study his views, the deep ideas will finally become clear and understandable and the simple ideas will be of interest just because you know they are true.

You really cannot afford to skip a single item!

\* \* \*

IN making the hoops for supporting the wires of a cage antenna it will be found that No. 00 hard-drawn copper wire will be suitable. Bend a piece of this wire into the proper-sized circle and solder the two ends together (flush) with hard solder. Then you can mark off the proper spacings for the wires by notching with a file. The

antenna wires should be wrapped around each hoop with a single turn and soldered firmly in place with the same hard solder.

If this is done the cage will be absolutely permanent.

\* \* \*

WHEN you finally *do* go to bed at night, after listening-in all evening (possibly well on into the morning) are you happy but tired and worn out? Well, then, your "A" battery may feel the same way, and it is a good plan to turn on the charger so that the battery may rest and recuperate while you retire and do the same thing. There is nothing like keeping a battery up to full charge to add to its life. A fully charged battery will also be a great help in enabling you to tune in and hold those long distance signals.

\* \* \*

ONE dead "B" battery connected in the plate circuit of a receiving set will make you think that there is a lot of static in the air and at the same time make you believe that the set has "gone wrong." Always test your "B" batteries with a small high-resistance voltmeter.

\* \* \*

KEEP the terminals of the storage battery coated with a thin coat of vaseline and always be sure that no green, gray, or yellow substance is allowed to collect on them. This will corrode the clips or the copper wire which connects the battery with the set and may often cause noises in the set.

THERE is no fault in a receiving set that is as bothersome and which will last as long without the operator finding out how to eliminate it as the existence of "body capacity."

Body capacity in a receiving set causes the wavelength, to which the set is tuned, to vary when the operator's hand is brought near to or taken away from the tuning dials. In such a case, the operator may have tuned in a distant station, and when he takes his hand away from the dial, the signal will have faded out; if he brings his hand near the dial again the signal will come back in again. So much for body capacity; it is a decided nuisance, and takes the pleasure out of DX hunting.

It may be easily avoided, however, by one of two methods of shielding. One method would be to place a copper sheet on the back of the panel, between the panel and the instruments. The sheet should be grounded.

The better way, would be to place the part (the shafts) of the condensers and variable tuning instruments which face

the front of the panel or project through the panel into the knob at ground potential, or at ground potential as far as the radio-frequency currents are concerned.

Therefore, in all of the diagrams which will be published in POPULAR RADIO, the proper way to connect the variable-inductive or variable-capacitive instruments will be shown. The rotating coils or rotating plates will be designated as R, and the stationary coils or plates will be shown as S.

The symbol for the variable condenser will therefore be as shown at A, in Figure 1, and the variable inductance (variometer) will be as shown at B.

\* \* \*

Do not leave kinks in your telephone cords, as this will finally allow them to wear through the fine braided wire and result in a loose connection. Make a practice of untwisting the cords each time you put the telephones on your head and the cords will last a much longer time.

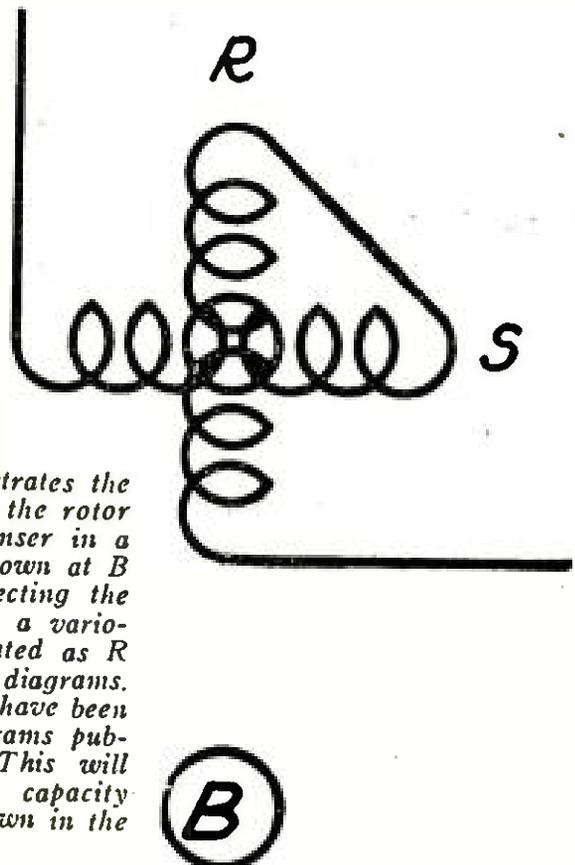
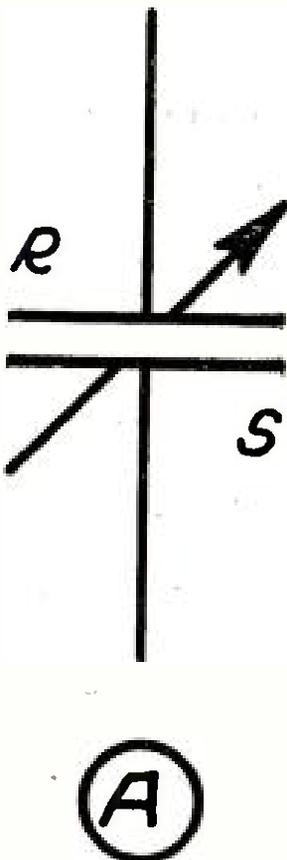


FIGURE 1

The symbol shown at A illustrates the proper method for connecting the rotor and stator plates of a condenser in a radio circuit. The symbol shown at B shows the method for connecting the rotor and stator windings of a variometer. The rotors are indicated as R and the stators as S in both diagrams. The use of these two symbols have been made a standard in the diagrams published in POPULAR RADIO. This will eliminate troublesome body capacity from any of the hook-ups shown in the magazine.



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

FIGURE 1: No. 1,458,949. CARRIER RADIO-TELEPHONE SYSTEM. Invented by Harold W. Nichols, Maplewood, N. J.

The primary object of this invention is to provide a carrier system which is both efficient and economical. Another object is to provide means whereby a pure modulated wave and energy of the fundamental carrier frequency may be transmitted from a signal station. Other objects will be apparent to those skilled in the art from a reading of the patent, copies of which may be obtained from the Government printing office.

FIGURE 2: No. 1,458,466. ANTENNA SELECTOR SWITCH. Invented by Alfred Crossley, Washington, D. C.

The object of this invention is to provide a practical selector switch capable of rapid manipulation to connect various combinations of underground, elevated or loop antenna to the receiving apparatus. Another object is to provide means for insuring perfect electrical contact of the switch elements.

FIGURE 3: No. 1,454,307. RADIO-TELEGRAPHY. Invented by Adrien L. Anderson, Palo Alto, Calif.

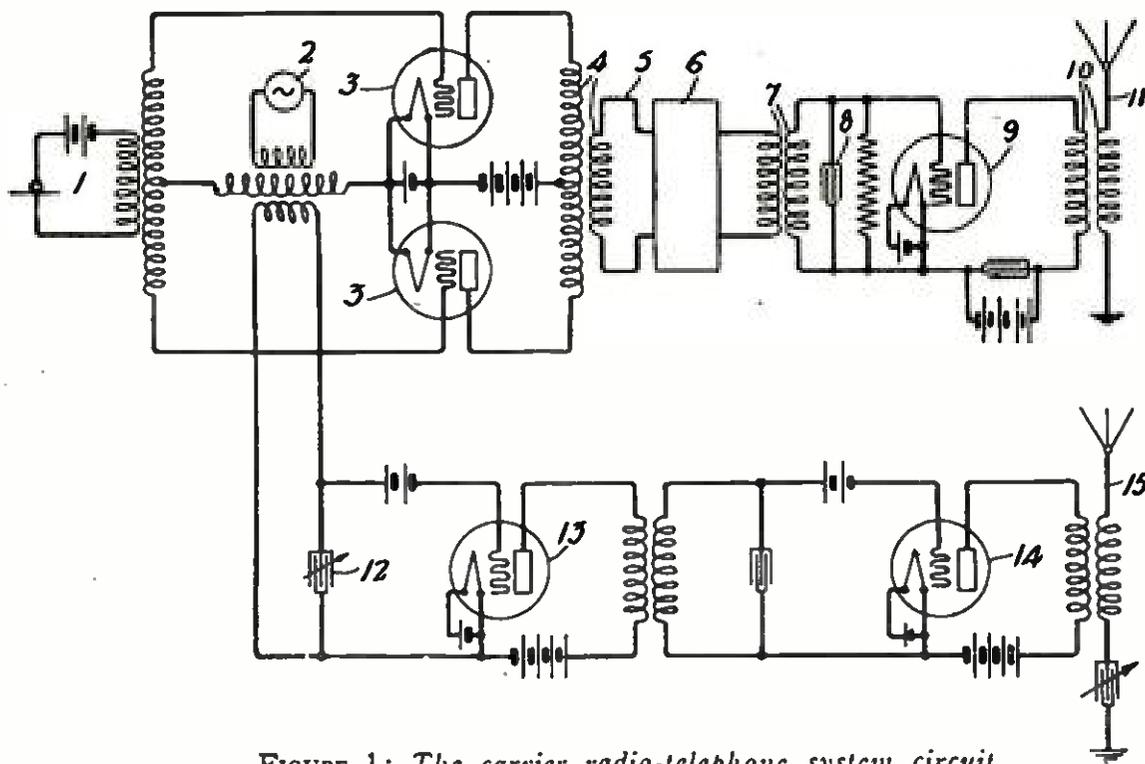
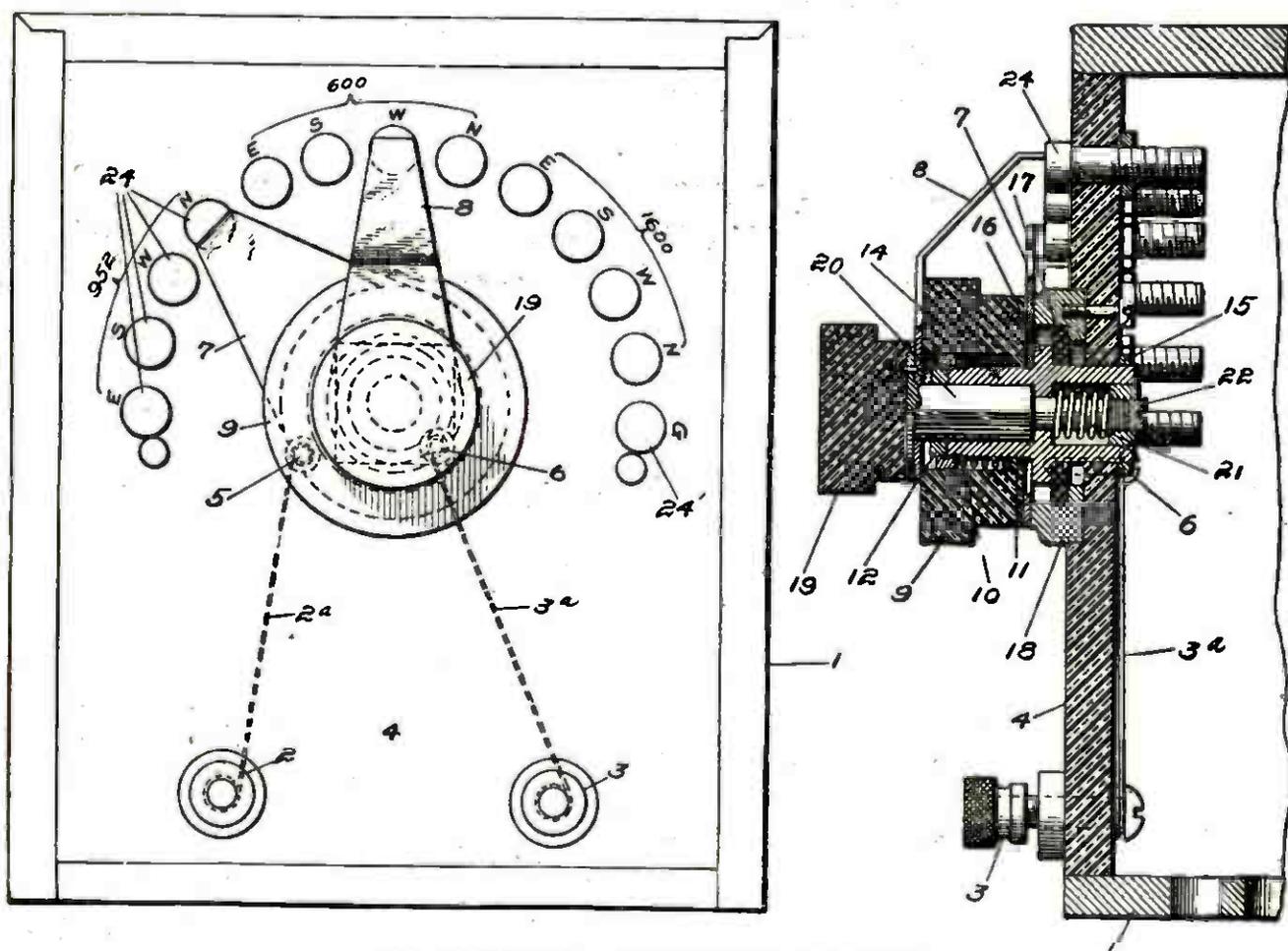
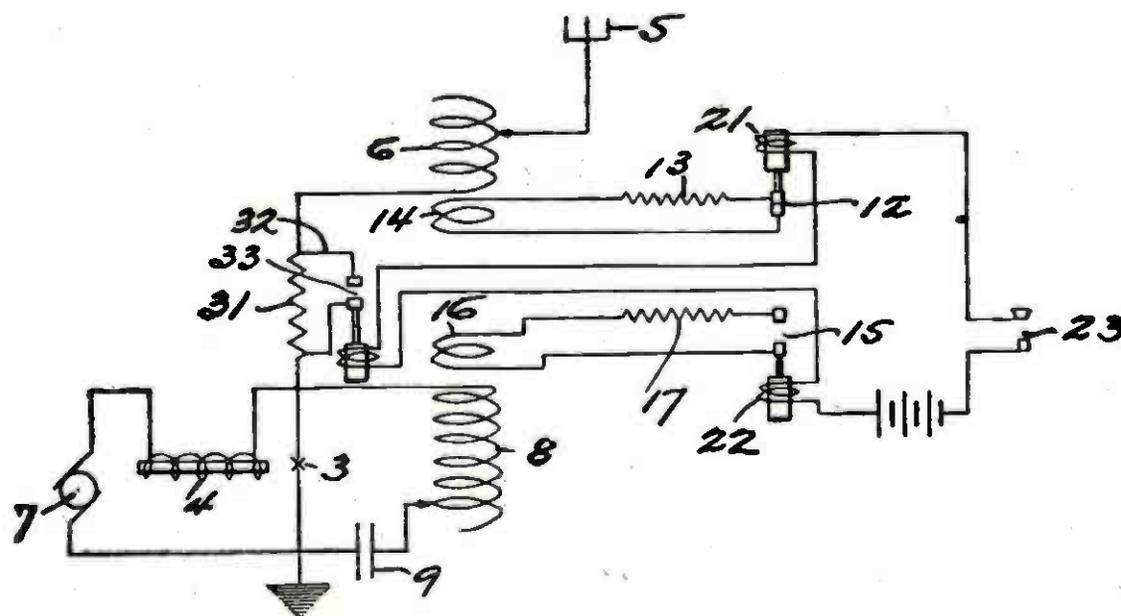


FIGURE 1: The carrier radio-telephone system circuit.



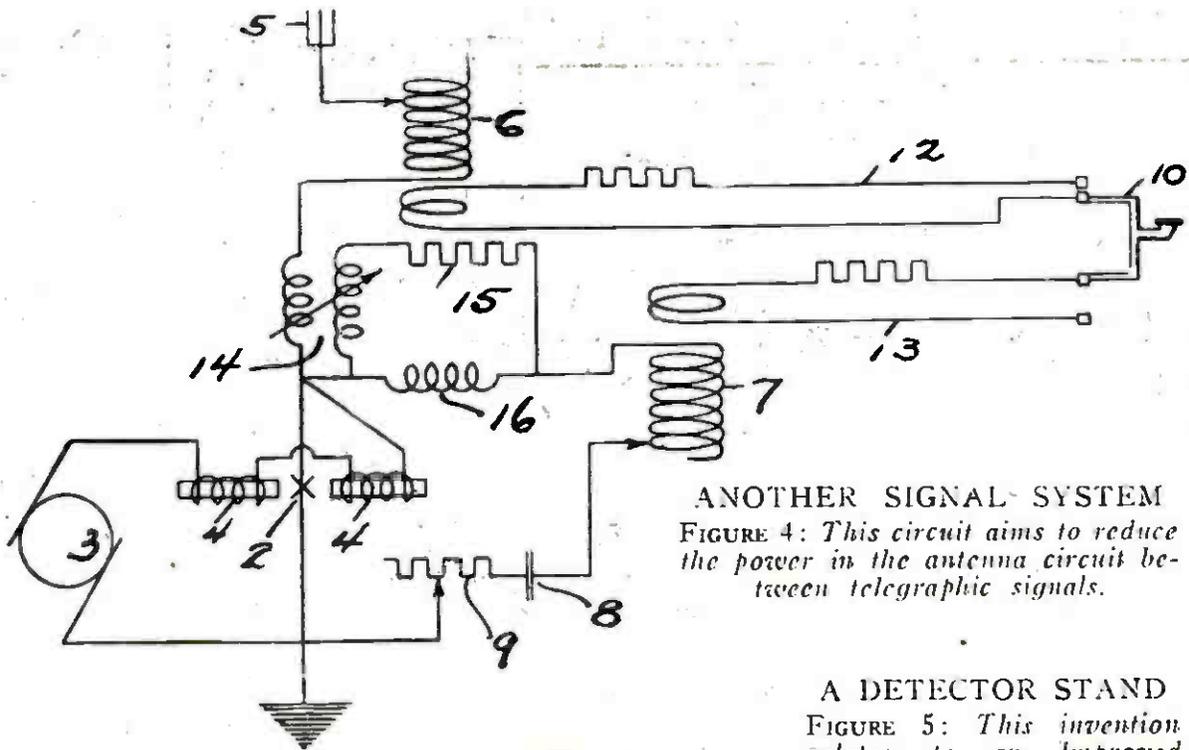
AN ANTENNA SELECTOR SWITCH

FIGURE 2: The front and side elevations of the selector switch which is designed for automatically changing connections to various antenna systems.

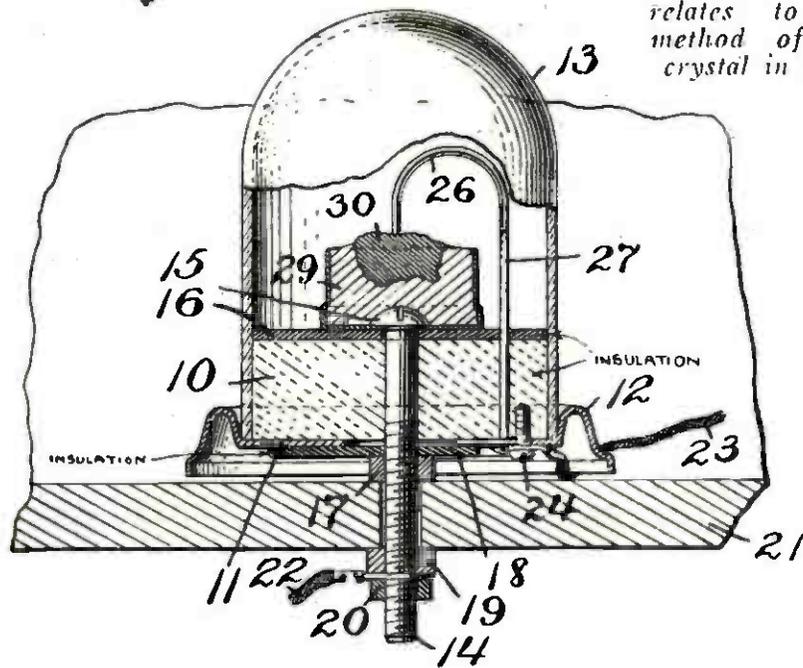


A RADIO-TELEGRAPHIC SIGNAL SYSTEM

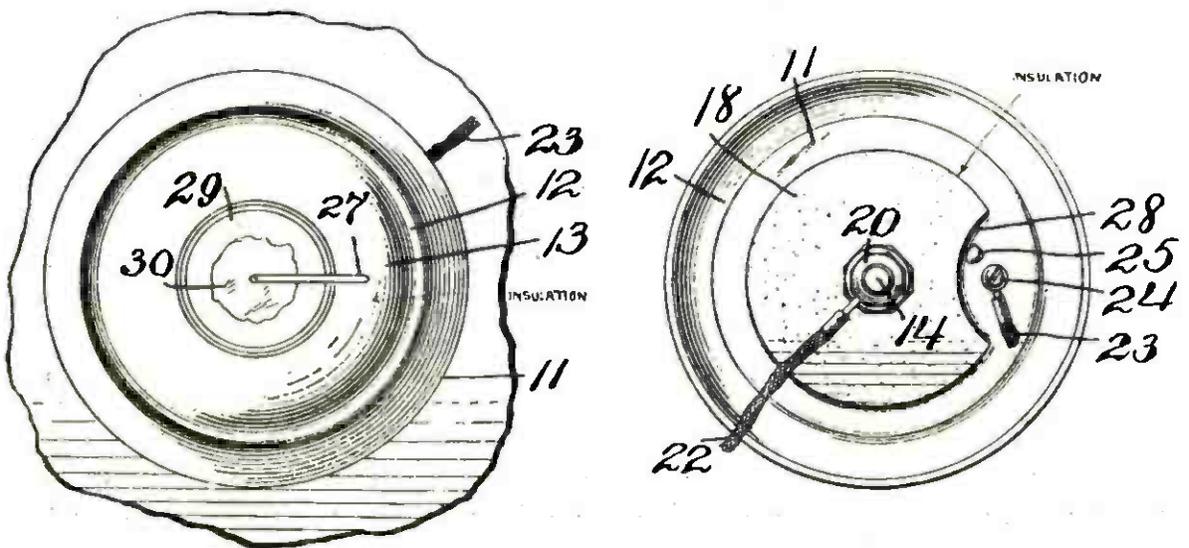
FIGURE 3: The circuit of the new system for signaling with a single wave. It uses an arc transmitter, with an automatic keying device to produce telegraphic signals without any of the familiar backlash of the old system.

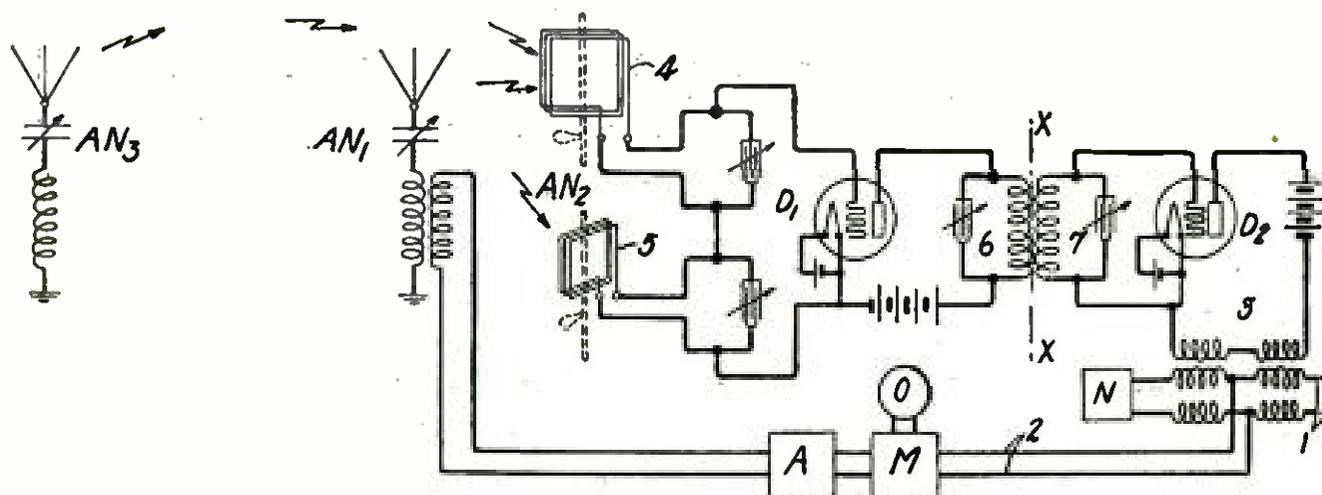


**ANOTHER SIGNAL SYSTEM**  
 FIGURE 4: This circuit aims to reduce the power in the antenna circuit between telegraphic signals.



**A DETECTOR STAND**  
 FIGURE 5: This invention relates to an improved method of adjusting the crystal in a receiving set.





A NEW RECEIVING CIRCUIT

FIGURE 6: The Mills circuit which includes a means for impressing an auxiliary radio carrier on the detector circuit without impairing reception.

This invention relates to radio telegraphy and particularly to radio-telegraphy transmission systems. Its object is to provide a single-wave radio signaling system.

FIGURE 4: No. 1,454,630. RADIO TELEGRAPHY. Invented by Harold F. Elliott, Palo Alto, Calif.

This invention relates to radio-telegraphy signaling systems and particularly to single-wave signaling systems in which the source of oscillations is connected to the antenna circuit and to a local oscillating circuit, the electric constants of the two circuits being such that the oscillations may be caused to prefer one circuit to the other. Systems of this nature are particularly advantageous in continuous undamped-wave signaling, in which the source of oscillations is an arc or other continuous undamped-wave generator. In systems of this type, the current in the antenna is reduced to relatively low values during the intervals between the dots and dashes of the signal.

It is the object of the invention to reduce the magnitude of the residual

current in the antenna during such intervals to smaller values. The invention possesses other advantages, some of which are set forth in the patent.

FIGURE 5: No. 1,454,997. CRYSTAL DETECTOR. Invented by Gaetano Greco and Karl G. Wolff, Newark, N. J.

This invention relates to an improved crystal detector for radio receiving sets. It is adapted to be placed in position in a set and is easily accessible for adjustment.

FIGURE 6: No. 1,457,447. RADIO RECEIVING CIRCUITS. Invented by John Mills, Wyoming, N. J.

This invention relates to radio receiving circuits, particularly to that type employing the principle of successive detection.

The principle object is to provide a means whereby, in an intermediate-frequency receiving circuit, a regulable amount of auxiliary radio carrier-wave may be impressed on the input circuit of the first detector without detriment to reception from the distant station.

## Do Ether Waves Cause Gravitation?

SCIENTISTS are coming to believe in the existence of a new kind of ether wave—the remarkable ultra-X rays. Knowledge of them may solve some fundamental scientific mysteries. The latest developments in this amazing field of research will be told in POPULAR RADIO for December.



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

*No Danger of Hypnotic "Spells" Sent Out by Radio*

THE instances reported recently in which patients in hospitals and elsewhere have been hypnotized by radio do not involve, say the scientists, any new or startling scientific principle. Once a person has been hypnotized by a certain hypnotist and has become accustomed to the control of that individual the hypnotic trance can be induced later without the personal presence of the hypnotist. A written note, words spoken over the telephone, even a definite message sent by the hypnotist and repeated to the patient by a third person are sufficient to restore the hypnotic control. It is quite natural that words spoken by radio and heard by the patient at a listening apparatus will have the same effect. Such hypnotic messages are effective, of course, only on the patient who has been accustomed to being hypnotized by the particular hypnotist who is sending out the message. There is no danger, the experts assure us, that any kind of "spell" sent out over the radio would affect listeners other than the particular person for whom the message was intended.

\* \* \*

*A Bug that Eats Lead Cables*

ONE of the most curious troubles encountered by the electrical engineer has turned up in California. The name of it is *Scobicia declivis*. This is not a disease; it is the name of a variety of beetle. With plenty of food available in the fruits and vegetables for which the Golden State is so famous this perverse bug delights to gnaw the lead coatings of telephone cables. He bores little holes through the lead and presently rain water gets in and causes a short circuit. The damage done is so serious that the United States Bureau of Entomology at Washington has been asked to help devise a remedy.

\* \* \*

*Snake Doctoring by Radio*

IN England recently one of the "uncles" who broadcast talks on snakes (all of the English broadcast talkers seem to be uncles) received

next morning a letter from a small boy requesting a diagnosis of a snake, carefully described, which said small boy had captured in the paternal garden. The description showed the snake to be extremely poisonous and a message was broadcast immediately advising the captor to watch his step, or rather to watch the snake.

\* \* \*

*What an Electrical Wizard Is Worth to the Country*

THE direct money value of Mr. Edison's inventions to the persons who have invested in them has been computed by a writer in the *New York Times* as \$15,599,000,000. Even this staggering sum is incomplete for it does not include the much larger indirect values created by the electrical industries based on Mr. Edison's ideas and inventions.

\* \* \*

*Can Static Be Used as a Fertilizer?*

RECENT careful tests in Iowa reported in the *Chemical News*, confirm the earlier idea that a good deal of nitrate, valuable for fertilizer, is being produced all the time in the air and falls to the earth dissolved in rain and snow. The nitrate is supposed to be formed in the air out of nitrogen gas by means of sparks and other discharges of atmospheric electricity, either the great sparks of lightning or smaller imperceptible ones around dust particles or rain drops. It is these same atmospheric discharges which are believed to be responsible, in part at least, for radio disturbances. Perhaps static may have a very practical use in the world after all if it assists in adding nitrate to the soil.

\* \* \*

*Broadcasting a \$10,000,000 Lecture*

TWICE recently Dr. Russell H. Conwell of Philadelphia has broadcast his lecture "Acres of Diamonds," a lecture familiar to two generations of lyceum and Chautauqua attendants all over the country which has earned for Dr. Conwell more than ten million dollars, nearly all of which he has spent in the cause of popular education.

*Education by Radio*

It seems possible that radio broadcasting may prove to be the solution for the vexed question of popularizing the facts and viewpoint of science. A short, interesting scientific talk, received at home over the radio set, will attract many listeners who never could have been persuaded to wade through scientific books or to attend a two-hour lecture at the university. During the past few months the New York Section of the American Chemical Society has been broadcasting short chemical talks once a week over WJZ. WEAJ will soon broadcast some of the extension courses of Columbia University. A radio lecture on accountancy was received recently in a New York high school. These mark the beginnings of what must soon be a powerful instrument of national education.

\* \* \*

*Scrambling the Program for Outsiders*

IN England, where all broadcasting is a monopoly of a single company authorized for this service by the government, there has been patented an ingenious system of preventing unauthorized outsiders from listening-in by means of pirated or "bootleg" sets. This system adds to the carrier wave, in addition to the modulation of the regular program, a mass of confused tones and signals sufficient to obscure the program altogether. Authorized subscribers to the service are then supplied with specially designed filter coils, which may be changed from time to time, and which have the effect of removing the "scrambled" signals.

\* \* \*

*Are There Martians for Us to Reach by Radio?*

EVER since the announcement of the supposed radio signals from Mars (though these signals turned out to be without any probable connection with that planet) the old scientific problem of the habitability of Mars has been of interest to the radio fan. The newest piece of scientific news about Mars is that it may be, after all, warm enough there for life to exist. It has been claimed that because of the thinness of the Martian atmosphere the surface temperature of that globe must be very low, approaching the intense cold of space. This seems to be a mistake. Dr. W. W. Coblentz of the United States Bureau of Standards has succeeded in measuring the heat reflected from the Martian surface and comes to the conclusion that the mean surface temperature of our sister planet is between 50 and 70 degrees Fahrenheit, about the same as the mean temperature of the earth. The nights, however, are quite cold and the days very warm. This confirms Professor Percival Lowell's idea that the Martian climate is much the same as that of a terrestrial desert.

\* \* \*

*Radio Displaces the St. Bernard Dogs*

THE Swiss Alpine Club proposes to install at several points on the Alps small radio stations by which lost travelers can summon help from towns far below in the valleys. So the rescue work begun many years ago by the

monks of the Monastery of St. Bernard, assisted by their famous trained dogs, yields as does everything else in the modern world to the progress of science.

\* \* \*

*A Bishop Finds Old Friends by Radio*

THE Bishop of Birmingham, in England, broadcast a talk recently and was surprised to receive many letters from old friends of whom he had altogether lost track and who communicated with him after hearing his voice again through the ether. Radio provides, the Bishop says, a new and unexampled way to extend one's personal touch to thousands of people whom one cannot hope to meet face to face.

\* \* \*

*Airplane Travelers Entertained by Radio*

A NUMBER of the commercial airplanes used in passenger travel in Europe have been equipped with radio sets by which broadcast concerts may be received during flight. If the greenish tinge of countenance so frequently observable in the inexperienced air passenger as he alights at Paris or at London means anything, entertainment en route must be, we think, the least of one's desires. Yet it is possible that absorption in the remarks of one of the "uncles" of the British Broadcasting Company might be a welcome distraction, removing those disquieting thoughts of how little there is beneath the floor of the cabin.



Keystone

*A FAITH-HEALER BY RADIO*

Willis Vernon Cole, formerly a healer of the Christian Science Church, has recently issued a code book that covers every human ailment that the author feels capable of treating "metaphysically." Just send him the code word that covers your case—and the healer will do the rest by wire or radio.

### *The Most Powerful Radio Equipment of Europe*

WHILE the United States has been carrying on an intensive campaign in broadcasting and the use of radio by amateurs, France has been hard at work developing its commercial radio business through private enterprise. Today France is reported to have the largest, most efficient and most powerful equipment in Europe.

\* \* \*

### *Radio Calls Bridal Couple to Sick Bed*

A BROADCAST appeal by radio for knowledge of the whereabouts of Mr. and Mrs. George A. Lange, who were known to be on a honeymoon tour of New England, recently resulted in locating the couple in a secluded inn at the town of Lost River, N. H., whence they made their way home at once on receipt of a message that the bridegroom's mother was dangerously ill.

### *A Gold-Mounted Receiving Set for a Prince*

AMONG the countless wedding presents received by the Duke and Duchess of York was a wonderful gold mounted radio receiving set. It is a portable loop receiver, mounted on a mahogany tea wagon, complete in every detail, with loudspeaker and even a charger for the storage battery attached to the shelf beneath.

\* \* \*

### *Transmitting Sets for Japanese Fishermen*

A NEWSPAPER dispatch reports that the chief of the Nagasaki Prefectural Marine Products Bureau of Japan, together with a committee of men interested in marine products, is reported to be investigating the possibilities of installing radiophone outfits on the larger sized fishing boats which have their base at Nagasaki, to enable them to communicate with shore when in difficulties, and to report the catch in time for their owners to realize on it.



General Electric

### THE NEW "MAGNETO-MICROPHONE"

A new device, consisting of a moving magnetic coil pivoted between the poles of a permanent magnet which may be firmly anchored to the frame of a piano, has been developed by the engineers at the broadcasting station WGY. The instrument picks up the vibrations directly from the sound-board without any reference to the sound wave in the air. It is this principle that enables it to reproduce electrically all the fine shadings of tone-quality of the concert piano, and to eliminate the hissing and "tinny" sounds that almost always accompany transmission through a carbon microphone. In the picture is shown a studio piano that is equipped with three of these new microphones attached in positions that allow them to pick up the bass, the middle, and the treble ranges with the correct relative volume.



## Ask any radio expert

**T**HE first duty of a radio panel is to give satisfactory insulation, as any radio expert will tell you. The wise fan selects his panel with special care and insists on having one that supplies the proper insulation resistance.

Celoron Radio Panels provide satisfactory insulation under all conditions. They have high dielectric strength and great surface and volume resistivity, and do not warp or crack when exposed to moisture.

### *Cut in standard sizes*

For your convenience, Celoron Radio Panels come ready cut in eight standard sizes. Your dealer will hand you the size you want, and you can begin to build your set at once.

Celoron panels are easy to saw, mill, and tap, and will engrave evenly without feathering. Each panel is

wrapped separately in glassine paper.

Select from the following standard sizes the panel that suits your needs:

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 $\frac{3}{16}$

If your dealer cannot supply you, ask him to order, or write direct to us. Indicate by number the size you need. We also furnish Celoron in full-sized sheets and in tubes, and can cut panels in special sizes if desired.

### *This booklet free*

Write for a copy of our booklet, "Tuning in on a New World," which contains a list of the leading broadcasting stations in the United States and Canada, an explanation of symbols used in radio diagrams, and several efficient radio hook-ups. It will be sent to you free on request.

*To radio dealers: Send for special dealer price list showing standard assortments*

## Diamond State Fibre Company

BRIDGEPORT

(near Philadelphia)

PENNSYLVANIA

BRANCH FACTORIES AND WAREHOUSES

BOSTON

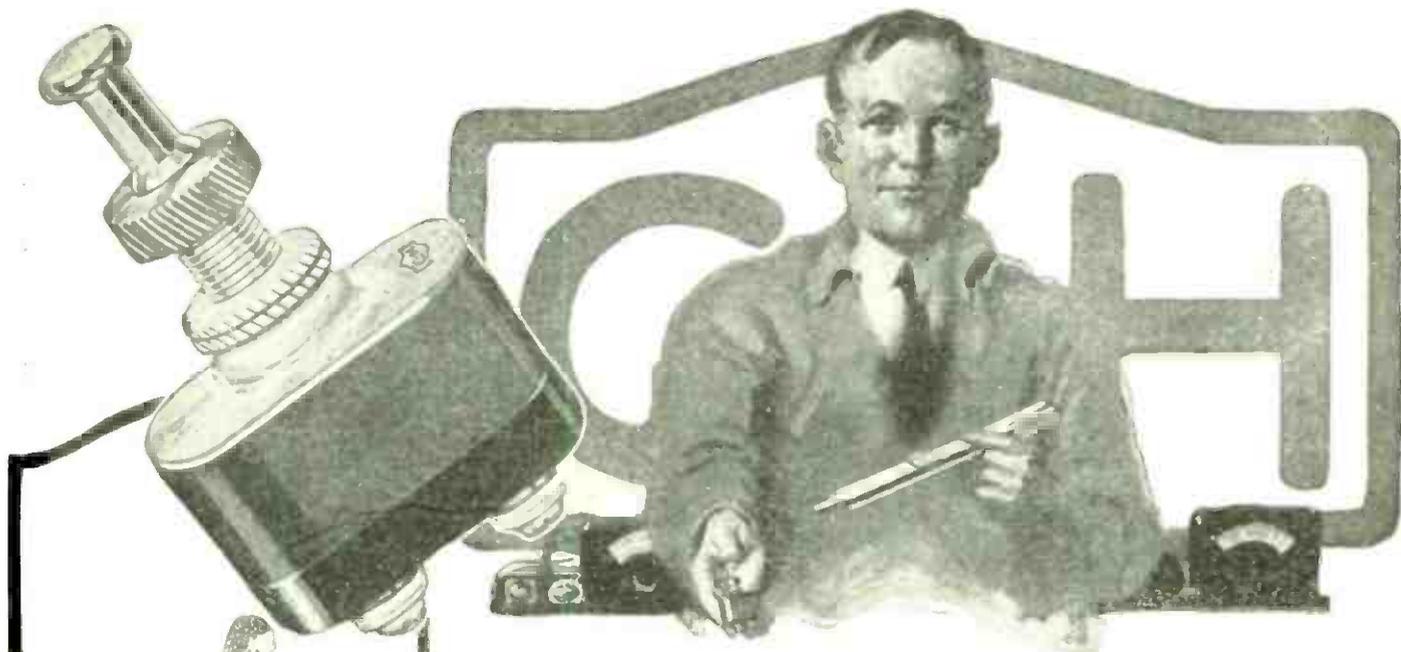
CHICAGO

SAN FRANCISCO

Offices in Principal Cities

In Canada: Diamond State Fibre Company of Canada, Limited, 245 Carlaw Ave., Toronto

# CONDENSITE CELORON STANDARD RADIO PANEL



## A Switch by the Master Builder for Your Radio Panel

*Beautiful Appearance  
Correctly Designed—Easily Installed*

In the radio world the name Cutler-Hammer and its symbol the famous C-H trade-mark have become guide posts to quality. In only a few months after their introduction more than a half million radio rheostats with the little mark of approval of the master builders of all electrical control apparatus were purchased.

Now these specialists offer another necessity for your panel, the C-H Radio Switch embodying the same careful design and workmanship to provide more pleasant, convenient reception and protect your expensive equipment at a negligible cost. Its sturdy knife blade mechanism that snaps—not merely slides—is capable of carrying 3 amperes at 110 volts, yet is built with a precision that enables you to use it in your most delicate circuits without any microphonic noises.

It will control your "A" battery to positively indicate whether the tubes are *on* or *off*—your "B" batteries—parts of circuits—condensers—battery charger—practically any demand you may have for current control. It is fully adjustable for panel thickness and can be installed in any set in a few minutes—only a single  $\frac{3}{16}$ " hole is required. Carried by dealers everywhere—if yours has not yet been stocked, send 60c plus 10c carrying charges and you will be supplied direct.

**THE CUTLER-HAMMER MFG. CO.**

Member Radio Section, Associated Manufacturers of Electrical Supplies  
MILWAUKEE · WISCONSIN



Disconnecting a battery lead is one way of shutting off a radio set, but many tubes and batteries have been ruined by putting it back on the wrong post. A C-H Radio Switch costs 75c—if you save only a few dry cells it quickly earns its cost.



What do you do when the phone rings? Just push the C-H Radio Switch button—answer the phone—pull the button and the same program is back on. No turning back rheostats or disturbing your delicate settings when you have C-H convenience.



With the new tubes that operate at a dull red it is easy to forget to turn off the "A" battery—there is nothing to indicate whether the set is ON or OFF. The nickel button of a C-H Radio Switch sticks right out to say "I'm ON—don't forget me!"

**CH**

# RADIO SWITCH

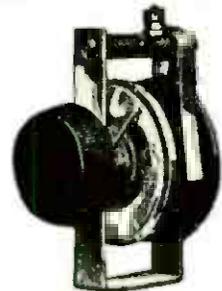


**"Built by  
Rheostat Builders"**



**C-H 4-Ohm Radio Rheostat**  
Perfect control for the one ampere, six-volt tubes, or WD 11 (dry cell) type. With vernier, for detector tube control.

Type 11601-H1 . . . . . \$1.50  
Plain type for amplifier tube control.  
Type 11601-H2 . . . . . \$1.00



**C-H 30-Ohm Radio Rheostat**  
Precise control of the one-quarter ampere, six-volt (UV 201-A and C301-A) tubes or the UV 199 type on 4.5-volt source.

Type 11601-H9 . . . . . \$1.50



**C-H 125-Ohm Radio Rheostat**  
For control of the current-saving UV 199 tubes on a current source of six volts. Use your storage cell with the new tubes—it will need recharging only at long intervals.

Type 11601-H . . . . . \$1.50



**C-H Variable Resistance Unit**  
Adds to your five-ohm rheostat just the resistance required to control the 1/2 amp. 6-volt "A" type tubes or the UV 199 type. Saves the cost of new rheostats and the trouble of re-drilling your panel. Fully adjustable for change in battery potential.

Type 11601-H12 . 25c

## Every Tube You Buy Should Have the Protection of C-H Control

*There Is a Specialized Rheostat by the Master Builder for Every Requirement*

The Cutler-Hammer engineers, world-famed specialists in electrical control, provided in their now famous C-H Radio Rheostats a new standard in accuracy of design and quality of workmanship among radio instruments.

Outstanding, was their originality of construction. Built almost entirely of non-warping metal—finished in beautiful satin nickel and ebony black—furnished with adjustable, spring contact fingers, comfortable knobs of genuine Thermoplox, and nicked pointer, these rheostats were quickly recognized as worthy of the trade-mark they carried.

And as the science progressed and new tubes were introduced the C-H engineers evolved new models anticipating every requirement. Today there are four specialized C-H Rheostats (the 4-ohm vernier, the 4-ohm plain, the 30-ohm and the 125-ohm) to control any tube you desire. Each has been designed for the service it must render, and can only be wired to give the voltage needed for the tube it protects. For satisfaction in radio, demand the mark of the master builder on your control instruments.

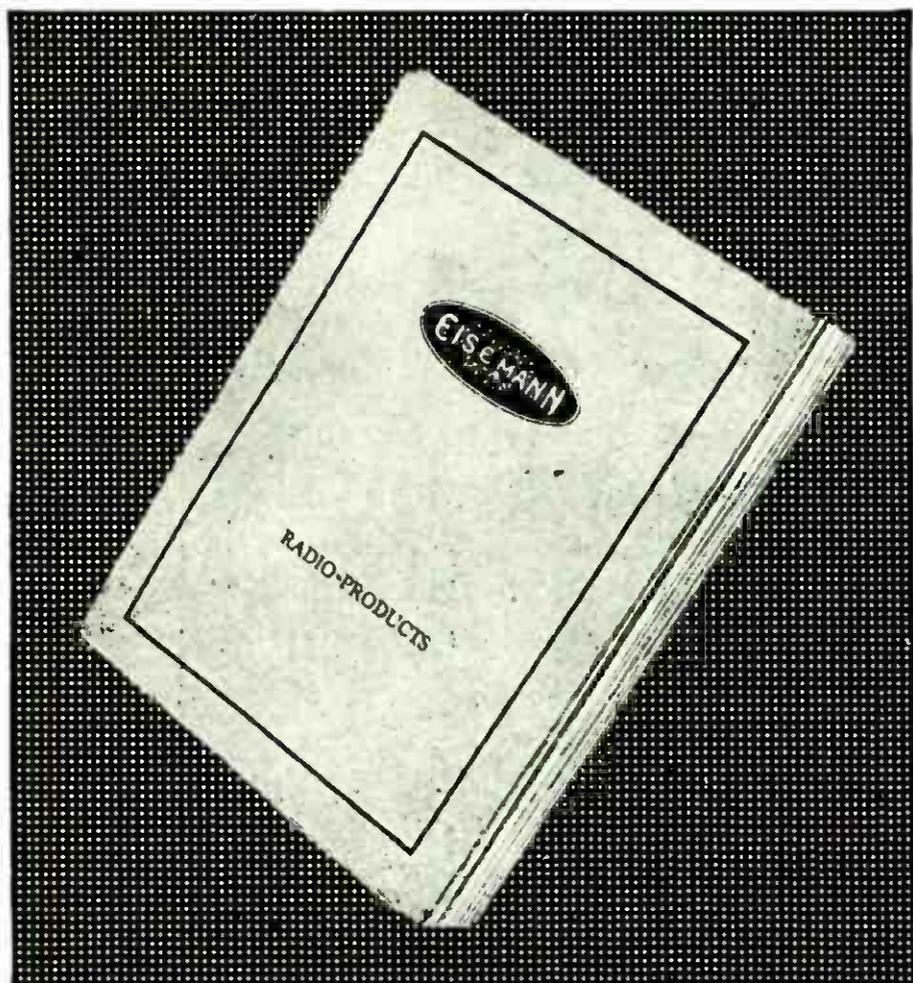
**THE CUTLER-HAMMER MFG. CO.**

*Member Radio Section, Associated Manufacturers of Electrical Supplies  
MILWAUKEE, WISCONSIN*

*One Half Million C-H Radio Rheostats Now in Use*

# CUTLER-HAMMER

Please mention POPULAR RADIO when answering advertisements.



## *Just off the Press*

Upon request, our latest radio catalogue will be sent to those interested in the construction of receiving sets—without charge.

Each part we manufacture is illustrated and described in detail.

*Write for it today.*

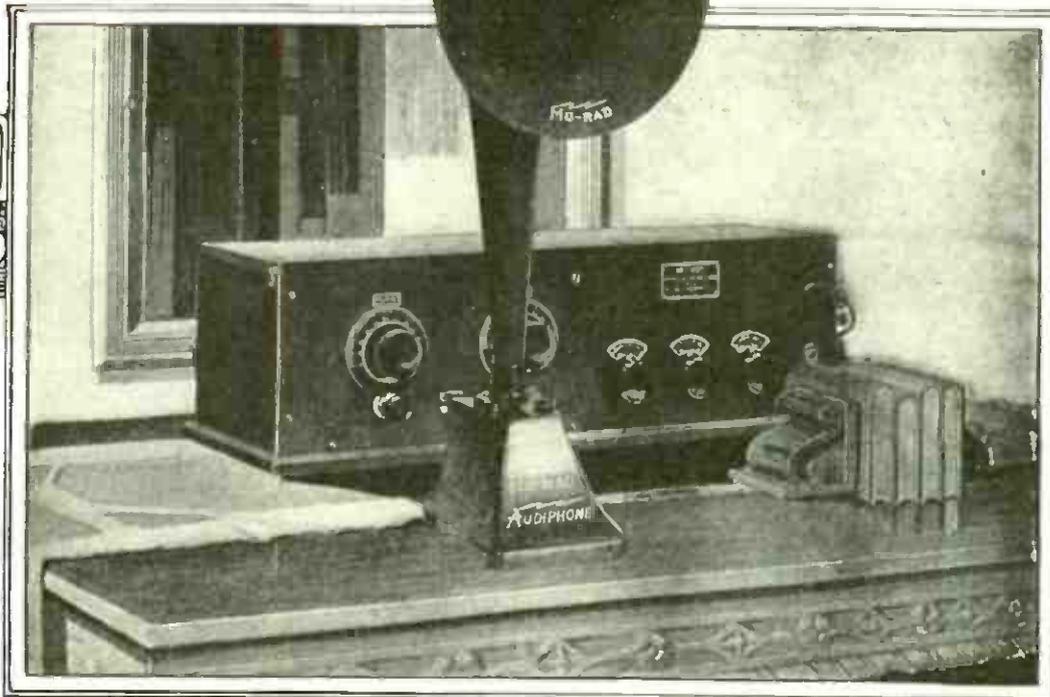
**EISEMANN MAGNETO CORPORATION**

William N. Shaw, *President*  
**BROOKLYN, N. Y.**

DETROIT

CHICAGO

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*A New MU-RAD Accomplishment* —  
**The MU-RAD AUDIPHONE**

The super-sensitive mica diaphragm produces sound by the contraction and expansion of an actuating contact, just as the vocal cords produce the voice.

*No Extra Battery Connections*

PRICE  
**\$ 25**

**T**HE REVOLUTION, wrought in radio reception by the MU-RAD RECEIVER is equalled by this radical improvement of sound amplification. The *MU-RAD AUDIPHONE* aimed for a higher perfection than ever attempted — duplication in electro-mechanical form of the greatest sound producing organ, the human voice. The result of five years' continuous research is a radio reproducer worthy of a finer classification than "loud speaker"; it is *a new radio instrument!*

WRITE FOR LITERATURE AND THE NAME OF THE NEAREST MU-RAD DEALER DEMONSTRATING THE MU-RAD AUDIPHONE

**MU-RAD LABORATORIES, INC.**

809 FIFTH AVE. ASBURY PARK, NEW JERSEY



Price **\$1.50**

Actual Size  
Patents Pending

### Accurate Vernier Regulation With The Chelton Midget (A VARIABLE CONDENSER)

The CHELTON MIDGET furnishes the most accurate Vernier regulation when **shunted** across the plate of the main condenser with minimum body capacity.

By far the easiest and most accurately adjustable **neutralizing condenser** on the market, having a capacity range of .00001 to .000045 MFD, such as required for Hazeltine's Neutrodyne and other circuits.

The Chelton Midget Condenser adjustment can be used to replace all fixed condensers regardless of capacity and give a vernier adjustment if required.

The new Chelton Catalogue showing a number of new instruments will be ready for mailing to all recognized jobbers and dealers October 1st. Write for your copy.

Pocket Hand Edition will be ready for mailing to amateur radio fans November 1st.

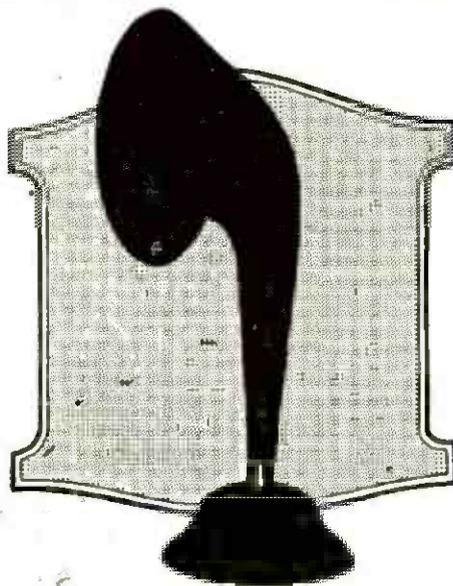
*Since 1910 Manufacturers of High Grade Electrical Specialties*

## Chelton Electric Company

4863 Stenton Avenue PHILADELPHIA



YOUR PHONE PLUS A FIBERTONE MAKES  
A BEAUTIFUL MUSICAL INSTRUMENT



## Tribune Institute Approves "Fibertone"

The New York Tribune Institute has approved the "Fibertone"—a tribute only to quality merchandise of proven performance.

And performance is what counts! Here the Tribune makes this complimentary statement: "Excellent reproductions are obtained with a Fibertone in use with a single phone from any good head set."

Make your own comparison and it will be found that for the price, the Fibertone is unequalled in tonal quality. Its construction is entirely of fiber, insuring against tinny and vibrative blasts. Operates on one stage of amplification. Your dealer will gladly help make this comparison for you.

#2 Fibertone (14 in.) . . . . . \$12.50

FIBER PRODUCTS CO.

240-C North 10th St. Newark, N. J.

# \$8

# FIBERTONE

RADIO HORN

Jobbers and dealers write for trade prices

Please mention POPULAR RADIO when answering advertisements.

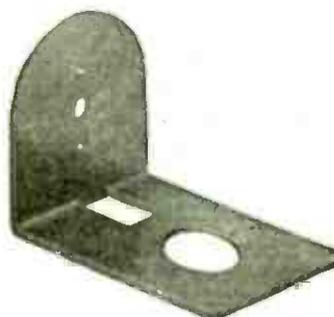
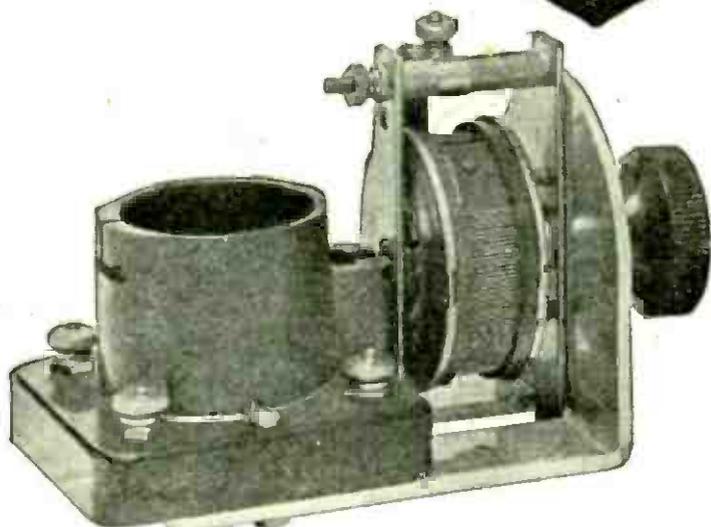
MAKES

YOUR



MOUNTING

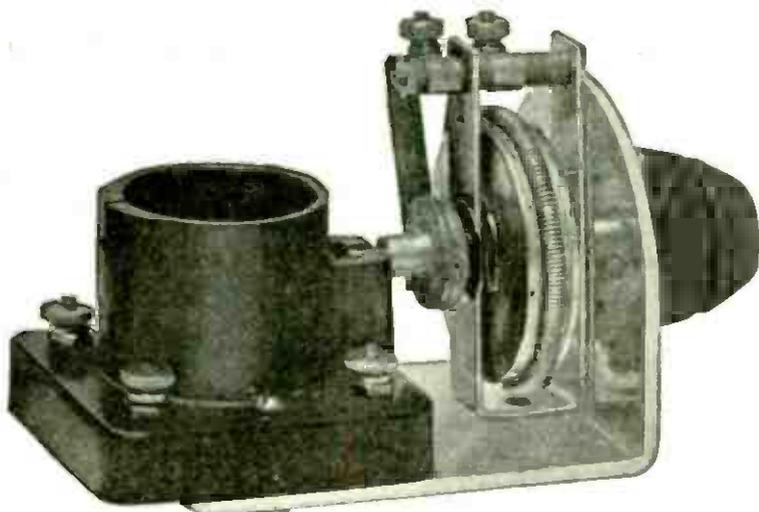
EASY



MOUNT YOUR OWN  
DETECTOR  
BRACKET

Cat. No. 217—30c

Cat. No. 206 Detector Unit (30 ohm)—\$3.00  
Cat. No. 211 Detector Unit (4 ohm)—\$2.40  
Cat. No. 198 Amp. Unit (4 ohm)—\$7.50  
Cat. No. 105 Amp. Unit (30 ohm)—\$8.10



MOUNT YOUR OWN  
AMPLIFIER  
BRACKET

Cat. No. 218—35c

Cat. No. 139 Detector Unit (Ver.)—\$3.00

**R. MITCHELL CO.**

255 Atlantic Ave.

Boston, Mass.

Pacific Coast Office: 709 Mission St., San Francisco

Export Office: 44 Whitehall St., New York

Please mention POPULAR RADIO when answering advertisements.

# RHAMSTINE\*

## Victophone

Loud Speaker



Replacing the tone-arm of your phonograph, the Victophone gives you undistorted amplification and a full, pleasant tone and volume that is incomparable. If your dealer hasn't the Victophone, we'll gladly send it, post paid. State make of phonograph.

**\$7.50**

Complete with Cord

For home or laboratory.  
The Rhamstine\*

Electric Soldering Iron is especially designed to meet the needs of the radio experimenter. Nichrome element, renewable tip, nickel finish. Complete with plug, cord and self-fluxing solder.

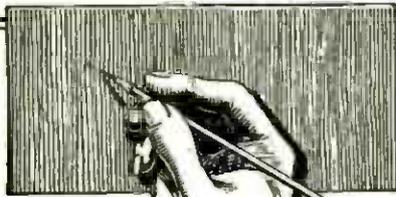
**\$2.50**

Complete



J. THOS. RHAMSTINE,\* Woodbridge at Beaubien Detroit, Mich.

\* Maker of Radio and Electrical Products



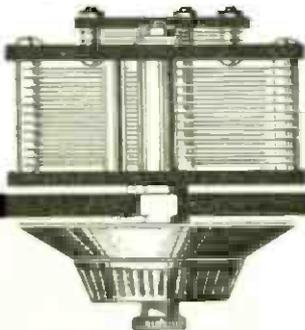
BORING ONE HOLE



INSERTING SHAFT



ADJUSTING NUT



# RATHBUN

SINGLE-HOLE MOUNTING

## SUPERIOR CONDENSERS

ANOTHER point of RATHBUN extraordinary superiority —stator plates—all one rigid, immovable unit. Spaced to the thousandth of an inch and then anchored solidly into precision-milled brass tubes by die-casting under extreme pressure. No possibility of warping, no adjusting, no washers. This point, with single hole mounting and other points of RATHBUN superiority, makes these condensers distinctly better value.

### LIST PRICES—RATHBUN CONDENSERS

PLAIN TYPE		VERNIER TYPE	
5 Plate	.000125 \$3.00	3 Plate	.000075 \$1.00
11 "	.00025 3.00	COMBINATION	
23 "	.0005 3.50	VERNIER TYPE	
43 "	.001 4.50	3-11 Vernier Variable	\$4.50
		3-23 "	5.00
		3-43 "	6.00

Write TODAY for the name of the nearest Rathbun dealer and for illustrated literature.

RATHBUN MANUFACTURING CO.  
Jamestown, New York

Please mention POPULAR RADIO when answering advertisements.



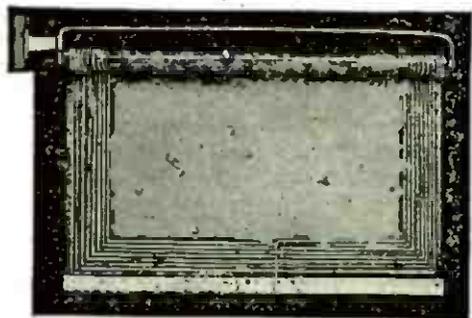
A New Pathé Product

# CURTANTENNA

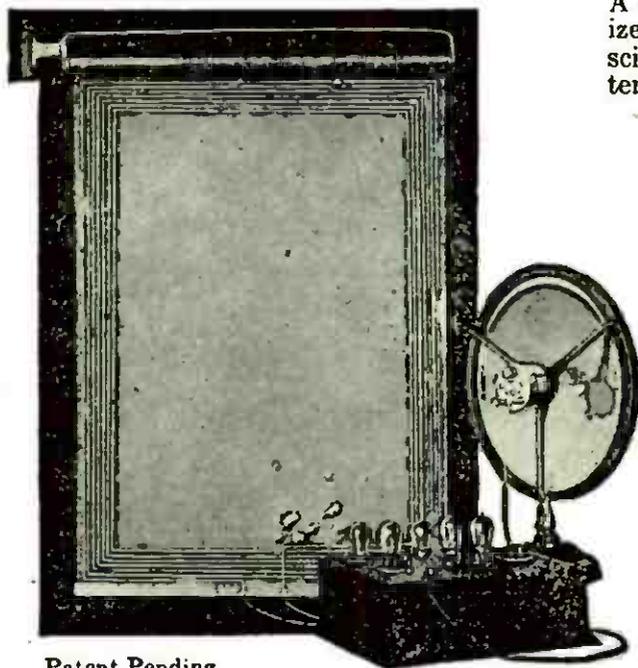
## The Only Variable Loop



Showing Collapsibility and Portability of Curtantenna



Showing How Curtantenna Can Be Varied In Size



Patent Pending

Showing Curtantenna Fully Extended in Conjunction with Set and Pathé Loud Speaker

A REVOLUTIONARY development in radio aerials for indoor use.

When fully opened is one of the largest and most efficient loops for broadcast reception.

Is instantly collapsible without kinking or tangling the wire.

Ideal for sharp tuning—unsurpassed for distance—reduces static to a minimum. Particularly effective in large cities where several stations are broadcasting at same time. Gives a degree of selectivity hitherto unobtainable.

When closed is as portable as a walking stick.

Comes with wall bracket and swivel or may be attached to any door in house.

Positive in results—very attractive in appearance—easy to handle.

Size can be varied at will.

Over 1500 miles have been covered by users of the CURTANTENNA.

A quarter of a century of highly specialized experience in the manufacture of scientific devices is behind the Curtantenna.

## Price \$8.50

On sale at leading radio stores. If your dealer has neglected to stock the Curtantenna, send remittance direct and shipment will be made, charges prepaid, immediately.

Other Pathé products such as the famous Pathé Loud Speaker, Pathé Dials and Pathé Variometers and Variocouplers have already established themselves as standards among users of the best radio material.

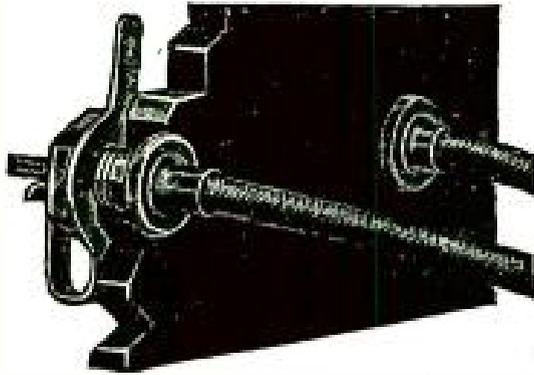
Catalogue of Pathé radio products, together with a detailed wiring diagram of a loop receiving set which covered 1500 miles using a CURTANTENNA, will be mailed on receipt of 4 cents postage. Address Dept. 198

### **PATHÉ PHONOGRAPH & RADIO CORPORATION**

20 GRAND AVE., BROOKLYN, N. Y.

533 SO. WABASH AVE., CHICAGO, ILL.

*Quick, Positive Connections*  
**UNION RADIO  
TIP JACKS**



**Cost Only 25c a Pair**

That they give you quick, positive temporary connections is only one of the many big advantages of Union Radio Tip Jacks. Just what you want when you build your own set or experiment with different circuits and hook-ups.

They can be attached to all standard thicknesses of panels. The bushing is  $\frac{1}{4}$ " in diameter and fits a  $\frac{1}{4}$ " hole. Will grip all wires from 24 B & S gauge up to antenna wire, battery leads, loading coils and vacuum tube lugs.

No parts to chip, lose and deteriorate. All parts heavily nicked.

**Other Guaranteed Parts**

Dial adjusters for minute variations in capacities of variable condensers. Price 60c.

Variable Condensers. Famous for performance Without dials, 3 Plate—\$1.00; 13 Plate—\$2.00; 23 Plate—\$2.30.

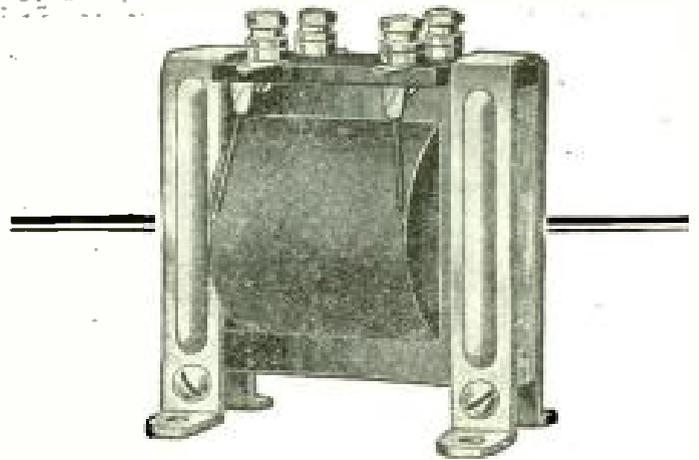
Tube sockets of molded condensite highly polished. Phosphor Bronze contact springs. Reinforced bayonet slot prevents breakage. Accommodates all standard tubes. Price 75c.

Should your favorite Radio Store not carry Union Radio Tip Jacks and Guaranteed Parts send your order direct to us, also write for your copy of "The Union Radio Catalog A."

**Retailers and Wholesalers**

Samples of our guaranteed, reasonably priced "Quality Products" sent on request. Our terms and trade discounts are liberal. Write for our proposition.

**UNION RADIO CORPORATION**  
200-MT. PLEASANT AVENUE, NEWARK, N.J.  
NEW YORK OFFICE 116 WEST 32nd STREET



**GENUINE  
JEFFERSONS**

**The Standard Audio  
Frequency Transformers**

No matter what circuit you wish to complete, there is a JEFFERSON Audio Frequency Amplifier which will insure 100% Amplification, the elimination of distortion and the quiet easy tuning so eagerly sought after.

**FIVE JEFFERSON TYPES**

to choose from—manufactured by the pioneers in the audio frequency transformer field. Right from the start put Jeffersons in your set—don't experiment—expert Radio Engineers, after careful and exhaustive tests have found them perfect in every detail of construction.

DESCRIPTIVE BULLETIN sent free and our Engineering Department will be glad to make recommendations as to the proper transformer to be used in any circuit.

**Jefferson Electric Mfg. Co.**  
427 S. Green Street Chicago

Please mention POPULAR RADIO when answering advertisements.



# Aladdin's Lamp Outdone

IN the fairy stories they asked Aladdin for music and by rubbing his wonderful lamp he produced it for them. No doubt if they had wanted crop and market reports or a bedtime story Aladdin could have produced them also. But these were fairy stories. Whoever thought they would come true?

## PARAGON

Reg. U.S. Pat. Off.

### RADIO PRODUCTS

Tonight if you sat down with a PARAGON Three-Circuit Receiver you could hear the music of a world-famous orchestra or the marvelous voices of opera singers just as clearly as if you were sitting in the same room with them. You can choose the program you want and enjoy it without interruption.

The name "PARAGON" on radio products means perfection. To listen in with a Paragon set is to experience the full fascination of the world's latest wonder.

*An Illustrated Catalog of Paragon  
Radio Products Is 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 Type  
RD-5 Regenerative  
Receiver and Detector  
—\$60.00

Type A-2 Two-Stage  
Amplifier—\$40.00  
(Licensed under  
Armstrong Patents)

# "ALL-AMERICAN"

*Sets another  
World Record!!*



THE RECEPTION on board the Berengaria, night after night, of the signals from the Drake Hotel, Chicago, during the entire voyage, from New York to Cherbourg, France, a distance of 4000 miles, was a world record achievement for consistent reception. The set used employed "ALL-AMERICAN" Amplifying Transformers.

Today another record is being made. Slowly winding its way up into the frozen North is the Bowdoin, on board of which is Captain Donald B. McMillan, on a scientific expedition to the North Pole.

Night after night, up in the Arctic Ocean, he is listening to the world thousands of miles south of him. Again "ALL-AMERICAN" Amplifying Transformers are being used, and again new world records are being achieved.

You, too, can set new records with your own set by the use of "ALL-AMERICAN" Amplifying Transformers.

Ask your dealer to show you these world record-breaking instruments. They are as attractive as they are efficient.

Book of Successful Hookups sent free on receipt of 2c for postage.



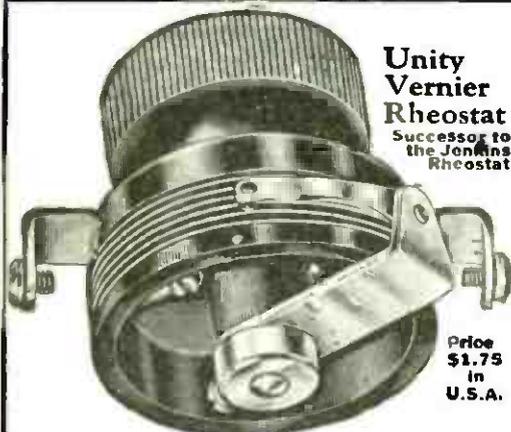
Audio Frequency Transformer



Radio Frequency Transformer



**RAULAND MFG. CO.**  
200 No. Jefferson St., Chicago, Ill.



Unity Vernier Rheostat  
Successor to the Jenkins Rheostat

Price \$1.75 in U.S.A.

Interchangeable Resistance Cartridge



Complete \$.80  
Bracket .45  
Cartridge .35

Unity Cartridge Rheostat

DEALERS:

## Unlimited Adjustment and Practical Convenience

The highest type electrical instrument for controlling resistance. A single wire followed its entire length by a contact gives noiseless adjustment and permits infinitesimal refinement in tuning. A cut-out switch turns tube on or off with absolutely no change in tuning. Made in any resistance. Stocked in 8 ohms, 20 ohms and 40 ohms. All capacities \$1.75 list.

### Built for Convenience

Nothing like this new Unity Cartridge Rheostat has ever been offered the radio enthusiast. Interchangeable resistance cartridge may be slipped in or out by hand in a moment's time without removing bracket or terminal. No need to buy new rheostats when you change tubes in your set. Simply pay 35c for the Unity Cartridge of the correct resistance. Made in any resistance. Stocked in 8 ohms, 20 ohms and 40 ohms. All cartridges 35c list. If your dealer cannot supply you, send money order or check and dealer's name to factory.

"Hear a set that uses one"

**Unity Manufacturing Company**  
226 North Halstead Street, Chicago, Ill.

Automatic Screw Machine Products, Stampings—  
General Manufacturing on Contract or Royalty

Send name and address to Factory for Free Counter Display

Please mention POPULAR RADIO when answering advertisements.

**AMPLION**

**Junior  
DeLuxe**

**\$26<sup>00</sup>  
List**



England

Canada

Scotland

Australia

Wales

New Zealand

Ireland

So. Africa

Norway

India

Sweden

France

Denmark

Italy

Holland

Spain

Belgium

Japan

## The Uncanny Amplion A "Human" Loudspeaker

**YOU** can scarce believe your ears when you first hear the Amplion Loudspeaker.

The clearness, softness and rich tone-quality with which it reproduces voice and music are so real as to be uncanny. You get a new thrill from radio. Delicious "chills" course up-and-down your spine, as they do when you listen to some master of voice or instrument face-to-face.

American Engineers who have tested the Amplion are unanimous in their opinion that for true reproduction and volume it's the best loud speaker yet produced.

The Amplion is not a head receiver fitted with a horn, but the adaption for Radio of an electro-magnetic and acoustic instrument which for thirty years has been successfully used in all parts of the world.

Ask your dealer to let you hear the wonderful "AMPLION" Loudspeaker. Send for illustrated folder.

*Patentees Alfred Graham & Co.*

**SIGNAL ELECTRIC MFG. CO.**

*Sole United States Distributors Menominee, Michigan*

**BURNDIPT OF CANADA, LTD.**

*Canadian Distributors 172 King St., West, Toronto*

*The Supremacy of the AMPLION  
is the Supremacy  
of Actual Performance*

## Good Plugs Are Important

The successful operation of any radio receiving set depends upon the accurate functioning of every part in the set. Plugs on headpiece and loud speaker cords are important units.

Without good plugs you can't get good results.

# CICO



### TWO WAY RADIO PLUGS

are the largest selling round plugs in America today because no other plug made combines such sterling qualities with so low a price.

Price 60c

Consolidated Instrument  
Company of America, Inc.

41 East 42nd Street  
New York

# Teleradio



## Radio Engineers Know— and buy these features

### SUPER-SENSITIVE

1. A guarantee that less than five per cent variation in resistance ever exists between the coils of Teleradio head sets. The secret of accurate reproduction of faintest signals.
2. Positive adjustment of diaphragm—insures best tonal qualities.
3. Improved self adjustable friction-sleeve—positive position grip.
4. Drawn aluminum case—all metal parts highly nickel polished. Light and durable for the hardest usage.
5. Fabricated head band for unusual comfort and ease.
6. Latest engineering principles and best of materials employed in every detail of construction and manufacture.

If your dealer cannot supply you, write for catalogue and prices.

\$5.50



Jobbers and  
dealers write  
for trade prices

TELERADIO  
ENGINEERING  
CORP.

488-490 Broome St.  
New York City

Please mention POPULAR RADIO when answering advertisements.



*Natural*  
*Re-PRODUCTION*  
*Atlas*  
**AMPLITONE**  
LOUD SPEAKER

*Letters from Users*  
*Requested*

What have you accomplished with your Atlas Amplitone? Tell us about it!

ALL of the program, natural as the original, re-PRODUCED on the *Atlas Amplitone*. Faithfully responsive, not to just one small range of sound intensity, but to the *full scale* of tone harmonics. The "double diaphragm" — triumph of the radio and acoustic sciences — automatically accommodates itself to every pitch. Blast and distortion are entirely eliminated. The "double diaphragm" is adjustable to operate most efficiently with individual receiving conditions. Ask the nearest Atlas Amplitone dealer for a demonstration. Hear the difference this great innovation makes.

*Write for Booklet "B"*  
Contains helpful information.

*Sole Canadian Distributors*

**The Marconi Wireless Telegraph Company of  
Canada, Limited**

Montreal

Canada

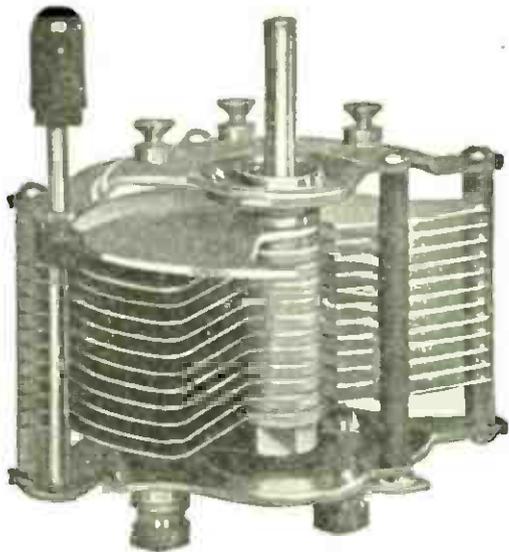
**Multiple Electric Products Co. Inc.**

ORANGE ST.

RADIO  
DIVISION

NEWARK, N. J.

# MIGNON NEW TYPE STRAIGHT LINE VERNIER AIR CONDENSERS



## POINTS OF SUPERIORITY

1. Stator plates instead of being loosely fitted are 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.
6. Patented vernier arrangement eliminating body capacity.
7. Accurate and correct spacing of special spring aluminum plates.
8. Lowest dielectric losses proven by laboratory tests.
9. Friction adjustment on rotor shaft, assuring positive and permanent tuning adjustment.
10. Independent vernier control. Vernier does not rotate with main rotor plates.

## COMPARE PRICES AND QUALITY

Type G., 13 Pl., .0002 M. F., \$2.75—Type H., 23 Pl., .0005 M. F., \$3.25—Type J., 43 Pl., .001 M. F., \$3.50.

*These Prices Subject to Advance Nov. 1, 1923*

Sold by all Leading Electrical Firms and Radio Dealers.  
If not Obtainable from Your Dealer, Write us Direct.

*Jobbers, Dealers and Set Manufacturers Write for Discounts.*

## MIGNON ELECTRIC MFG. CORP.

27-33 SOUTH WATER STREET

ROCHESTER, N. Y.



# the Most Successful Non-Magnetic Instrument

There is no rasping, no growling, no harshness. It reproduces exactly what your set brings in—with larger volume—clear, mellow, resonant tones that all can hear.

only  
\$7.50



## The New 1924 Models

are now ready. Even better than the 1923 Speaker that brought delight to thousands of radio homes. Two types, for single or double phone connections, same price. For use with your own phones. Heavy iron sound channels. Horn of heavy aluminum, with beautiful black indestructible finish. Fifteen inches high.

Hear the Moon Loud Speaker at your dealer's. If he hasn't got it, order direct from us on our guarantee of satisfaction or refund.

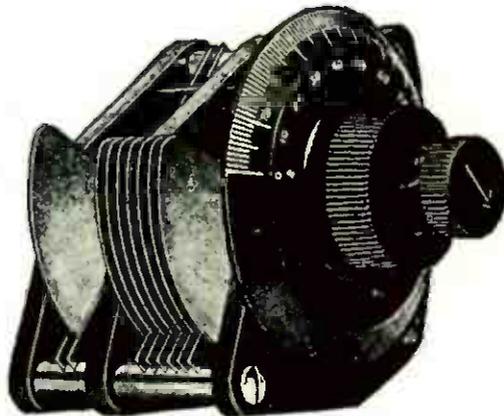
*Dealers: Write for proposition.*

**WILSON UTENSIL CO.**  
DEPT. W. DAYTON, OHIO

Please mention POPULAR RADIO when answering advertisements.



## THE IMPORTANCE OF VARIABLE CONDENSERS



**N**EARLY all modern receiving circuits contain one or more variable condensers. Upon the performance of these vital parts depends largely the degree of success of your receiving set. It is easy to produce condensers which look efficient, but effectiveness in these parts is much more than skin deep.

### CHELSEA VARIABLE CONDENSERS

Enable any receiving circuit to give its best. Plates are die cast into solid units giving permanence of electrical and mechanical connections and rigidity at all times. This is the only sure method of construction which avoids corrosion and insures low resistance. Insulating material is the best obtainable—genuine bakelite—molded by Chelsea. This insures low electrical losses. Large brass self-aligning bearings eliminate all play and maintain the proper air gap at all times. Plates are of heavy stock of the proper design. These are some of the reasons why you should use Chelsea condensers to achieve the results you hope for.

Made in eleven styles, they form a complete line in which there is the proper type and capacity for any receiving circuit.

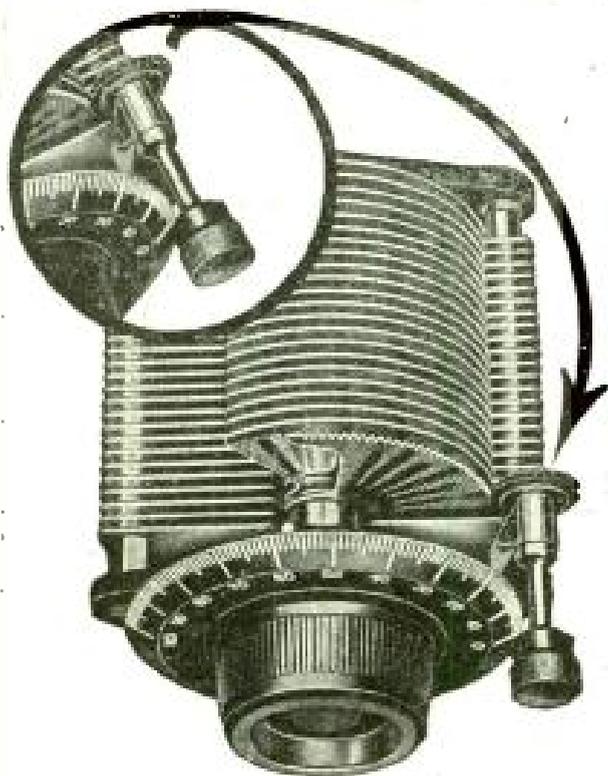
*Prices from \$2.50 to \$6.75*

#### OTHER QUALITY CHELSEA PARTS:

Variometers with Vernier . . . . .	\$8.00	Rheostats . . . . .	\$1.00 and \$1.40
Varicouplers . . . . .	8.00	Tube Sockets . . . . .	.50 and .75
Audio Transformers . . . . .	\$3.75 and 4.50	Dials . . . . .	.40, .45, and .50

*Write to Department 3 for our large catalog, which illustrates and describes the complete line of Chelsea Receiving Sets and Parts*

**NATIONAL CHELSEA RADIO CORP.**  
739 Boylston St., Boston, Mass.



## Heath's Radiant Condensers

Now the "guess" has been taken out of condenser buying. The source of greatest uncertainty, the plates, by a new process of stamping and tempering in **Heath's Radiant Condensers** are **PERMANENTLY FLAT**. They are as proof against warping and buckling as a steel straight edge. These condensers will keep their fine alignment without any adjusting during their entire life!

### A Vernier Adjustment Geared Like a Watch

Ordinary vernier adjustment reduced to micrometer fineness. Extreme delicacy of adjustment. Smooth, positive, accurate as a watch. **Heath's Radiant Condensers** are especially adaptable to the fine tuning required on high amplification.

Write for Illustrated Folder.

#### PRICES

##### Vernier Type

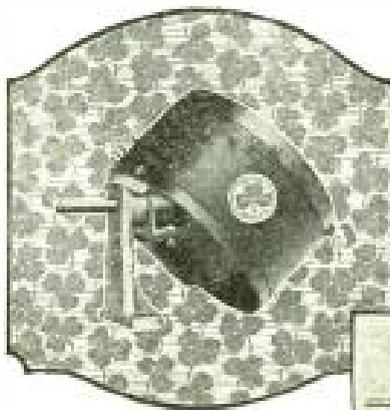
13 Plate including 2 $\frac{1}{8}$ " dial and knob.....	\$5.00
25 Plate including 2 $\frac{1}{8}$ " dial and knob.....	5.50
45 Plate including 2 $\frac{1}{8}$ " dial and knob.....	6.50

*Jobbers and Dealers Write  
Immediately for Proposition*

# HEATH RADIO & Electric Mfg. Co.

204 First Street  
Newark, N. J. U. S. A.

IMITATED BUT NEVER DUPLICATED



\$3.50  
each



## DEPENDABLE — for all new wave lengths

—Range 150 to 600 meters, tunes in on all new high wave lengths.

—180° type, gives double selectivity of ordinary 90° instrument.

—Tubes of genuine grade XX bakelite wound with single green silk covered wire.

—Angular movement of rotor gives super selective tuning with ease.

—Direct flexible leads to Fahnestock clips eliminate contact noises of spring contacts.

—Aluminum die cast frame reduces body capacity. For bench or panel mounting.

#### VARIOMETER

Write for descriptive specifications

Dealers write for trade prices

SHAMROCK MANUFACTURING CO.  
320 Market St., Newark, N. J.

# SHAMROCK

FOR SELECTIVE TUNING

180° VARIO-COUPLER  
VARIOMETER

Please mention POPULAR RADIO when answering advertisements.

# MU-RAD RECEIVERS

*The Ultimate  
in  
Radio  
Reception*



*The New  
Star in  
the Radio  
World*



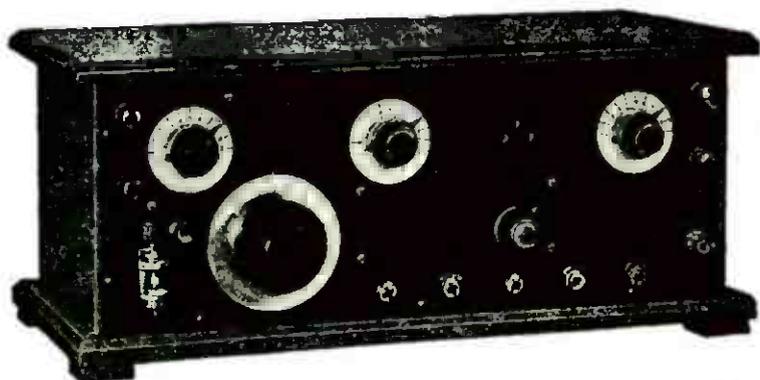
“WHEN KNIGHTHOOD WAS IN FLOWER,” Crusaders in distant lands communicated with their own countries by carrier pigeon. The system, learned from the Saracens, was greatly perfected by the Crusaders. *Today*, ordinary radio reception has been excelled by a new perfection of the art—MU-RAD RECEIVERS. Swift as thought, clear as the voice, sensitive beyond belief! Cities, 4300 miles and more away, send their news and entertainment to the MU-RAD owner. Conservatively guaranteed for 1000 miles, using only a two-foot loop aerial.

WRITE FOR LITERATURE

**MU-RAD LABORATORIES, INC.**

809 FIFTH AVE. ASBURY PARK, NEW JERSEY

# EACO DUPLEX RECEIVERS



*Excel in—*

**RANGE  
VOLUME  
CLARITY  
EFFICIENCY**

## A Revelation in Radio Frequency

A supersensitive Receiver incorporating two stages of Tuned Radio Frequency. Affords the user choice of either crystal or tube detector, with or without amplification. Ideal for use with loud speakers of any type. Delivers great volume from distant Broadcasters. Will operate without an aerial.

Literature and prices furnished upon request.

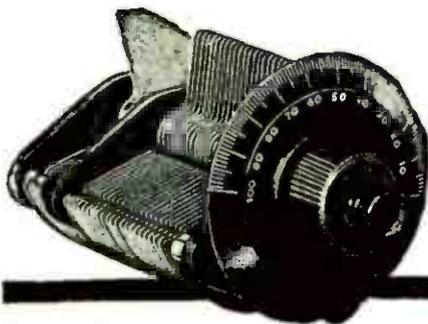
**ECONOMIC APPLIANCE COMPANY, Irwin, Penna.**

# U.S. TOOL CONDENSERS

**WITH THE PERFECT  
END PLATES OF  
LAMINATED  
CONDENSITE  
CELORON**



**C**HEAPER insulating materials *might* do as well, for ordinary purposes, but our respect for the good opinion of the radio public permitted nothing but the best—CONDENSITE-CELORON. Moisture, which only needs to be retained on the surface to form a perfect path for the escape of radio frequency currents, vanishes from the surface of CONDENSITE-CELORON "like water off a duck's back." Greatest dielectric and tensile strength.



**U.S. TOOL  
COMPANY INC.**

*116 Mechanic St.  
Newark, N.J.*



# How often do you get a new B battery?

**T**HE current from a B battery is relatively small. But it must be always on the job. B batteries that run down quickly are the bane of the radio fan's existence. Your B battery can help you get the most pleasure from radio, or it can be your greatest nuisance. It all depends on the kind of battery you buy.

The wise radio amateur knows it pays to get a good B battery in the first place. And that means an Exide. The new Exide B Battery is built with extra-heavy plates. That is one reason why it lasts so much longer than the ordinary battery. It can be recharged again and again, saving you the annoyance of frequent replacements.

Exide B Batteries give steady, noiseless current. They are strangers to the hissing, frying noises caused by internal discharge. The 12 cells are encased in rubber, with special vents to allow gas to escape when the battery is being recharged. They are designed throughout to prevent electrical leakage.



**Exide A Battery for six-volt tubes**

Supplies uniform filament current. Is dependable and long-lasting. Comes in four sizes, of 25, 50, 100 and 150 amp. hr. capacities.

the latest developments in radio receiving. The one-cell Exide A Battery will heat the filament of a 1.1 volt .25 ampere tube for 96 hours; the two-cell Exide A Battery will heat the filament of a 3 volt 60 milliamper tube for approximately 200 hours.

## Two low-voltage A batteries

If your set operates on low-voltage tubes, it will be worth your while to examine the new Exide two- and four-volt A batteries. They are right in line with

They are specially adapted to WD-11 and UV-199 vacuum tubes.

The Exide A Battery for six-volt tubes gives full-powered, care-free service. It requires only occasional recharging. Like all Exide Radio Batteries, it is built of the finest materials available, is sturdy and long-lasting.

When you hook up your set with Exide A and B Batteries, you are sure of getting maximum signal strength. You can reproduce broadcast selections in clear bell-like tones.

Wherever reliable storage batteries are required, you will find the Exide doing its work ungrudgingly. It is recognized as the

leading storage battery in every field of industry. A majority of all government and commercial wireless plants are equipped with Exide Batteries.

Don't let inefficient batteries spoil your pleasure in radio. Go to any radio dealer or Exide Service Station and ask for Exide Radio Batteries.

If your dealer can't supply you with free booklets describing the complete Exide line, write direct to us.



**Two- and four-volt  
A batteries**

Consist of one and two cells, respectively, with rated capacities of 24 and 12 ampere hours. The two-volt battery weighs 5 lbs., the four-volt battery 6 lbs.

# Exide

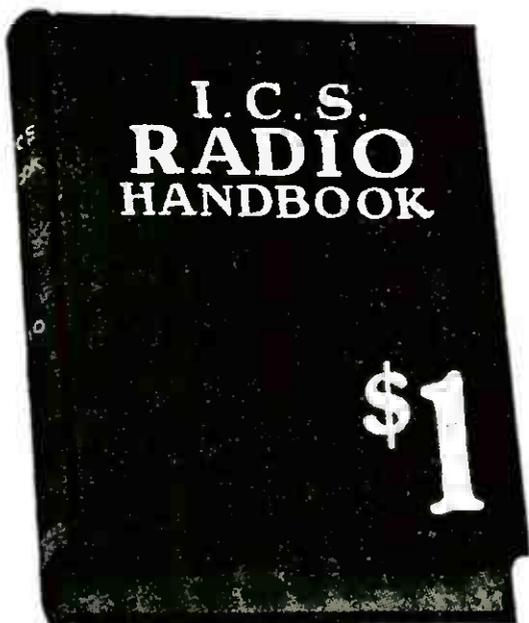
## RADIO BATTERIES

**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



# At last! A practical authoritative book on RADIO

514 pages. Price only \$1  
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

**T**HE most complete book of its kind ever published. Written, compiled and edited by practical radio experts of national reputation. Packed with concise, sound information useful to every radio fan—from beginner to veteran hard-boiled owl. Hundreds of illustrations and diagrams to make every point clear. Note this *partial* list of contents:

Different types of receiving and sending hook-ups, 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.

TEAR OUT HERE

INTERNATIONAL CORRESPONDENCE SCHOOLS  
Box 8250-B, Scranton, Penna.

I enclose One Dollar. Please send me—post-paid—the 514-page I. C. S. Radio Handbook. It is understood that if I am not entirely satisfied I may return this book within five days and you will refund my money.

Name.....

Address.....



## Send 50c for this FADA NEUTRODYNE BOOK

It tells in simple language how to construct a Neutrodyne circuit receiver using FADA parts. Nothing is left in doubt. Both four and five tube Neutrodyne wiring diagrams are included. In addition, in the rear of the book there are both four and five tube full size paper panel drilling templates.

This 32-page book and the use of FADA Neutrodyne and standard parts will insure successful Neutrodyne circuit receiver construction.

**F. A. D. ANDREA, INC.**  
1581-D JEROME AVE., N. Y. C.



The special FADA Neutrodyne parts including three Neutroformers, two Neutrotons and the HOW-TO-BUILD-IT book sell for \$25.00.

Please mention POPULAR RADIO when answering advertisements.

# RADIO ON THE FARM THE DAILY MARKET REPORTS



WITHOUT THE  
AUDIOPHONE

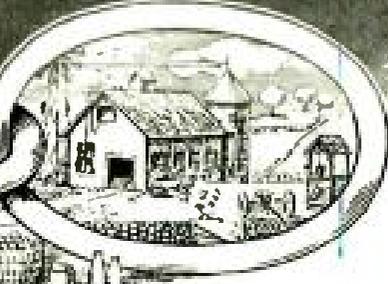


IT LINKS  
THE CITY  
WITH  
THE FARM

WITH THE  
AUDIOPHONE



TRADE MARK  
**AUDIOPHONE**  
REG. U.S. PAT. OFFICE



**M**ARKET reports through the **AUDIOPHONE** can be depended upon because nothing is lost from the original broadcasting.

Not only is it easily possible to distinguish the words of a speaker, but also the minute gradations in pitch, timber and quality of overtones, which distinguish individual voices.

The same qualities that make the **AUDIOPHONE** a source of profit by day, gives pleasure in the evening to the entire household, furnishing entertainment and educa-

tion of a varied nature because it is equally efficient in reproducing the speaking voice, singing voice and all musical instruments.

The **AUDIOPHONE** is complete and self-contained—needs no separate battery or other accessories—goes to you ready for use in connecting to your receiving set. It will prove a source of lasting pride and pleasure.

Audiophone Sr.....	\$32.50
Audiophone Jr.....	22.50
Bristol One Stage Power Amplifier.....	25.00

Send your name and address to receive copy of Bulletin No. 3006-L.

## THE BRISTOL COMPANY WATERBURY, CONN.

*Branch Offices:*

**Boston  
Detroit**

**New York  
Chicago**

**Philadelphia  
St. Louis**

**Pittsburgh  
San Francisco**



**NOTHING IS WORTH WHILE UNLESS IT IS "RELIABLE"**

*A little device that makes a vast improvement in your radio receiving*

**75¢**

**RELIABLE NEUTRALIZING CONDENSER**  
for all tuned radio circuits and all latest type circuits

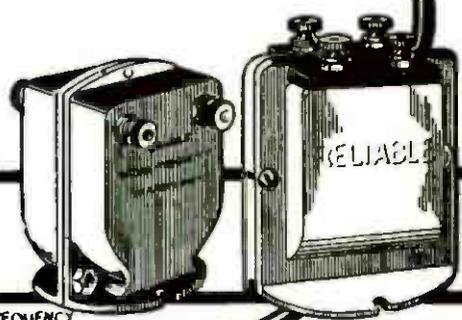
**T** HIS little fellow is all that a cough drop means to a husky throat — it clears up your messages so as to take out the "scratchy" fog-horn effects that otherwise mar concert, lecture or song.

It has many other uses. For tuning to the higher wave length broadcasting stations, it greatly increases the tuning range; also neutralizes the capacity reactance of inductive couplings, affords a vernier adjustment for the grid condenser, and is particularly favored for balancing up all circuits to give a fine adjustment.

**AUDIO AND RADIO FREQUENCY AMPLIFYING TRANSFORMERS**

Audio transformers furnished in three different stages of ratios as follows:	Radio adjustable type transformers as follows:
6 to 1    4 to 1    2 to 1	No. 4    200-400 meters
Fully enclosed, of the shielded type. List price \$4.50 and \$5.00. Ready for convenient mounting. Fully guaranteed.	No. 5    400-600
	No. 6    200-500    " long range
	No. 7    300-505
	List Price \$2.75 each. Static reduced to a minimum.

Dealers and Jobbers: Investigate the "Reliable" Business Boom



**The Reliable Parts Mfg. Co.**  
2819 Prospect Ave. Cleveland, O.

**WEIGHS ONLY 8 OZ**

**The Scientific**

**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**

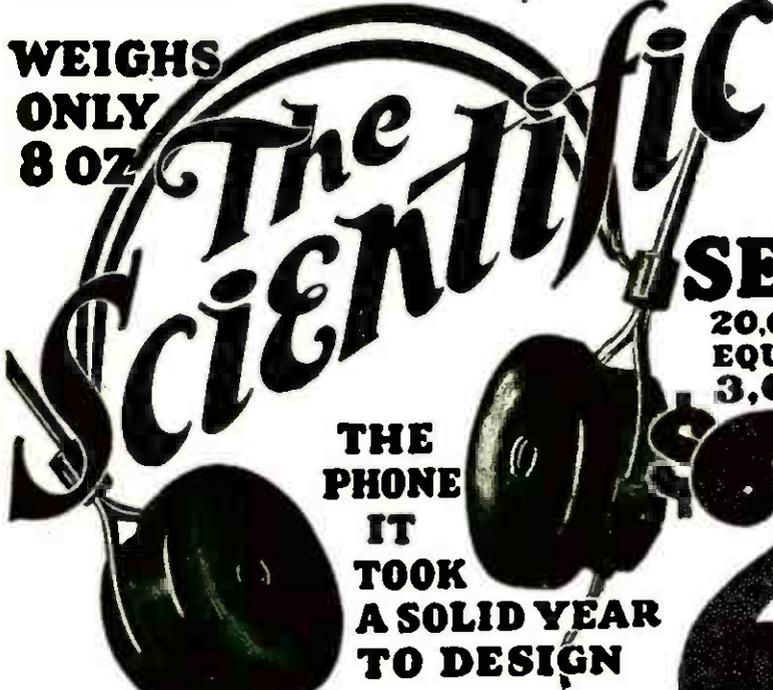
**Order TODAY by Postcard and Pay Postman on arrival**

**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.

# Build your own set with Gilfillan Parts

THE work is interesting, instructive and not difficult. Then too, the finished set will give you splendid results—at low cost—especially if you have assembled it with *Gilfillan* standard high-quality parts.

Gilfillan Radio Parts are the perfect combination of scientific design, accurate workmanship and best materials; so when you select "*Gilfillan*" you're certain of the inbuilt dependability of that part.

If your dealer does not handle this superior line, write us for name of nearest dealer, descriptive folder and list.

Genuine Gilfillan Radio Parts can always be identified by this trade-mark. Look for it.



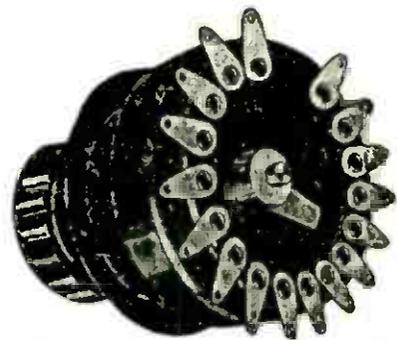
1925 McGee St.,  
Kansas City, Mo.

1815 W. 16th St.,  
Los Angeles, Cal.

225 W. 57th St.,  
New York, N. Y.

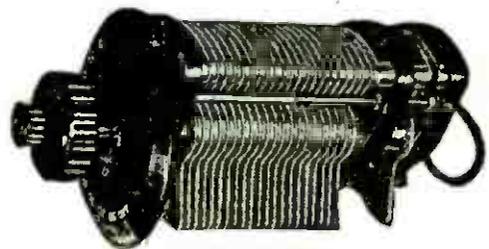
Licenseses General Bakelite Co.

## Two New Gilfillan Radio Parts



PRIMARY INDUCTANCE  
SWITCH

15 point. Provided with solder lugs.  
Moulded brown bakelite black knob  
and dial.



CONDENSER

With Vernier and pigtail connection.  
Obtainable in 43 plate, as above, and  
23 plate sizes.

## Other Gilfillan Parts

Varicouplers (2 sizes)	Tube Sockets
Variometers (2 sizes)	Tube Socket Adapters
Air Condensers (3 sizes)	Detector Amplifier Units
Audio Frequency Transformers	Detector Units
Potentiometers	Vernier Air Condensers
Primary Inductance Switches	Filament Rheostats
Panel Switches	Vernier Rheostats
	Moulded Knobs, etc.

# GILFILLAN BROS., INC.

Radion being an insulation material especially made for wireless use, has the lowest phase angle difference, lowest dielectric constant, highest resistivity and supreme moisture, gas and acid repelling properties.



The Supreme Insulation  
**RADION**  
**Panels**  
 are easiest  
 to drill, saw  
 or engrave  
 with simple  
 tools at  
 home

18 STOCK SIZE PANELS

6 x 7	7 x 21
6 x 10 1/2	7 x 24
6 x 14	7 x 48
6 x 21	9 x 14
7 x 9	10 x 12
7 x 10	12 x 14
7 x 12	12 x 21
7 x 14	14 x 18
7 x 18	20 x 24

American Hard Rubber Co.  
 11 Mercer St., New York

**RADION**

Panels-Dials-Knobs-Sockets-Insulators



**BRANSTON RADIO**

Branston D. L. Honeycomb Coils  
 and Mountings Give Better Tuning



GREATER  
 Strength—  
 Clearness—  
 Selectivity

BETTER  
 Quality

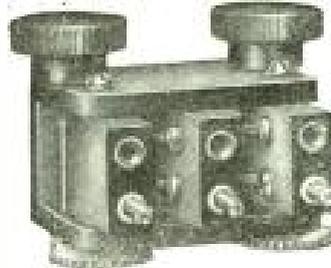
INSIST  
 ON THE GENUINE

Branston D. L. Honeycomb Coils are accepted as standard in regard to superior construction and electrical units of measurement.



R-62 Three Coil Bevel Geared type. Back Panel Mountings. \$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.



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-73 Three Coil Bakelite Mounting. \$4.50

Neatest three coil mounting on the market. Made of Genuine Bakelite and complete with flexible leads.



R-71 Two Coil Mounting. \$3.25

Very neat and capable of smooth operation. Only two mounting screws required. Complete with flexible leads.

Hookup Circular Sent for 2c.

Compiled by experts and includes five good Honeycomb Coil "Hook-ups" and complete catalog of famous Branston Radio Apparatus. Write today. Give us name of your radio dealer. If he can't supply you, write.

All Branston Coils and Mountings are licensed under De Forest Patents.



Insist on the Genuine Branston. "Standard of the World."

CHAS. A. BRANSTON, Inc.

811 Main Street

Buffalo, N. Y.

In Canada—Chas. A. Branston, Ltd., Toronto, Ont.



## BROADCASTING

**T**RANSMITTING delicate electrical currents has been highly developed. Receiving them as sent is vital to your enjoyment.

No matter how efficient your receiving set may be, it rests with the headphones you buy to transform these currents into sound. Beautiful, clear and distinctive tones of music or spoken words cannot be reproduced by inferior headphones.

Twenty-five years of research and painstaking manufacture by the Holtzer-Cabot Electric Co. has produced for you the supersensitive No. 2 Universal Headset.

This light weight, sanitary set reproduces positively and faithfully with an exceptional purity of tone and extreme sensitiveness.

**Holtzer-Cabot No. 2 Universal**  
The supersensitive phone

**Holtzer-Cabot No. 4 National**  
The quality phone at a minimum price

*Be sure and send for a copy of our booklet "What you should know about Radio Reception."*

**THE HOLTZER-CABOT ELECTRIC CO.**

125 Amory Street, Boston, Mass.  
6161-65 South State Street, Chicago, Ill.  
Department B

*Holtzer-Cabot*  
BUSINESS ESTABLISHED 1875

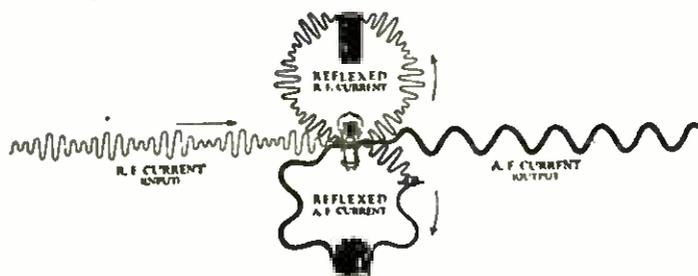
HEAD SETS



# Vacuum Tubes Do Triple Duty With Erla Synchronizing Transformers



Perfect synchronization of received and reflexed r. f. currents make Erla radio transformers indispensable in reflex work. List, \$5



For the first time, the full efficiency of vacuum tubes is completely utilized and brought under control. In Erla reflex circuits, tubes do triple duty, providing simultaneous amplification of radio frequency, reflexed radio frequency and reflexed audio frequency currents. Yet, so precise is the manipulation of this complex current flow, that the tremendous gains resulting are achieved without a single drawback.

Not only do Erla reflex circuits demonstrate decisive superiority in range and volume, but they are also unequalled in selectivity, purity of tone, and ease of control. Even the single-tube circuit provides far-flung loud speaker range, while the three-tube circuit surpasses costliest multi-stage units in transcontinental loud speaker reception. And the two-tube circuit is close behind.

Essential to the operation of these circuits, and the secret of their success, are Erla synchronizing radio and audio transformers. Providing perfect synchronization of received and reflexed currents having the same phase characteristics, they assure tremendously magnified amplification without distortion.

Complete diagrams and descriptions of perfected Erla reflex circuits are set forth in Erla Bulletin No. 14, obtainable gratis from leading radio dealers. Or write us direct, giving your dealer's name.



Rectified radio frequency and reflexed audio frequency currents are accurately synchronized by Erla audio transformers. List price, \$5



Erla tested capacity condensers are unequalled in rigid, unvarying accuracy, so vital to success in reflex work. Eleven sizes, 35c to \$1 ea.



Erla bezels greatly enhance the finest cabinet assembly. Telescoping rim, in bright nickel or dull enamel, fits any 1/4" to 1/2" panel. List, 20c

Dealers and Jobbers—Erla progress constantly widens avenues of trade. Write for liberal terms and discounts



Difficult, dangerous use of soldering irons is eliminated by Erla solderless connections, saving time, temper and money. List, 5c ea.



Providing utmost sensitiveness with perfect stability, the Erla fixed crystal rectifier is uniquely adapted for reflex work. List, \$1

Electrical Research Laboratories  
Dept. R 2515 Michigan Avenue, Chicago

# ERLA



## The New 1924 Model "4-Way" Switch Plug!

Many refinements have been added to make this the best radio plug

—a switch plug which makes it possible to tune in through head set and switch in loud speaker by turning dial. Two head sets can be readily attached, or one head set and loud speaker. Both can be used at same time or either one alone. **Order yours TODAY.**

# \$1.50

FOUR WAY CO., 29 Worthington St., Springfield, Mass.





Na-ald Adapter No. 429  
For UV-199 and C-299  
Tubes. Price 75c



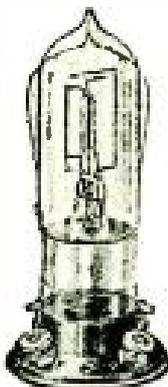
De Luxe No. 400  
Price 75c



Small Space No. 401  
35c, 3 for \$1.00



Na-ald W.D. 11 No. 411  
Price 75c



No. 450 Price 50c  
Two-in-one Socket  
For W.D.11 and  
200 Tubes

# It's the contact that counts

A CAREFUL examination will show that each contact in Na-ald sockets and adapters is of a wiping nature on a broad surface, and so designed that strong tension is permanent, no matter how often the bulbs may be removed or how much the connecting prongs in the tubes vary. Na-ald Sockets are moulded of Bakelite with uniform cross-section, cure and other engineering features incorporated, to avoid plate to grid losses and to insure that each tube develops its fullest efficiency.

The new Na-ald dials combine rare beauty of design with highest efficiency in use. These dials are moulded from genuine Condensite in such a way that absorption losses are reduced to a minimum. Knobs are so shaped that fingers do not conceal clear numerals and graduation on the bevel of Na-ald dials.

*Na-ald Circuit Booklet packed with each Na-ald product*

*Write for "Why a Bakelite Socket?" and other descriptive literature*

## Alden Manufacturing Company

Manufacturers of sockets and dials for every radio requirement

Dept. C 52 Willow Street

Springfield, Mass.

Cable Address, Aldenco



Na-ald Special  
Socket No. 499  
for UV-199 and  
C. 299 Tubes. Price 50c



No. 3023-4  
2 Inch  
35c, 3 for \$1.00



No. 3003-4  
3 Inch  
35c, 3 for \$1.00



No. 3783-4  
3 1/2 Inch  
Price 75c

# NA-ALD



## Three Aces!

**I**N the experience of radio engineers, amateurs and experimenters there is a suggestion which clearly points the way to the battery buyer who desires the most fitting and practical combination of electrical energy, low cost per hour of service, long shelf life and uniformity of discharge.

### "ASK ANY RADIO ENGINEER"

These "Three Aces," the famous Burgess "B"—the new *double strength* Radio "A" and our latest product, the Vertical "B" Battery are playing an important part in correct and dependable reception of radio broadcast. Each is

#### "A Laboratory Product"

*Good dealers everywhere recommend and sell Burgess Batteries*

### BURGESS BATTERY COMPANY

Engineers—DRY BATTERIES—Manufacturers  
Flashlight—Radio—Ignition—Telephone

General Sales Office: Harris Trust Building, Chicago  
Laboratories and Works: Madison, Wisconsin

Branches: New York Boston Washington St. Paul  
Kansas City New Orleans

*In Canada:*

General Offices and Works: Niagara Falls, Ontario  
Branches: Toronto, Montreal, Winnipeg, St. John



"Pioneer"  
Variocoupler  
\$7.00

The first impression you get from looking at Pioneer Variocouplers and Variometers is that beyond doubt they are the most beautiful instruments yet devised.

The beautiful Bakelite in a grained mahogany finish has a richness that has never been equalled before.

The heavy copper wire, covered with green silk, gives a contrast that makes the instruments irresistible and adds tremendously to the beauty of any set.

The mechanical parts are no less wonderful. The hardware of heavy bronze—the close-coupled rotor and stator—the positive contacts, all demonstrate the highest mechanical skill and attention to detail.

A special feature is the winding of the variocoupler on the inside of the shell—which is original and exclusive with Pioneer.

Ask your dealer to show you these instruments. If he cannot supply, write us, giving his name and address.



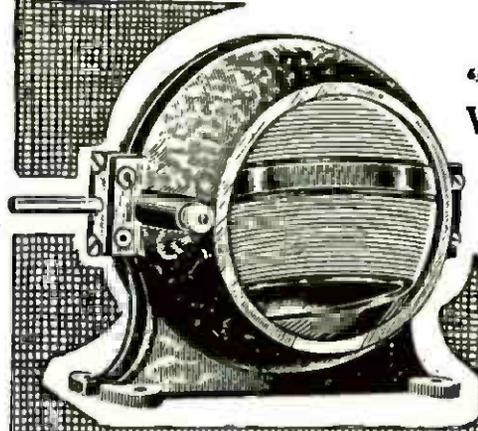
100 Pioneer Ave.

Galesburg, Illinois

#### BRANCH OFFICES:

European Branch Office:  
27-28 Anning Street  
London, Eng.  
Gaston E. Marbaix  
European Manager

New York City.....220 Fulton St.  
Chicago, Ill.....33 E. Clinton St.  
Kansas City, Mo...208 Baltimore Bldg.  
Minneapolis, Minn.705 Plymouth Bldg.  
San Francisco.....623 Larkin St.



"Pioneer"  
Variometer  
\$6.50



# 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 (\$22.00 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! JOBBERS!

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 a "HOMCHARGER Year." Send for your copy and Trade Discounts TODAY.

*Insist*  
on the **GOLD SEAL**

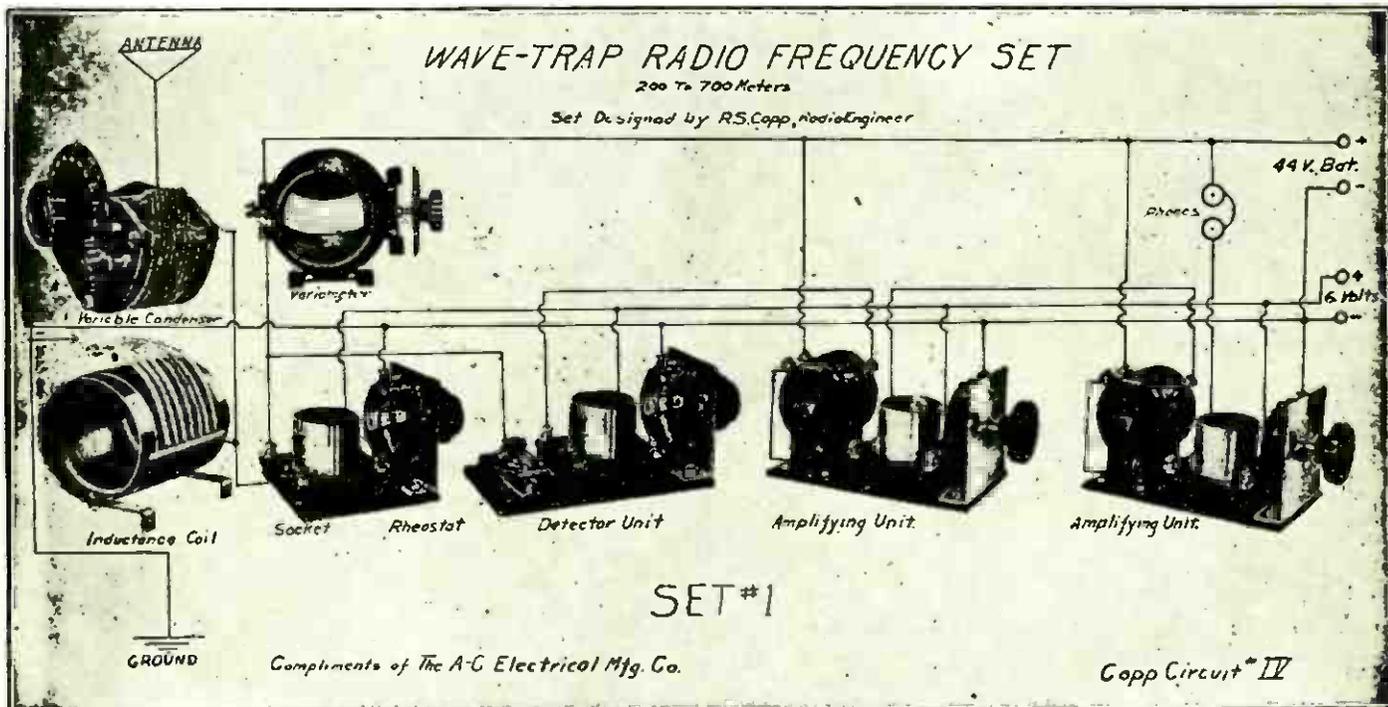


It is your protection against substitution. When buying order by name and verify by the GOLD SEAL, which appears on the carton as well as the nameplate.

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

# SAVE \$75.00

By building your own set using this wonderful circuit and A-C DAYTON Radio Products



This high class set as shown above would cost \$125.00 but we are offering you the opportunity of building this same set at a cost of not over \$50.00. All A-C Dayton units are wired and complete, ready for connection in the circuit. This set has one stage of Radio-frequency amplification and two stages of Audio-frequency, producing a set with extreme long range and good signal strength.

A-C Dayton Radio Products represent a complete line of radio parts, and are so designed as to be co-ordinated in any type of radio circuit, producing a beautiful and efficient set at a reasonable price. If your dealer does not have full information on circuits, write us direct or have him send for full description and our latest catalog describing the many uses of our parts and units.

**THE A-C ELECTRICAL MFG. CO.**

**DAYTON, OHIO.**

*Makers of Electrical Devices for over 20 years*

## RADIO FANS

Tune in on station  
**WEAF** (New York)

every Thursday at 8:50 P. M. and listen to a story or article selected from

**HEARST'S INTERNATIONAL**

This is one of the most popular weekly features "on the air"

# FREE

Write for free copy of Radio Reprint No. 1—it contains a complete Cappy Ricks story by Peter B. Kyne. Address Radio Editor, 1-A, Hearst's International Magazine, 119 West 40th Street, New York City.



Price Only \$29.50

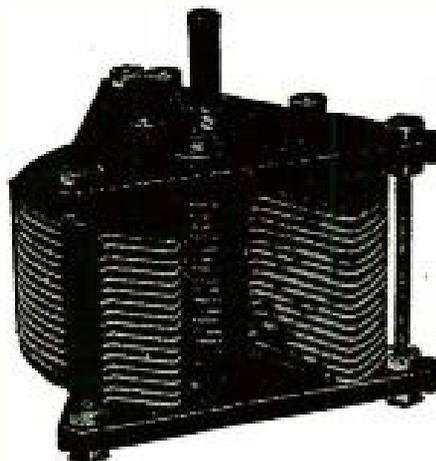


At the low prices shown below you get the efficiency of sets costing three times as much. These radio frequency receivers—pick up stations over 1,500 miles away under good conditions—everywhere. Operate either on DRY CELLS or storage battery. Cabinets of solid mahogany and workmanship the finest throughout. Order direct or send for bulletin. Two tube outfit, as shown above, for use with headphones only. . . . . \$29.50 Four tube outfit for loudspeaker or headphones. . . . \$54.50

**DEALERS**—write for proposition quickly—it's a winner.  
**AGENTS**

**THE MIDWEST RADIO COMPANY**  
812 Main Street. Cincinnati, Ohio

# Sharpen Your Tuning



A

General Radio Co. Type  
247 Variable Air Con-  
denser.

**N**O operator of a radio receiving set need be told of the advantage of sharp precise tuning. It is not always clear, however, how this may be obtained. After a good tuning coil has been chosen look to the CONDENSER for the answer.

Years before radio became a popular pastime, the General Radio Co. was manufacturing low loss, scientifically designed condensers for use in such discriminating laboratories as those of the Bureau of Standards, Naval Radio, General Electric, Westinghouse, Western Electric and the leading educational institutions of the country. The efforts of these years of research work in our own laboratory have resulted in the design of a condenser incorporating the best features in design and at the same time available at a price substantially lower than other good quality condensers.

Here are some of the important features: Sharp tuning through low loss design using hard rubber properly placed—Heavy brass plates soldered together keeping capacity constant and greatly reducing danger of shortcircuiting—Low zero capacity giving wide wave length range—A CONTINUOUS VERNIER formed by a gear and pinion combination. Only one setting required.

Made in three sizes, 250, 500 and 1000 m.m.f. to fit every circuit. Mounted condensers are fitted with calibrated direct reading capacity dial.

Prices \$3.00 to \$8.50. Send for Educational Pamphlet, "Quality Condensers" and new RADIO BULLETIN 916U.

## GENERAL RADIO CO.

Manufacturers of Electrical and Radio Laboratory Apparatus

MASSACHUSETTS AVENUE AND WINDSOR STREET

CAMBRIDGE, MASSACHUSETTS



\$14.50

### Seven Reasons for C. I. C. Supremacy

1. High volume efficiency.
2. Superior quality of reproduction.
3. Attractive appearance.
4. Convenient size.
5. Adjustable air gap.
6. Unconditional guarantee.
7. Moderate price.

Our booklet "Loud Speaker Facts" will prove these points to you. A copy free on request.

CONNECTICUT INSTRUMENT COMPANY  
Stamford, Connecticut

Canadian Distributors: Perkins Electric Ltd., Toronto, MONTREAL, Winnipeg.  
New York Representative, Mr. C. B. Cooper, 154 Nassau St.  
New England Representative, Hill Specialty Sales Co., Boston.  
Chicago Representative, Stackhouse and Allen, 550 W. Monroe St.

## ANNOUNCEMENT

### Genuine PACENT \*Duo Lateral Coils Mounted

\*REG. U.S.  
PAT. OFF.



PATENTED  
June 1, 1920  
April 3, 1923

### A Complete Line of Improved Coil Equipment

- I. PACENT COIL PLUG—Quick to connect. Vise grip on coil. Set screw connections with coil leads. Cat. No. 110. Price \$1.00.
- II. COIL PLUG RECEPTACLE—an improved receptacle. Special Pacent feature to insure tight contact. Cat. No. 111. Price \$1.00.
- III. MOUNTED COILS—The genuine Pacent Duo Lateral Coils equipped with improved plug. Sizes MS 25 to MS 1500. The perfect combination. Prices \$1.40 to \$3.85.
- IV. MICROMOUNT—a de luxe 3 coil mounting affording fine vernier coupling adjustment. Cat. No. 115, with base, \$9.50. Cat. No. 115A, same as No. 115 less base and binding posts, \$8.00.
- V. MICROCOUPLE RECEPTACLE—a single receptacle permitting vernier adjustment of coil. Cat. No. 118. Price \$2.00.
- VI. PANEL RECEPTACLE—a fixed receptacle for panel mounting principally for use with Cat. No. 118. Cat. No. 119. Price \$1.50.

Duo Lateral Coil Labeled PACENT  
is the GENUINE

Don't Improvise—"PACENTIZE"

Send for Booklet P-11 describing  
Pacents Radio Essentials

PACENT ELECTRIC CO., Inc.  
22 Park Place New York, N. Y.

Sales Offices:  
Chicago, Philadelphia, St. Louis, Minneapolis  
Washington, D. C., San Francisco, Jacksonville

# Pacents

## RADIO ESSENTIALS

# The "A" Battery's Power in Your Radio Receiving Set

THIS IS NUMBER TWO OF A SERIES

**T**HE sole purpose of the "A" Battery in your Radio Receiving Set is to furnish current to heat the filaments of the tubes.

And this can be done satisfactorily only by an "A" Battery that supplies an adequate steady current.

Anticipating the popularity of the dry cell tube in Radio, and realizing that it required a Dry Cell capable of standing up under service conditions differing from what dry cells are called upon to meet in other fields, the National Carbon Company developed the Eveready Radio Dry Cell specifically for this new use.

A dry cell gives its maximum service only when designed especially for the work it is intended to perform. There are for dry cells several uses which are so alike that one type of cell serves for all. This is the field covered by the ignition or general purpose dry cell.

The conditions encountered in Radio are different from the conditions grouped together under the term "general purpose." And while the general purpose dry cell performs well as an "A" Battery, it was found possible to produce a Dry Cell "A" Battery capable of delivering more service on Radio loads.

Thirty years of dry cell experience and an immense research organization resulted in the superior Eveready Radio Dry Cell. One of the outstanding features of this special cell is that while it will last much longer when used as an "A" Battery, it is no larger than the standard dry cell.

The increased service life of the Eveready Dry Cell "A" Battery greatly offsets the slight increase in cost; so this battery is not only the best, but it is the most economical you can buy. "The Story of Eveready Dry Cell Radio 'A' Batteries," which tells how to use Dry Cells to the greatest advantage with the various dry cell tubes now available, will be sent to you free on request.

\* \* \* \*

The "A" Battery gives power to your Radio Receiving Set. Eveready Batteries—especially made for Radio—serve better, last longer, give better results.

*Note: This is number 2 of a series of informative advertisements which will appear in this magazine. They are designed to help users get the most out of their Batteries and their Radio Sets. If you have any battery problem, write to G. C. Furness, Manager Radio Division, National Carbon Company, Inc., 128 Thompson Ave., Long Island City, N. Y.*



## POWER

for Your Radio Set

Eveready Dry Cell  
Radio "A" Battery  
(No. 7111)

Directions and wiring on the jacket tell just how to use this battery with the different dry cell tubes.

This special Radio Cell is also available in two and four cell multiple batteries for receiving sets employing from two to four WD-11 or WD-12 tubes.

### Other Radio Batteries

Eveready Storage "A" Batteries—best suited for filament heating of all Radio Tubes not especially designed for dry cells. The quality storage battery with the long life plates, \$15 to \$20.

Eveready "B" Batteries—the life of your Radio.

Eveready "Three" Battery—3 cells, 3 purposes.

*Manufactured and guaranteed by*

NATIONAL CARBON COMPANY, Inc.

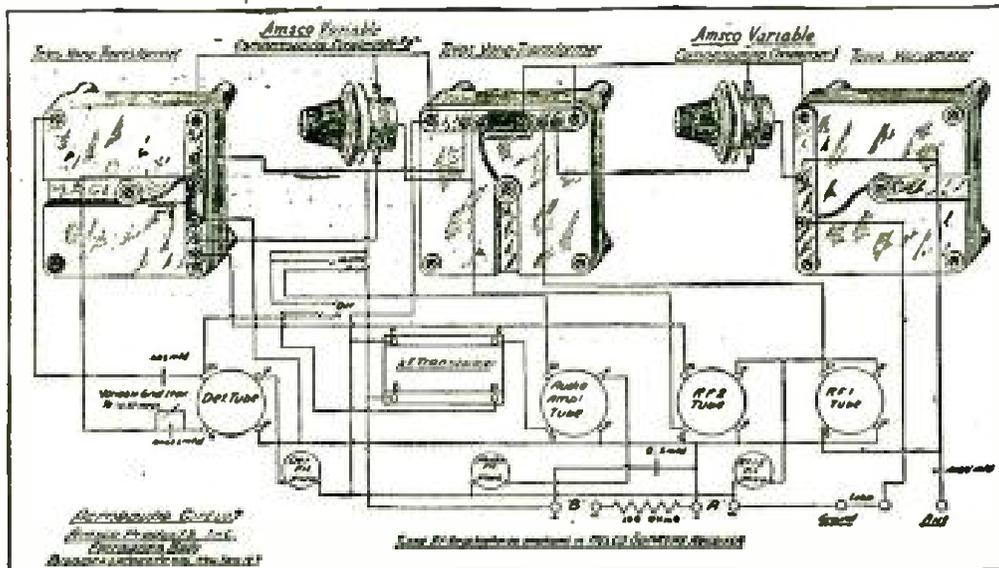
# EVEREADY Radio Batteries

—they last longer,

Please mention POPULAR RADIO when answering advertisements.

# THE ACMEDYNE CIRCUIT

as described in detail by Mr. Laurence Cockaday in his article on Tuned Radio Frequency Amplification in a recent issue of Popular Radio, and praised and recommended by many other leading Radio Publications in the United States and Canada, is employed in the



## MELCO-SUPREME

The Radio-Frequency Amplifying Receiver that—

Price Only  
**\$140**

Complete knock-down parts for Melco-Supreme including drilled engraved Bakelite panel and solid mahogany cabinet  
**PRICE \$90**

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.

Write for our complete literature illustrating and describing MELCO-SUPREME in detail, and also our entire line of AMSCO Parts.

## AMSCO PRODUCTS, Inc.

BROOME and LAFAYETTE STS.

DEPT. PR

NEW YORK CITY



## The TRINITY LOUD SPEAKER

The Trinity Loud Speaker is an instrument that combines the best qualities of a phonograph reproducer in combination with electro-magnetic principles best fitted for radio amplification.

Perfect reproduction of all music and speech without distortion. No storage batteries required. The instrument is of a heavy duty type and is guaranteed fully by the manufacturers.

For sale by good dealers. Literature upon request.

**TRINITY RADIO CORPORATION**  
446 1/2 Tremont Street, Boston, Mass.

TYPE  
AI  
\$25.00  
21" Fibre  
Horn

## BATTERY CHARGING RECTIFIER and LARGE STORAGE BATTERY \$20

Battery Charger of well known make connects to any lamp socket. Recharges battery overnight at 5 amp. rate. Furnished with long charging cable with battery clips. Battery is 6 volt, large capacity. Specify whether used for auto or radio. Guaranteed for one year. Act at once, as we have only a limited number of this combination offer at this bargain price. Send money order, or will ship C. O. D. on 25% deposit.

### BELMONT BATTERY CO.

3231 Sheffield Ave.

Chicago, Ill.



HEADPHONE  
CUSHION

FANS List of Bargains

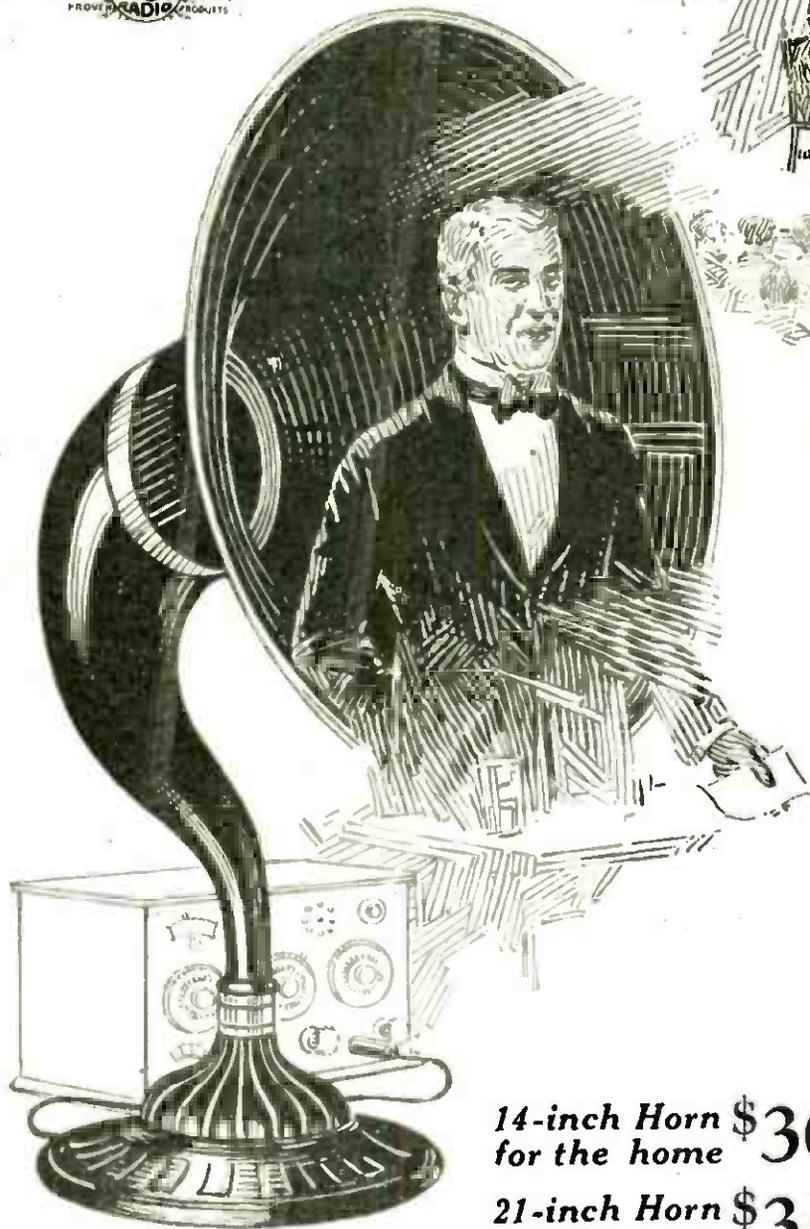
**RADIO FANS**  
Rejoice when using these pneumatic phone cushions. They gently hug the ears, shutting out all room noises. Fits any type headset Money back guarantee if you are not satisfied

FREE

**RADIO BARGAINS**

17 N. LA SALLE ST - CHICAGO

ONE OF THE  
**GERACO**  
PROVED RADIO PRODUCTS



**So far —  
yet so  
near!**

THE Mayor—the Senator—the Gov-  
ernor—the President—or other  
prominent speaker.

Hear him in your own home as clearly  
and distinctly as he is heard by audien-  
ces, scores of cities away! With MUSIC  
MASTER!

Have the family pull up chairs and  
listen to discussions of national topics  
by leaders of the state and nation.  
Through MUSIC MASTER, the most  
natural of radio reproducers.

Attached to any good receiving set,  
MUSIC MASTER completes the enjoy-  
ment of radio. It is the comfortable,  
the unselfish, way to hear radio. Hear  
MUSIC MASTER, with its unrivaled  
wood horn, at your radio dealer's.

*Dealers Everywhere*

**14-inch Horn \$30  
for the home**

**21-inch Horn \$35  
for Concerts**

**GENERAL RADIO CORPORATION**

Makers and Distributors of High-Grade Radio Apparatus

CHICAGO

PHILADELPHIA

PITTSBURGH

S. W. Cor. 10th & Cherry Sts.

**MUSIC  
MASTER  
RADIO REPRODUCER**

# IF YOU CAN'T BUY THEM AT YOUR DEALER'S SEND DIRECT TO US

"Red-Heads" are guaranteed radio phones. You run no risk when you buy them. Money back if, after 7 days' trial, you're not satisfied that they're the best receivers on the market at the price. Why not act right now and get a pair? It'll mean getting the maximum from broadcasting from the day you put them into use.

## RED-HEAD RADIO RECEIVERS



These remarkable head-sets are made by The Newman-Stern Co., one of the pioneer radio manufacturing houses in America.

### JUST OUT

The new 1924  
Model F

**\$6.50**  
PER PAIR  
Complete

This is the standard 3,000 ohm "Red-Head." The 1924 Model F has eleven improved features. Sensitive and fine-toned; aluminum case; famous brown-red ear caps; military headband; high-grade cord.

"Red-Heads" sent prepaid on receipt of price if you are unable to get them at your dealer's.

THE NEWMAN-STERN COMPANY  
Dept. PR Newman-Stern Bldg. Cleveland

The new 1924  
"Red-Head" Jr.

**\$5.00**  
PER PAIR  
Complete

The Junior Model has most of the quality features of the standard Model F here described. The resistance is 2,000 ohms per set instead of 3,000 ohms. A remarkable value.

# The Condenser Sensation of Modern Radio



Through the accuracy and dependability of Freshman Condensers, hook-ups and circuits have been perfected which have completely revolutionized the art of Radio Reception.

*These little Stokers of energy and rectifiers of Radio Current are the very heart of a well-built radio set.*

The proper fixed condenser will make all the difference in the world in the reception, clarity and selectivity your set affords.

Capacity	Each	Capacity	Each
.0001	\$ .35	.0025	\$ .50
.00015	.35	.003	.60
.00025	.35	.0035	.70
.0002	.35	.004	.75
.0003	.35	.005	.75
.00035	.35	.006	.75
.0005	.35	.007	1.00
.0006	.40	.008	1.00
.0008	.40	.01	1.00
.001	.40	.015	1.50
.0015	.40	.02	2.00
.002	.40	.025	2.50

The FRESHMAN is so designed that constant equal pressure is exerted on the condenser plates over the entire area. They are the only condensers that do this and therefore the only condensers that avoid noises, which are due to variable pressure on the plates.

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*Radio Condenser Products*  
106 SEVENTH AVE., NEW YORK

**BARKELEW**  
**FOUR-PHONE PLUG**  
for  
STANDARD JACKS

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(The All-Metal Quality Instrument—Guaranteed)

"A solution to the small soldering problems of the discriminating assembler"

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ONE-HALF ACTUAL SIZE

Unbreakable Construction—Economical Operation on any Electric Circuit

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## The Thrill of Great Distance

For 12 years, Tuska-built radio receivers have been famous for long range reception, and have made records that are unsurpassed.

F. R. Alger of Prince Albert, Saskatchewan, Canada, says, "I am sending a list of 67 stations, a total distance of 78,200 miles away. You will realize that all stations are far removed from us; most of them have to come over 1,000 miles. The Tuska is remarkable for simplicity of tuning. It has been a source of great satisfaction."

*You needn't know  
a thing about radio*

Night after night, year after year, a Tuska Radio will bring fine entertainment into your home, at a trifling expense for operating.

You need not depend upon good-natured friends with radio experience to help put a Tuska in your home. Surprise them all by doing it yourself. It is easy to install your own "listening post," and pick up your choice of the wonderful concerts that fill the air.

At pleasure you can tune out any program and tune in another more to your liking. The same Tuska that fills your rooms with clear, unmarred music and distinct speeches will also pick up broadcasting from stations 2,000 or more miles away.

Some of the most experienced radio inventors and engineers in this country designed and built the Tuska. It is right, forever, and needs no tinkering. Have no fear that it will become obsolete. A Tuska set bought today will be serviceable for years to come.

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Hartford, Conn.

**Tuska Popular  
No. 225**  
**3-bulb Regenerative  
Receiving Set**  
Piano finish mahogany cabinet. Amplifier switch. Concealed binding posts. Armstrong circuit, licensed under Patent No. 1,113,149. Price \$75, without bulbs, batteries or loud speakers. Ask for special circular No. 15E, describing this set.



# TUSKA RADIO

## REFLEX SUPERIORITY! RESULTS GUARANTEED!

Are you getting the best from your Reflex Set?



### M. P. M. (MILLION POINT MINERAL) CRYSTAL

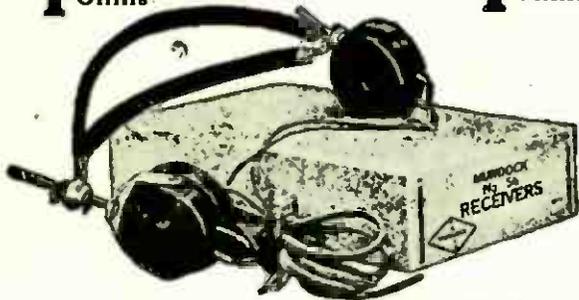
—tested and guaranteed—has proven itself the superior crystal for Reflex Reception. M. P. M. will not corrode or burn out; does not lose its sensitiveness; and clear, musical, economical reproduction is assured. Unsolicited testimonials show marvelous long-distance records, both with and without amplification. Ask your dealer for M. P. M., or send us 50 cents for two unmounted, or 70 cents for two mounted; and, in addition to crystals, we will send you diagram of a reflex circuit that we guarantee will give absolute satisfaction.

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\$4.00  
2000  
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Enables you to have four pairs of headphones connected at once. GET ONE

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Nutmeg Brand

Based on 30 Years' Manufacturing and Electrical Development-Work

Try the new H&H Transformer W306— with a turn ratio of 6 to 1—in combination with our W303: turn ratio 3 to 1.



The result will emphasize to you the "why" of this latest addition to the H&H Radio Family!

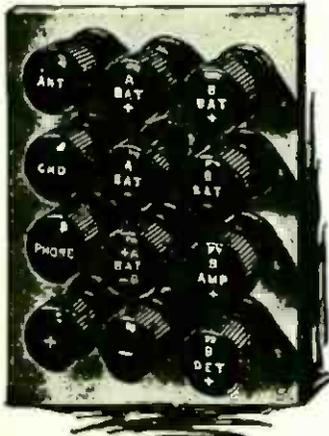
EVERY H&H (Audio Amplifying) Transformer is tested, before shipping, with 1500 volts potential between the primary and secondary winding; also between these windings and the core. This test certifies to the durability and integrity of workmanship, though technical data will be sent gladly if requested. Price of H&H Transformer—

W303, Turn ratio 3 to 1 . . . . . \$4.50  
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Write for new 32-page catalogue showing complete Radio Line and three practical photographed hook-ups

We will carefully fill your order direct if you cannot get the goods locally. Send us your Dealer's name and address and secure a photo of an excellent one-step dry cell hook-up, free.

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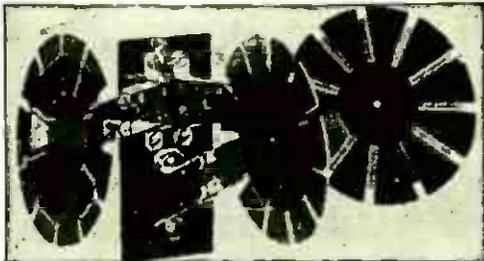
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Have non-removable tops.

They'll look classy on your set because the engraving will match your dials.

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The GOODMAN is the niftiest short wave tuner on the market. Awarded certificates of merit. Our pamphlet tells all about it. Send for one. Price \$6 and PP. on one pound.  
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## The Reproducer Supreme

SO simple in operation that any Radio user can obtain perfect results—so sensitive and flexible in scope that the professional will find it fully responsive to every requirement—the new Magnavox Combination Set A1-R or A2-R brings a degree of radio usefulness and enjoyment never before attained.

Every condition in the art of radio reproduction is most successfully met by Magnavox apparatus.

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- R2 with 18-inch curvex horn . \$60.00
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Equipped with binding posts  
and a five foot flexible cord;  
requires no battery for the field. 35.00

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Reproducer with 14-inch curvex  
horn and 1 stage of amplification 59.00
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- A1—new 1-stage Power Amplifier 27.50
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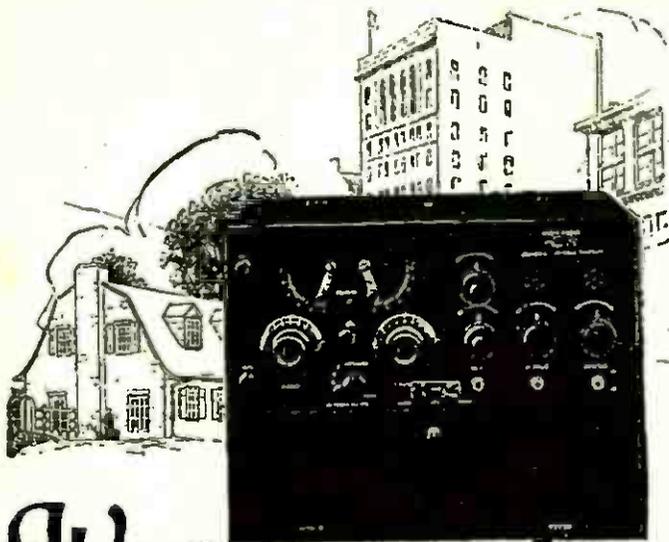
The New Magnavox Combination Sets A2-R [2-stage] and A1-R [1-stage] insure the utmost in convenient, home radio reproduction.

Magnavox Radio Products can be had of good dealers everywhere.  
32-page catalog sent on request.

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PERKINS ELECTRIC CO., LTD., MONTREAL, CANADIAN DISTRIBUTORS



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"Local Conditions" do not exist where Moon Satterlee Antennaless Radio is installed. Here is a set which brings distortionless speech and music to you no matter where you live or how severe the local conditions. The Moon is operated by simply grounding to a water pipe or radiator—no antenna, loop or indoor wire is necessary.

Stations within a conservative 1000 mile radius are regularly received with a non-power loud speaker on this set.

It is the ideal set for use in apartments, automobiles, yachts or railroad trains where an antenna is not practical. Extremely sensitive, unusually receptive, yet simple to operate.

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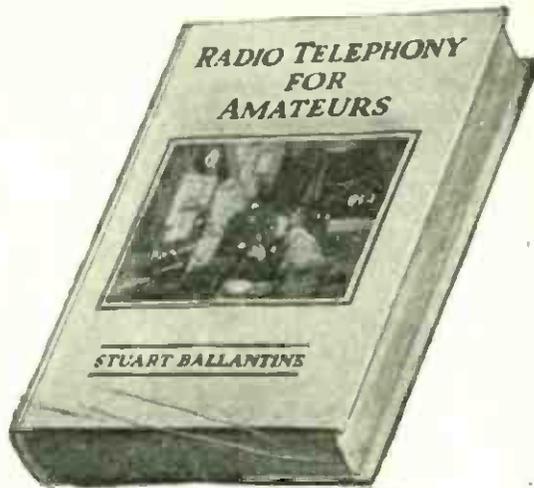
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501 Steinway Ave., Long Island City, N. Y.

In Canada: Continental Equipment Co., Ltd., New  
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You know the A B C of radio—now take the next step. Learn how to apply the fundamentals so as to greatly improve your results. Get the latest on scientific reception: build a transmitter. Your difficulties will vanish like magic before the lucidity of Mr. Ballantine's explanations and clean-cut diagrams. Two previous editions of this work bought out by thousands of enthusiastic amateurs. After reading this condensed table on contents, send along the \$2—get ahead of the crowd.

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1. Unlimited range
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6. Beautiful workmanship
7. Factory guarantee



**T**HE S. P. 2 Receiver stays sold, minimizes service expenses, unlimited range offering good volume and good distance, absolutely guaranteed. What more can you ask, Mr. Radio Business Man? Your letter head brings our proposition.

Catalogue 101A:—To "Radio Fans" on receipt of 10 cents

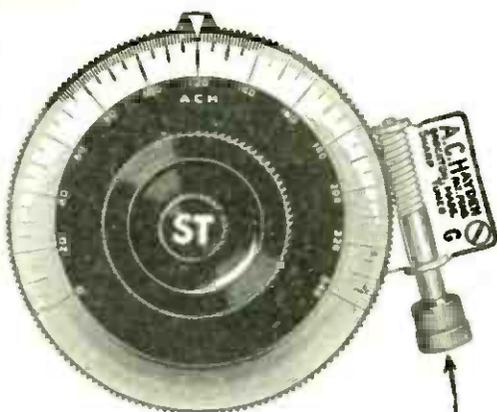
**PITTSBURGH RADIO SUPPLY HOUSE**

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3-in. DIAL (156-to-1) 4-in. DIAL (215-to-1)

Positive movement, no friction to slip, and no back lash in the spiral machine cut worm gear. (Not Moulded.)

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Rough tuning with dial for one thousandth of an inch in either direction with the Sharp Tuner Knob. Both controlled by center Knob ST. Eliminates a vernier condenser. Locks instrument automatically. Dial grounded, reducing body capacity.

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 Regular fitting 5-16 inch hole, 1/4-inch and 3-16 inch Bushings,  
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3 in. DIAL

156-to-1

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215-to-1

### READ THIS LETTER

A. C. Hayden Radio & Research Co.,  
 Gentlemen:—

Please send me collect one of your ACH Sharp Tuners with 4-inch Dial by mail C. O. D.

We are owners of Radio K. Q. P. the oldest upstate broadcasting station in Oregon. We have been using your ACH Tuners for over a year having purchased three from the Blue Diamond Electric Co. of this city. We have found them entirely what you claim for them and although we did not like the proposition of having to cut down the shafts of our Variometers and Condenser, we found that the results justified the sacrifice of about half an inch of shaft.

With the aid of these Tuners on a 3-inch Circuit Regenerative Set the tuning is so close that signal strength nearly resembles that obtained on a Super Heterodyne Set. We propose to use the 4-inch Dial on a Condenser shunted across a box of special design, wound spider-web style, which is not only very directional but also extremely critical, so much so in fact, that the ordinary Vernier Condenser is unreliable. We want the 4-inch ACH Tuner for a 1/4-inch shaft.

Please forward at your earliest convenience.  
 Yours truly,

HUGH G. BALL,  
 Radio Station Hood River News.

July 9, 1923.

Full information on request. Mail orders sent prepaid in U. S. A.

A. C. HAYDEN RADIO & RESEARCH CO., 25 East Battle Street  
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## Tuned Radio Frequency Transformer

For use in Standard Radio Frequency Circuits—Neutrodyne Circuits—Reflex Circuits. Tunes to any wave length between 200 and 1000 meters.

Don't overlook the fact that many of our best broadcasting stations have been assigned new wave lengths. Every piece of Day-Fan Radio Apparatus is designed to operate over the entire public broadcasting range.

Write for 1923-1924 Catalog

## The Dayton Fan & Motor Co.

Dayton, Ohio  
 Established 1889

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Audio Frequency Transformers  
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 Bakelite Variometers  
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 5, 10, 20, 30 Ohm Rheostats  
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**DAY-FAN**

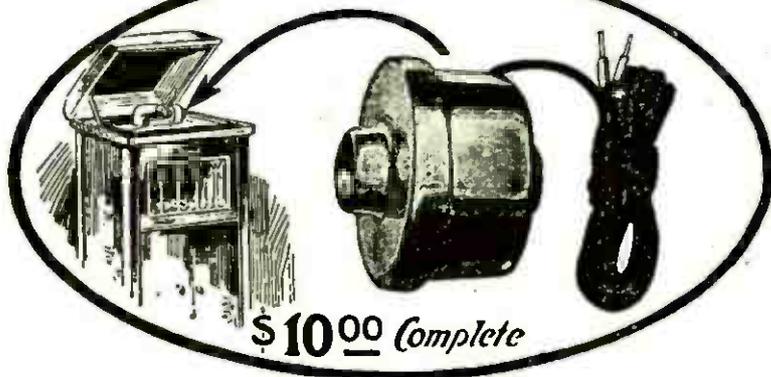
Complete Detector Units  
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**CONDENSER**

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# Morrison



## Loud Speaker

### RADIO SATISFACTION

True enjoyment of Radio begins when you and your family can sit comfortably in your living room and listen to all broadcasting reproduced in Clear, Full Volume. No annoying rattles, no harsh vibrations, no need for constant adjusting and fussing.

Morrison Loud Speaker gives you that kind of Radio satisfaction and pleasure, when attached to either your

### PHONOGRAPH OR HORN

Attach the Morrison Loud Speaker to the tone arm of your phonograph—takes only a moment—and you have the benefit of the excellent phonograph sound box. Or attach it to any horn.

A little dial on the back of the Morrison Loud Speaker adjusts the tone from soft, mellow notes, to full-volumed, clear notes.

There is nothing to get out of order. Any one can use this wonderful radio unit with the same perfect results as an expert.

Order from your dealer, or send direct to us if your dealer cannot supply you.

**DEALERS**  
 If you are interested in one of the fastest-selling Radio units on the market, write or wire for our proposition—it is interesting.

*Satisfaction  
 guaranteed  
 or your money  
 back.*

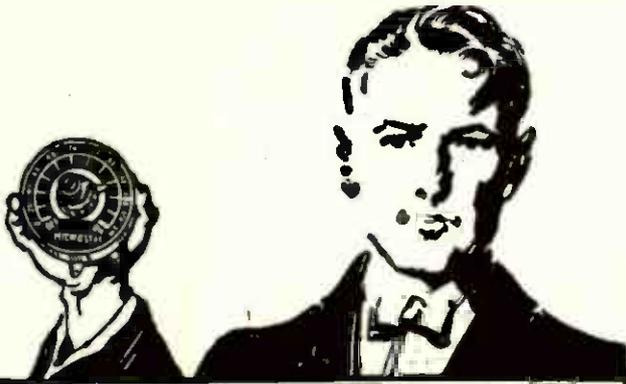
Price complete with 5 foot cord	
Nickel Plated Model	\$10.00
Gold Plated Model	\$15.00

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## MORRISON LABORATORIES, INC.

345 JEFFERSON AVE., EAST,

DETROIT, MICH.



## Have your Dealer show you a "MICROSTAT"

A SUPER VERNIER RHEOSTAT

### \$3.00

And worth it

Premier "MICROSTAT" represents the highest state of development yet obtained in the Radio Rheostat field and operates or functions quite differently from other Rheostats in that its two resistance units—one low (6 ohms) and one high (40 ohms)—are connected in parallel (not in series) and the vernier adjustment is done on the high resistance while the current flows without interruption through the low resistance unit.

To grasp and understand this principle of the "MICROSTATS" Method of functioning is to concede its unsurpassed efficiency in adjusting and controlling, to the smallest quantity, the current flow through the filament of the tube—a great and important essential in selective tuning.

While accomplishing this prime and essential feature an absolutely quiet and noiseless adjustment automatically results for current flow is not—nor never can be interrupted—which sooner or later results in all Rheostats operating a Vernier in series with a low resistance Rheostat unit and which interruptions produce noises which defeat the true function of a Vernier for accurate selective tuning.

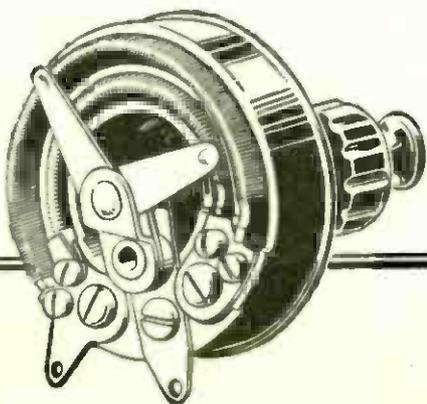
#### "MICROSTATS" EXCLUSIVE FEATURE

**UNIVERSAL IN OPERATION**—Controls any tube  $1\frac{1}{2}$  to 6 volts from 6 volt battery. **STAYS PUT**—Not affected by vibration. **FULL ON**—All Resistance cut out. **RESISTANCE UNITS**—Genuine "NICHROME" wire—6 ohms low—40 ohms high—connected in parallel—total safe carrying capacity, 3 amperes. **MAIN BODY OR BASE**—Bakelite Moulded. **DIAL**—Silver etched on black background. **KNOBS**—Moulded—Thermoplox. **MOUNTING**—one hole only in panel. **NO MOUNTING SCREWS.**

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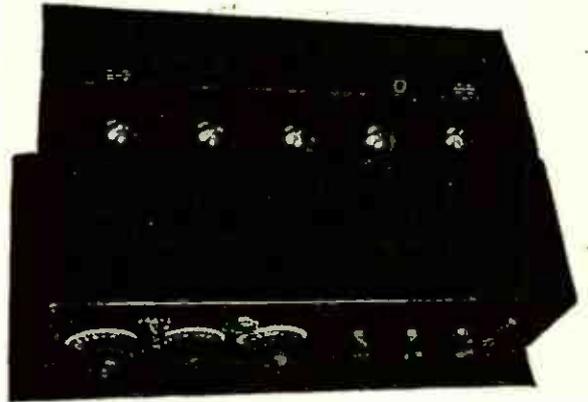
### Premier Electric Company

3807 Ravenswood Ave.  
CHICAGO, U. S. A.



## You Must See

this wonderful instrument to realize its beauty, its perfection in design and workmanship. You will have to listen to the beautiful programs which may be brought to your home by its use before you realize what "SERVICE" means.



**SERVICE TYPE 212 Receiving Set with folding loop antenna, f.o.b. Cincinnati, O.**

### \$150.<sup>00</sup>



Dealers, are you furnishing your customers with "SERVICE?"

WRITE FOR BOOKLETS

*This is a TELEFORE product*

## SERVICE RADIO CO.

4729 Montgomery Road  
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# Radio Catalogue Free—

**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.

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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.

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New "REGAL" Items for the 1923-1924 Season

New "Regal" No. 162  
Double Arm Inductance  
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 Amplifying  
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..... \$4.50  
5 to 1 Ratio..... 4.75

New "Regal" No. 120  
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For fine adjustment control of tubes and superfine tuning, the Regal Vernier stands alone. Nothing just like it on the market. Complete with Knob:

6-Ohms..... \$1.25  
30-Ohms..... 1.25

If your dealer does not carry "REGAL" Products, write us direct

(Send for Catalog No. 24, showing 30 Big "REGAL" Items)

**THE AMERICAN SPECIALTY COMPANY - Bridgeport, Conn.**

## The "Devouring Monster" of Radio

to most people has been the need of such large cash outlays at one time, and to many radio enthusiasts this has meant the purchase of lower priced, less satisfactory apparatus, or waiting for an interminable time to be able to secure the apparatus they wanted. This is no longer the case, as an

### Attractive and Conservative DEFERRED PAYMENT PLAN

for the purchase of "ANY piece of ANY make" of Radio Sets, Parts and Supplies, is now available to every responsible person. Write for full particulars, or better yet, send 25c. in stamps or coin and have the IODAR BULLETIN come to you each month. The IODAR BULLETIN contains a little of everything of interest to every radio enthusiast, as well as all the details of the IODAR PLAN, and is truly a catalog of opportunity.

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## Send For This Handy Book Today

Contains  
Description  
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Illustrations  
of all  
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Explains  
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### *This Pocket Size Edition Gives:*

Variable Condenser Capacities — Variometer construction — Illustrations and description of radio symbols. Q Why rheostats should have greater contact surface. Q Advantages of light weight receivers. Q Why Bakelite is the best insulation for radio. Q New and ingenious inductance switch and knob — Defines radio terms — Explains importance of good aerial and ground. Q But — most of all — It shows the beginner, why the highest class apparatus is the most economical and satisfactory — 54 pages of interesting information and illustrations.

THIS BOOK IS FREE



**Write for it today. Address Radio Dept. H.**

KELLOGG SWITCHBOARD & SUPPLY COMPANY

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**Simple as  
A B C**

—And comprehensive, too. The new Valley Battery Charger, Type ABC, charges all Radio storage batteries—2-volt peanut tube batteries, 6-volt A Batteries, and 1 to 4 B Batteries. Also charges 12-volt batteries.

Plugs into regular electric light socket. Uses a negligible amount of current—a dime's worth for an average charge.

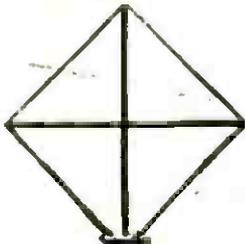
Unfortunately, production is limited. Don't miss out, and don't buy another until you have seen the Valley Type ABC Charger. At all good radio dealers.

**VALLEY ELECTRIC CO.**  
3157 S. Kingshighway · St. Louis, Mo.

## Valley Battery Charger

**ROCKY MOUNTAIN**  
RADIO PRODUCTS

**CRYSTALS** Any Style of Radio Material at Lowest Prices!



**NEW K-D  
SPRING LOOP  
AERIAL**

LIST PRICE  
**\$1.00**

Distributors  
**Bus, Aerial, Magnet WIRE**

Write for Discounts

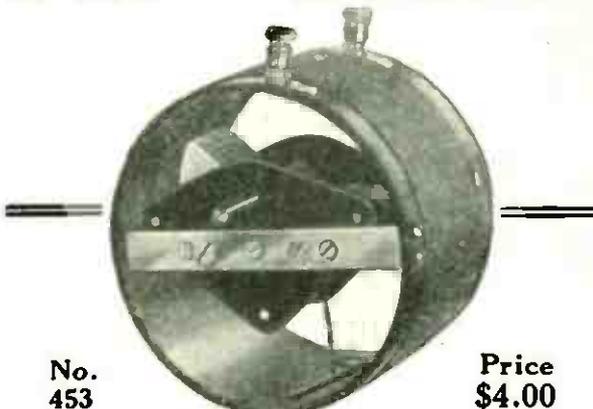
**Rocky Mountain Products Co.**  
9-B Church St., New York

## VERNI-TUNER

(Trade Mark)

**3 in 1** Primary, Secondary and Variable Condenser

**NO TAPS · · NO INTERFERENCE**



No. 453

Price \$4.00

**"Razor Like"—Selectivity**

Enthusiastically acclaimed by Radio Amateurs.  
**SAVES LABOR—SPACE—MONEY**

Main tuning device for all Reflex circuits, all Standard Regenerative Circuits, Tuned Radio Frequency Circuits and the Horne Combined Reflex and Tuned Radio Frequency.

Other units for Reinartz, Cockaday, Flewelling and other circuits.

Booklet of 14 circuits free with each device.

At your dealer or postpaid on receipt of purchase price. Write for leaflet.

**HORNE ELECTRIC & MFG. CO.**  
Mercer & Colgate Sts. Jersey City, N. J.



## Six Questions and The Answer

Do you have difficulty obtaining and maintaining a FINE adjustment with your radio set?

Do you want to make your set 100% MORE selective?

Do you want to hear stations that you believed your set would never bring in?

Do you want to eliminate some of the body capacity with which you have been troubled?

Do you want to add fine vernier adjustment to a plain condenser that will be more efficient than the so-called vernier condenser and at much less cost?

Do you want to improve the appearance of your set?

## If your answer is "Yes," then USE THE UNIVERNIER

The Univernier is a knob and silver plated 360° scale with a self-contained mechanism which reduces motion of the shaft to the knob 12 to 1. Slight pressure on the knob will cause the device to function as an ordinary knob.

As easily installed as the ordinary knob. Makes variocouplers, variable condensers, variometers, tickler coils, variable radio frequency transformers, potentiometers, and rheostats all vernier in action. Eliminates trouble from unbalanced instruments. A necessity on neutrodyne hook-ups. Makes all adjustments constant.

The use of the Univernier is the only logical and fundamentally correct method for obtaining vernier adjustment of radio apparatus.

List Price \$1.25

Made in two sizes:

No. 251 for 1/4" shafts	Diameter of knob 2 1/4"
No. 188 for 3/16" shafts	Diameter of scale 3 1/4"

At your dealers or post-paid upon receipt of the above amount.

**Walbert Manufacturing Company**  
533 Wrightwood Ave. Chicago, Ill.  
Dealers and Jobbers write for Discounts

# An Authority Describes The Ideal Radio Receiver

"It seems to us," says the Editor of Radio Broadcast, "that a set having radio and audio frequency amplification, without regeneration, must be possible in such a design that the only adjustment required is the one dial tuning the antenna circuit—the antenna being a loop . . . . To do away with the tinkering—simply to turn one handle to a definite marked point and get the station wanted . . . . that is the kind of a set which will find favor in the future."

Yes, Mr. Editor, you are right. Such a set is already finding favor all over the United States. It is the De Forest D-7-A Reflex Radiophone, and the D-10 Four-Tube Reflex fills the same prescription, with the addition of a Vernier Variable Condenser for precision tuning.

DE FOREST RADIO TEL. & TEL. CO.  
Dept. P. R. 3 Jersey City, N. J.

*If located west of Pennsylvania, address*

DE FOREST RADIO TEL. & TEL. CO.  
WESTERN SALES DIVISION  
Dept. P. R. 3, 5680-12th St. Detroit, Mich.



RADIO  
CATALOGS

FREE

Send us your name and address and we will send you the De Forest catalog and price list of sets, audions and parts.

In spite of new fangled circuits, the De Forest Reflexes are snatched up by the radio public faster than we can make them, because of their *simplicity* of installation and operation—the fact that they cost so little to operate—the elimination of the outdoor aerial—and their great selectivity. You can get the station you want, when you want it, without interference.

These features, with a range on indoor loop of from 1,500 to 3,000 miles according to atmospheric conditions, have made people prefer De Forest Reflexes at \$125.00 and \$150.00 to sets costing four times as much.

Whether you buy complete sets or build your own—

"Rely on De Forest, the Greatest Name in Radio."

D-7-A Reflex Radiophone, \$125.00;  
D-10 4-Tube Reflex Radiophone,  
(illustrated) \$150.00. Prices plus  
approximately 6% for transportation  
west of the Rockies. These  
Reflex sets operate either on wet or  
dry cells with De Forest wet or dry  
cell audions.



# CURKOIDS FOR RADIO FREQUENCY

*The Curkoid Adjustable Radio Frequency Unit is the solution of the Radio Frequency Problem*



*Because* it is the only unit on the market which permits of adjustment of coupling between primary and secondary.

*Because* it is the only unit which employs Curkoid inductances, giving highest inductive value for minimum distributive capacity and resistance.

*Because* it is adapted to any band of wavelengths by the selection of the correct combination of interchangeable Curkoid Inductances.

*Because* it is adapted for use with any make of vacuum tube for any ratio of transformation which can be obtained with interchangeable Curkoid Inductances.

*Because* it is readily used in tuned radio frequency circuits in connection with efficient variable condensers.

Curkoid Inductances are wound in the form of a curtate epitrochoid, giving the highest value of inductance for a minimum distributive capacity and resistance. Adjacent turns are separated by the greatest distance possible without sacrifice of efficient magnetic field distribution.

The Curkoid Adjustable Radio Frequency Unit is designed for use with or without a tuning condenser. Micrometer coupling adjustment moves the coil but 1-400 of an inch per turn of the control knob.

The Curkoid Two Coil Coupler and The Curkoid Three Coil Coupler make possible the use of any circuit.

Booklet giving hook-ups and structural data for tuned and untuned radio frequency circuits, neutrodyne, regenerative, super-regenerative and Reinartz circuits will be mailed to you upon receipt of ten cents.

*Curkoid Adjustable Tuned Radio Frequency Coupler \$2.75, without Variable Condenser*

**RIEGER RESEARCH CORPORATION**  
114 West 44th Street - - - New York City

# SPECIAL OFFER

*Two new yearly subscriptions \$3. to POPULAR RADIO for only . . . .*



Rope this Special Offer! It means a big saving to you. You and a friend of yours may have POPULAR RADIO for a whole year, provided you are both NEW subscribers. Just throw a check for \$3 around the double coupon and MAIL IT TO-DAY before the price goes up to \$3 for only one year's subscription!

*(Coupon good only until December 15th, 1923)*

POPULAR RADIO, Dept. 114.  
9 East 40th Street, New York City.  
Please send POPULAR RADIO for one year to:

NAME.....  
ADDRESS.....  
CITY.....STATE.....

And also to this other new subscriber. Here's my cash remittance—(or a check or money order for \$3).

NAME.....  
ADDRESS.....  
CITY.....STATE.....

*(No extra for Canada. Foreign countries 25 cents extra per subscription.)*

Please mention POPULAR RADIO when answering advertisements.

# THE NEW ACE

## Three Tube Regenerative Receiver

Manufactured under Armstrong U. S. Patent  
No. 1,113,149



For Use with 6 Volt or 1 1/2 Volt Tubes



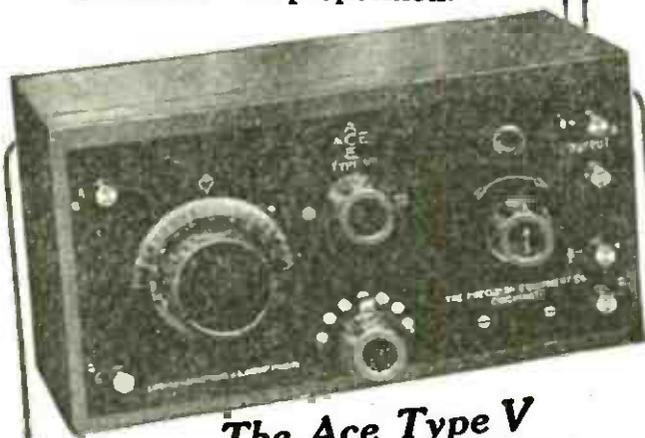
ONLY



If your dealer cannot supply you, order direct, mentioning his name. Ask for "Simplicity of Radio." Your copy is FREE.

### DEALERS:

Write on your letterhead for attractive sales proposition.



### The Ace Type V

Formerly Called Crosley Model V

The low cost of this set together with its efficiency and simplicity makes the great demand for it increase daily.

A long range receiver. Stations from coast to coast can be heard distinctly. An Ace Two-step Amplifier in connection with this set at \$20 makes use of loud speaker practical. Has Crosley Multistat, which permits use of any make tube.



This New Ace Type 3B Armstrong Regenerative Radio Receiver combines detector and two stages of Audio frequency amplification. The lowest priced quality receiver ever offered.

When you tune in with this set distant stations come in as though they were only a few miles off. The two stages make the use of a loud speaker possible—this is a desirable feature. Its efficiency has passed every test.

One of the few sets that functions perfectly with all makes of tubes. Has filament switch which eliminates necessity of turning out the rheostats when set is not in use. With this switch you can turn off set and come back later to same concert without retuning. The telephone jack makes it possible to use head phones. When head phone plug is inserted it automatically eliminates loud speaker, but does not affect the filament current. Has genuine mahogany cabinet with beautifully engraved panel.

### THE PRECISION EQUIPMENT COMPANY

*Rowell Crosley Jr.* PRES.

1116 Vandalia Ave.

Cincinnati, Ohio



## DESIGNED ESPECIALLY FOR RADIO RECEIVING

We are Manufacturers of Fine Furniture and we sell direct to you with only a small factory profit.

A handsome hardwood hand-rubbed mahogany or golden oak finished Radio Table. Size of top 20 x 34 inches x 31 inches high.

Conceals A & B batteries. Small drawer holds tools and accessories.

PRICE, FREIGHT PAID, East of Mississippi River.....\$18.00

FREIGHT PAID to Rocky Mt. States...20.00

FREIGHT PAID to Pacific States.....22.50

Cash with order. Prompt shipment.

### CABINET PRICES REDUCED!

Hardwood, hand-rubbed mahogany finish. Hinged top.

Panel Size	Depth	Price
6x7 in.	7 in.	\$2.25
6x10½ in.	7 in.	2.50
6x14 in.	7 in.	3.00
6x21 in.	10 in.	3.75
7x18 in.	10 in.	3.50
9x14 in.	10 in.	3.50
12x14 in.	10 in.	4.00

POSTPAID, East of Mississippi River.

POSTPAID to Rocky Mt. states, add 25 cents.

POSTPAID to Pacific states, add 50 cents.

Cash with order. Prompt shipment.

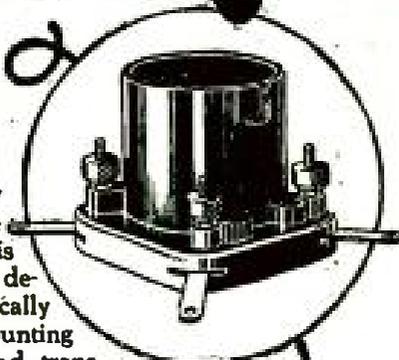
Send for free catalogue of Radio Furniture.

**THE SOUTHERN TOY CO.**  
HICKORY, NORTH CAROLINA

Announcing

# E. T. Flewelling Sockets

The first unit of a series of parts designed by Mr. E. T. Flewelling, inventor of the 'Flivver Circuit,' which will assemble into a really capable set is the Flewelling Socket. This socket has terminals so designed that they practically assemble the set by mounting on tuner, rheostat and transformers direct.



Internal capacity has been whipped by so spacing a new type of contact terminal that ideal conditions for radio frequency and reflex work are established. Further—good, clean contact against the base part of the tube terminals, with an easily inserted and firmly held tube, results in eliminating doubt as to good electrical contacts.

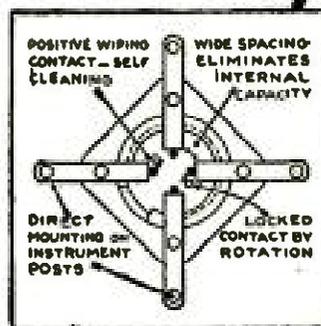
E. T. Flewelling says:

*"Stray or internal capacity effects must be eliminated if we are to secure maximum results."*

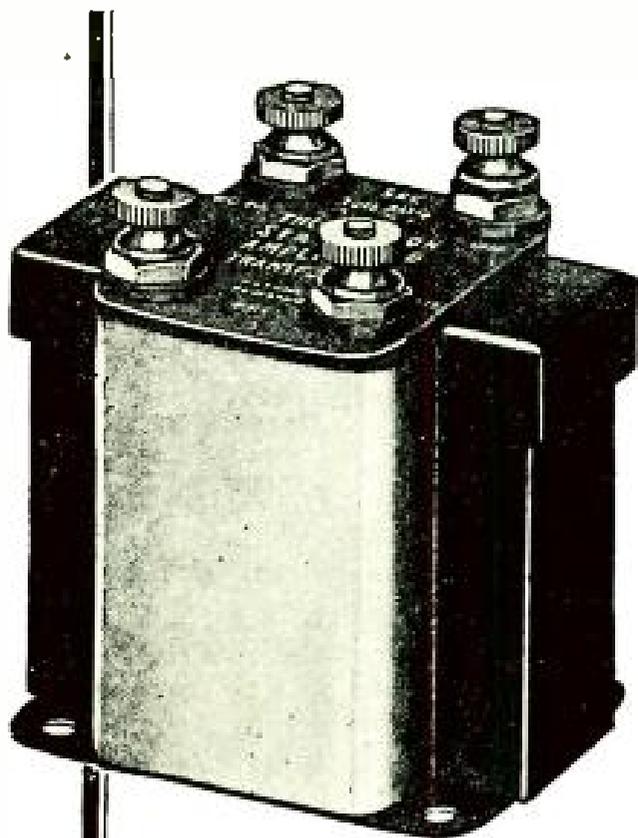
Watch this space in our advertisements for a series of helpful hints that will enable the radio fan to build a better set than has heretofore been deemed possible.

### PRICE

Standard tube Socket \$1.00. At your dealers or, until he is supplied, post paid upon receipt of price.



**BUELL MANUFACTURING COMPANY**  
2979 Cottage Grove Avenue  
CHICAGO



## The New **THORDARSON** Super Transformer

More than a quarter of a century has been devoted by Thordarson engineers to the design and development of power transformers ranging in size from the smallest bell ringer to the first 1,000,000 volt transformer the world ever saw.

That knowledge and practical experience has been intelligently devoted to devising an Audio Frequency Amplifying Transformer that would produce the greatest volume consistent with *true tone quality*.

Here it is—its specifications and efficiency under all atmospheric conditions and over all audible signals, ranging from 100 to 7,000 cycles have been tested and endorsed by the

foremost radio engineers in the United States. Thousands of these new amplifying transformers are daily furnishing the means to greater pleasure and entertainment to discriminating radio amateurs and experimentors.

*Developed and manufactured entirely by Thordarson engineers in the Thordarson plant*

It is not merely an assembly of bought coils, core iron, etc., as is the case of most audio frequency transformers in the market.

Core is made of .007 highest grade silicon steel, No. 36 gauge, the cross section of which measures  $\frac{3}{4}$  inch—twice that of the usual type transformer. Coil is *square layer wound* of No. 40 wire to fit the square core. The winding process and machinery were designed and developed exclusively by Thordarson.

The basic principle and construction of this new Thordarson product are scientifically, electrically, and mechanically correct. Exhaustive tests and experiments have proved conclusively that:

1. Core losses are reduced to a minimum.
2. Over-saturation of the core is eliminated.

3. When in use the resistance of the plate circuit of one tube and the resistance of the grid circuit in the following tube are balanced to a degree heretofore unequalled.

4. The received energy is increased sufficiently to actuate loud speaking devices without distorting the incoming signal.

5. The volume produced is as great as *pure tone quality reproduction will permit*.

The new Thordarson amplifier is the choice not only of thousands of amateurs and experimentors, but an increasing number of leading receiving set manufacturers now specify Thordarson Transformers as standard equipment.

### *Make your own test*

Words nor pictures nor specifications alone can do justice nor prove the superiority of Thordarson products. Let your own ears guide you in your comparison.

SOLD AT ALL GOOD DEALERS

PRICE, MOUNTED ONLY  
6 to 1 ratio transformer . \$4.50  
(with Red Label)  
3½ to 1 ratio transformer 4.00  
(with Blue Label)

# THORDARSON

ELECTRIC MFG. CO.

Huron and Kingsbury Streets, Chicago

### The Ideal Gift

# \$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 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.

Write Immediately for Free Charger Bulletin

## The France Mfg. Co.

10444 Berea Road Cleveland, Ohio

Pioneer Manufacturers of Patented Battery Chargers

## Reliable RADIO Goods

We are distributors for

Radio Corporation of America	Magnavox
Grebe	Murdock
Brandes	Burgess
Nath. Baldwin	Acme
Se-Ar-De	Dubilier
Remler	Eveready
Gould	Cutler-Hammer
Signal	Frost
Carter	

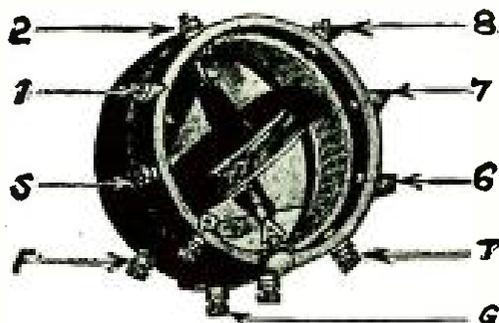
and other manufacturers of high standing.

We carry a comprehensive stock of the latest receiving sets, parts and supplies of the leading manufacturers, and ship from stock promptly.

FREE Illustrated, CATALOG sent on request

JULIUS ANDRAE & SONS CO.  
127 Michigan St., Milwaukee, Wis.

ANDRAE in Business Since 1860



F to S—Main Inductance  
A to G—Vernier Rotor  
T to P—Untuned Primary  
6 to 8—Loading Coil

## THE B-T VERNIER TUNER

in our No. 2 Hook-up is giving thousands of users better range, control, selectivity, and dependability than they ever before experienced.

For diversion, they try out others among the good tested circuits for which we supply photo-diagrams.

Our slogan has always been "More than you expect," and in the language of the highest grade firms throughout the radio world, our products "are in a class by themselves."

If you do not know B-T parts you are missing something. Circulars on request.

**BREMMER-TULLY MFG. CO.**  
534 So. Canal St. Chicago

## For Long Distance Reception ATHERTON

AUDIO-FREQUENCY TRANSFORMERS

Rank Absolutely Supreme

Powerful Amplification  
Clear and Perfect Reproduction on All Wave Lengths



No Distortion nor Howling  
No Resonant Peak

Designed to Meet the Characteristics of All Tubes

The Highest Grade Amplifying Transformer Manufactured

Unrestrictedly Guaranteed

RATIO 5 to 1  
Recommended for 1st Stage.

RATIO 3.75 to 1  
Recommended for 2nd Stage and All Stages Thereafter

List Price, \$6.50 All Ratios.

Sold by all high grade radio dealers, or mailed postpaid direct upon receipt of price.

Dealers and Jobbers Write for Attractive Discounts.

**WOLVERINE MANUFACTURING COMPANY**  
603 East Water Street  
Milwaukee, Wisconsin, U. S. A.

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# ATWATER KENT

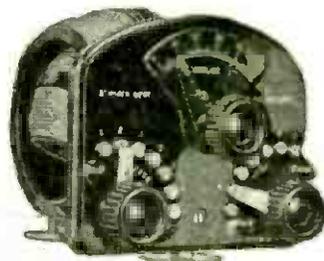
## RADIO EQUIPMENT



2-Stage Amplifier



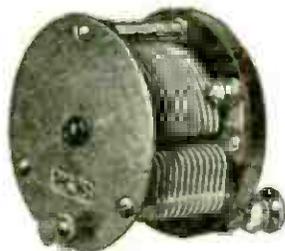
Type 11 Tuner



Mounted Variocoupler



Variable Condenser  
Table Mounting, Front  
Control



Variable Condenser  
Panel Mounting

ATWATER KENT Radio equipment is distinctive for the quality of its performance. Parts and Sets embrace a variety sufficiently wide to meet the requirements of every user of radio.

Sets commence with the simplest combination of tuner and detector unit and include the most complete arrangement of units that has been found practical.

Parts include every instrument necessary to the assembling of complete sets.

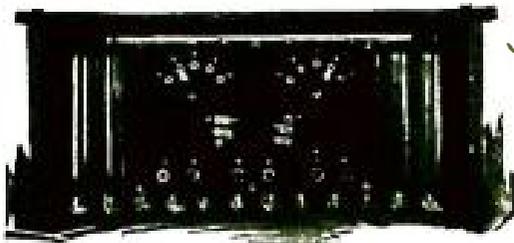
Every ATWATER KENT Radio Product represents the accumulated experience of more than 25 years in the design and manufacture of scientific electrical equipment.

All insulating parts are made of moulded condensite—they are moisture proof.

*Literature describing the entire line of Atwater Kent  
Radio Sets and Parts sent on request*

ATWATER KENT MANUFACTURING COMPANY  
4933 STENTON AVENUE, PHILADELPHIA, PA.

*Makers of*  
THE WORLD'S HIGHEST GRADE IGNITION  
STARTING AND LIGHTING



## “Satisfaction increasing; customers want more”

That's the message that came across the continent with an order from an Oregon distributor. KICO Batteries always make good. Alkaline type, won't sulphate or buckle. Life unlimited. Not harmed by short circuiting, overcharging, idleness. Panel switches give single cell variations. Recharge from any 110-volt A.C. line with small home rectifier. Charge lasts 3 to 6 mo. in detector plate circuit.

### GUARANTEE

Your money back on any KICO Battery if not satisfied within 30 days' trial. Write for full information on "A" and "B" Batteries.

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

Unmounted Rectifier... \$1.00  
Mounted Rectifier... \$2.50

**KIMLEY ELECTRIC COMPANY, Inc.**  
2667 MAIN STREET, BUFFALO, N. Y.

**KICO** Storage "B" Batteries—  
long service, low cost



MA-13

## Do You Know Why the Mu-Rad Sells, Mr. Dealer?

Simply because to hear the Mu-Rad is to buy it! One of Chicago's largest radio stores sells the Mu-Rad entirely by demonstration. Their records show that 8 out of 10 demonstrations result in a sale! That's profitable business!

### Write for Mu-Rad Franchise

We are the exclusive distributor of the Mu-Rad Receiver in the states of Illinois, Indiana and southern Wisconsin. If your store is in any one of these three states, Mr. Dealer, write us today for details of our special exclusive territory proposition. Winter's here—there's need for haste!

We also carry a complete stock of  
**WESTERN ELECTRIC CO.**  
**GENERAL RADIO CO.**  
parts. Write for details and discounts.

**Chicago Radio Apparatus Co.**  
Jobbers of Good Radio Merchandise  
General Offices: 407 S. Dearborn Street, Chicago



*A Twist of the Wrist* — **IT'S SET**

## YELLOW TIP MICROMETER ADJUSTING CRYSTAL DETECTOR

The every-purpose detector—fixed or changeable adjustment, just as you desire. Tune with the YELLOW TIP. No hunting or looking for a sensitive set—just "A Twist of the Wrist—It's Set". Micrometer adjustment in a moment, fixed indefinitely. Ideal for reflex and other circuits. **\$2**

Write for folder and name of your nearest dealer.

**Wholesale Radio Equipment Company**  
Exclusive Factory Representatives  
36 William Street Newark, N. J.

Dealers and Jobbers—Write for Attractive Proposition

## AMPL-TONE PHONES



2200 Ohms—\$6.00

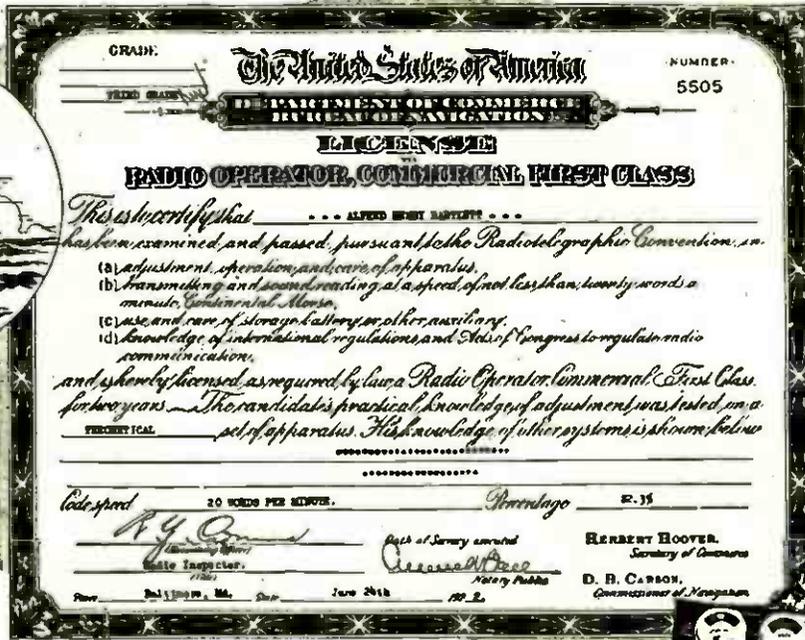
### OUR MOTTO IS QUALITY NOT QUANTITY

Every precaution is used in buying materials, in assembling parts and testing phones, assuring the purchaser of a perfect, comfortable and durable phone with a loud, clear and equalized tone.

Every phone guaranteed.

If your dealer cannot supply you, write us

**C. M. FRENCH MFG. CO.**  
SEYMOUR, CONN.



## Get This First Class Radio License You Can Earn Big Money With It



THE best paid positions in radio go to the men who hold the Government's First-Class Commercial License. The radio men on every ship, in every land commercial station, in every broadcasting station, must have one of these licenses. Every radio inspector must pass the first-class license examinations. Engineers, mechanics, installation and maintenance experts must all of them own a Government First-Class Commercial License in order to operate a transmitting station. It is every radio man's ambition to get a license, not only because it is the highest mark of honor he can get but because it also opens to him all the wonderful opportunities in this great profession.

Emmett Welch of Peculiar, Mo., is Radio Salesman making \$300 per month and expenses, Merle M. Wetzel is inspector in the Engineering Dept. of a Public Service Co., Edwin Forsyth is on his way to Scotland as first-class licensed operator on board ship. Read in the panel of the fine salaries paid in all the wonderful positions open to you as soon as you get the Government First-Class License.

### Pick Out the Job You Want and We Will Help You Get It

We have trained hundreds and helped them to splendid paying positions in Radio. You will be interested in knowing exactly what these graduates are doing and in reading the actual letters written by them. Our new Free Book contains scores of these letters, each one a story of success in itself. Send for this book.

- Here is a brief list of positions in Radio, and the salaries they pay.
- Radio Mechanic, \$1,500 to \$4,000 a year.
  - Radio Inspector, \$1,800 to \$4,500 a year.
  - Radio Salesman, \$2,000 to \$10,000 a year.
  - Radio Engineer, \$3,500 a year and up.
  - Radio Executive, up to \$15,000 a year.
  - Radio Instructor, \$200 to \$500 a month.
  - Radio Draftsman, \$7 to \$15 a day.
  - First Class Snip Operator, \$120 a month, all expenses paid.
  - Commercial Land Station Operator, \$150 a month and up.
  - Broadcasting Station Operator, \$125 to \$250 a month.

### Win Your Government License This New, Easy Way

The National Radio Institute, America's first and largest Radio School, has devised a remarkable new method that makes it easy for you to win your license. No previous experi-

ence in electricity or radio is necessary. Spare time study at home prepares you in an amazingly short time to pass the Government examinations, so you can get one of the fine jobs waiting in this great field. The diploma we give you upon completion of the course, counts for 5 to 10 credits on all government license examinations.

### Four Radio Instruments Free

An extraordinary feature of this course is the use of four patented instruments, owned exclusively by us, which give practical training in radio operation, installation and maintenance and repair—all of which you must have to become an expert.

Among these instruments is the wonderful Natrometer, said by experts to be the perfect device for teaching the Radio Code. All of these instruments are given free during the course.

### Send for Free Radio Book

Thousands of positions are open to Radio Experts. Find out what your opportunities are in this fascinating profession. Send for interesting free book, "Your Opportunity in Radio," which gives complete details on plan by which the National Radio Institute quickly qualifies you for a Government Commercial License. If you are sincerely ambitious, send the coupon or a postcard for free book NOW.

## NATIONAL RADIO INSTITUTE

Dept. 32L WASHINGTON, D. C.

## NATIONAL RADIO INSTITUTE

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Send me your free book, "Your Opportunity in Radio," with full particulars about the opportunities in radio, and how you will quickly train me in my spare time at home to win a Government First-Class Commercial License. Also tell me how your free Employment Service will help me to a position.

Name.....Age.....

Street.....

City.....State.....

*"Where ignorance is bliss  
'tis folly to be wise"*

but that is no excuse for not using the acknowledged best audio transformer—

**The AMERTRAN**  
REG. U.S. PAT. OFF.



Price \$7  
Ask your dealer.

Or, sent carriage charges collect.  
(Wt. 1 lb.)

**STANDARD of EXCELLENCE**

Turn ratio, 5:1. Amplification ratio, 30-40 times audibility in the flat part of the curve.

Send for Circular 1005

**American Transformer Company**

Designers and builders of radio transformers for over 22 years.

175 Emmet St., Newark, N. J.

**\$9.50 A Complete \$9.50 LOUD SPEAKER**

A Loud Speaker for thousands of Radio Fans who are looking for a moderate priced speaker with quality.



Heavy metal horn, 21 inches high, bell 11 inches in diameter, complete with special loud speaking unit and 5 ft. cord.

Colors: Plain Black or Brown Satin finish; also special Alligator grain in Black and Green or Black and Yellow.

Price of horn only with phone adapter, without loud speaking unit, \$5.50

Liberal Trade Discounts

**ACKERMAN BROTHERS CO., Inc.**

301 West 4th St. Dept. "PR" New York, U.S.A.

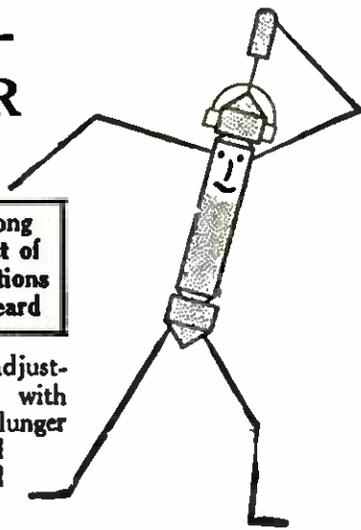
**DURHAM + DUBILIER**

Tube Control

Equal the other fellow's

Long list of stations heard

Distance depends on fine adjustment—the kind so easy with DURHAM one-finger plunger resistance control. Mounted on famous Micadon grid condensers.



**DURHAM Variables**  
No. 101—0.1 to 5 megs.  
No. 201A—2 to 10 megs.

**DUBILIER Condensers**  
.00025 mfd.  
.00050 mfd.



Guaranteed Satisfaction

Your dealer has it for \$1.10 complete

**Durham & Co., 1936 Market St., Philadelphia**

Dealers:—Other stores in your town list DURHAM-DUBILIER—on their cash register! How about you?

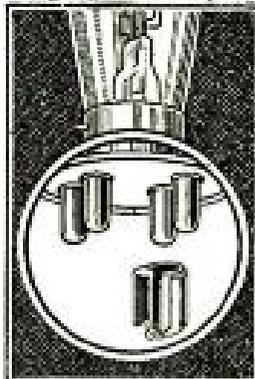
**GAMBLING?**

**YOU ARE IF YOUR RADIO TUBES ARE UNPROTECTED**

Your Vacuum Tubes are the most delicate parts of your Radio Set.

They are easily blown out—you have probably already had this exasperating experience—it is apt to happen at any time.

"B" Battery wires accidentally crossed for only an instant with the filament leads or sudden excess current from the "A" Battery will do it.



You can prevent this and save yourself money and inconvenience and relieve your mind at a trifling cost.

**INSTALL RADECO SAFETY FUSES**

on all your tubes. Applied in an instant to one of the filament terminals. Will fit any standard tube going in any standard socket.

Price 50 cents each, sent postpaid and fully guaranteed. Do not delay. Order now. Specify type of tube used.

DEPT. 2  
**RADIO EQUIPMENT COMPANY**

Manufacturers and Distributors of Standard Radio Equipment  
630 Washington Street Boston, Mass.  
New England's Oldest Exclusive Radio House  
Dealers:—Write for our proposition

# New York Coil Company's Radio Products

Are leaders everywhere due to quality, ease of installing and assurance that your set will bring in the results when finished. Used by leading constructors and handled by the best informed dealers.



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
23 ".....	2.00
43 ".....	3.00
3 ".....	1.25



Supplementary  
Vernier Condenser  
\$1.00

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.



Our skeleton type tuned Radio Frequency Transformers really give the D X results with loop or indoor aerial that you have long wished for. Totally unlike any other in design or results. Two required, fully guaranteed.

\$4.00 Each



Get literature on *Variometers, Couplers, Mica Condensers, Inductance Tap Switches.*

**NEW YORK COIL CO., 338 Pearl St., N. Y. CITY**

**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.)

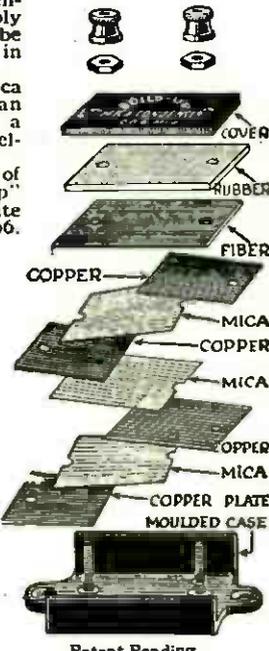
"Build-Up" Condensers are dilation proof. They insure high efficiency and will add satisfaction to the operation of any set. Each assembled complete in neat carton. Prices:

Mfd.	List Price	Mfd.	List Price
.00025	50c	.0025	65c
.0005	50c	.005	70c
.001	55c	.006	75c
.002	50c		

Extra envelope containing 20 mica and 20 copper plates, or sufficient to build up a condenser from .00025 to .006 list price 26c. Table showing required number of plates for any capacity is furnished with each condenser.

Ask your dealer or order direct.

**CHARLES SCHINDLER**  
1403 West Delaware Avenue  
TOLEDO, OHIO



Patent Pending

Warren Radio Loop,  
cut away to show  
construction



## Free Your Set From INTERFERENCE



The U. S. Army Signal Corps use loops to obtain absolutely unlimited, uninterrupted radio communication. To really enjoy your super-sensitive set, banish interference from static, stray atmospherics by using a loop aerial, the best you can buy—a Warren Radio Loop. More "persistent" than the dangerous, cumbersome old-fashioned outside aerial. Easier to tune. Built on stronger frame and protected from dust, dampness and meddling by tight cover. Types for all wave meter lengths from 175 to 18,000. Most compact, efficient loop perfected. Buy a Warren Radio Loop Now!

Type A-737 (300-700 meters) 6 inches square—non-directional.....	\$10
Type A-7236 (175-1000 meters) 6 inches square—non-directional.....	\$12
Type B-2537 (300-700 meters) 18 inches square—directional.....	\$20
Type BL-2520 (200-18,000 meters) with honeycomb coil mounting, 18 inches square—directional.....	\$25

Send for Bulletin I-102

**V-DE-CO RADIO MFG. CO., Dept. F, Asbury Park, N. J.**



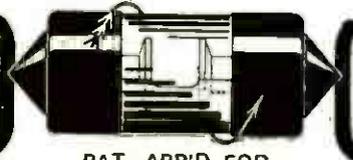
# BDXX Durable!

BDXX panels are PERMANENT. Their service is unending. Once installed, they satisfy for all time. Never has it been necessary to replace one.

## bakelite-dilecto!!

(A Laminated Phenolic Condensation Material)  
Highest in dielectric strength. Surprisingly hard and tough; yet readily machined. Proof against water, heat, fumes, solvents and milder acids. Ozone from high-voltage electrical apparatus, which quickly ruins hard rubber, has absolutely no effect on Bakelite-Dilecto. XX grade Bakelite-Dilecto has every radio-advantage. Insist on it at any electrical store.

**THE CONTINENTAL FIBRE CO.**  
Factory: Newark, Delaware  
Dealer Service From:  
New York, 233 Broadway  
Pittsburgh, 301 Fifth Ave.  
Chicago, 332 S. Michigan Ave.  
San Francisco, 75 Fremont St.  
Los Angeles, 411 S. Main St.  
Seattle, 1041 Sixth Ave., S.



PAT. APP'D FOR

# 75¢ TURN-IT 75¢

## GRID-LEAK

### "ADJUSTABLE"

**YOUR SET DESERVES ONE!**

**EVERYBODY** has fussed with grid leaks to find the one best suited for his tubes and circuit and has discovered many of the variable carbon leaks would not hold their adjustment.

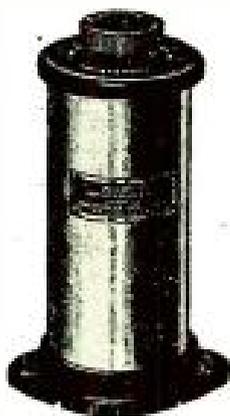
**BUT** when you clip a **TURN-IT** in your standard mounting you can be sure your grid-leak problem is solved.

**THE** high resistance liquid with its smooth flowing, velvety contact instantly gives you the value required and there it stays until you turn it to another value.

Your dealer should have one, if not send 75c to

**Charles E. Bonine**  
20 South 15th St. Philadelphia

Tells how to get those stations  
you read about but never hear



**BALLANTINE  
VARIOTRANSFORMER.**

for  
Radio Frequency  
Amplification  
(Patents Pending)

On Sale at All Good Radio Stores  
or Postpaid, Price \$9.60

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**“Radio Frequency Amplification  
with the  
Ballantine Variotransformer”**

Here's a booklet that will help you get many stations that you've never heard before. Based on research of the Radio Frequency Laboratories, Inc., it gives the latest developments in tuned radio frequency amplification. Furthermore, it tells how to use the *continuously variable* BALLANTINE TRANSFORMER for both amateur and broadcast wavelengths—with amplification *uniformly high*.

*Free for the asking, this 25-page booklet is full of facts, helpful information and practical diagrams. Edition is limited—better write for your copy at once.*

**BOONTON RUBBER MFG. CO.**

224 Fanny Road

Boonton, N. J., U.S.A.

**T**O the manufacturer of one or more articles of meritorious radio equipment, this organization, well experienced in the trade of Spanish and Portuguese speaking countries, offers a service of exceptional interest.

We now handle the export business of Dubilier Products, Burgess Batteries, Rasla Products and Freed-Eisemann and are equipped to take on one or two additional high grade lines. Full information and statistics on market conditions in these countries will be given confidentially on request.



AD. AURIEMA  
116 BROAD STREET  
NEW YORK CITY

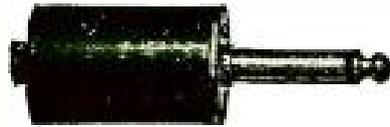
## \$6.00 Headphones of Sterling Quality

Telephone Instrument Manufacturers of long experience now offer radio buyers, Headphones that have been brought to a high state of efficiency by successful manufacturing of voice transmission equipment. Leich Radio Headphones with Eureka Head band are light weight, comfortable, and durable. Bakelite caps and metal containing cups guard the accurate adjustment necessary to maintain a sensitive instrument.



1B-2000 ohm Headphone \$6.00

An ideal combination is the Leich Headphone with No. 60 L'-Radio Plug attached.



60 L'-Radio Plug \$.90

Order direct or thru dealer or jobber.  
Radio Booklet 101G lists the additional accessories.

**LEICH ELECTRIC CO.**  
GENOA, ILL.

## STA-PUT JR.



The latest arrival in the best line of radio plugs in the world. Lightning adjustment without tools. Extra small size and fine polished finish.

List price fifty cents

**MARTIN-COPELAND COMPANY**  
Providence, R. I., U. S. A.



## INSIDE COIL MOUNTINGS

Coils are inside the cabinet where they belong.

The movable coil is operated from a dial on the panel, giving vernier adjustment and eliminating body capacity.

Pigtail connections. Adjustable tension springs.

Made in double and triple sizes.

No. 2A Mountings..... \$3.75

No. 3A " ..... 5.00

Use "Honeycomb" or "Spiderweb" inductance for best results.

**WIRELESS ELECTRIC CO.**  
204 Stanwix St. Pittsburgh, Pa.

Please mention POPULAR RADIO when answering advertisements.

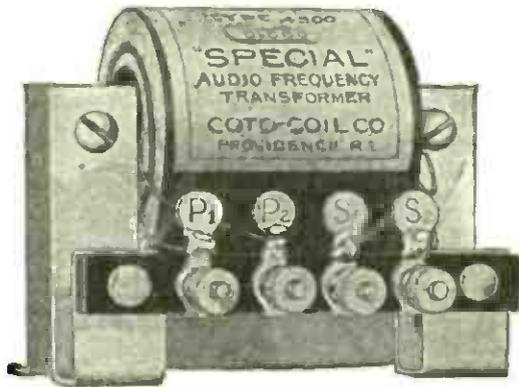
# Coto

"Built First to Last"

## You Double the Real Fascination of Radio—

when by your own ingenuity and effort, you equal and very likely surpass the best results obtained by ready made radio sets.

Build your own, your personal set. Know the joy of conquering the infinite. And build it right. Coto for compactness, portability and reliability.



### Coto Special Audio Frequency Transformer

A triumph of manufacturing economy. Designed to sell at a price but superior in material, in workmanship and in performance. Absolute dependability, as your dealer will assure you. Turn ratio 3 to 1. Excellent volume of amplification. Type 4500..... **\$2.50**

**Jobbers! Dealers!**

The Coto line of superior radio apparatus is already on its way to tremendous selling. You deserve a share of this business. Write for folder and price lists.

### Coto Coil Co.

87 Willard Avenue

Providence, Rhode Island

Pacific Coast Branch,  
329 Union League Bldg.,  
Los Angeles, Cal.

Northwestern Branch,  
Geo. F. Darling,  
705 Plymouth Bldg.,  
Minneapolis, Minn.

Southeastern Branch,  
C. P. Atkinson,  
Atlanta Trust Co. Bldg.,  
Atlanta, Ga.



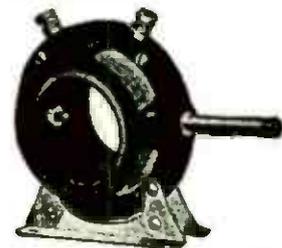
### Cotogrip Tube Socket

Has unique double positive grip of tube terminal posts. Best hard rubber insulation. **85c**  
Type 7000.....



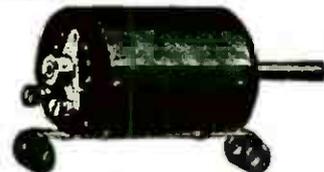
### The Original Honeycomb Wound Coils

Popular low priced favorites of the amateur and experimenter. Descendants of the Coto Coils that guided the N. C. navy planes across the Atlantic. Sold mounted or unmounted.



### Coto Compact Moulded Variometer

A little gem in moulded bakelite. Stator is honeycomb wound. Range 200 to 600 meters. Size 3 1/2 x 1 1/4 x 3/4 inches. Base or panel mount. **\$5.00**  
Type 8000.....



### Coto Tapped Radio Frequency Transformer

Efficiently covers the whole broadcasting range because it is TAPPED. Just turn the switch. Type 5000 **\$7.50**

## For Better Receiving



### Elgin Precision Condensers

Accuracy in your condensers means better results in your receiving. Elgin Precision Condensers are accurate. Permanent accuracy and rigidity are built into them.

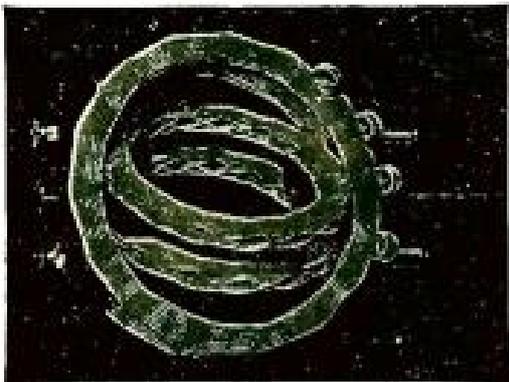
**Fully Guaranteed**

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	—
23 Plate	.0005 M. F.	3.00	4.50
43 Plate	.001 M. F.	4.00	5.50

3" diameter composition dials, 50c extra

See your local dealer. If he cannot supply you send his name with your order to

**The Elgin Tool Works, Inc.**  
69 N. State St., Elgin, Illinois



### R. M. C. Diamond Weave Variocoupler and Variometer

Due to diamond weave construction and the fact that 7/8 of the total area of windings are supported in mid-air, capacity and dielectric losses are reduced to a minimum in R. M. C. Variometers and Variocouplers. The rotor is continuously variable. These products may be used in any circuit where a high grade coupler or variometer is required. All metal parts are nickel-plated. Panel mounting requires very small space. Screw holes covered by 2" dial.

R. M. C. products are built for the finest sets that can be constructed.

Variocoupler.....\$4.25  
Variometer.....\$4.25

*Write for catalog of other diamond weave coils, and Radio Frequency Transformer.*

**THE RADIO MANUFACTURING COMPANY**  
of Springfield, Massachusetts  
Dept. B 97 Dwight Street

# Acoustically Correct



The Trimm extra large Loud Speaker unit with its wonderful ADJUSTO instantly regulating loud speaker to signal strength insures greatest volume without flaws or distortion. At three prices:

**ACOUSTICOLA**  
Standard Model with non-metallic horn, 21 1/4" high; bell 10" diam. ....\$22.50

**ACOUSTICOLA GRAND**  
With solid Cast Aluminum Horn; the world's finest loud speaker. ....\$35.00

**ACOUSTICOLA**  
Phonograph Attachment \$10.00

**TRIMM High Grade HEADSETS**

"Professional" model-3000 ohm...\$7.65      "Dependable" model-2400 ohm...\$5.00

Any Trimm product shipped and sold on approval and Guaranteed FOR LIFE. Write for descriptive folders. Mention your dealer's name.

**TRIMM RADIO MFG. CO.**  
Dept. 51  
24-30 S. Clinton St., Chicago, Ill.

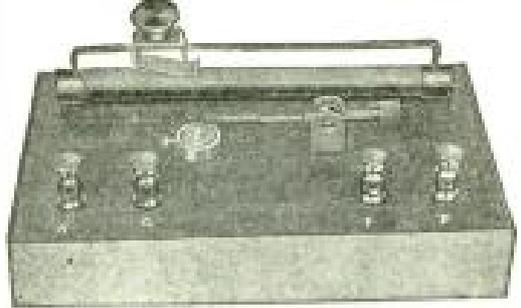
INSTRUMENT MAKERS

DEPENDABLE  PRODUCTS

SINCE 1909

## PRECISION HIGH EFFICIENCY CRYSTAL SETS

Guaranteed to receive local broadcasts with volume and clarity equal to any sets manufactured



### FREE FAMOUS TESCO RADIO Crystal Set (Shown in Cut)

To introduce the wonderful T-B-H radio headset we will give absolutely free of charge, the most efficient crystal receiver on the market.

**SEND NO MONEY**

Just pay postman \$5.00 plus postage. Money refunded if not absolutely satisfied.

**THE EASTERN SPECIALTY CO.**  
3552 N. Fifth Street, PHILADELPHIA, PA.



## *Boys have built the radio business*

**M**ETEORIC, magic, unbelievable—that describes the stupendous growth of the radio business. The demand for sets and parts has increased 60,000 per cent in two years. What has caused this surge of radio interest? The contagious, resistless, energetic enthusiasm of boys.

The lure of radio has caught the imagination of youth. All over

the country a vast majority of radio sales are made to boys, or to adults purchasing for boys. To the very limit of his means a boy buys his own equipment, but, lacking funds, he so convinces dad of his desire for radio, and of his knowledge of construction, installation and operation, that dad digs deep and buys the best his pocket affords.

**THE  
AMERICAN BOY**  
"The Biggest, Brightest, Best Magazine  
for Boys in All the World"

goes straight to the source of radio sales. Five hundred thousand go-getting sons of well-to-do parents read it regularly from cover to cover. Dyed-in-the-wool radio fans, they turn to its advertising columns for the equipment to supply their radio needs.

Averaging 15½ to 16 years old, their knowledge of radio commands the respect and confidence of their elders; their buying

power is large, and their influence on buying decisive. Your advertisement, broadcasted to these up-to-the-minute, radio-saturated boys, will find the greatest market in the world tuned in and listening eagerly.

Start the new year with a message to the army of AMERICAN BOY readers. Copy for January should reach us by November fifteenth.

**THE SPRAGUE PUBLISHING COMPANY**

(Member A. B. C.)

548 Lafayette Boulevard, Detroit, Mich.

Please mention POPULAR RADIO when answering advertisements.

**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.  
 CHARGES PREPAID  
 21 E. SOUTH WATER ST.  
**CHICAGO**  
 Circular on request

**KEYSTONE**  
 RADIO LIGHTNING  
**ARRESTERS**



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.

**Electric Service Supplies Co.**  
 17 & Cambria Sts.  
 Philadelphia

Monadnock Bldg., Chicago  
 50 Church St., New York



*Approved!*



**Approved by Radio Experts for Radio Amateurs**

Approved because:—  
 Wave length is 550 Meters; 16 soldered leads; straight wound stator on genuine bakelite tubing; kiln dried rotor; Fahnestock spring clip connections; non-conductive adhesive. You can

**GET ONE FOR \$3.50**  
 20 Diagrams Free with Each  
 For sale at your dealer's—otherwise send the \$3.50 directly to the manufacturers and you will be supplied.

**G. H. FISCHER & CO.**  
 123 Liberty Street New York City

**NEW TYPE**  
 Variable Resistance Leak



**ONLY THE KNOB**  
 SHOWS ON THE PANEL

This device is especially built for use as a tuning instrument. Its construction is such that it will withstand unusual usage. Fully guaranteed. Absolutely no pencil markings. Can be mounted on any panel in a few seconds. It will enable you to get stations you have never heard before.

Complete with either .00025 \$1.00  
 or .0005 Freshman Condenser  
 Without Condenser . . . . . 75c

At your dealers, otherwise send purchase price and you will be supplied without further charge

**Chas. Freshman Co. Inc.**  
 Radio Condenser Products  
 106 Seventh Avenue, New York

# 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

## PARTS FOR THE FAMOUS HAYNES CIRCUIT

1000 Miles for \$15.00

*The Identical Parts Used by Mr. Haynes in His Own Personal Receiving Set—Assuring the Utmost in Selectivity, Long Distance Range, Economy, and Simplicity of Arrangement. Invaluable to experimenters converting ordinary, simple regenerative sets to include the Haynes Circuit*

### The Haynes Condenser

\$3.50

Meets every requirement—extreme low minimum capacity and maximum capacity of exactly .00023 mfds. No other condenser achieves just the right balance between perfect selectivity and over critical adjustment.



### The Haynes Bank Wound Coupler

\$4.35

Furnished with only the taps you actually use and just the right number of turns on the secondary. Bank winding provides 100% efficiency on higher broadcasting wave lengths.



#### For Radio Experimenters

- Haynes-Griffin Oscillator Coupler . . . . . \$3.50
- F. & K. .0005 Microtune Vernier Condenser — each . . . . . \$5.80
- H.-G. 20 ohm Rheostat . . . . . \$ .85
- Dubilier .005 Fixed Condenser . . . . . \$ .60
- Fada Socket . . . . . \$1.00

LAURENCE M. COCKADAY, R. E., describes the Haynes Circuit on page 222 of September Popular Radio. Reprints of this interesting article will be mailed by us anywhere upon receipt of a 2c. stamp. Also Mr. Cockaday's article in October issue of Popular Radio telling how to add a Two-Stage Audio Frequency Amplifier to the Haynes Circuit.

The appeal of the Haynes Circuit is universal. To the experienced amateur because of its astonishing long reception and wonderful selectivity; to the radio novice because of its easy construction and operation. So simple that no one can possibly go wrong.

1000 Miles for \$15.00

The outstanding feature of the Haynes Circuit is its simplicity and compactness of arrangement with all instruments panel mounted.

Most experimenters will find it well worth their while to substitute parts recommended by Mr. Haynes for those they may have on hand.

- Haynes .00023 Condenser . . . . . \$3.50
- Haynes Bank Wound Coupler . . . . . 4.35
- Fada Rheostat . . . . . .75
- Fada Socket (Panel Mounting) . . . . . 1.00
- Switch Arms . . . . . .20
- 4 Switch Points and 2 Stops . . . . . .06
- 10 Binding Posts . . . . . .50
- 2 3-inch Dials . . . . . .90
- 1 Dubilier Grid Condenser .00025 mfds. (with leak mounting) . . . . . .45
- 1 Grid Leak 1 meg . . . . . .35
- Bus Bar, Solder, Copper Lugs and all miscellaneous material . . . . . .55
- 7x15 Grade A Hard Rubber Panel . . . . . 1.50
- Panel Drilled for Mounting all the above instruments (extra) . . . . . 1.50

#### Accessories

- 7 x 15 solid mahogany cabinet, piano finish, \$4.25; Haynes-Griffin Head Phones (2200 ohms) \$4.75; W. D. 12, UV 201 A or UV 199 Vacuum tubes, \$6.50; 22½ volt variable B Batteries, \$1.25; 1½ volt dry cell A batteries, \$ .40 each.

Complete parts to build the Haynes Two-Stage Amplifier cost \$15.00 additional, including drilled panel. Tubes, cabinet, and batteries are not included at this price.

Parcel Post Prepaid in U. S. anywhere east of the Mississippi River

**HAYNES-GRIFFIN RADIO SERVICE, Inc.** 41 W. 43rd St. New York City  
New York's Largest Radio Store

Please mention POPULAR RADIO when answering advertisements.

# POPULAR RADIO with Your Other Favorites — at Special Club Prices!

Your pick of these leading magazines at reduced rates in combination with a year's subscription to POPULAR RADIO

**G**LANCE over this big list of magazine bargains that have been arranged for your benefit. Here is your chance to get almost any magazine you want—and by ordering *now* with a year's subscription to POPULAR RADIO you get *both* magazines at special low prices.

If you are already a subscriber to POPULAR RADIO or to any of these other magazines, these special club offers allow you the privilege of renewing or extending your subscription *at a considerable saving of money.*

As you know, the subscription price of POPULAR RADIO will soon advance from \$2 to \$3 a year. Yet practically all of these magazine combinations are figured at a price for each magazine that is lower than even the present subscription price.

Fill your magazine requirements *now* for the coming year and save money. Simply check the offer you want and mail the coupon below, with your remittance. All subscription prices quoted are for one full year, and may be sent to *one* or to *separate addresses* unless otherwise noted.

But do not delay. These offers are good only until December 15th, 1923. After that date POPULAR RADIO advances in price and these prices will be withdrawn. Safeguard yourself *now* against POPULAR RADIO's raise in price, and in addition get these other magazines at special bargain club rates!

McCall's Popular Radio \$3.00 Reg. For.....	<b>\$2.40</b>	Modern Priscilla Popular Radio \$4.00 Reg. For.....	<b>\$3.25</b>
Youth's Companion (52 issues) Popular Radio \$4.50 Reg. For.....	<b>\$3.75</b>	Scientific American Popular Radio \$6.00 Reg. For.....	<b>\$5.25</b>
American Magazine Woman's Home Com- panion (both to one address) Popular Radio \$6.00 Reg. For.....	<b>\$5.00</b>	Pictorial Review Modern Priscilla Popular Radio \$5.50 Reg. For.....	<b>\$4.50</b>

## Or You Can Make Up Your Own Club of POPULAR RADIO With:

American Boy.....	\$4.00 reg., for...	<b>\$3.75</b>
American Magazine.....	4.50 reg., for...	4.25
Asia.....	5.50 reg., for...	4.75
Boy's Life.....	4.00 reg., for...	3.50
Century.....	7.00 reg., for...	5.75
Christian Herald (52 issues).....	4.00 reg., for...	3.15
Collier's (52 issues).....	4.50 reg., for...	3.75
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Designer.....	3.50 reg., for...	2.85
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Judge (52 issues).....	7.00 reg., for...	6.25
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Photoplay.....	4.50 reg., for...	4.25
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Popular Science Monthly.....	4.50 reg., for...	4.25
QST.....	4.00 reg., for...	3.60
Radio.....	4.50 reg., for...	4.00
Radio Broadcast.....	5.00 reg., for...	4.25
Radio Digest (52 issues).....	7.00 reg., for...	6.25
Radio News.....	4.50 reg., for...	4.00
Radio World (52 issues).....	8.00 reg., for...	7.25
Review of Reviews.....	6.00 reg., for...	4.75
Scribner's.....	6.00 reg., for...	5.25
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Vogue (26 issues).....	7.00 reg., for...	6.25
Wireless Age.....	4.50 reg., for...	4.00
World's Work.....	6.00 reg., for...	5.25

**Note:** If you wish any TWO or more of these magazines with POPULAR RADIO, simply deduct \$1.75 from the bargain club price quoted, then add POPULAR RADIO at \$1.75. For example:  
 Collier's.....\$3.75 less \$1.75= 2.00  
 Radio News..... 4.00 less 1.75= 2.25  
 POPULAR RADIO, added at only..... 1.75  
**Remit this amount \$6.00**

POPULAR RADIO, Dept. 111,  
 9 East 40th Street, New York City.  
 Enclosed is \$..... Please see that yearly subscriptions are at once entered in my name for each of the magazines I have checked in the special bargain club list at the right.

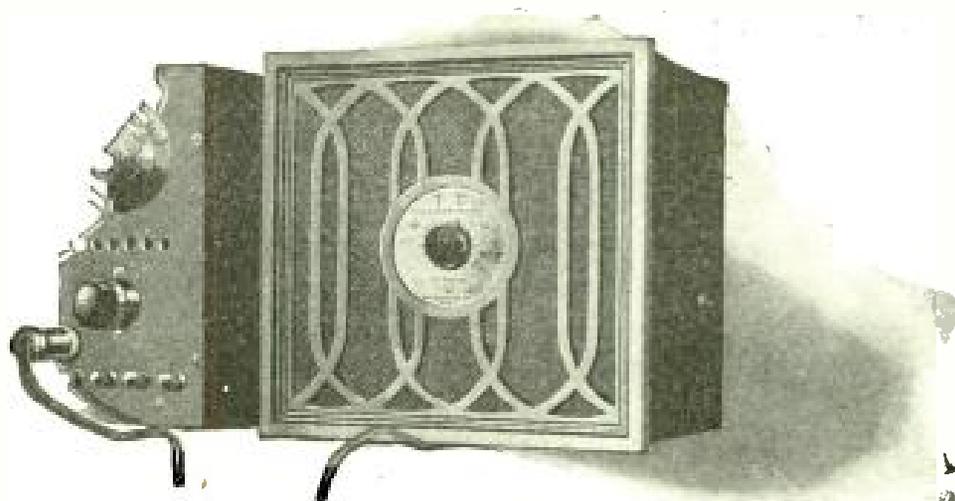
Name.....

Street and Number.....

City..... State.....

(If not a NEW subscription, please mark R after the name of the magazine, to indicate RENEWAL.)

Prices for Canada and foreign countries will be quoted on request.



## Where do you keep your radio?

Gone is the day when radio was called "wireless" and kept in the attic or the kitchen. Today, radio is in the same room with the piano, phonograph and the floor lamp, for it is furniture and should be selected as furniture on a basis of beauty as well as utility. In other words

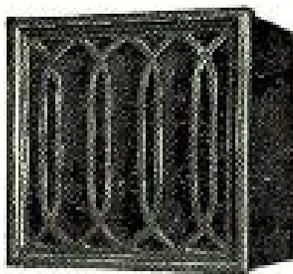
### *It's time to consider appearances*

This applies particularly to loud speakers. Timmons Talkers, with their symmetrical lines and the rich hand-rubbed mahogany finish of their cabinets and grills are the most beautiful loud speakers in the world.

We have also perfected the most efficient method of tone reproduction ever known. It is *reflected* tone. Two concealed metal horns are used. Both are surfaced with "acousticoat"—a substance which makes them absolutely dead to distortion and false tones. Everything is heard as naturally as it is broadcast.

And now we ask you to hear and see the result of our work—the new Timmons Talkers. Your dealer carries both models—A, \$35; N, \$25.

Ask him for our folder "Volume without Noise"—or write us

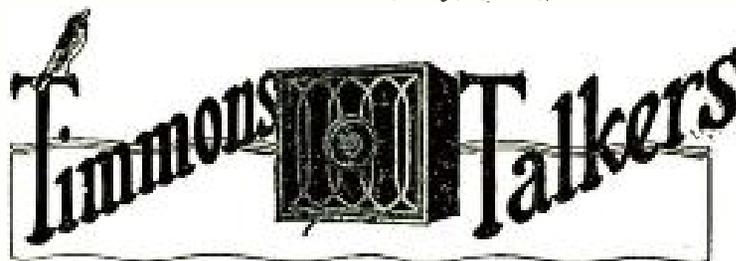


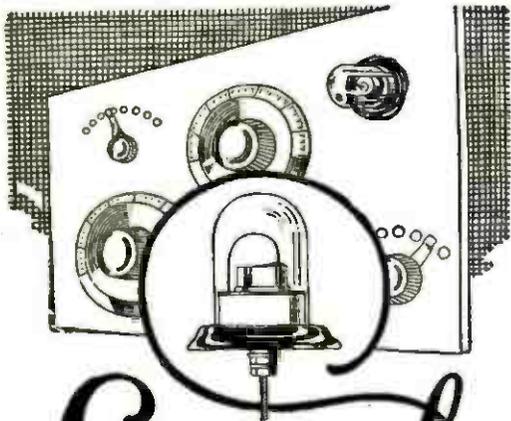
The screen of type A (Adjustable) is rich bronzed gold. Type N (Non-adjustable) has a screen of copper-color mercerized Madras.

## J.S. TIMMONS

339 East Tulpehocken St.  
Germantown, Phila., Pa.

Manufacturers of Radio and Loud Speaking Telephone Apparatus





# Grewol

THE PERMANENT DETECTOR

OFTEN imitated but never equalled. Maximum detector efficiency made constant, lasting. No flimsy cat-whisker; no parts to wear loose, no hunting for the sensitive spot. The GREWOL is proof against all ordinary detector troubles. The only detector for reflex, duplex and all circuits. Fully patented. Unconditionally guaranteed. **\$2.00**

Tested and approved by Jack Binns, radio editor of the N. Y. Tribune.

If your dealer has no GREWOLS, send \$2. to us with your dealer's name.

Write for Booklet

**RANDEL WIRELESS COMPANY**  
4 Central Ave. Newark, N. J.



For Radio Aerial Installation

## THE BULL DOG MAST SEAT

FILLS A LONG FELT WANT by enabling anyone to install a firm and rigid mast, on either a peaked or metal ridge roll type of roof, with ordinary tools found around the home, thereby eliminating customary trouble, labor and expense. Supplying neat, substantial construction throughout the entire aerial.

Seat for 1 1/2" mast, hinged type. . . . . \$3.00  
Seat for 1 1/2" mast, peaked type, plain. . . . . 2.50  
Seat for 1" mast, peaked type, plain. . . . . 2.00  
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Jobbers and distributors write for discounts.

**MAST SEAT MFG. CO.**  
119 5TH ST. S. E.  
MINNEAPOLIS MINN.

Head Set  
\$4.50



Loud Speaker  
\$12.00

## "ROYALFONE"

KING OF ALL



A head set far superior to the average and just as good as the best.

Equally good for all distances.

A loud speaker of superior qualities. Reproduces signals with no distortion at high amplification. A home instrument at a very moderate price.



**Royal Electrical Laboratories**  
Ordway Bldg., Newark, N. J.

*Royalfone*  
KING OF ALL

Pick Up Distant Stations Easier with

## The BROCKWAY VARIABLE CONDENSER

It gives greater efficiency in radio frequency, reflex neurodyne and other critical circuits. Combines advantages that no other condenser can give.



**Easier to Adjust** than a vernier. Two complete revolutions of dial (720 degrees movement) make accurate tuning easy.

**Saves Space** behind panel, leaving more room for other instruments, tubes, B batteries, etc.

**Improves Any Circuit** requiring 11 to 43 plate condenser. Gives longer distance reception.

If your dealer has no Brockway Variable Condenser in stock, ask him to order for you; or we'll send postpaid on receipt of price with dealer's name and address.

PRICE \$3.50.

**BROCKWAY LABORATORIES CO.**  
Factories Bldg., TOLEDO, OHIO

Please mention POPULAR RADIO when answering advertisements.

SECOND ANNUAL  
**Chicago Radio Show**

**COLISEUM**

**NOVEMBER**

**20th to 25th**

**TUESDAY to SUNDAY  
INCLUSIVE**

**The World's Greatest Exposition of  
RADIO**

and Associated Industries and Conclave of Manufacturers,  
Distributors, Jobbers—Dealers and Radiophans

**A Contest for Amateur Builders of  
Radio Receiving Sets**

For the best home-made receiving set built by any amateur in the United States, using any hook-up:

**First Prize \$75.00      Second Prize \$50.00      Third Prize \$25.00**

All sets entered in this contest to be exhibited in the Show. Contest opens October 15th. Sets must be in by November 18th. For further details and Entry Blanks write to Contest Dept., Chicago Radio Show, 127 North Dearborn Street, Chicago, Ill.

The amateur exhibit will be in addition to the exhibits of all the leading radio manufacturers. Manufacturers who have not as yet obtained their allotment of space are advised to get into immediate communication with the management of the SHOW.

**OFFICE: SUITE 520  
127 No. Dearborn Street**

**JAMES F. KERR**  
Manager  
Telephone, State 4161

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# Still Time to Subscribe to Popular Radio at the Old Price!

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**I**N its improved and enlarged form, POPULAR RADIO now sells for 25 cents on the newsstands. The addition of 56 more pages of reading matter beginning with this November issue, now in your hands, makes POPULAR RADIO the biggest value for the money that can be had in the radio magazine field.

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To either **new** subscribers or **present** subscribers this same liberal offer is made. If you are already a subscriber, you may

*extend* your present subscription for one or two years at these low rates, thus insuring yourself of all the helpful hints and practical suggestions, interesting articles, new hook-ups, and the wealth of timely information on all phases of radio which will appear in the pages of POPULAR RADIO during the months to come.

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Do not delay filling out and mailing the attached coupon. This offer is good only until December 15th, 1923. After that date all subscriptions to POPULAR RADIO will be at the rate of \$3 a year. By taking advantage of this offer now, you save from one to three dollars.

And in addition, POPULAR RADIO itself—besides keeping you in touch with all the rapid developments in this fascinating field, will save you many times its cost when constructing and improving a set of your own, and will safeguard you against many an hour wasted in costly experiment.

Get only the *best* results with radio by becoming a regular subscriber to POPULAR RADIO. Fill out and mail the handy coupon today.

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9 East 40th Street, New York City

Please enter (renew, or extend) my subscription to POPULAR RADIO for ONE YEAR at the present rate of only \$2.00 a year. This saves me a dollar over what I would pay later, when the price goes up. I enclose \$2.00 (check, money order or registered mail).

Name.....

Address.....

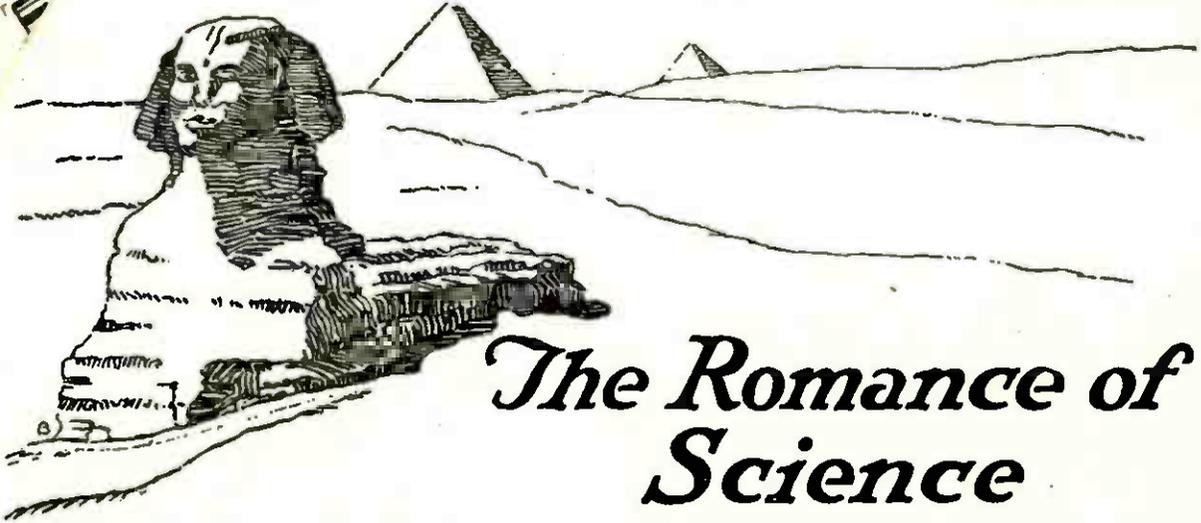
POPULAR RADIO, Dept. 115,  
9 East 40th Street, New York City.

Please enter (renew, or extend) my subscription to POPULAR RADIO for TWO YEARS at the special low rate of only \$3.00. This saves me three dollars over what I would pay later, when the price goes up. I enclose \$3.00 (check, money order or registered mail).

Name.....

Address.....

*(No extra for Canada. Foreign, ONE YEAR, \$2.25; TWO YEARS, \$3.50).*



## The Romance of Science

**C**ONQUESTS of science were the real achievements of Egypt's rulers. Instead of physical prowess, they sought the laurels of intellectual supremacy. Battles became experiments. Physics, astronomy, alchemy became the chessmen of their leisure. Where other nations plunged into wars and devastation, the Egyptians gave over their vigils to the investigation of natural phenomena.

To symbolize this intellectual power and their ability to create, they conceived the Sphinx, and with unparalleled skill and persistence engraved their triumph on the face of History.

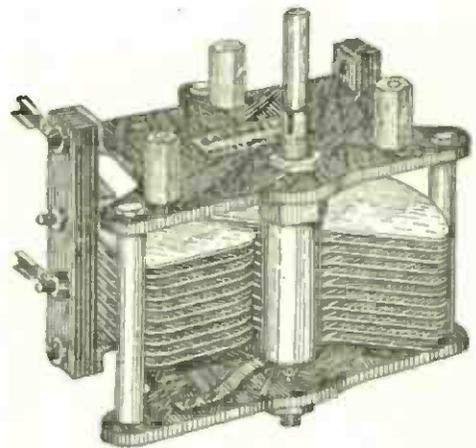
If you assemble your radio parts from plan or book, take time to drink in the romance of radio art. Know on what laws the perfection of your receiving set depends. To acquire such knowledge is not a boresome study, but an

absorbing recreation. As you read, you will understand the impelling appeal of science which has ever tempted Masterbuilders to create craftsman-like products which are more than adaptations of existing designs.

By understanding the scientific basis of radio phenomena, you will begin to appreciate what every radio engineer knows concerning condensers: - that there are no condensers equal to Cardwell's.

Cardwell rotor-grounded condensers afford entire absence of body capacity effects and permit fine tuning of the most distant stations. They have such infinitesimal losses, no laboratory has been able to measure them. Their mechanical ruggedness insures long usage and freedom from annoying difficulties. Not only will Cardwells often add a thousand miles to your receiving range but they permit the entire elimination of interference.

For Egyptian Nights' Entertainment,  
Read: "Cardwell On Condensers."  
Sent on Request.



Prices Vary From Three To  
Three Hundred Dollars

Sold Only Through  
Responsible Dealers

## Radio Service Laboratories

announce

# "The Best Built Set in America"

R-212

Embodying The Hazeltine Neutrodyne circuit in an improved form as to neutralization, workmanship, quality, appearance and efficiency of operation.

Distributed through all reliable dealers and jobbers direct from the factory.

## Radio Service Laboratories



Department F

Asbury Park, N. J.

Licensed by I.R.M. Inc., under Hazeltine Patents

## POSITIVE RESULTS

are being obtained by thousands of satisfied users of the

### EASTERN COIL SETS for the COCKADAY CIRCUIT

The remarkable features which are making this circuit (4 circuit tuner) more popular each day are its simplicity of construction and control—wonderful selectivity—distance records—clearness and loudness of reception, and the fact that all capacity squealing, interference, etc., are eliminated.

Made as per specifications of Mr. Cockaday, using No. 18 wire with D coil bank-wound.

COMPLETE ASSEMBLED SET OF B, C AND D COILS—PRICE..... \$2.75

Hook-up directions and material list furnished free with each set of coils.

Mail Orders Filled. Dealers Communicate

EASTERN RADIO MFG. CO.

22 Warren Street, Dept. PR New York, N. Y.

## ELECTRIC SOLDERING IRON



EVERY RADIO FAN has been looking for this iron for both radio and home use. Operates on A. C. or D. C. current.

GUARANTEED one year. Sent anywhere in U.S. or Canada Parcel Post prepaid on receipt of money order for \$2.28.

FANS Send 2c stamp for our list of RADIO BARGAINS

**RADIO BARGAINS**  
17 N. LA SALLE ST.—CHICAGO



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\$1

**Radio Adapter**  
Hear all broadcasting through phonograph. Make your own horn. Attach B-R Phonadapter to YOUR phonograph. All can hear. Entire family, neighbors, guests can hear operas, lectures, latest news, with this adapter. Stretches over receiver of any standard type head-set and attaches to tone-arm of ANY phonograph. Made of soft, pure gum rubber. Quickly attached and removed. Thousands in use. Will not amplify or distort. For single receiver **.50**  
For pair of receivers (more than twice the volume) \$1

Go to your dealer. If he cannot supply you send money order, check or currency at our risk. Prompt delivery—postpaid. Also send us name of favorite radio dealer.

**The Beckley Ralston Company**  
1801 So. Michigan Ave., Chicago, Ill.



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**DIRECT FROM FACTORY TO YOU**  
Greatest radio B battery on market. Absolutely fresh, full voltage, seamless cells, noiseless—will bring in Concerts **LOUDER** and **STRONGER!** Built correctly—full number of voltage taps—will work any tube or loud speaker. Real service **GUARANTEED.** Sold direct from our factories to you at lowest prices. Shipped prepaid to your door. **ORDER TODAY.** Send money order, check or pay C. O. D. Order By Number

No. 122B—22½ volt variable—regularly \$2.25—our price **\$1.98**  
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**AYRES BATTERY CORPORATION, Cincinnati, Ohio**

## "DUTCH RADIO VALVE"

Detector and Amplifying Tubes

Buy the wonderful "Dutch Radio Valve" for your receiving set. They are guaranteed.

6 Volt Detectors..... \$2.50  
6 Volt Amplifiers..... 3.00  
3 Volt Guaranteed..... 3.00  
1½ Volt Detectors..... 2.50

Mail orders solicited. Send Bank Draft or Postal Money Order.

**D. R. V. IMPORTING CO.**

515 Orange Street Newark, N. J.

DEALERS: Write for discounts.



## WE REPAIR The Following RADIO TUBES

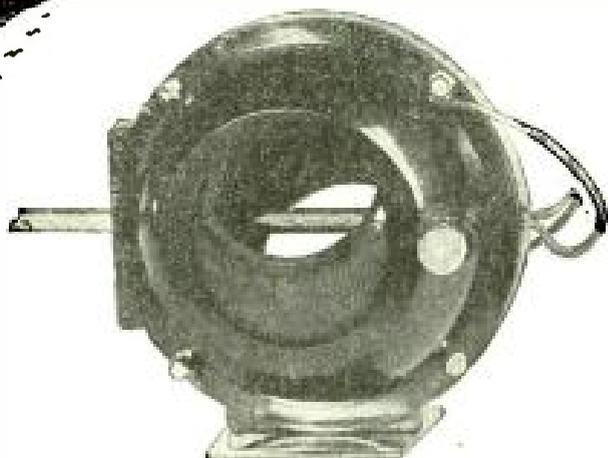
WD-11.... \$3.50	UV-199..... \$3.50
WD-12.... 3.50	C-299..... 3.50
UV-200.... 2.75	UV-201A..... 3.50
UV-201.... 3.00	C-301A..... 3.50
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Mail orders solicited and promptly attended to.

Dealers and Agents Write for Special Discount.

**H. & H. RADIO COMPANY**  
Clinton Hill Sta. P. O. Box 22-E. Newark, N. J.

# Raven Radio Instruments



Raven Bakelite Variometer  
Catalog No. B-101

are the height of perfection. The result of long and rigid laboratory research.

Made of Genuine Bakelite with the hardware used nickel plated throughout.

Their size permits their use in an extremely varied number of applications.

Made to conform with all wave lengths for both amateur and broadcast listeners.

## EVERY RAVEN INSTRUMENT IS UNCONDITIONALLY GUARANTEED

All Instruments are thoroughly inspected before leaving our factory and any purchase made by a Jobber, Retailer or User found defective in any way will be replaced by us with a new instrument free of charge to the purchaser.



Raven Bakelite Variocoupler  
Catalog No. B-102

Radio jobbers and dealers should write for our prices and descriptive literature on

- Bakelite Variometer . . . . . B-101
- Bakelite Vario-coupler . . . . . B-102
- Bakelite Tickler Coil . . . . . B-103
- Bakelite 180° Coupler . . . . . B-104
- Bakelite 180° Tickler Coil . . . . . B-105
- Bakelite Rheostat . . . . . B-106
- Wooden Variometer . . . . . C-101
- Wooden Tickler Coil . . . . . C-103

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# CATALOG E19-112 PAGES FREE

## EVERYTHING IN RADIO

One of the largest complete stocks in the world. 40 diagrams of latest Hookups.

## DEALERS ALL OVER THE U.S.

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**WHOLESALE RADIO DISTRIBUTORS**  
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## Cockaday Coil Set \$2.50

Including full size blue prints of panel layout, complete picture hookup, and fully illustrated instructions for construction and operation.

Coils are fully assembled, made exactly as specified by Mr. Cockaday, D coil bank wound. Far more efficient than any home made coils.

Standard parts for this sensational circuit—panel, coils, condensers, verniers, variable resistance, vernier rheostat, socket, double jack, dials, switch, contact points, posts, busbar wire, spaghetti, etc. (no tubes or phones).

**Complete for \$11.65**

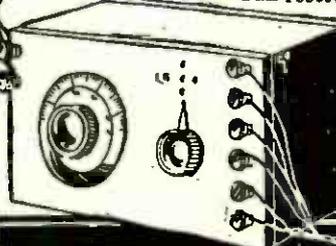
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Send No Money. **PAY THE POSTMAN**  
All Goods Shipped Parcel Post C. O. D.

**RADIO SURPLUS STORES**  
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## FREE VACUUM TUBE RADIO SET

Can receive 100 miles and more.



**RUSH** your name to learn how you can get a Vacuum Tube Radio Set **ABSOLUTELY FREE**. Don't delay; write today for **FREE RADIO PLAN**.  
**HOME SUPPLY CO.**  
Dept. 9  
131 Duane St., N.Y.C.

## RADIO TUBE & EXCHANGE

We Repair All Standard Makes of Tubes

Including	
W. D. 11 or W. D. 12.....	\$3.50
U. V. 200 or C. 300.....	\$2.75
U. V. 201 or C. 301.....	\$3.00
U. V. 201A or C. 301A.....	\$3.50
U. V. 199 or C. 299.....	\$3.50
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New 1 1/2 Volt Tubes.....	\$4.00

All tubes guaranteed to do the work.

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200 BROADWAY DEPT. 3 NEW YORK CITY  
All Mail Orders Given Prompt Attention  
Orders sent Parcel Post C. O. D.

# Loud Speaking Crystal Set

AT LAST

You can add a loud speaker to any crystal set by using the STEINMETZ Amplifier costing only \$8.50. Guaranteed to operate on any kind of crystal set regardless of what type it is, or we will refund your money. By using your crystal set with this amplifier music is brought in as clear as a bell and can be heard all over the room. Amplifier uses dry cell tube.

Write for our complete catalog and also information on a highly efficient detector and two-stage amplifier at \$22.50

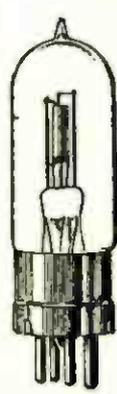
**STEINMETZ WIRELESS MFG. CO.**

Manufacturers and Engineers

5703 Penn Ave.

Pittsburgh, Pa.

## WE REPAIR All Standard Makes of RADIO TUBES



Including

W. D. 11 or W. D. 12.....	\$3.50
U. V. 200 or C. 300.....	2.50
U. V. 201 or C. 301.....	3.00
U. V. 201A or C. 301A.....	3.50
U. V. 199 or C. 299.....	3.50
U. V. 202 or C. 202.....	3.50
A. & P. or Moorhead set.....	2.75
A. & P. or Moorhead Amp.....	3.00
D. V. 6.....	\$3.00
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Broken glass shells replaced—No extra charge  
*Eight Hour Service*  
All tubes guaranteed and returned Parcel Post, C. O. D.

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\$100 Pair

## HEADPHONE CUSHION

HUDSON-ROSS

123 WEST MADISON ST.  
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## Let Radio Experts Buy for You

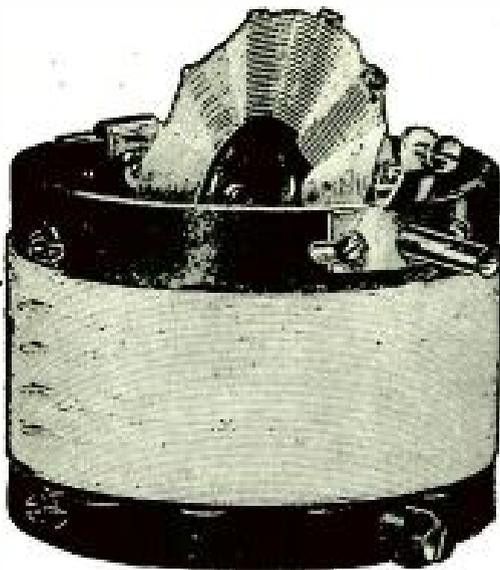
This  
Service  
Is  
Free

Why hunt from store to store? Save time, trouble and money—a group of Radio Experts in New York will act as your *personal representative*, buy for you any standard make of radio equipment you want, from the smallest part to a complete set, either assembled or unassembled, and deliver it to you prepaid—all for less than if you did your own buying. Satisfaction guaranteed. Advice on all radio problems—free to our clients. Write for plan.

**PERSONAL SERVICE PURCHASING BUREAU**  
505 Fifth Ave., Desk 12, New York

## You Don't Need Tubes

to get out of town. If you want new stations on your crystal set **WRITE ME TODAY**. Mine works 400 to 1,000 miles without tubes or batteries! Thousands have bought my plans and now get results like mine. **CHANGES OFTEN COST LESS THAN A DOLLAR**. Send self-addressed envelope for further information. Leon Lambert, 540 South Volusia, Wichita, Kansas.



**\$650 VARIOCOUPLER \$650**

WITH SPIDER WEB ROTOR PAT'D  
MINIMUM COUPLING—SELECTIVE TUNING

ROTOR—Spider Web design. 50 turns No. 25 d.s.c. wire  
STATOR—50 turns, No. 20 d.s.c. wire, 5 taps. SHAFT  
LENGTHS—for 1/8 in., 1/4 in. and 3/8 in. panels.  
Diameter—4 in. Height—4 1/4 in. Weight—1 lb.

The Hartman Electrical Mfg. Co.

Mansfield, Ohio

## Keep in Step USE RAY COILS

for  
Distance  
and  
Volume



Ray Coils "A" for Reinartz, Ray Coils "B" for RCS and Ultra Audion Circuits, Ray Coils "C" for RCS, Ultra Audion and tuned radio frequency for RCS Circuits.

A = \$2.50

B = 2.00

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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**

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## "UNITED" Radio Condensers and Transformers

**N**O matter what you pay for radio parts you generally get just what you pay for—cheap parts are cheap—not only in price but in materials and workmanship, and you can only expect to get cheap results.

"United" Radio parts are not built to meet a price—but to meet the exacting requirements of the radio set owner. The price is then figured. Large production, modern machinery and plant—good management—all combine to keep the price way down and yet the products are built as well both mechanically and electrically as it is possible to build them.

You take no chance when you buy "United" parts. We are so sure that they are correct that we will sell them on a money back guarantee.



United Audio Frequency  
Amplifying Transformers  
\$4.50 Prepaid



### "UNITED"

**Variable Condensers**  
without Vernier Dial and Knob

43 plate \$4.50	5 plate \$2.75
23 plate 4.00	3 plate 2.25
11 plate 3.50	Postpaid

With Vernier Dial and Knob  
46 plate \$6.50 26 plate \$5.50

If your dealer cannot supply, remit to us, sending in dealer's name.

**UNITED MFG. & DISTRIBUTING CO.**

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## CRYSTAL SET

**\$3.50**

"Neat, compact, efficient and remarkable value" is the expression used by one owner of a Ritter Grand Crystal Receiving Set.

Our guarantee:  
Receiving range, 25 miles or more. Wave length, 500 meters.

Audibility—  
Loud and Clear  
Outstanding  
Features:

Roller bearing slider, nickel plated hardware, mahogany finished base and top, height 6".

Sold by all dealers or by mail direct from factory.

**RITTER RADIO CORPORATION**  
232 Canal Street New York City

Originators and makers of the famous

**\$1.00 Ritter Portable Loop**

Some exclusive territories on Ritter products still open to distributors and jobbers



**CENTURY**

**THAT NEW CRYSTAL THAT GIVES SUCH WONDERFUL RESULTS!**  
 Entirely different from any other crystal on the market. Surface perfectly smooth, and supersensitive everywhere.

**CENTURY "RADIO REFLEX" CRYSTAL, Price \$1.00**  
 (For reflex circuits only)

**CENTURY "MAXITONE" CRYSTAL, Price \$1.00.**  
 (For crystal receiving sets)

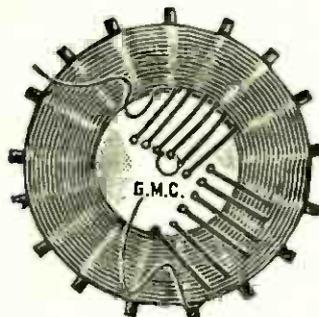
Order from your dealer or direct from:  
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**THE "POCKET-BOOK"** is a monthly net price catalog of Radio, Electrical and Lighting Supplies. All good dealers should have a copy; get on our mailing list now. No obligation. Use your letterhead.



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**WE SELL WHOLESALE ONLY**  
**OGDEN BOUL. & CARROLL AV. CHICAGO**



**Order by Mail**  
**Reinartz Coil**

This coil for standard Reinartz circuit Green silk windings Special this month \$1.75 post free

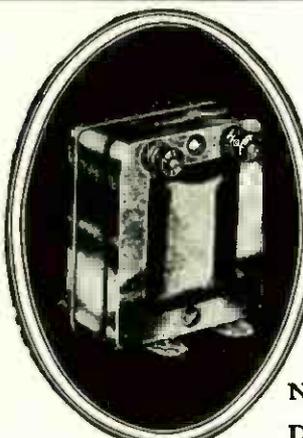
6 ohm Rheostat .75  
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 WD11—WD12—UV201A—UV199  
 and others for  
**\$3.00**

Quick service. All tubes repaired by us guaranteed to work as good as new. Send your dead tubes — we prepay parcel post to you. All you pay is \$3.00 to postman. We give 48 hour service.

**THOMAS BROWN CO.**  
 511-517 Orange Street Newark, N. J.  
**RADIO DEALERS—**  
**WRITE FOR OUR PROPOSITION**



**National Audio Frequency Transformers**

The New 6 to 1 Ratio National Transformer is for use on the first stage of amplification. Its greater ratio means increased volume, but the tone qualities that characterize the 3 1/2 to 1 ratio have been fully retained. Price of 6 to 1 ratio \$4.50 postpaid; of the 3 1/2 to 1 ratio, \$4.00 postpaid. Dealers: Write for interesting sales proposition.

**National Transformer Mfg. Co**  
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**RUSONITE**

**CRYSTAL RECTIFIER**

(Patent Pending)  
**THE PERFECT SYNTHETIC CRYSTAL DETECTOR SENSITIVE OVER ENTIRE SURFACE**  
 No Hunting for "Spots." Loud and Clear. Endorsed by Thousands of Satisfied Users

Sensitiveness Guaranteed	Price Mounted	50c
14 K. Gold Supersensitive RUSONITE CATWHISKER, Price Permanent. Will not Oxidize		25c
RUSONITE REFLEX CRYSTAL Manufactured Expressly for Reflex Circuits. Will Stand Up Under Heavy Plate Voltage	Price Mounted	\$1.00

Order from your dealer or direct from  
**RUSONITE PRODUCTS CORP.**  
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**"Read'em" Binding Posts**

Simplify the most complicated hook-up

Tell at a glance whether it is Antenna, Ground, Fones, A or B battery, etc. Name neatly engraved for keeps on top of each post. (See illustration.)

**Knobs Can't Come Off**  
 The irremovable knobs save time, trouble and petty annoyances. "Read'em" add to the appearance of any set. Don't be without them. Price 15c each. Set of ten \$1.50. If your dealer can't supply you with "Read'em" order direct.

Look for the name "Read'em" on every post

**The Marshall-Gerken Co.**  
 Dept. J. 27 N. Ontario St., Toledo, Ohio

**FREE**



**RADIO SET WITH DOUBLE HEAD PHONES**

This wonder RADIO SET in special metal cabinet with double head phones, complete ready to hook up

**ABSOLUTELY FREE**

**LISTEN** in on concerts, sports, lectures, singing, etc. **QUICK!** Send only your name to-day for wonderful **FREE RADIO PLAN.**

**GUARANTEE SALES CO.**  
 26-28 Washington Place Dept. 112, New York



Pat. Appl'd For

**96% Perfect  
Highest Award  
Given Any  
Condenser By**

**Radio News Laboratory  
HAMMARLUND  
VERNIER VARIABLE CONDENSER**

A product of engineering laboratories embodying every electrical and mechanical feature found in the most expensive professional apparatus. Affords super-accurate tuning for long distance reception. Eliminates annoying "cut-in" from undesired stations.

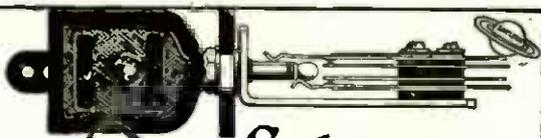
**Prices for Panel Mounting**

Alum. Plates		Brass Plates
\$7.00.....001 mfd. cap.	43 plate.....	\$8.50
6.00.....0005 mfd cap.	23 plate.....	7.00
5.50.....00025 mfd. cap.	13 plate.....	6.50
3 1/2" Bakelite Dial	\$ .75	Legs for Table Mtg. \$ .50

At your dealers—otherwise send purchase price and you will be supplied pospaid.

Send for descriptive circular

**HAMMARLUND MFG. CO.**  
144-146 W. 18th St. New York City



*The Saturn*  
**"Above the Ordinary"  
Radio Products**

**Automatic Plug**

Connected,—disconnected in a moment. Pulling tightens grip on cord tips. Lever instantly releases. Smooth, positive contact. Time and effort economized. Each Saturn Plug unconditionally guaranteed. Extra satisfaction at the same price.

List Price  
**\$1**

**Perfect Jack**

Rounded corner brass bracket, nickel plated. Spring German silver blades. Contact points of solid silver. Solder-flux compound on crowfoot offset of blades. Ready for quick connecting.

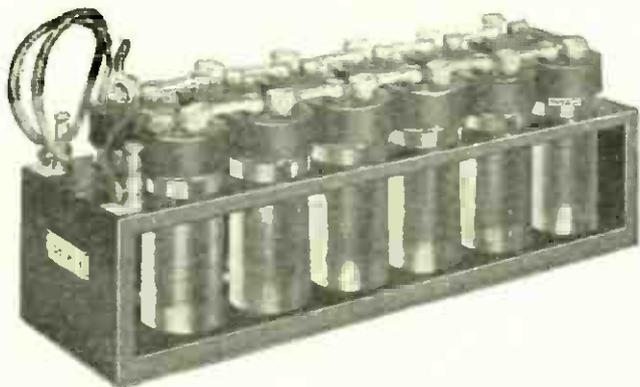
List Prices

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.



**24 V SENECA \$8.25 RADIO "B" BATTERY**  
Post Paid

**Absolutely Quiet Dry Charged**

The Seneca 24 Volt Radio B Battery is designed and constructed for long life, absolutely quiet and uninterrupted service, its separate cell assembly prevents current leakage common to other types. Seneca Batteries are shipped DRY with FULLY CHARGED PLATES and are ready for service immediately after addition of acid, without initial charging. They guarantee successful RADIO OPERATION. Send for yours today, if not satisfactory, return in 30 Days and money refunded.

For those who wish to build their own B battery we offer Genuine Seneca Battery Parts at 50c each, consisting of one each Pos. and Neg. DRY CHARGED plates, one Separator, one Glass Jar, one Cover with Gasket and Vent, and one Cell Connector. Shipped via P. P. prepaid upon receipt of price.

**SENECA BATTERY CORPORATION**  
1525 Main Street - - Buffalo, N. Y.

**HOWARD**



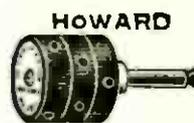
No. 1001  
6 1/2 Ohm Rheostat..... \$1.10  
25 Ohm Rheostat..... 1.10  
40 Ohm Rheostat..... 1.10  
Patd. 870,042



No. 1002  
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



No. 1003  
200 Ohm Potentiometer. \$1.50  
400 Ohm Potentiometer .2.00  
Patd. 870,042



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.**  
4248 North Western Ave., Chicago, U. S. A.

# Your Choice!

## —for Only 22 Cents in Stamps!

Hundreds of reliable hook-ups and circuit diagrams—practical hints and handy knacks—money-saving tips and pointers on how to make and improve your own sets. Take your pick of all this authoritative information on radio!

PERHAPS you haven't realized what a tremendous amount of information is available in the back issues of POPULAR RADIO. Since the first number was published, May, 1922, literally hundreds of requests have come to us for these valuable back issues of POPULAR RADIO which contain so many practical hints and worth-while suggestions.

There are still a few copies left of many of these back issues. *While they last* you can take your pick

of them at only 22 cents each, to cover cost and mailing. Here's your opportunity to complete your files of POPULAR RADIO and to add to your store of information on just the subjects which interest you.

Glance over this partial list of contents of each issue. Then tell us which ones you want, enclosing stamps, check or money order to cover your requirements. Our stock is getting very low, so don't delay taking advantage of this offer!

### May, 1922

- Harnessing waves to wire.
- How to make and install your own Receiving Set.
- How to tune a Regenerating Receiver.
- Symbols that help in reading diagrams.
- How to make soldered connections.
- How Radio waves are sent and received.

### June, 1922

- Wireless that we can see.
- Can we talk to the dead by Radio?
- How to use your Radio Set in summer.
- How electricity is generated.
- Tones that do and don't broadcast.
- How to make a simple tube Receiving Set.

### July, 1922

- Steinmets on ether waves.
- How to learn the code.
- How to make a two-circuit Receiving Set.
- How high frequency currents are generated.
- Pointers for preventing interference.
- How to make a loose-coupler coil.
- How to use your Phonograph as a loud speaker.

### August, 1922

- How machines are controlled by Radio.
- How Radio circuits are coupled and tuned.
- What "call letters" mean.
- Radio on your pleasure boat.
- How to make a variable condenser.
- The foolish fear of lightning.

### September, 1922

- How to build the Armstrong Circuit Receiver.
- How the Vacuum Tube works.
- A resonance wave coil for reducing static.
- How to make a rotary plate condenser.
- The simplest receiving antenna.

### October, 1922

- How to make a spider-web tuner.
- How the crystal detector detects.
- How to make your own grid condenser.
- Don'ts for Radio fans.
- How to use a Regenerative Set as a transmitter.
- How to restore worn-out crystals.

### November, 1922

- Sir Oliver Lodge on ether waves.
- How to add a Vacuum Tube to your crystal set.
- The most popular transmitting aerial.
- Right and wrong ways of adjusting the Regenerative Receiver.
- How to make a novel variocoupler.

### December, 1922

- Radio on your motor car.
- How to select the best coil for your set.
- How to make and use a loading coil.
- How the Vacuum Tube detects.
- A Receiving Set that takes notes.
- How to make a series-antenna condenser.

### January, 1923

(This issue in which appeared Mr. Cockaday's full description of his "DX" Regenerative Receiver is completely exhausted. A special Reprint of Mr. Cockaday's article may be had, however, for 22 cents in stamps.)

### February, 1923

- 20 tips on tuning.
- The Hoffman measurement charts.
- Shall I use a "hard" or "soft" tube?
- A novel tuner for shutting out interference.
- How the Audio-frequency amplifier works.
- Pointers on aeriels.
- How to add an Audio-frequency amplifier.

### March, 1923

- A Receiver without batteries.
- How to get the greatest efficiency out of your Radio circuits.
- How to make a one or two-step Audio-frequency Amplifier.
- How to make a Multi-Layer Coil.

### April, 1923

- Regeneration without Radiation.
- A crystal detector from a spool.
- How the Vacuum Tube detects and rectifies.
- How to make a simple single tube Receiving Set.
- Circuit diagram of the Cockaday DX-3 Circuit Tuner, with instructions on how to add three stages of radio frequency.

### May, 1923

(This issue, in which appeared Mr. Cockaday's description of his 4-Circuit Tuner, is completely exhausted. A special Reprint of Mr. Cockaday's article may be had, however, for 22 cents in stamps.)

### June, 1923

- How to use your Radio Set on your vacation.
- How the microphone transmitter works.
- How to build a good single tube receiver.
- How to make a crystal detector stand.

### July, 1923

- How to install your Radio Set on your boat.
- The ratio in size between your antenna and your coil.
- Useful facts about ear-phones.
- How to make a dry-cell tube Regenerative Set.
- How to keep up your storage battery.

### August, 1923

- How to build a Tuned Radio Frequency Receiver.
- Measurement chart for determining the constants for a loop antenna.
- How to calibrate your wave meter.
- Circuit diagram of the Cockaday 4-Circuit Tuner adapted for use with dry-cell tubes.

### September, 1923

- How to get a radio license.
- How weak signals are regenerated.
- How to make a battery charging rectifier.
- How to build the Haynes DX receiver.

### October, 1923

- Practical hints for Coil Calculations.
- How to make a Two-stage Audio frequency Amplifier.
- Ten good rules for Broadcast Listeners.
- How to make a simple Honeycomb Receiver.

## POPULAR RADIO, INC.

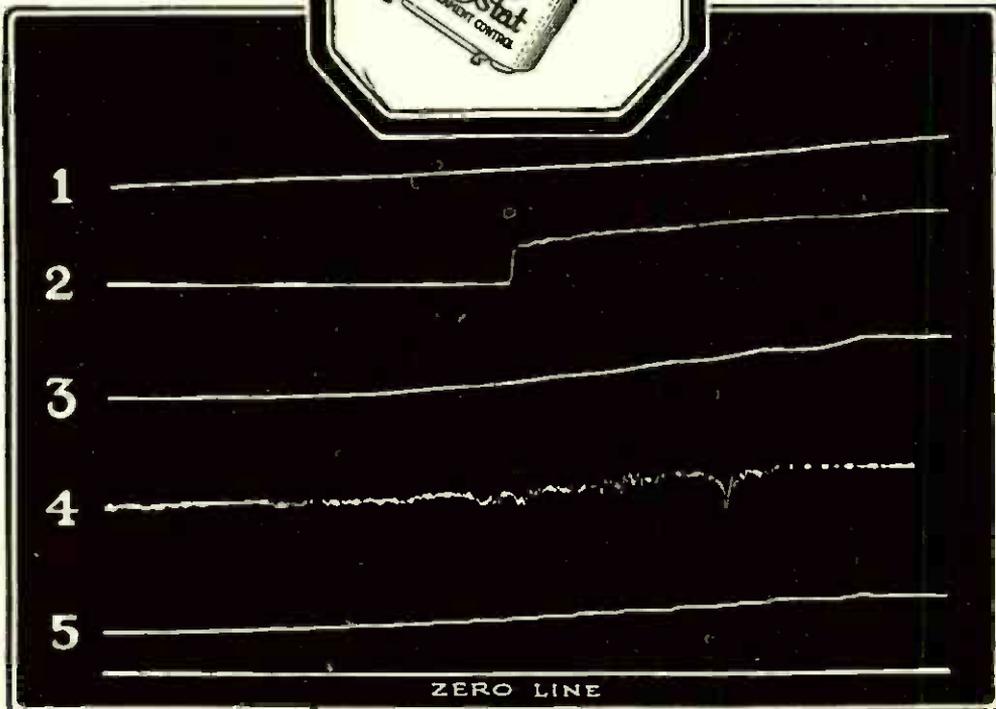
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STEPLESS • NOISELESS

COMPACT • PERMANENT

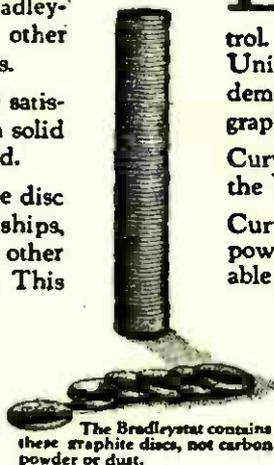


## The Graphite Discs in the Universal Bradleystat Surpass All Other Resistors for Perfect Filament Control

**S**UBSTITUTES have been offered, from time to time, for the scientifically-treated graphite discs in the Universal Bradleystat. Carbon powder, dust, flakes and other materials have been tried without success.

For a time, such materials appear to give satisfactory service, but they soon pack into a solid mass and the filament control is destroyed.

The Allen-Bradley Co. has built graphite disc rheostats for over twenty years for battle ships, mines, rubber plants, textile mills and other places requiring smooth, stepless control. This wide experience has made possible the Universal Bradleystat, backed by a guarantee of excellence and performance which assures every Bradleystat purchaser of a filament control that is perfect and permanent.



The Bradleystat contains these graphite discs, not carbon powder or dust.

**L**ABORATORY tests are made frequently to compare the performance of the Bradleystat with other types of filament control. A recent oscillograph test made at the University of Wisconsin is shown above to demonstrate conclusively the superiority of graphite discs over other resistance materials. Curve No. 1 is the smooth perfect control of the Universal Bradleystat.

Curves No. 2 and 3 show the control of carbon powder or dust rheostats. Observe the unreliable and irregular control obtained.

Curves No. 4 and 5 illustrate the control of two types of wire rheostats.

Remember—The Universal Bradleystat can be used with any receiving or amplifying tube, and with 5-watt sending tubes.

Retail Price \$1.85  
In Canada \$2.50

**Allen-Bradley Co.**  
Electric Controlling Apparatus  
276 Greenfield Ave. Milwaukee, Wis.

All Reliable Dealers  
Sell the Bradleystat

THE ALLEN-BRADLEY CO. HAS BUILT GRAPHITE DISC RHEOSTATS FOR OVER 20 YEARS

# A Brand New Grid Leak

WITH

## Stepless Adjustment from $\frac{1}{4}$ to 10 Megohms



September 8, 1923.

ALLEN-BRADLEY CO.  
Milwaukee, Wis.

Gentlemen:—

I just received our laboratory report wherein the Bradleyleak is complimented very highly when compared with other adjustable leaks. The Bradleyleak gave smooth, uniform control without sudden alterations of the grid circuit, and is the only device tested in our laboratory which is stable in operation. We found it quite independent of atmospheric conditions, a factor not found in other adjustable leaks exceeding one megohm.

I cannot impress you too strongly with the great necessity of an adjustable grid leak for radio receiving sets and feel confident that the Bradleyleak will find a very popular field as soon as its operation is appreciated.

Yours truly,

CROSLY MANUFACTURING CO.



*Crosley Laboratory Enthusiastic  
over this remarkable grid leak*

**T**HE Bradleyleak is now ready for you! After months of laboratory research, a new and better adjustable grid leak has been developed which provides a stepless range of resistance from  $\frac{1}{4}$  to 10 megohms. This problem has defied radio engineers for a long time, but finally has been solved through the use of two columns of discs of special composition placed under the variable pressure of the Bradleyleak knob. Any conceivable resistance is obtained with utmost accuracy by turning the adjusting knob. When once adjusted, the setting is permanent. [Read the letter from the Crosley Manufacturing Company's Laboratory.]

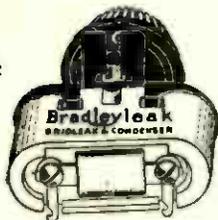
The radio world has been waiting for a real adjustable grid leak. Here it is! There is no substitute for the Bradleyleak, either in performance or accuracy. It is furnished with a grid condenser, if you desire. Your dealer will get the Bradleyleak for you. Avoid unreliable makeshifts, and improve your tube efficiency by installing the Bradleyleak.

**BE UP-TO-DATE! MAIL THE COUPON**

Retail Price

**\$1.85**

P. P. 10c



Condenser

.00025 mf.

35c extra

*Unaffected by atmospheric conditions.  
Smooth and uniform in adjustment.*

# Bradleyleak

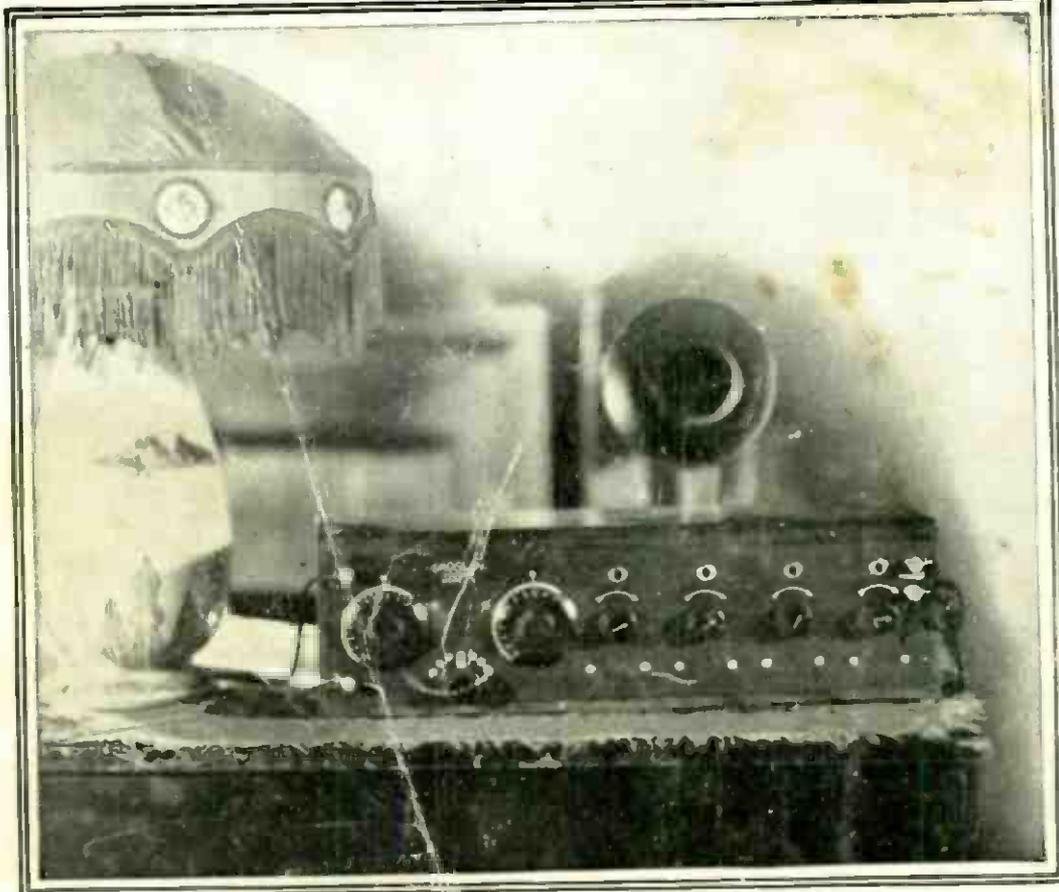
## THE PERFECT GRID LEAK

Allen-Bradley Co.  
276 Greenfield Ave., Milwaukee, Wis.

I am glad to hear that a dependable, adjustable grid leak can now be obtained. Please send me your descriptive folder.

Name \_\_\_\_\_

Address \_\_\_\_\_



## PERFECT PERFORMANCE

### Crosley Model X Gives Better Radio Reception

**T**HE popularity of Crosley Model X is becoming more manifest each day.

This four tube set—still priced at \$55—maintains its marvelous record of bringing in distant stations.

A man writing from Chatham, Va., says, "First let me state I own a Crosley Model X and you couldn't buy it for the United States mint. I have picked up over 130 stations in the U. S. and have listened to Havana, Canada, North Dakota, San Francisco, all Texas and ships at sea. Keep up the good work!"

You can depend upon an instrument bearing the name

# CROSLEY

This name has been accepted as a guarantee of the highest quality at the lowest cost.

All Crosley sets are equipped with the Crosley multistat, the universal filament control rheostat for all make of tubes.

Wave length range 200 to 600 meters.

Other Crosley parts include: Variable Condensers, Knobs and Dials, V-T Sockets, Variometers, Vario Couplers, Rheostats and the well-known Crosley Radio Frequency Amplifying Tuner.

A Crosley Instrument performs everything claimed for it—and more besides.

For Sale by Best Dealers Everywhere. Write for Free Catalog.

*We announce a new model—to be known as Model X-J. This has all the features of Model X and in addition—new molded sockets, new rheostats, new condensers with molded plates and jack for head phones. Price \$65.*

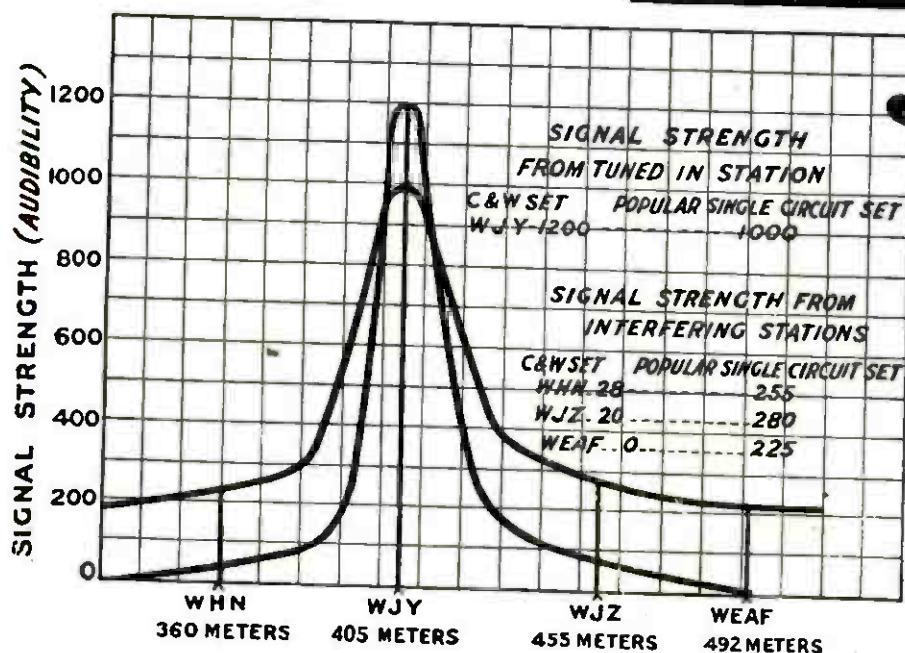
## CROSLEY MANUFACTURING COMPANY

918 ALFRED STREET CINCINNATI, OHIO

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Boston Office, B. H. Smith, 755 Boylston St., Room 316.

Chicago Office, 1311 Steger Bldg., 28 E. Jackson Blvd., R. A. Stemm, Mgr.  
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# Here is *Proof*



## of Cutting and Washington Superiority

Tested with other broadcast receivers—on the same antennae—listening to the same stations—the *audibility meter proves* that Cutting and Washington Sets give:

**Greater Volume from the Station You Want to Hear.**

**Less Interference from all Other Stations.**

Before you buy, *insist* on a demonstration of a Cutting and Washington Receiver (Armstrong patent). Ask your dealer or write direct for complete information.

*Dealers: The set you can prove to be best is the easiest to sell. Write us.*

**Cutting and Washington Radio Corp.**

Operating Station WLAG—"Call of the North"  
Minneapolis Minnesota



### How Test is Made

In the graph above a C&W Receiver and a popular single circuit set, using the same antennae, are tuned at New York to station WJY, 405 meters, 25 miles from New York City.

The micro-ammeter shows a signal strength of 1200 for C&W or 200 points greater than the other receiver.

Interference from other stations shown is 25, 20 and 0 for C&W—so low it is almost inaudible. Interference from other stations measures 255, 280, 225 for the other receiver—a serious annoyance.

This result is typical of C&W comparative tests.

# Cutting and Washington