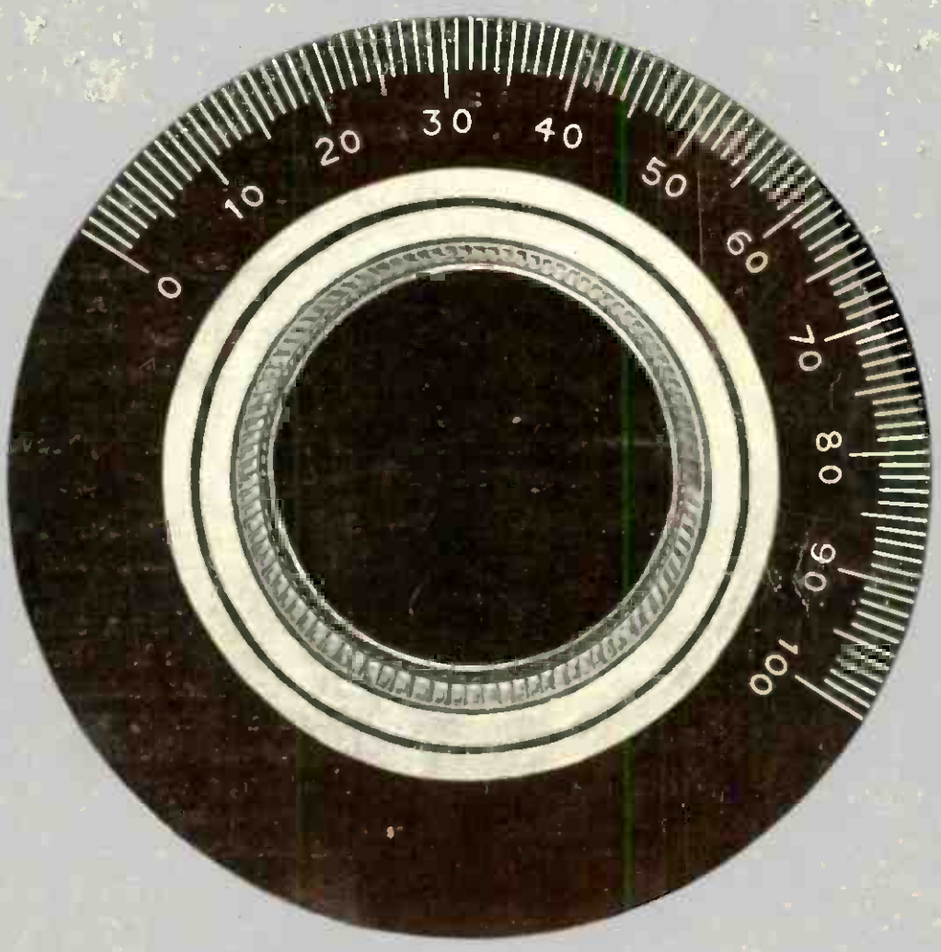
$2.00

Popular Radio

FEBRUARY, 1923

20¢



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Radiola Grand and Mahogany Stand with "B" Batteries, tubes and full instructions **$350.00**

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The finest principles of radio detection, amplification and loud speaking are embodied in the new Radiola Grand.

The Radiola Grand has been especially designed to receive broadcasting stations operating on the standard wavelengths of 360 and 400 meters but an additional range is available up to 550 meters. By means of the resonant loud speaking chamber, the entire family may receive broadcast music and other entertainment and instruction.

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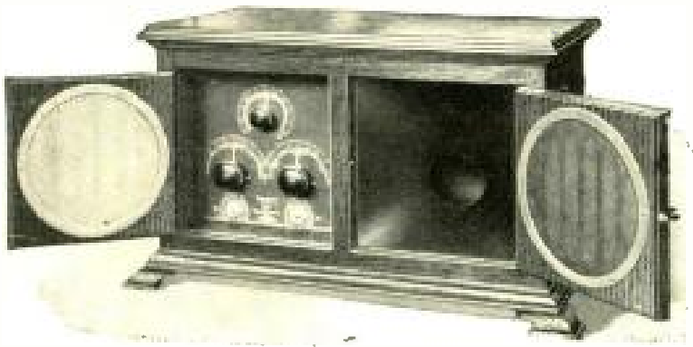
An exceptional feature of this instrument is its amplifying system which has been developed to such an extent that practically no distortion of speech or music exists.



Radiola IV, complete with 4 tubes (1 spare), all batteries, headset with telephone plug and silk covered leads for antenna and ground **$275.00**

RADIOLA IV

Radiola IV is a self contained console-type broadcast receiver. The cabinet contains a regenerative receiver, a detector, two stages of audio frequency amplification, a new loud speaker of unsurpassed tone quality and all necessary batteries.

Radiola IV is not only a highly efficient receiver, embodying the latest developments in design, but is also a thing of beauty that will grace a drawing room or library.

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FOR BETTER RESULTS USE

EVEREADY

"A" and "B" BATTERIES WITH YOUR RADIO SET

EVEREADY "A" BATTERIES

No. 6810	50 Amp. Hrs.	$15.00
No. 6860	90 Amp. Hrs.	18.00
No. 6880	110 Amp. Hrs.	20.00

—Hardwood Box, Mahogany Finish
—Convenient Handle, Nickel Plated
—Rubber Feet, Protect the Table

No Accidental Short-Circuits

All Eveready "A" batteries are equipped with a 4 volt as well as a 6 volt terminal, making it possible to use either 6 volt or 4 volt vacuum tubes in your set

EVEREADY "B" BATTERIES

No. 766—15 Cells—16½ to 22½ Volts (1½ Volt Steps) $3.00

No. 763—15 Cells—16½ to 22½ Volts (1½ Volt Steps) $1.75

—because of limited capacity, due to small cells, No. 763 is recommended only where light weight and small space are essential

No. 767—30 Cells—16½ to 22½ Volts (1½ Volt Steps) with a 45 Volt Tap for the Amplifier Tubes . . . $5.50

No. 746—72 Cells—16½ to 22½ Volts (1½ Volt Steps) with a 45 Volt Tap and a 108 Volt Tap $15.00

Guaranteed to be Absolutely Noiseless

Columbia Ignitor Six-Inch Dry Cells Equipped with Fahnestock Connectors

Columbia Dry Cells are suitable for the filament or "A" circuit of Westinghouse WD-11 Vacuum Tubes, which require one six-inch dry cell per tube

NATIONAL CARBON COMPANY, Inc.

Long Island City, N. Y.

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POPULAR RADIO

EDITED *by* KENDALL BANNING

CONTENTS *for* FEBRUARY, 1923

VOLUME III NUMBER 2

VOLUME III FEBRUARY, 1923 NUMBER 2

Published monthly by Popular Radio, Inc., 9 East 40th Street, New York, N. Y., telephone number Vanderbilt 9985; H. B. Emerson, President; E. R. Crowe, Vice-President; P. O. Batch, Treasurer. Price, 20 cents a copy; subscription $1.50 a year in the U. S., $1.75 in Canada; elsewhere $2.00 a year, payable in advance. The International News Company, Ltd., No. 5 Bream Bldg., London. E. C. 4, sole distributors in England. Entered as second-class matter April 7, 1922, at the Post Office at New York, N. Y., under the act of March 3, 1879. Printed in U. S. A.

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

A Page with the Editor

In the next issue of Popular Radio the Editor will spring a rare treat upon our readers. He has been quietly working on this March number for six months—not daring to announce it for fear that some accident might upset his plans. But at last his hopes have been realized—and next month he will present our readers with an "All-Star Number."

* * *

The March issue will be the first All-Star number ever issued by any radio magazine—or by any technical or semi-technical magazine, so far as the Editor knows. Every contributor is a scientist of international fame—and each has written an article that is a real contribution to the literature of radio. Glance over this partial list of contributors; it includes the leading radio scientists of the entire world:

Senator Guglielmo Marconi
Dr. Lee De Forest
Sir Oliver Lodge
Hiram Percy Maxim
Major-General George O. Squier
Paul Godley
Prof. James Arthur Fleming
John Hays Hammond, Jr.
John V. L. Hogan

This is incomparably the greatest list of radio experts ever assembled in one issue of any periodical.

* * *

"I never supposed that any periodical other than the journal of a scientific society could bring together the writings of so many distinguished men as Popular Radio has done," writes Hall Shepherd of Vanderbilt University.

* * *

This number of Popular Radio which you are holding in your hand is just exactly *double the size of our number of ten months back!*

This 100 percent growth has been as remarkable as it has been inevitable. Such a wealth of new and valuable and timely articles has been crowding into the editorial sanctum that the Editor can no longer hold it back in the files to await its turn for publication. It simply *has* to be presented to our readers while it is fresh—when our readers can profit from it most.

The demand of our readers, *"We want more* Popular Radio," has been answered.

* * *

Radio sets or parts that are forwarded to Popular Radio will be distributed without charge in those veterans' hospitals that can use them to best advantage. What other good fellows will help to let our disabled soldiers to listen in on the ether?

* * *

"Every day, in every way, Popular Radio is getting better and better," writes Noble Foster Hoggson, of New York, in paraphrase of the famous *dicta* of Dr. Coué.

When a disabled soldier in a veterans' hospital in Trenton, New Jersey, appealed to Popular Radio for a receiving set to help him while away his otherwise dreary hours, he started a chain that the Editor hopes will encircle the country. Through the generosity of a reader, Cyril Nast, the Trenton veteran had his wants satisfied.

* * *

Popular Radio's appeal to its readers for radio sets or parts to be presented to other veterans' hospitals has not fallen on deaf ears. The latest gift of radio parts comes from O'Donnell Brothers of Morris Run, Pa., and has been delivered to the U. S. Veterans' Hospital in the Bronx, New York, with the grateful approval of Dr. A. P. Chronquest, the Senior Surgeon.

* * *

Last month the police arrested a man on Broadway for selling fifty-cent pieces for a quarter.

What will the police do when they discover that we are selling Popular Radio for only 20 cents?

* * *

As evidence that Popular Radio's efforts to serve the interests of the radio fans of the country (which is another way of saying the "radio interests" of the country) is not confined to mere discussion and preachments—turn to page 120 of this number and read of the practical, constructive efforts to develop broadcasting with which this magazine is actively associated.

* * *

The transmission of symphonic music from the concert auditoriums to the broadcasting station by means of telegraph wires (instead of by the usual telephone wires) marks an innovation. And to prove that it *could* be done, Popular Radio and station WJZ got to work and *did it*—and did it better than has been done before by the telephone wires, according to reports.

* * *

Only hold-ups, murder and sudden death prevented Albert Bahr of Kansas City from promptly renewing his subscription to Popular Radio; as it was, his renewal came along nearly a week later than he intended. "It was neglected," he apologizes, "owing to the excitement over the robbery of my son-in-law's grocery and the murder of both him and his twelve-year-old son, who were shot at the time. Enclosed find my renewal subscription."

Well, we'll overlook the delay this time, under the circumstances.

Kendall Banning

Editor, Popular Radio

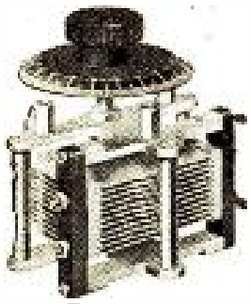
CARDWELL PRODUCTS

RECEIVER

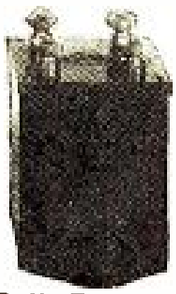
TYPE 125A

Double Circuit, using primary condenser; detector; two stages of audio, one radio frequency. Solid mahogany cabinet. A highly efficient long-distance set. Range 200 to 700 meters. **Price** **$125.00**

Easy to Adjust—
No Howling—Beautiful Workmanship



Type 123A



Radio Frequency Type 104A

Audio Frequency Type 124A

Cardwell Condensers Are Guaranteed

superior to others of similar type in the following respects.

Mechanical Construction—(All-metal frame. No insulated bushings.) Frame exceptionally rigid. Permanent alignment of plates.

Roto—Zero Potential to Frame—"Body capacity" and leakage practically eliminated.

Minimum to Maximum Capacity—Greater range than any other of equal plate area.

Dielectric—Entirely outside the electrostatic field.

Dielectric Loss—Reduced to the minimum. Less than ¼ square inch total area of contact between fixed plates and dielectric mounting strip.

(Eminently Superior for Loop sets.)

Adaptability—Condenser can be mounted on metal without bushings or on dielectric panel without changing capacity or increasing dielectric or leakage losses.

Price $4.75 Less knob and dial or Price $5.75 with knob and dial

A low price for a really superior instrument of (.0005 mfd. capacity.)

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WESTERN ELECTRIC CO.

The same rigid supervision and inspection that governs the above is also enforced in the manufacture of sets and parts for amateur use.

RADIO FREQUENCY—Range 200-500 Meters

Genuine moulded bakelite case. Correctly designed—low capacity—efficient winding. Will increase the receiving range of a set enormously. **Price** **$4.50**

AUDIO FREQUENCY—Ratio 9 to 1

Vacuum impregnated windings, specially treated silicon steel laminated core. Possesses excellent amplifying qualities, free from distortion. Operates well with all tubes. **Price**..... **$5.00**

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The Allen D. Cardwell Manufacturing Corporation

81 PROSPECT STREET **BROOKLYN, N. Y.**

No Wireless Receiving set is complete without

MAGNAVOX Radio
The Reproducer Supreme

R-2 Magnavox Radio with 18-inch horn: this instrument is intended for those who wish the utmost in amplifying power; for large audiences, dance halls, etc. $85.00

R-3 Magnavox Radio with 14-inch horn: the ideal instrument for use in homes, offices, amateur stations, etc. $45.00

Model C Magnavox Power Amplifier insures getting the largest possible power input for your Magnavox Radio. 2 Stage . $80.00
3 Stage . 110.00

When you purchase a Magnavox product you possess an instrument of the highest quality and service.

Magnavox products can be had of good dealers everywhere. Write us for copy of new illustrated booklet.

EVERY improvement in the science of radio broadcasting and reception only emphasizes the truly extraordinary qualities of Magnavox.

To enjoy all that radio offers in the way of daily concert, lecture and news, ask your dealer for a receiving set equipped with the Magnavox Radio Reproducer and 2-stage Power Amplifier.

Magnavox can be used with any good receiving set—the better the set, the more Magnavox can do for you.

The Magnavox Co., Oakland, California
New York: 370 Seventh Avenue

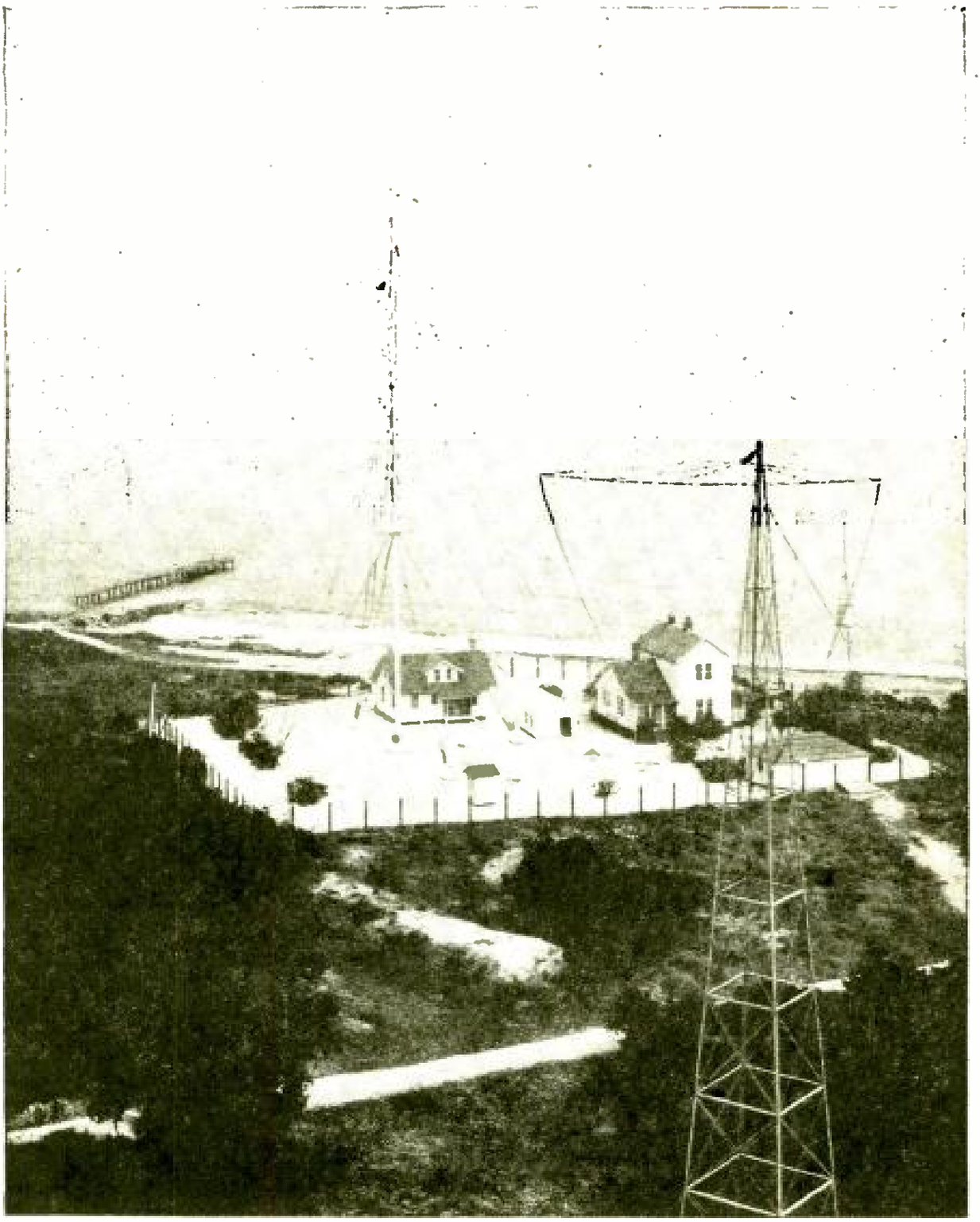
From a photograph made for POPULAR RADIO

Important—to All Amateurs!

"I am writing a series of articles for POPULAR RADIO *on points concerning which amateurs would probably be glad to get information. . . . I write not for mathematicians, nor yet for beginners, but aim at boiling down the results of mathematics into popular form suitable for amateurs who want to understand the principles of what they are doing, and who are constructing parts of their own apparatus."*

Oliver Lodge

This new series of articles by Sir Oliver Lodge begins in the next issue—March.



U. S. Navy Official

The Voice That Carries Around the World

From shore station to shore station, from ship to ship, "orders from headquarters" are transmitted by radio telegraph to any point on the globe where Uncle Sam's naval emissaries are permanently or temporarily located. This picture shows a representative Naval Radio Station, at the edge of the tropics in St. Augustine, Florida.

Popular Radio

VOLUME III FEBRUARY, 1923 NUMBER 2

"Clear the Ether!"

What the Navy Is Doing for Better Broadcasting

No radio amateur need be reminded of his novice days when, with his crude set, he was unable to tune out the incessant "interference" from the powerful radio stations of the Navy. This interference came from two sources: (1) from the high-powered arc transmitters which caused harmonics and (2) from the land and ship spark stations which emitted broad waves. How the Navy is clearing the ether of this bug-bear—to the gratification of the radio fan—is told in this article.

By COMMANDER S. C. HOOPER, U. S. N.

TWO years ago the government surveyed its shore naval stations, equipped with the most modern types of apparatus, with considerable pride and satisfaction. All the needs of radio communication between ship and shore, transcontinental and transocean were being met and it was felt that the spark equipment would suffice for many years to come, that the apparatus represented the last word in practical radio equipment.

Quenched spark transmitters were installed at coastal radio stations for communication with ships at sea and arc transmitters were provided for the transoceanic and transcontinental shore radio stations. These two types of transmitters were the only transmitters which were known to the art as being rugged, reliable, flexible in wavelength range and economical to maintain. The required transmission ranges were obtained with these transmitters and the selectivity was such that stations situated from fifty to two hundred miles from each other did not produce waves which interfered with the proper handling of traffic.

Up to this time vacuum tube transmitters were in an embryonic stage and there was considerable doubt as to whether this form of transmitter would ever be developed so that powers in excess of a few watts energy could be produced reliably. It is true that higher powered vacuum tube transmitters were in existence. but such transmitters had not been subjected to service tests over long periods. In such a state of development it was thought that it would be many years before the vacuum tube transmitter would be suited for continuous, reliable service, such as is required for shore radio stations.

This statement is based on the results obtained during the extensive development work undertaken by the Navy, in collaboration with commercial companies,

From a photograph made for POPULAR RADIO

"MOST OF THE COMPLAINTS ABOUT THE NAVY'S INTERFERENCE WERE TRUE"

So frankly reports Commander S. C. Hooper, in charge of the radio research department of the U. S. Navy. So the Navy promptly got to work to remove the causes.

on vacuum tube radio telephone and telegraph transmitters. In this work much time, effort and money was expended by the Navy to produce reliable vacuum tube equipment, but the Navy could not conscientiously place this equipment in service without the fear of expending large sums for maintenance.

Like an avalanche, the radio telephone craze came into vogue and everybody interested in this new type of entertainment bought a receiver. It did not matter what kind of a receiver was bought so long as the radio telephone concerts could be heard. Immediately from different points along the coast where naval shore radio stations were situated, inquiries began to come from the public about the interference experienced from these transmitting stations.

With these inquiries came various statements from different persons, to the effect that the Navy quenched spark transmitting stations were obsolete and inasmuch as they were a public nuisance they should be scrapped and new equipment installed. This was most likely brought about by the close associations of the radiophone enthusiasts with the reception of continuous wave signals, which naturally are sharply tuned. They compared the broad wave from the spark transmitter and the sharp wave from the radio telephone or continuous wave

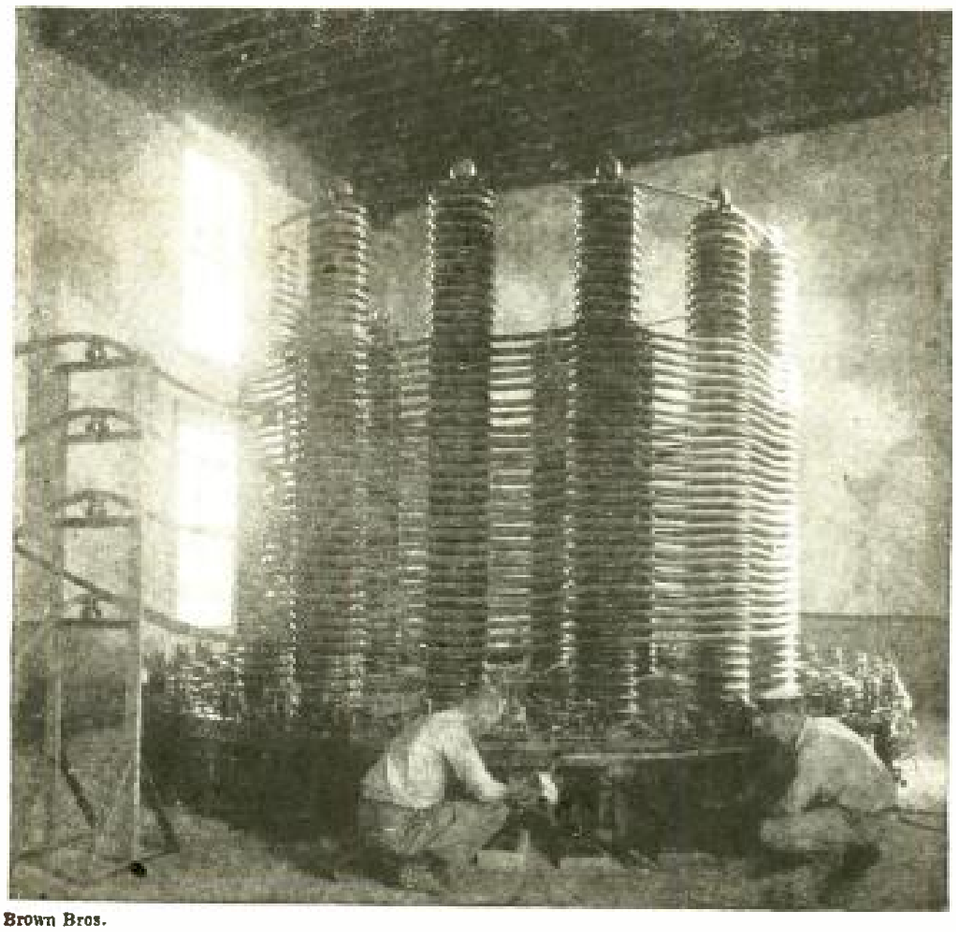
transmitter and then drew their own conclusions on the antiquity of the Naval quenched-gap transmitters. They did not, however, realize that the radio telephone transmitters to which they were listening were going through a stage of experimental development work at the cost of considerable sums of money in the development of high-power vacuum tubes. The method pursued in the experimental development work on radio telephone transmitters was suitable for the purpose of introducing the new entertainment, but equipment so developed could not be installed at shore radio stations where reliable transmitting ranges were required at all times, without saddling the taxpayer with undue expenses.

Tied in with the complaints on spark transmitters were a limited number of complaints on the interference caused by "mush" and harmonics emitted from arc transmitters at high-power shore radio stations. These complaints came from districts within a twenty-mile radius of the high-power stations. All the complaints were found to be true.

According to all communication laws, the handling of radio traffic is given priority over all experimental or other work.

The government realized the priority of radio traffic, but in order to remedy conditions, immediately set about to devise methods for removing the cause of the interference.

A thorough survey of the situation was made, and it was decided that the quenched-spark apparatus, considered the most modern a year previous, must ultimately be considered as a thing of the past and continuous wave transmitters



Brown Bros.

ONE OF THE CAUSES OF THE RADIO FAN'S TROUBLES

One of the giant tuning coils used to transfer energy from the generators to the antennas of the Navy's radio stations, and the source of the "mush" or harmonics that disturb the small receiving sets. The Navy's radio engineers have developed several methods for eliminating "mush," the adoption of one of which will solve the problem.

must be made standard. It was also decided that steps should be taken to eliminate the emission of mush and harmonics from high-power arc transmitters. If it was not possible to eliminate the harmonics and mush from such transmitters, steps should be taken to replace these transmitters with high-frequency alternators or high-power vacuum tube transmitters.

This decision was an important one, but it needed considerable thought on the part of the government, for the scrapping of the existing equipment on naval ship and shore stations and the replacement of such equipment by continuous wave transmitters would cost the taxpayer approximately $5,000,000, possibly more

For shore stations alone this would have amounted to at least one-third of the sum mentioned. How would the taxpayer consider such an expenditure when at the time the cry of the people was to reduce the taxes?

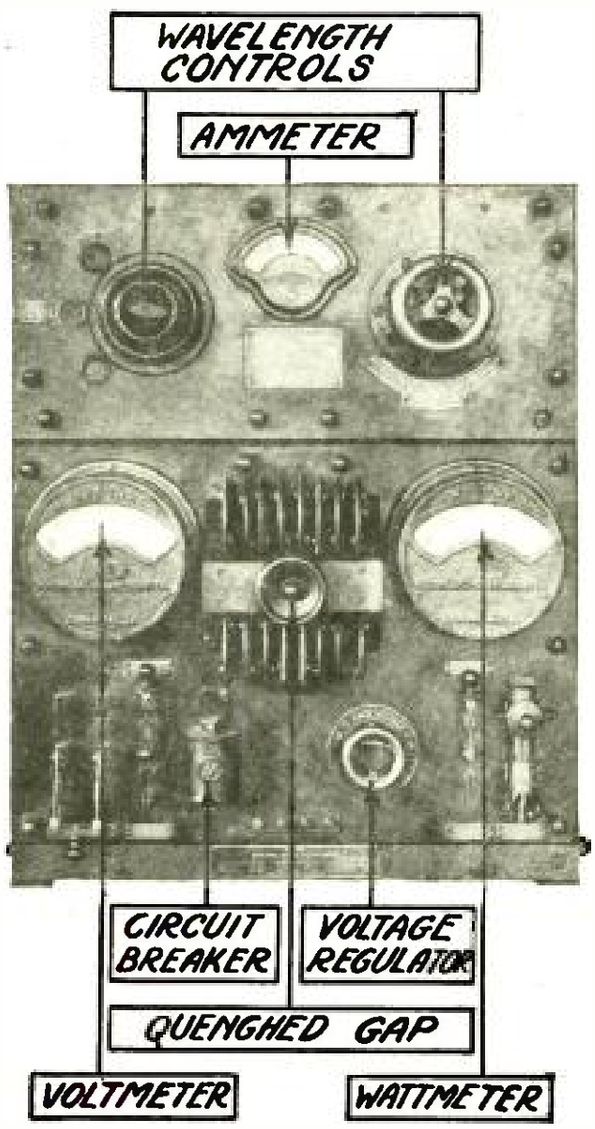
Numerous conferences were held in which the research and design engineers of the Navy Department were present. The outcome of these conferences was the adoption of the following procedure:

(1) To convert the existing spark transmitters to the new type vacuum tube transmitter, which employs the high voltage alternating current produced in the secondary of the transformer of the spark transmitter. This type of transmitter is now called the "Alternating Current Vacuum Tube Transmitter." Such a transmitter would employ the same power equipment as the spark transmitter and with the exception of the vacuum tubes and fittings would be identical to the original spark transmitter.

This change-over required considerable development work, but within the space of one year the work was completed, and after severe tests the new apparatus was finally accepted as a practical transmitter. Various sizes of this type of transmitter were made and were immediately installed on ships and at shore radio stations.

The illustration on this page shows a Navy standard ½ K. W. spark transmitter, while that on page 75 shows the same transmitter remodeled into a vacuum tube transmitter. The remodeled transmitter has a transmitting range which is twice that of the spark transmitter. This assertion is based on results obtained during practical tests when equal power input was supplied to both transmitters.

The expenditure involved in changing over the spark transmitters to vacuum tube transmitters was found to be ap-



THE DISCARDED SPARK TRANSMITTER

This apparatus is being remodeled as shown on page 75. This type causes the interference with which most radio fans are familiar.

HOW RADIO IS USED ON UNCLE SAM'S DESTROYERS

So successful was the Navy's experimental work with the radio telephone during the war—especially on vessels of the destroyer class—that it proved to be a factor in creating broadcasting as we know it today.

proximately one-third the cost of a new vacuum tube transmitter. The big saving, as the result of this policy, can be easily understood when it may be stated that a saving of $1,000 a transmitter on each ½ K. W. transmitter was obtained. A total of $300,000 was saved in remodeling fifty ship sets from spark transmitters to vacuum tube transmitters.

In view of the achievements accomplished in the saving of such sums of money, it was decided to proceed with the work of altering all spark transmitters to vacuum tube transmitters, and to alter as many sets a year as funds were available from other projects. This plan is now being carried forward and at the present time alterations have been authorized for at least one hundred ship sets.

The Navy Department further decreed:

(2) That intensive research work was to be proceeded with to eliminate the compensation wave from arc transmitters and also, if possible, to eliminate or reduce the arc mush and harmonics.

This work has practically been completed, thanks to the untiring efforts and brilliant work of Naval radio engineers. The single wave method of transmission for arc transmitters of all sizes up to 500 K. W. is a success and at the present time is in operation at numerous Naval ship and shore stations.

Various methods of eliminating arc mush and harmonics were tried at Navy Yards and also at high-powered shore radio stations. Virtually, this investigation was assigned to several Navy Yards and radio laboratories with the hope that some engineer would devise a suitable method of accomplishing this tremendously important objective. At first the problem seemed to be too big to solve, and it caused considerable worry to the engineers engaged in this work. They tried this method and then that method, but they seemed to come back again to the place where they started. It was discouraging work and it required more

patience than even the proverbial fisherman is said to have had.

But after many months of brain-racking work a solution was found. A great sigh of relief was given when it was proved that this problem was solved, for if it had not been, the scrapping of millions of dollars' worth of arc transmitting equipment would have been necessary.

The new equipments are now being given service tests to compare the relative efficiency of each of the various successful methods of eliminating harmonics and mush. The best method will be adopted and installations will be made as soon as funds are available. It is believed that the arc transmitter will be so modernized that it will radiate a pure wave and all interference caused by these transmitters eliminated to the satisfaction of the public.

By virtue of the expenditure of approximately $15,000 in research work, the Navy has saved its arc systems from being scrapped. This scrapping, as previously stated, would mean a waste of millions of dollars' worth of equipment. In the saving of this equipment the Navy, through necessity, has contributed much to the advancement of radio in general and broadcasting in particular.

I estimate that it will require at least three years for the government to modernize its radio equipment to the extent that no further complaints will be received from the great army of radio fans, concerning unnecessary interference due to Naval transmitters.

It must be realized, of course, that the

Edwin Levick

ONE OF THE PUBLIC SERVICES RENDERED BY THE NAVY'S RADIO MEN

When Uncle Sam's sailors undertook to furnish position reports to vessels approaching our shores, they vastly facilitated navigation—and they are doing it without charge. Here is a navy operator reading the direction of a ship at sea by means of the radio compass.

producers of radio sets for radio telephone broadcasting stations and the amateur must share their portion of the responsibility in keeping the air clear and at the same time remaining within the assigned band of wavelengths.

This will not be as easy a task as it at first appears, particularly the problem of keeping the wavelengths of transmitters fixed. This assertion should be carefully weighed, as it has been the Navy's experience that the wavelengths of transmitters must be checked daily and if necessary the transmitters must be recalibrated; otherwise they are subject to wide errors. Indeed, the Navy makes a practice of carefully checking the wavelength of each radio transmitting system, especially those at the high-power radio stations. This results in keeping all Naval high-power stations always on their assigned wavelengths.

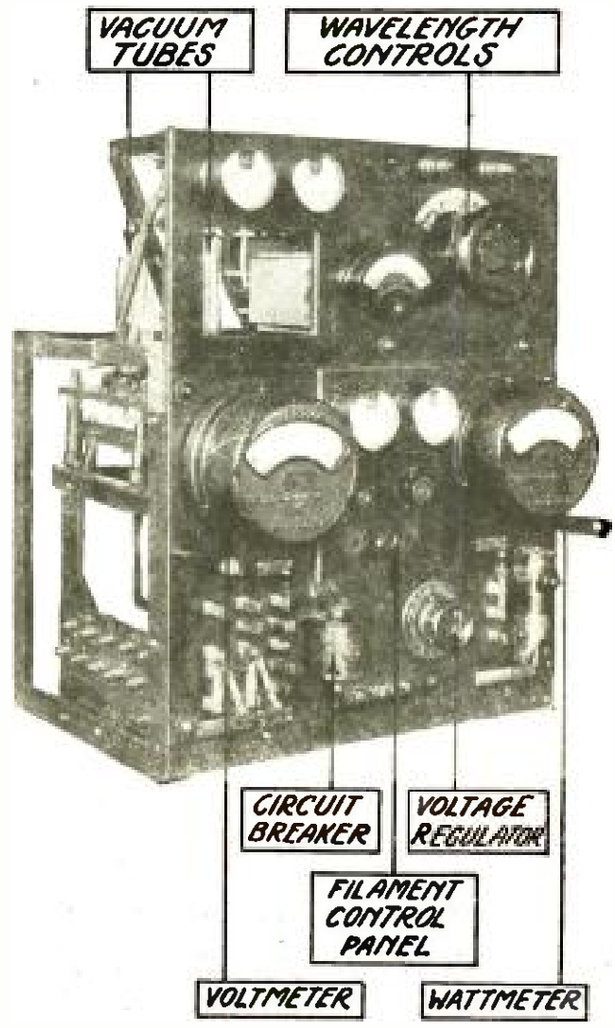
At no time is a Naval station allowed to transmit on a wavelength that is more than one-half of one percent off the assigned wavelength.

Although the transmitting equipment presented an extremely hard problem to solve, there also was a need for improvement in receiving equipment, whereby greater selectivity could be obtained. With the increase in the number of high and low-power radio stations in this country and abroad it became imperative that selective receiving apparatus be employed in order that radio traffic could be expeditiously handled with the minimum amount of interference.

After careful study of the problem it was decided to use receiving systems which involved the combination of loops and antennas with an extra tuning device for weeding out interference and static. Resort was also made to a separate heterodyne for the reception of both medium and long continuous wave signals.

The question whether it is advisable to continue the use of regenerative receivers, especially when these receivers while oscillating are miniature transmitters, is a difficult one. It has been suggested that the regenerative receiver be retained and provision made to add an additional vacuum tube transfer circuit between the antenna and the receiver, which connection would stop the emission of interfering signals. This has been considered, as also has the use of a radio-audio frequency amplifier with separate heterodyne.

Superhuman efforts are being made by the Navy to keep the Government equipped, at reasonable expense, with a radio system that is as near 100 percent efficient as is possible, and at the same time, in order to merit the good-will of the radio amateur, to keep the service beyond reproach.



THE NAVY'S NEW TRANSMITTER

This is the converted equipment which used to employ a spark but which now employs vacuum tubes that send out radio waves of exceptional purity.

© by Major Hamilton Maxwell

Six nights a week the Army's radio station at Fort Wood is operated by the Amateur Radio Reserve—*an organization that is casting a radio net over the entire country. This article tells how it started and what it is doing.*

By HOMER CROY

ON the south side of Gramercy Park, New York, is a club frequented exclusively by men—The Players. Here each noon writers, actors and artists of distinction gather for their midday meal. In a corner is located a group that is known as "the Round Table," which indulges in much gay banter.

On one occasion this group included two men. One was round-faced, with hair tinged with gray, rather portly of body and with a quick, unexpected laugh —and the smoker of a great many cigars. The other man had a blond, bony face overhung with thick eyebrows and gold glasses, an artist, but also an ardent radio fan—since the days when radio was just finding its toes. It was William Andrew Mackay (2AQB), the creator of the Mackay system of naval camouflage. He was telling how each night, from his home in Coytesville, New Jersey, he listened to the great chatter going on in the air, wholly unknown to the general public. He told how he himself had spoken into the night, talked with persons he had never seen, how he had become acquainted with his phantom friends, carried on long conversations with them, yet hadn't the slightest idea what most of them looked like. The Round Table listened soberly; there were no irrelevant remarks. It was unusual.

Across the table from the speaker was the round man with the graying hair, puffing at his cigar. During the war he

had served as a major, and now, although back in civilian life, he was quick to think of the interests of the army. The man was Lieutenant-Colonel Kendall Banning.

"Isn't there some way of recognizing all these radio fans and of organizing them so that they could be of real service to the army?" he asked.

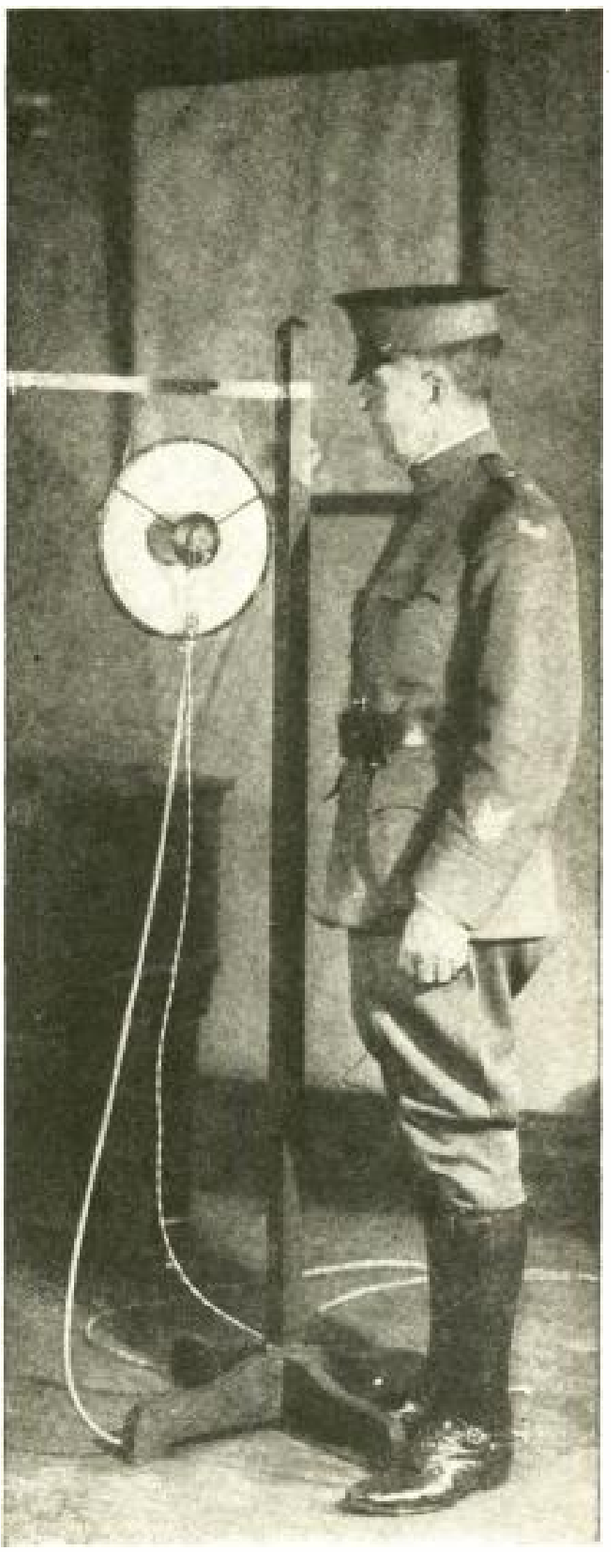
So the idea was born.

In a few days it was presented to Colonel Edgar Russel, who served as the chief signal officer of the A. E. F. The Colonel was interested; saw the possibilities. A call was sent out for a meeting of the radio amateurs, including some of the chief figures among them. They gathered in Colonel Russel's office, where many of them saw each other for the first time—these men who had been acquainted so long. The meeting was called to order, an organization was effected, and the name "Amateur Radio Reserve, 2nd Corps Area, United States Army" was chosen. It should be under the guidance of the army, yet not of it; it should be next of kin, yet not related; the army should be its big brother, yet not want to boss it. An executive council was appointed, with Dr. Alfred N. Goldsmith as chairman. Charles J. McBrearty was made secretary, and to his long and industrious hours much of the development of the organization has been due.

The baby forthwith started to grow, to gurgle, to grab things on the wall.

The United States is a big and powerful country, but often it has strange economies. After the war was over Congress peeled the Signal Corps to the bone. The appropriation for telephone and telegraph communication of the 2nd Corps Area was cut down to $1,200 a year, which was hardly enough to keep in it the breath of life. Communication had to be kept open. The post office was resorted to. Messages which had once gone by wire were now sent out with good wishes and a stamp.

And then the Amateur Radio Reserve walked in. It said:



International

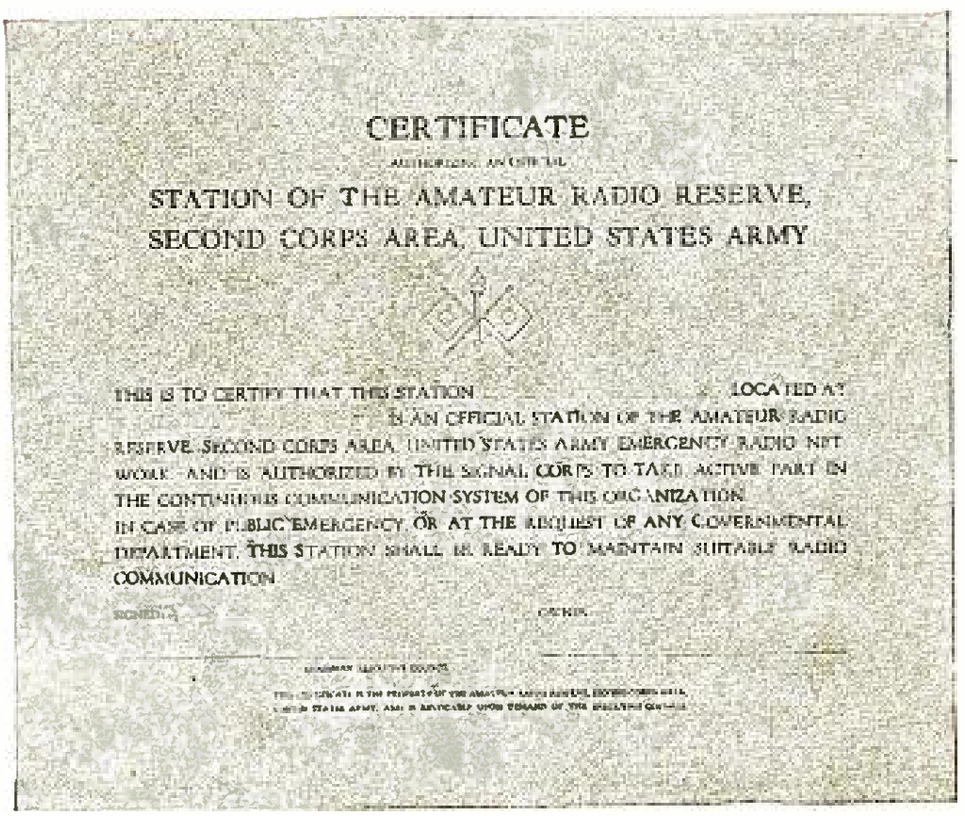
MAJOR GENERAL BULLARD HAS A WORD WITH THE AMATEUR RADIO RESERVE

One of the advantages of station WVP lies in the fact that the members of the Reserve can keep in direct touch with headquarters, not only for entertainment but for practical instructions in radio by the army's experts. Note the "soup-plate" transmitter and the wires leading from it to the transmitter.

"Here, we'll help you send those messages."

And it did.

A sort of Fiery Cross was established, not dissimilar to the Fiery Cross in the days of old Scotland. When that land was invaded, one clan sent word to another by means of a burning cross borne aloft by a runner; over vale and moor he rushed to the next clan. There the cross was snatched from his fainting hands and rushed on its way. So now the new carriers of the Fiery Cross went out with their message. The men were known, they were registered; from post to post flew the word, relayed on by one of the guards to another. It is now being so done; wireless operators, members of the Amateur Radio Reserve, pick up messages for the army and fling them across the country—carry them over vale and moor. Only they don't leave their homes. They merely press a key and the messages rush out into the night. How astonishing it would be to the runners bearing the flaming cross in the days of tempestuous Scotland if someone had told them that some day messages would be carried over the country without legs, without shouts, without wires! They would have thought something was the matter with the person and sped away faster than ever! But now it is actually being done each night. Between eight and ten o'clock in the evening this invisible army goes into action; it picks up government messages and sends them along—and not one cent of pay does a member get. It is all for the good of the cause; it is another way of carrying the Fiery Cross. A storm is raging; the telegraph lines are down; the government wants to send a message through the blizzard. The invisible army is there, for radio laughs at storm; the only thing that it is afraid of is static. It is more concerned with static



CERTIFICATE

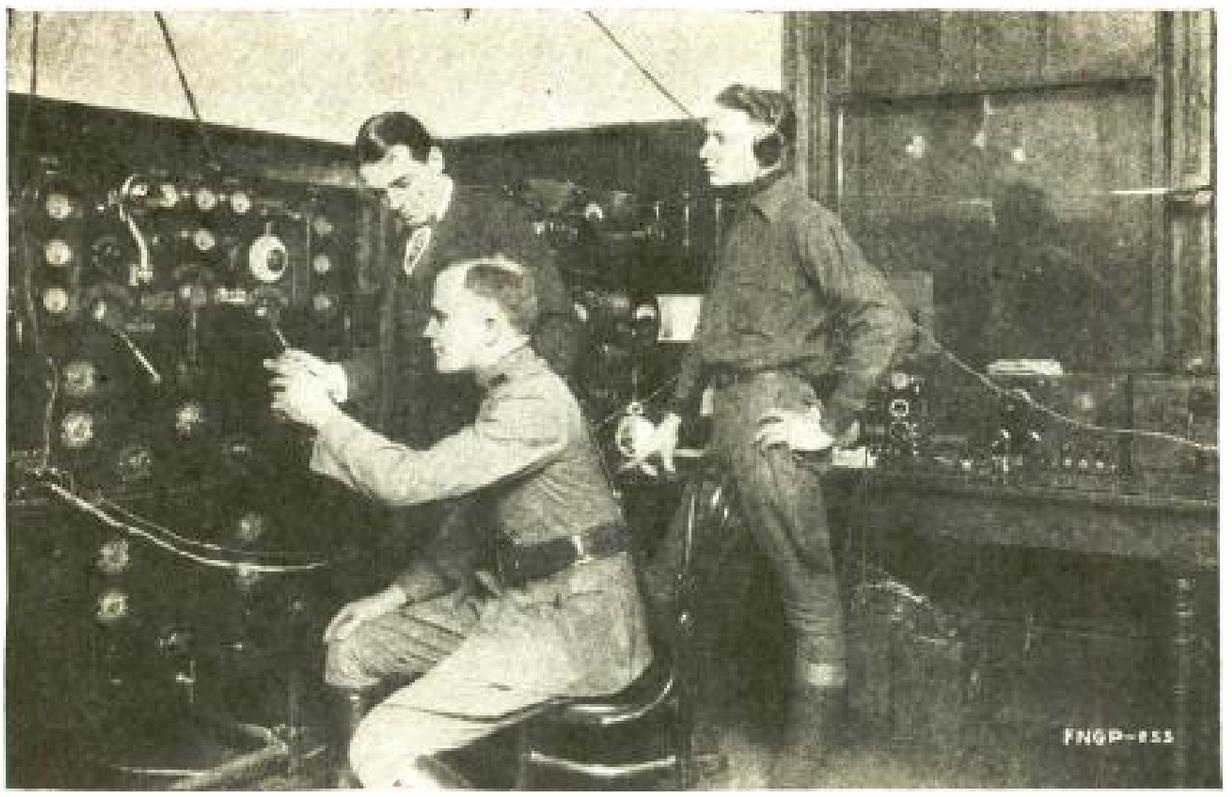
STATION OF THE AMATEUR RADIO RESERVE,
SECOND CORPS AREA, UNITED STATES ARMY

THIS IS TO CERTIFY THAT THIS STATION ... LOCATED AT ... IS AN OFFICIAL STATION OF THE AMATEUR RADIO RESERVE, SECOND CORPS AREA, UNITED STATES ARMY EMERGENCY RADIO NET WORK AND IS AUTHORIZED BY THE SIGNAL CORPS TO TAKE ACTIVE PART IN THE CONTINUOUS COMMUNICATION SYSTEM OF THIS ORGANIZATION. IN CASE OF PUBLIC EMERGENCY OR AT THE REQUEST OF ANY GOVERNMENTAL DEPARTMENT, THIS STATION SHALL BE READY TO MAINTAIN SUITABLE RADIO COMMUNICATION.

SIGNED ... CHIEF.

THE AWARD OF MERIT TO THE AMATEUR

To become a member of the Amateur Radio Reserve, every candidate must conform to the requirements that cover his apparatus, his experience and his proficiency—and he must agree to relay messages at specified hours. Then (if his station is in the Second Corps Area, U. S. A.) he gets this diploma to hang in his radio room.



BEHIND THE SCENES OF A BROADCAST ENTERTAINMENT

When Richard Barthelmess, the film star, visited station WVP to give a talk as part of an Amateur Radio Reserve program, he visited the radio station—which is in a separate building of its own.

than an elephant is with a mouse, but a blizzard does not come with static in its hair, and so the lines of communication are kept open.

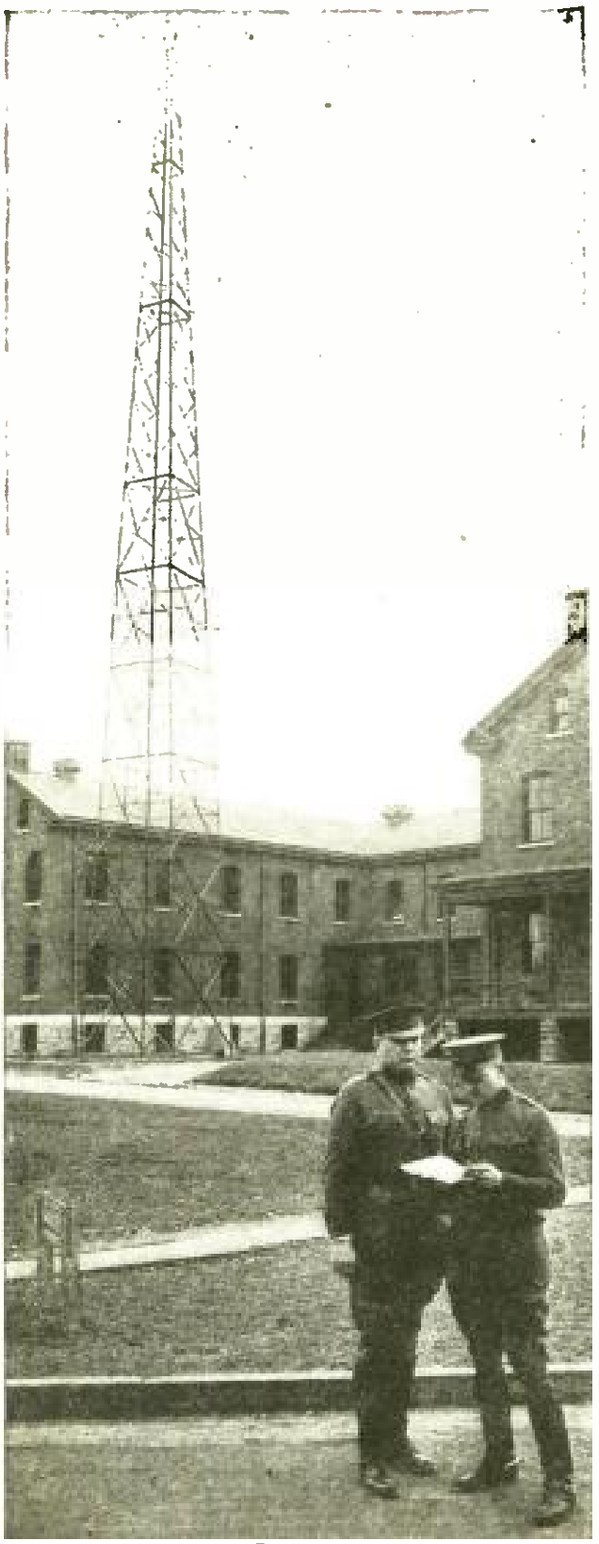
The Amateur Radio Reserve doesn't stop with its work of relaying government messages, helpful and patriotic as that is. That is only the beginning. The general public knows the Reserve through its broadcasting.

Six nights a week it takes over the broadcasting station WVP and sends joy and delight, entertainment and education, into the air. This high-powered station belongs to the Signal Corps of the United States Army, but for fifty-five minutes, six nights a week, it belongs to the Amateur Radio Reserve. The government doesn't chirp in with a word. It furnishes the equipment and the electricians for operating the station, but the Reserve is the big boss. Charles J. McBrearty is the master of ceremonies. You have heard his voice many times. You have heard this sentence over and over:

"This is the United States Signal Corps Radio Station, call letters WVP, at Fort Wood, Bedloe's Island, New York Harbor, transmitting on a wavelength of 1,450 meters. The first offering will be—"

McBrearty is the man behind the voice. Any night that you go out on the eight o'clock boat from the Battery and see a thick-set fellow with blue eyes industriously smoking a cigar, you may put him down as McBrearty. And when you get to the station and meet a dapper-looking lieutenant who looks as if he might be a whirlwind dancer—then that is Lieutenant Paddock. When you go in to broadcast you don't see anybody; you hear voices, shufflings of feet, mysterious sounds—and when you finish and look around the room is full.

The preliminary announcement as required by the Signal Corps is misleading. About one person in a hundred knows where Bedloe's Island is. As a matter of fact, it is the Statue of Liberty island.



From a photograph made for POPULAR RADIO

ONE OF THE ANTENNA TOWERS ON BEDLOE'S ISLAND

Through this station Uncle Sam keeps in touch with his public-spirited young radio amateurs who serve in the radio net in the Second Corps Area. This net includes about 20 stations, operated by about 80 members of the Reserve. These stations, beginning at New York City, are located at easy working distances up along the Hudson river valley and as far north as Plattsburg, on Lake Champlain.

The sending station is almost under the lady's left elbow. The only way to go back and forth is by boat—and pity on the poor wight who misses the last boat.

Singers, musicians, readers, poets, whistlers—they all come to WVP. In addition the Reserve sends out information and material of real help. It wants to be of service to its members, to make them expert radio men. So, for five minutes, five nights a week, the Reserve sends out instructions about radio. Arrangements have been made with POPULAR RADIO by which some of its helpful articles are sent out. "How to Select a Radio Telephone Receiving Set" was one; another was "How to Tune a Regenerative Receiver."

Unfortunately, however, announcement of this new feature was sent out in garbled form by a too zealous member. When it appeared in print it was to the effect that the Reserve would teach radio by mail. McBrearty almost had to put on a new stenographer. The letters flooded in. The Reserve teaches nothing by mail; all that it has to impart goes out by a faster method. The letters were amusing and pathetic. They go to show how eager people are to learn about radio. A boy from Honesdale, Pa., wrote in and said that he was anxious to get lessons by mail—and then closed: "My moral character is very good. I do not chew, smoke, swear or drink tea."

If mail lessons were to go out, certainly this model young man would be placed at the head of the list!

Curious and unexpected requests come to the Reserve. A telegram was received from the Rutherford (New Jersey) High School saying that it was planning to have a dance and that it could not get the orchestra it wished and could the Reserve put on a dance program for that night? The Reserve did; the dance was a success.

A request came from the people of Bronxville saying that a fair was to be held and could the Reserve supply some of the entertainment? The Reserve did.

Even so far away as Cuba the Reserve brings cheer and entertainment. One of the enthusiastic members is Frank H. Jones, who works for a sugar company at Tuinucu, in the heart of Cuba, and where there is no "great shakes" in the way of entertainment. Mr. Jones gives radio dances; he has a regular dance program card for the guests, even to the pencil tied on by a frazzled string; the card is filled out by the guests, the names written on the ruled lines—and then the little brown building under the Statue of Liberty tunes up and far away on the sugar plantation light-hearted merrymakers glide into each other's arms.

Many have the idea that since the Reserve broadcasting is done on 1,450 meters that a small receiving set will not suffice, but this is not true. Here is a letter that refutes this argument, from an amateur in Jersey City:

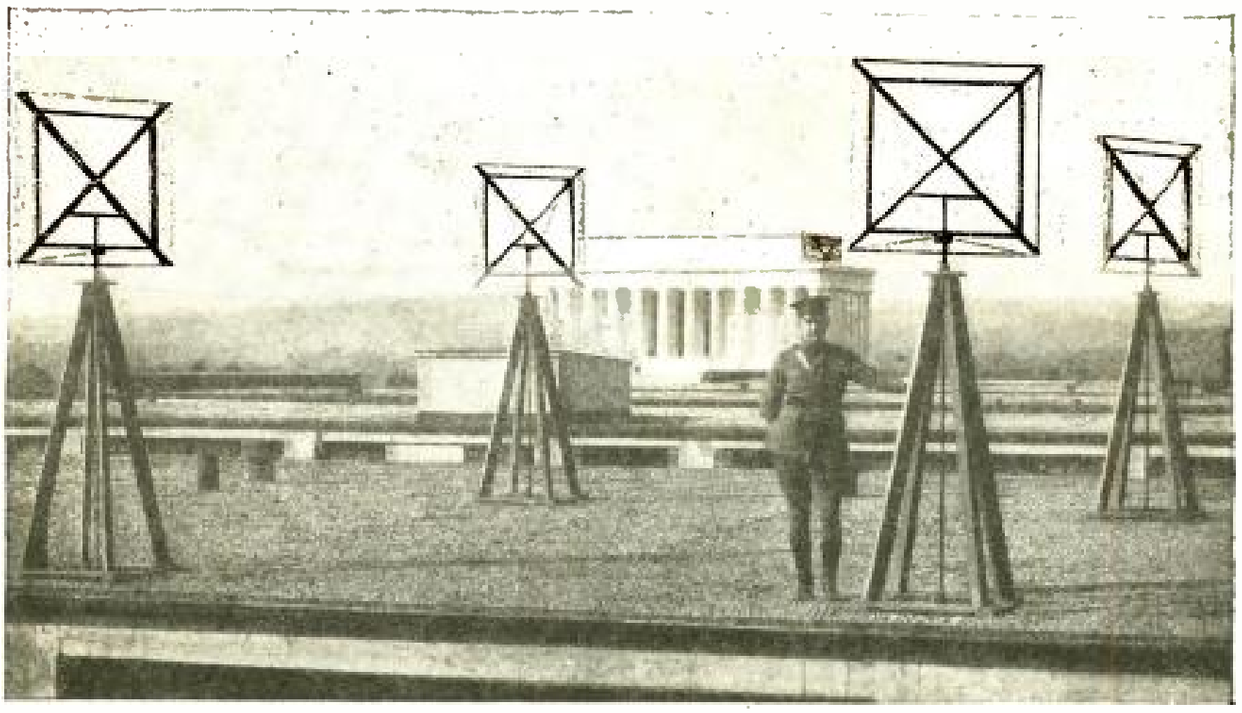
"I wish to let you know that I have only a small crystal set without any honeycomb attachment, and I can pick up WVP almost any time I wish to."

Members of the Amateur Radio Reserve are all of the better class radio enthusiasts. They are experienced men (there are no women) and must, according to the rules and regulations of the body, have had a year of radio. They pay a dollar a year dues, which doesn't begin to pay the expense. This the army contributes for the great help the members are giving in relaying messages. If a member wishes a "station certificate" he sends fifty cents additional; then he has something worth while to hang on his walls.

The members are all civilians, but if at any time war's black cloud should settle over the country, the members of the Amateur Radio Reserve will be given the the first opportunity to take up work in the Signal Corps—and the Signal Corps is becoming of constantly increasing importance in time of trouble. The little station certificate will then mean something.

Thus has it grown: nightly it relays messages for the government free of charge, and nightly furnishes entertainment and instruction for thousands, until now it is one of the real factors in the radio world.

And the baby was just a year old last June!



The first photograph of the army's permanent Radio Central in Washington, D. C. These loop antennae pick up signals that come from distances up to 6,000 miles.

Photograph by Bray Productions

20 TIPS ON TUNING—

That Every Radio Fan Can Use

1

SET the detector in adjustment. If it is a crystal type, locate the sensitive spot with the assistance of a buzzer test. If it is a vacuum tube, the filaments should be lit; then if one terminal of the phones is disconnected a sharp click will indicate that the tube is functioning.

2

TIGHTEN the coupling between the primary and secondary circuits by bringing the primary and secondary coils into closest inductive relation. (Not necessary in the single circuit type of receiver).

3

TUNE the antenna or primary circuit. This is done by taps on the inductance or by a variable condenser.

4

TUNE the secondary circuit. This is usually done by means of a grid variometer or a variable condenser.

5

IF the set is regenerative the tickler circuit should now be adjusted for maximum regeneration without distortion. In a honeycomb set this is done by moving the third coil (tickler coil) nearer to or farther away from the secondary circuit. Other regenerative circuits employ a variometer for this purpose.

6

IN the case of interference the coupling should be decreased and the signals tuned in again, in the primary and secondary

circuits, until the interfering signal is eliminated. In a single circuit receiver the inductance of the antenna circuit should be varied and the signals retuned, with the antenna tuning condenser, until an adjustment is found where the interference is reduced to a minimum.

7

If your antenna length is too long (over 150 feet) put in a series variable condenser to bring down the wavelength to a suitable value.

8

If your antenna length is too short (under 75 feet) it would be advisable to put in either a variable condenser across the antenna inductance or a loading inductance in series with the antenna inductance to boost up the wavelength to a suitable value.

9

In a regenerative receiver it is advisable to regulate carefully the adjustment of the filament current; if the filament is high, less regeneration will be found necessary, and if the filament is reduced more regeneration will be required. One particular combination of these two adjustments will bring in the signals clearest and with least distortion.

10

There are three methods of varying the inductance of a coil: By means of taps, by means of a slider or by means of a continuously variable inductor such as a variometer.

11

Sharper tuning is accomplished by inductively coupled tuners than by conductively coupled tuners, and by two circuit receivers than by single circuit receivers.

12

Regeneration causes an effect similar to the elimination of resistance from the radio frequency circuits of a receiving set, and in this way does away with energy losses in these circuits, thus producing louder signals.

13

A vernier condenser (a variable with two or three plates) is a great help in tuning when it is connected across the secondary coil of a variocoupler in a regenerative circuit.

14

Distributed capacity in a tuning coil is deleterious to sharp tuning. Shellac or varnish or any form of wax adds to the distributed capacity of the coil to which it is applied.

15

The looser the coupling in a two circuit tuner the sharper will be the tuning.

16

A receiving set connected to a short, low antenna will tune sharper than if connected to a long, high antenna, although the latter will give stronger signals.

17

Tuning on a loop antenna is sharper than on an outdoor antenna; this is the case with all closed oscillatory circuits.

18

The less resistance in an oscillating circuit the sharper will be the tuning in that circuit.

19

The use of a smaller grid condenser in the vacuum tube detector circuit (say .00025 mfd. instead of the usual .0005 mfd.) results in greater selectivity of tuning.

20

At least 50 percent of the efficiency of a receiving set lies in the skill of the operator who is tuning it.

From a photograph made for POPULAR RADIO

I MEET WITH "INTERFERENCE" IN THE PURSUIT OF MY RADIO WORK

I had just taken a blank and started to write my message when I was greeted by an old friend—the traffic manager.

Orson Sends a Radiogram

Most folks still think that commercial radio messages are laboriously ticked out on the familiar telegraph key. But how they are really sent (as seen by a layman) is told here by the popular illustrator—

ORSON LOWELL

IT is still difficult to convince my numbed senses that what I saw actually took place. Of course, I knew in a taken-for-granted sort of way that radio communication between continents is carried on in regular commercial fashion, but this—

Why, this was so commercial that it was spooky! Imagine stepping from Broad Street, in the very heart of the financial district in New York, with nothing but this hazy conception of the sending and receiving of radio messages, into the room I shall here describe. There are six long tables; on one side of each table sit two men at typewriters working like mad, translating into messages a zigzag ink line on a paper tape that issues with astonishing speed from a little brass instrument. Across the table from these two men sits a third man at another typewriter-like machine which punches a curious series of dots into another paper tape. This tape he feeds into another little brass instrument, and a message is on its way to London or Ber-

fin, or perhaps to a ship at sea. That's all there is to it, for each table is a duplicate of the others!

If this radio station had been located in a shack on some distant beach, if there had been a lone operator who pressed a telegraph key to the accompaniment of a great crashing electric spark, even if there had been a maze of complicated instruments, it would have been more convincing.

One might be inclined to lament that commercialized radio had lost some of the romance of early days—it is so matter-of-fact—were it not so utterly marvelous. When one can dictate a message on one side of a table and have the same message handed to him on a radiogram blank at the other side of the same table two minutes later with the calm statement that in that brief time your message had been to Europe and back, it's something to marvel at. That happened to me.

I might have gone through the rest of my life without suspecting that the things I "knew" about international communication were mostly wrong, if old Alex Anderson hadn't attended that fancy dress ball as Diogenes. To complete his costume I loaned him one of my prized possessions, a perfect specimen of an antique lantern. And it was just my luck two weeks later, when I received a commission for a painting to depict the development of lighting fixtures and needed that lantern for a model in the worst way, to discover that Alex had gone on a sudden business trip to London. I might have found another lantern for a model, but it wouldn't have been *my* lantern—you know how it is. So, for the sake of my own peace of mind, I decided to cable Alex and ask him where my lantern was.

At another time I might have passed 64 Broad Street with no more than a curious glance at the sign over the door, "Radiograms via RCA." But having decided to cable Alex, something prompted me to step in that morning and ask about rates to London. I expected to find radio rates outrageously high and then hunt the nearest Western Union office. Imagine my surprise, then, to find that I could send my message to London by radio at a saving of seven cents a word over cable rates. Further, the man at the window calmly assured me that I would get quicker service, because the message would go direct from that very building to the heart of London without being relayed.

So I took a radiogram blank and addressed Alex in London. I had just written:

"Where in the devil is my——"

Someone slapped me on the back and I looked up into the face of my old friend, W. A. Winterbottom.

"Speak of the devil and he's sure to appear," I said, and I showed W. A. the beginning of my message and explained.

"And," I said, "what are *you* doing here, anyway?"

I knew W. A. had been connected with wireless in some sort of way for twenty years or more.

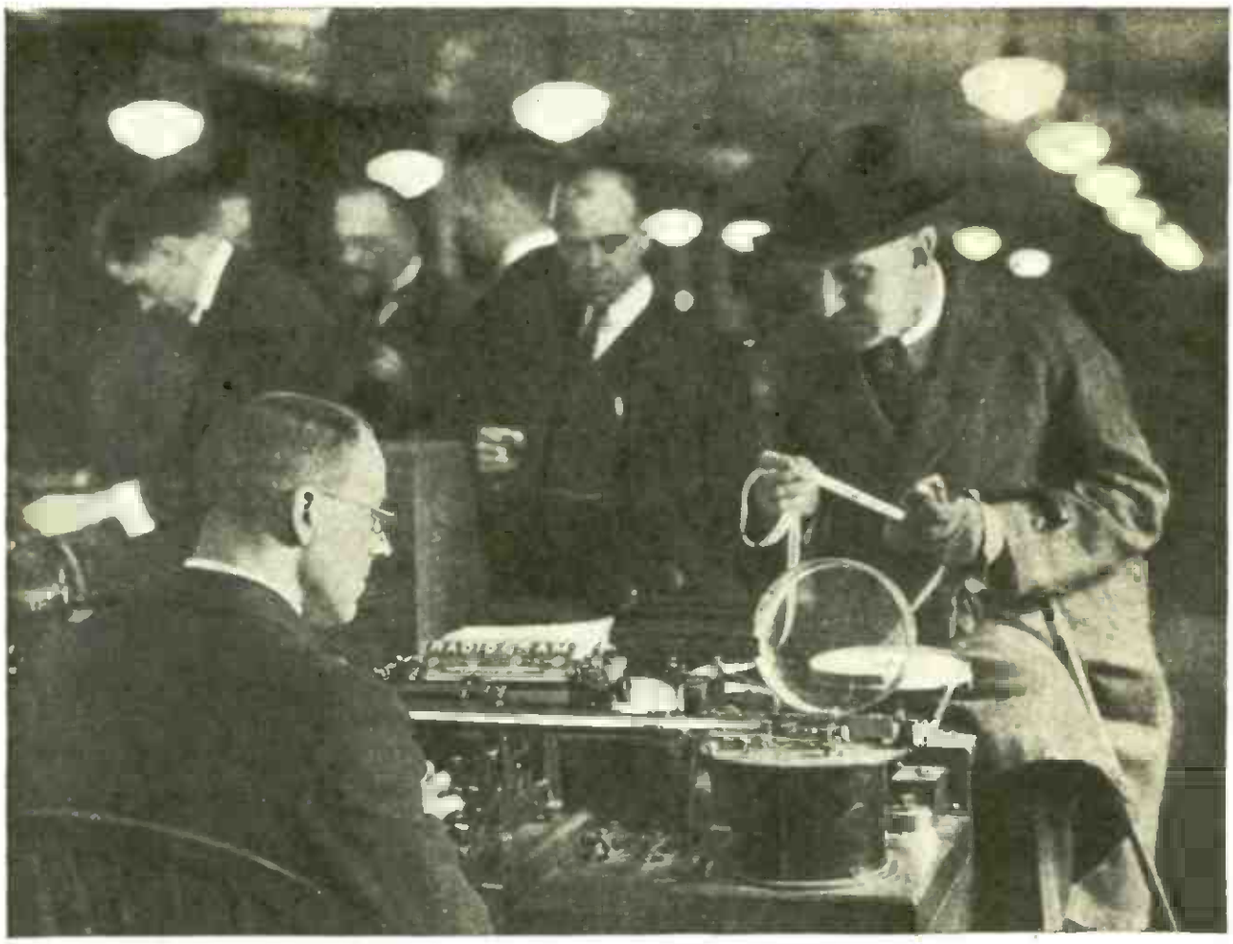
"I'm traffic manager for the Radio Corporation," he announced.

We talked over old times and the upshot of it all was that W. A. invited me to look over the plant. I was glad of the opportunity, for in the brief time I had been in the office I had conceived a great curiosity to know just how my message was going to get from that very building direct to the heart of London.

"Let your message go until we have finished," W. A. suggested.

So we passed through the outer office and into the forbidden regions above and beyond.

"The business," said W. A., "is growing so rapidly that this building will not hold us very much longer. You know I have been in radio twenty years and some remarkable progress has been made, but the really big things all have come within the past two years. Why, two years ago this office consisted of a little room downstairs and one small



From a photograph made for POPULAR RADIO

I LEARN HOW MY MESSAGE GOES TO EUROPE AND BACK IN A FEW SECONDS

The operator was translating into typewritten words the zigzag line on the paper tape which kept moving along a groove in front of the typewriter.

room upstairs, and that was all we needed to handle the radio traffic to and from this country. Since then we have been leasing more space, knocking out partitions and building additions to our plant almost constantly. In fact we aren't through yet and it now looks as if we would have to begin looking for larger quarters.

"This office now handles more radio traffic than any other in the world. All the world, it seems, wants to communicate with America, so this very office is the hub of radio communication for the whole world. As a matter of fact you can communicate from this office direct with Great Britain, France, Italy, Germany, Norway, Japan, and Hawaii, and we will soon have extensive connections with South America. In addition we can reach, through our connections, nearly all countries of Europe, Asia and Africa. And this is only a beginning. We plan to double and triple our facilities in the next few years."

"Good gracious," I said, "won't that take a lot of money? Who is going to put it up?"

"This company," said Winterbottom, "that is, the Radio Corporation of America. We are in partnership with the General Electric Company and the Westinghouse Electric and Manufacturing Company. You see, it's thoroughly American, and these firms are behind it with their capital and facilities. Our plans not only include telegraphic communication between America and all the world, but between South America and the rest of the world, and we will, no doubt, offer telephone service by radio, too, in the not distant future."

"But, man," I protested, "what's all this I have been reading about the radio telephone. Why haven't you adopted telephone service instead of telegraph already? I'd like to call up a friend of mine in London this very minute and pour a few confidential words into his ear."

"Of course," he said, "it is physically possible to do it, but there are several good reasons why we haven't, yet. The radio phones you have been hearing about are the numerous broadcasting stations that are sending out concerts and lectures for the entertainment of a couple of million new radio fans. The chief reason we use telegraph is because of the speed. We send and receive messages at the rate of a hundred words a minute, so that during the time a single telephone conversation would tie up our plant, we can send twenty or thirty messages. You can see that a radiophone message to Europe would be pretty expensive for that reason. Then there is the language barrier. That is the chief reason, I think, why telephonic communication will never be used on a world-wide scale. Aside from the difficulty of establishing connections through two centrals, each speaking a different language, only limited use could be made of such service because the subscribers could not understand each other. As it is now, most of our messages are sent in code. Our messages look like an unintelligible jumble of letters and even we do not know what they mean. But we transmit the message as it is given to us and when it is decoded at the other end, it is translated at the same time. So you see that telegraphic communication easily gets around the language barrier and it is possible for two firms to do business, neither understanding the language the other uses."

We had now entered the long operating or traffic room, which I have previously described. We stood at the back of the nearest operator, who was engaged in translating into code messages the zigzag line on the paper tape, which was kept moving across the front of his typewriter by a roller device. Apparently the speed of the tape was so gauged that the operator had to work at top speed to keep up with it.

"We send and receive more messages than any other station," said W. A. Each table you see represents a circuit for communication with a certain country. This first table is the British circuit, next is the German, and so on. You notice that it takes three men to handle the British circuit. I have seen the arrangements for handling the other end of this business in England and it takes just twelve Englishmen to do the work these three Americans are doing.

"We have got away from the old ticker key entirely. That was too slow, so we have developed these machines, which do the work two or three times as fast and more accurately than the best operators we have. It takes two operators to translate the messages that come in over one machine. We have designed and built these sending machines, too, and both are being copied all over the world. We are setting the pace in commercial radio just now, and several of the men you see in the room have been sent here by their governments to learn our methods. Come over and meet Mr. Wilfred Larsen of Naerboe, Norway."

I shook hands with Mr. Larsen and found him a most interesting chap. He is not so much a stranger in a strange land, he told me, for was he not in daily communication with the great radio station at Naerboe? And isn't it possible to get just as chummy by radio over the great stretch of the sea as any two railroad telegraphers could be over ten miles of wire?

I thought I had never seen a finer, cleaner looking bunch of fellows than the operators, and I said so to W. A.

"These men," he said, "are the pick of hundreds of applicants. A man must be a top-notcher to hold down a job in this

room. We have three shifts a day and each shift works seven hours. And let me tell you, seven hours of this high-tension grind is a good day's work. There are no holidays, here, for the Fourth of July doesn't mean anything to the people at the other end of this system. Neither does any other of our national holidays. The only day in the year when our business lets up at all is Christmas. That's the nearest thing there is to a world-wide holiday. Another thing, our business doesn't stop at night. Remember that while we are in bed asleep, Japan is at mid-day and her business activities are in full swing. The same thing is more or less true of the other continents and that is an additional reason why the radio telephone cannot be used on a world-wide scale successfully. There is not even an appreciable slack in business here on Sunday. Even were Sunday observed faithfully over all the world, Saturday's business from one part would lap over into Monday's business from another part, for our communication with all parts is instantaneous."

From a photograph made for POPULAR RADIO

I SEE WHERE THE SIGNALS COME IN

On these tubes the messages from England, France and Germany are amplified—so my guide explained. It seemed plausible.

We had walked down the length of the room and into a smaller one at the end.

"And here," said my guide, "is where the signals come in. They are weak when they reach us, and so we have here a set of amplifying tubes very much like the ones used for listening to radio concerts. We bring the current up to the strength required to operate our machines with these."

He took a pair of ear-phones, pushed a plug into a hole, and held the 'phone to my ear. I heard a rapid, but regular succession of high pitched squeaks.

"That's the big station at Nauen, Germany, you hear," he said.

Then I listened to squeaks of a different pitch and different speed which, W. A. said, came from the big station at Bordeaux, built during the war by the A. E. F.; finally I listened to a big station at Towyn, Wales. All were tumbling messages into that office at break-neck speed.

"Well, W. A.," I said, "I have never seen anything quite so marvelous. Let's complete the job and go up on the roof to have a look at the aerial."

W. A. sort of exploded, buried his face in his handkerchief, and made funny noises for a full minute. Finally he could speak.

"Old man," he said, "your ignorance is refreshing. The only aerial we have on the roof is a very small one for test purposes only."

From a photograph made for POPULAR RADIO

I'M TOLD WHERE MY LOST PROPERTY IS—AT 18 CENTS A WORD

The radiogram had traveled across the Atlantic and back—only to inform me that my lantern was hanging before my eyes.

"Oh, I see," I said, "you don't need those things any more, either."

"Oh, yes, we do," he said; "do you really want to see the aerial?"

"I want to see the whole works," I said stoutly.

"What day can you go conveniently?" he said, drawing out a note book.

"What day?" I demanded, "Say, W. A., where is this aerial thing anyway?"

"It's about seventy miles from here, out on Long Island. But I advise you to go ahead and 'see the whole works.' There's not a sight like it anywhere else in the world. It'll take all day but it's worth it and I'll see that you are passed through and shown everything. What do you say?"

"I'm game. Make it Friday."

"Done!"

"But say," I said, "please enlighten me just a little bit now. How does it happen that the operators are here in New York and your aerial is seventy miles away out in Long Island?"

"Well, you see, in the old days when a radio station was both a receiving and a sending station, and the operator worked with a key and head set, he had to stop his sending machinery to receive a message and he could not receive while sending. We receive and send simultaneously here. That is done by sending our message by land wires to our sending station where it is relayed automatically and sent out from the aerial. The receiving station is about eighteen miles away from the sending station and the process is reversed there. That is, the message is received by an aerial, automatically transferred to land wires and carried to this room. We have a number of stations scattered up and down the Atlantic coast, all operated automatically from this room.

At the stations themselves there is only the machinery with men to tend it. There are no operators.

"The biggest of these stations—indeed the biggest station in the world is Radio Central, near Port Jefferson, Long Island. That's the place I want you to visit. I'll not tell you about it. You can see for yourself. But I promise you it will be a day well spent."

"Fine business, W. A.," I said, "now I've got to be getting along and I still have this radiogram to send to old Alex Anderson."

I sent the radiogram and it read:

"Where in the devil is my antique lantern?"

* * *

Not two hours later a messenger boy dressed in a neat brown uniform, but none the less all messenger boy, came to my studio with Alex's reply. It read:

"I returned your precious lantern it hangs on north wall of studio take a look.—Alex."

I took a look. And would you believe it, that darned lantern was hanging before my very eyes!

And Alex had sent the radiogram collect at eighteen cents a word.

In a following article Orson Lowell will give his layman's impressions of the amazing Radio Central Station on Long Island—where the huge equipment made him "feel like a pygmy in a giant's home."

International

THE GUMSHOE MAN GOES IN FOR RADIO

Here is just an ordinary rubber heel to which has been attached the parts of a practical little crystal receiving set. It was made by George E. Johnson of Minneapolis at a cost of $1.35. It receives over a radius of about fifteen miles.

From a photograph made for POPULAR RADIO

SOLVE YOUR EQUATIONS WITH A RULER AND A PENCIL

By merely laying your ruler across the alignment charts on pages 93 and 94 you may determine in an instant the problems in radio calculations that otherwise necessitate extensive computations—and do it more accurately.

MEASUREMENT CHARTS

FOR DETERMINING CONSTANTS OF RADIO CIRCUITS AND CALCULATING CAPACITIES OF CONDENSERS IN SERIES

By means of the "radio slide rule" originated by Mr. Hoffman, radio amateurs everywhere have been able to save a vast amount of time and at the same time insure accuracy in their calculations in the design of radio apparatus. The ingenious charts reproduced in this article constitute an equally valuable contribution to the science of radio; they were devised by the same inventor for the exclusive use of POPULAR RADIO.

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

ONE of the most important problems to confront the amateur who designs his own radio set is how to calculate the correct sizes of the inductances and the condensers for the various parts of a radio circuit for a given wavelength.

There are several mathematical formulas for determining these "constants" as they are called. But these formulas are usually so complicated that they are not much used by the ordinary amateur.

Most amateurs who design their sets resort to the "cut and try" system; that is, they wind a temporary coil with taps, connect it in the circuit, find the correct tap and then build a permanent coil with a corresponding number of turns on it. Sometimes they build a number of coils and try them all out in order to find the best size to use.

Fairly good results are often obtained in this way, but this method is obviously unscientific. It entails a waste of time, energy and money. It is better and more practical to use standard formulas that will give the correct sizes for all parts to be built; further, these standard formulas enable the builder to design his set on paper and then build it according to the recorded specifications; in that

way he will know in advance just what the results will be.

For the benefit of the average amateur, some of these standard formulas have been simplified and are represented here in the form of "alignment charts."

These charts offer the most convenient possible way of solving equations which have three or four variables. They make it possible for the ordinary radio fan to use the formulas without the aid of anything more than common sense and a ruler.

The prime problem to be dealt with in radio is that of "resonance" in the different circuits. In order to have resonance in a circuit, or in other words, in order to tune a circuit to any particular wavelength, the circuit must contain inductance in the form of a coil, and capacity in the form of a condenser. A certain value of inductance and a certain value of capacity together in a circuit give it a certain wavelength; unless either or both of these values are varied, the circuit will absorb energy of no other wavelength.

The basic formula for the wavelength (W.L.) follows the equation:

$$W.L. = 1884 \sqrt{LXC} \quad \ldots\ldots\ldots\ldots\ldots 1$$

wherein L is the inductance in microhenries and C the capacity in microfarads. The above formula is shown in chart form in Figure 2.

In order to illustrate the method of using this chart, let us take the following problem: In Figure 1 we have a coil connected in an antenna circuit. This circuit is equivalent to a coil with a condenser connected across it—the condenser in this case being the capacity between the antenna and ground.

The example is this:

To find the proper value of inductance for this coil when used in an antenna circuit that has a capacity of .0002 microfarads, in order to tune up to 400 meters. With a ruler on the chart in Figure 2, connect the value of capacity (.0002mfd.) on scale 1, with the wavelength desired (400 meters) on scale 2. The answer will be found at the intersection on scale 3; it is 225 microhenries.

This same example applies to calculations for a secondary circuit in which the capacity will be the variable condenser connected across the coil.

To calculate a circuit that has two capacities (as shown in Figure 4), we find first the resulting capacity which will follow the relation:

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} \quad \ldots\ldots\ldots\ldots\ldots 2$$

wherein c_1, c_2 are the capacities connected in series and c is the resulting capacity. This formula is plotted on a chart shown in Figure 3.

Let us take another example:

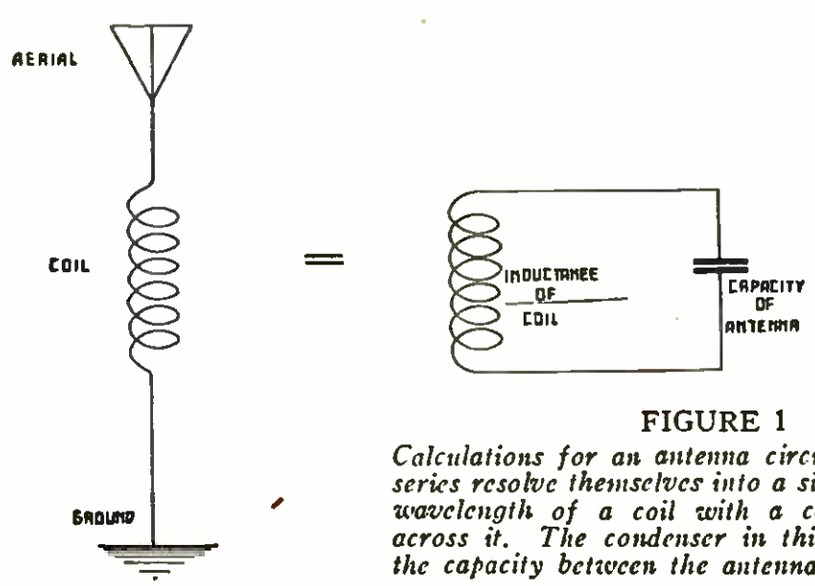
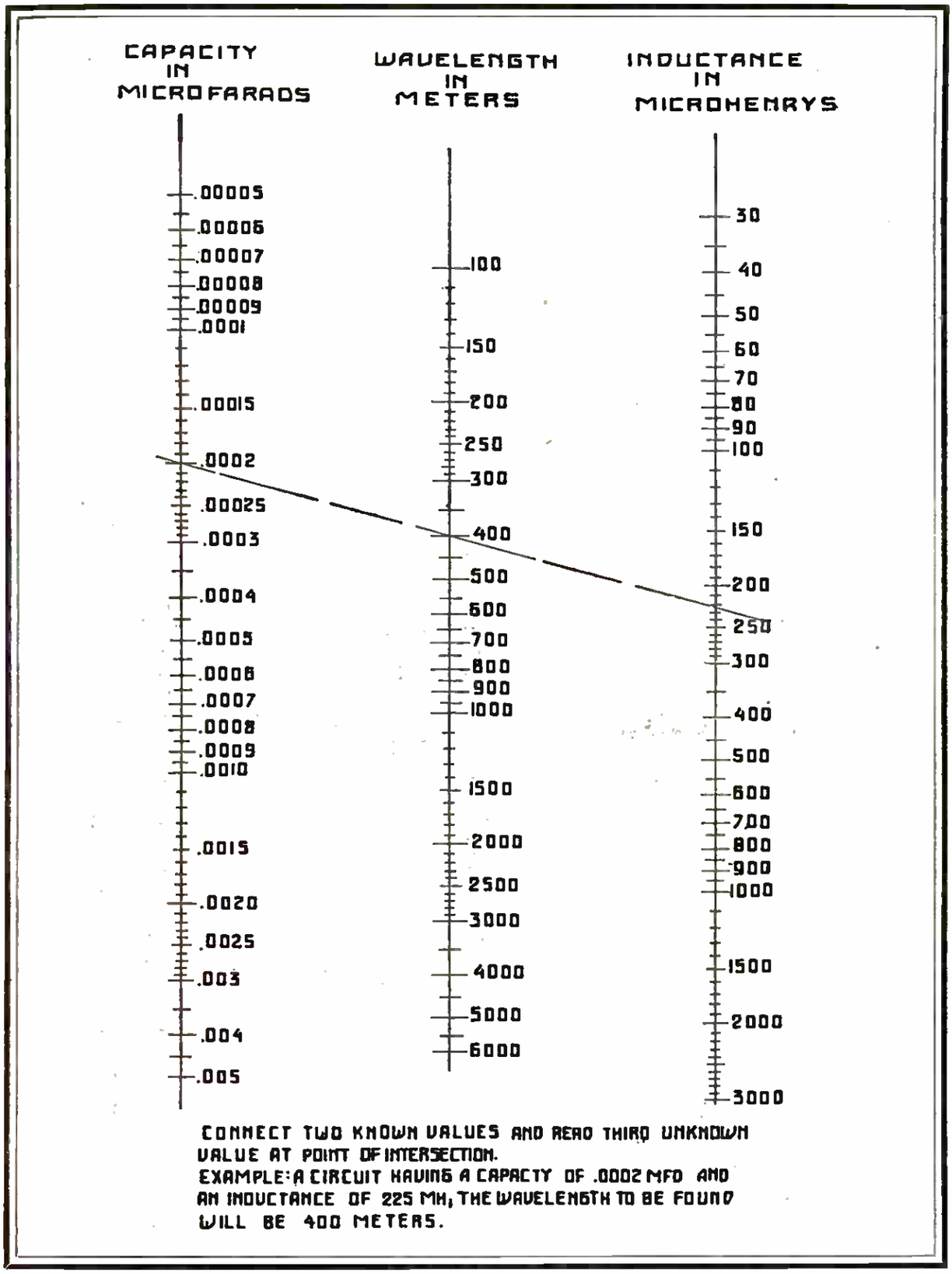


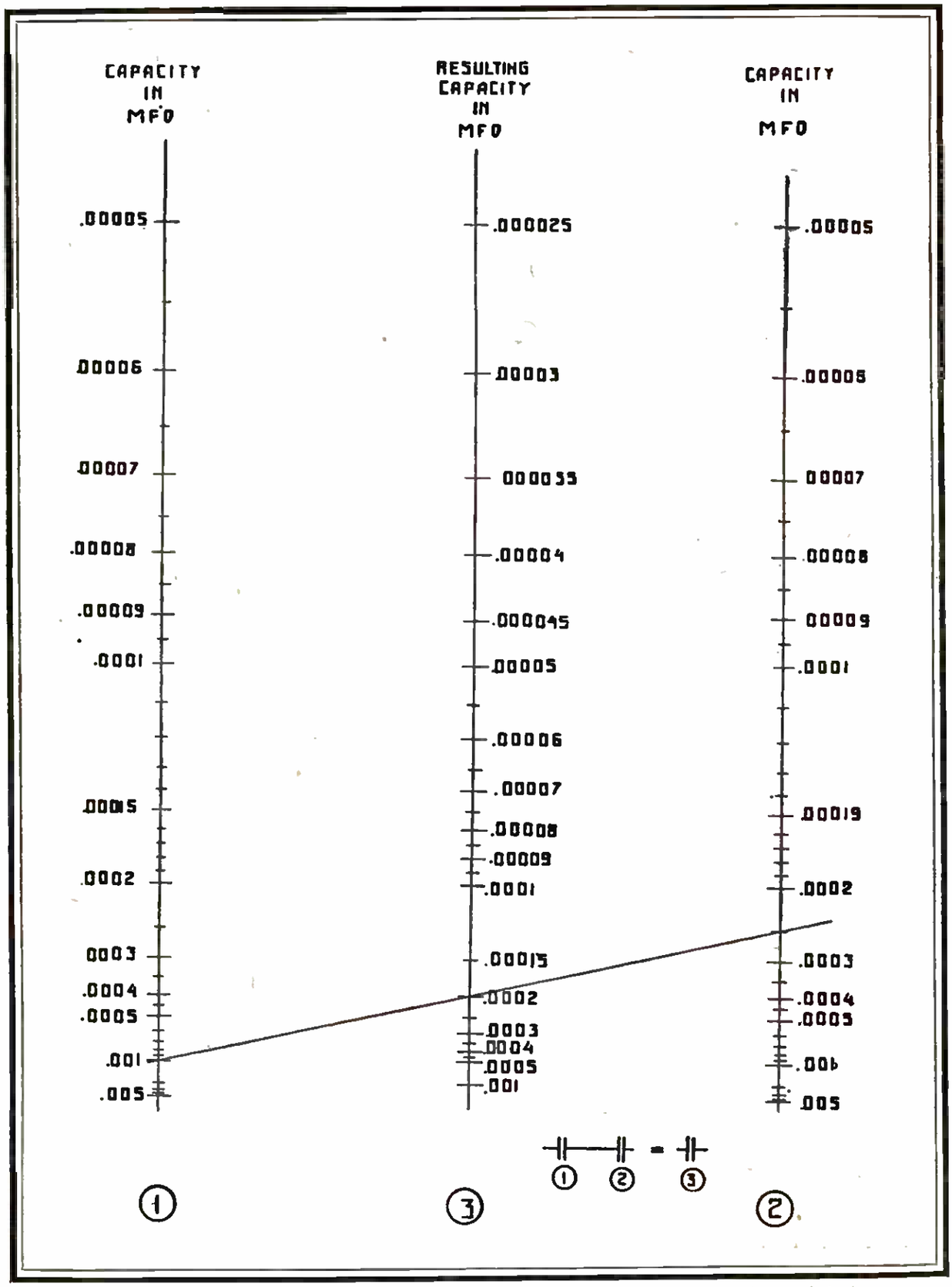
FIGURE 1

Calculations for an antenna circuit with a coil in series resolve themselves into a simple formula for wavelength of a coil with a condenser shunted across it. The condenser in this case represents the capacity between the antenna and the ground.



A CHART FOR DETERMINING THE CONSTANTS FOR YOUR SET

FIGURE 2. *By merely laying his ruler across this chart (in the manner indicated by the diagonal line) the practical amateur may calculate the proper sizes for the condensers and the inductances of the set he proposes to build for use with a certain wavelength range. He need know little or no mathematics; the chart solves the difficult and intricate problems involved. The amateur has only to read from this chart the answer to his particular problem.*



A CHART FOR CALCULATING THE CAPACITY OF CONDENSERS IN SERIES

FIGURE 3. *The capacity of two condensers connected in parallel may be easily found by adding the capacities of each of the condensers together, which will give the capacity of the whole. But to determine the capacity of condensers in series is a more complicated matter. This chart indicates the answer to this problem; by laying a ruler across, as indicated by the diagonal line, calculations may be made.*

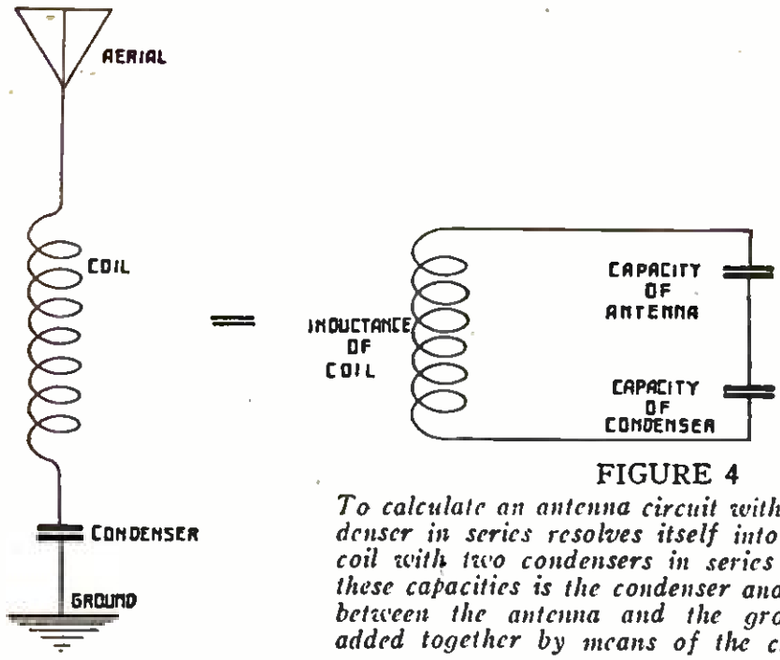


FIGURE 4

To calculate an antenna circuit with a coil and a condenser in series resolves itself into a formula for a coil with two condensers in series with it. One of these capacities is the condenser and the other is that between the antenna and the ground. These are added together by means of the chart in Figure 3.

Find the correct value of inductance to use in a circuit shown in Figure 3 in which a condenser is placed in series with the antenna circuit, the antenna having a capacity of .00025 mfd. and the condenser a capacity of .001 mfd. to tune to 400 meters.

The first step is to find the resulting capacity of the two condensers with the aid of the chart in Figure 3. Connect .001 on scale No. 1 with .0025 on scale No. 2 by a straight line and read at the intersection with scale No. 3 the resulting capacity of .0002 mfd. Having a capacity of .0002 mfd. and a desired wavelength of 400 meters, we find that we will need an inductance of 225 microhenries, as found in the first example we have given.

The chart shown in Figure 2 may also be used to find the wavelength, when the capacity and inductance are known, or to find the capacity when the inductance and wavelength are known. The general rule is this: Connect two known values on any two scales and the unknown will be found where the line crosses on the remaining scale.

The amateur is advised to keep these charts for reference, to be used along with additional charts on the design of coils necessary to get a certain value of inductance, and also with charts that will calculate the capacity of an antenna.

By the use of these charts the amateur may design his set with a definite knowledge of what wavelength range to expect when his set is finally put together and connected up.

Simple Coil Calculations for Amateurs

Mr. Raoul J. Hoffman—the author of the above article and the creator of many valuable time-saving charts and formulas—has prepared another article that will prove invaluable to the man who builds his own coils and who must know specifically how to determine (1), the dimensions for the diameter; (2), the length; (3), the number of turns; and (4), the size of the wire he should use. In POPULAR RADIO—for March.

From a photograph made for POPULAR RADIO

The author—who is pictured above in his electrical laboratory at Cornell University—is an associate of Prof. Vladimir Karapetoff, whose remarkable experiments with inductances and antenna formulas have established him as an authority among radio amateurs everywhere.

Shall I Use A "HARD" OR "SOFT" TUBE?

Should the amateur discard the temperamental soft tube as a detector and select instead the slightly less sensitive hard tube that has greater stability? The answer to this disputed question is pointed out in this article by—

WILLIAM C. BALLARD, JR.

THE directions that accompany most vacuum-tube receivers advise the user to employ a "soft" tube as detector and "hard" tubes as amplifiers. But after the tubes have been obtained the only apparent difference between them, in most cases, is in the label on the base of the tube. That is because the only actual difference between a hard and a soft tube is in the amount of gas that is left inside the tube when it is sealed off.

The term "soft" as applied to a vacuum tube is something of a puzzler to most people, as there is nothing about any kind of a vacuum tube that would suggest such a name. The name, however, has been handed down from "X-Ray" terminology and indicates a tube through which a discharge can be easily produced and whose rays have but feeble penetrative power. When these tubes are investigated it is found that they do not have a very high vacuum and contain appreciable traces of some gas or gases. If the traces of gas are removed from the "X-Ray" tube either by absorption or pumping, the

tube becomes "hard" and requires a much higher voltage for its operation as a consequence. The rays sent off by a hard tube have much greater penetrative power and are frequently spoken of as "hard" rays.

In order to understand just why a trace of gas makes a tube a good detector we will have to consider briefly what goes on in the detector circuit.

Figure 1 shows a common connection used for detector tubes. The radio signal sets up an alternating current in the antenna circuit almost exactly similar to the kind of alternating current we use for electric lights and power, but one which changes its direction about ten thousand times as rapidly as the kind we use for such purposes. An alternating current is one that flows for a while in one direction, stops, and flows for the same time in the opposite direction; then it reverses and flows in the original direction again, and so on indefinitely. The alternating currents with which we have to deal in radio reverse their direction of flow very rapidly. For instance, if we are receiving a 300 meter wave the current never flows in any given direction for over one-half of one millionth of a second. The usual way by which the rapidity in which a current builds up and dies down is measured is in "cycles per second." When the current has built up in one direction, reduced to zero, built up in the other direction, reduced to zero and come back to its original starting point, we say that it has gone through one "cycle." Applying this form of measurement to the 300 meter wave mentioned above, it requires one millionth of a second to complete a cycle. Hence the frequency is recorded as one million cycles per second.

If we were able to put a current of this character through the windings of a telephone receiver there would be little or no effect produced. While the current is flowing in one direction it tries to pull the diaphragm or vibrating metal plate toward the magnet, and when the current has reversed the opposite force will be exerted on the diaphragm. But for the 300 meter wave these opposing pulls will only last for one-half of one millionth of a second apiece, and before the first pull has any chance to move the diaphragm the second pull acts on the diaphragm and neutralizes the effect of the first pull. Since the push and pull are equally strong there will be no appreciable motion of the diaphragm.

But we can make these currents actuate a telephone receiver if we can make the pulls stronger than the pushes or *vice versa*. Under these conditions the effect of one pull cannot be exactly balanced out by the next push, and after several strong pulls and weak pushes the diaphragm will begin to move. As the diaphragm moves it pushes a little air along in front of it and thus produces a sound wave.

From the way in which the process has been described the reader may think that the diaphragm is moving slowly, but actually it moves so rapidly that your eye cannot begin to follow it. But as rapidly as it is moving, its motion is slow compared to the lightning-like changes of the radio current, and we may have several hundred pushes and pulls before there is any appreciable motion of the diaphragm.

One way to make the pulls stronger than the pushes would be to entirely eliminate the pushes, or more strictly speaking, the electric currents that produce the pushes. This is just what happens when we use a crystal detector. The crystal has the property of letting currents pass through easily in one direction and of shutting them out almost entirely in the other direction.

The vacuum tube accomplishes this result not by shutting off all current in one direction but by making the pushes and pulls of unequal force. Referring to Figure 1 again, the radio waves set up currents in the antenna circuit and their effect is in turn transmitted over on to the grid of the detector tube. These alternating currents in the antenna circuit produce alternating voltages on the grid, which may be considered in the light of electric pushes and pulls following each

other rapidly. The telephone receivers shown in the diagram are not connected directly in the grid circuit but are placed in a second circuit known as the "plate circuit" on account of the fact that in order to complete the circuit, current has to flow between the filament and the plate. The peculiar action of the vacuum tube lies in the control which the grid has upon the current flowing in the plate circuit. The grid acts as a sort of screen through which the plate current has to pass in its passage from the filament to the plate and the amount of current that gets through the screening grid depends upon the voltage applied to the grid at that particular instant. If the grid is positively charged, by connecting the positive side of a battery to it and the negative side to the filament, the plate current will increase to a value higher than the value which would flow when the grid is connected directly to the filament by a piece of wire. When the connections to the battery are reversed so that the negative pole is connected to the grid and the positive pole is connected to the filament, the plate current will drop to a still lower value.

The simplest way in which to express a complex relation such as exists between plate current and grid voltage is in the form of a "curve." To show the relation between plate current and grid voltage we rule a number of equi-distant parallel lines, both vertical and horizontal, and assume that distances measured in a horizontal direction to the right represent *positive* grid voltages, horizontal distances measured to the left represent *negative* grid voltages, vertical distances measured upward represent *positive* plate currents and vertical distances measured downward represent *negative* plate currents. The heavy horizontal and vertical lines represent the lines from which we start the measurements. In order to find out just what current will flow when the grid is one volt negative we look for the first vertical line to the left of the heavy vertical line and follow this line up until it crosses the curve. The distance that we had to travel along the first left-hand line to reach the curve will give us the value of the plate current under the specified condition of one volt negative on the grid, and this length can be most easily

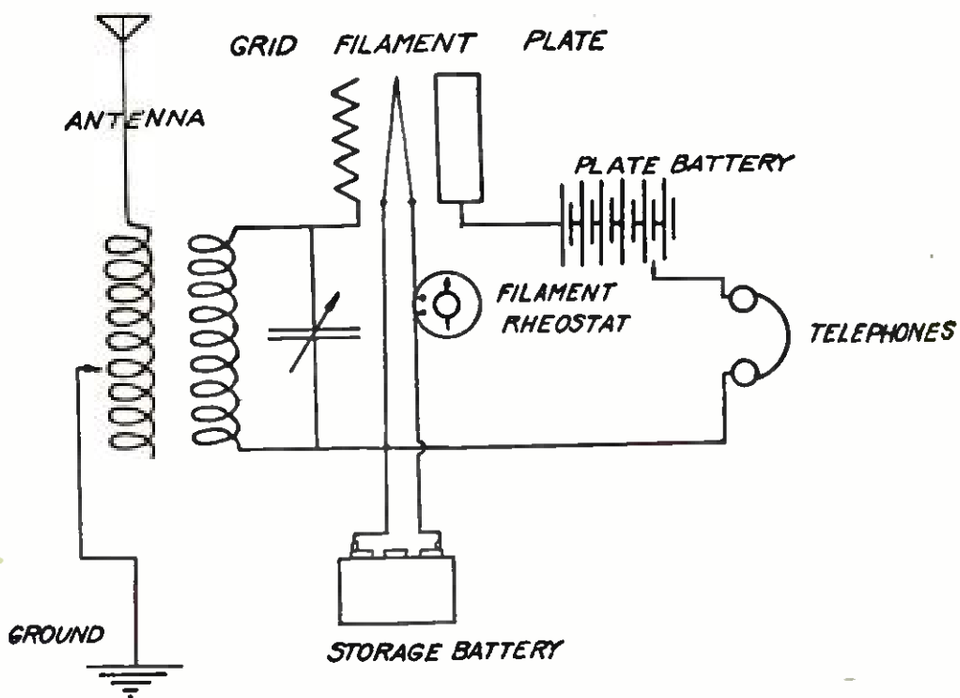


FIGURE 1

A vacuum tube used as a detector is shown in this diagram. To simplify the explanation of the functioning of the circuits, the grid condenser, which is used in most cases, has been omitted.

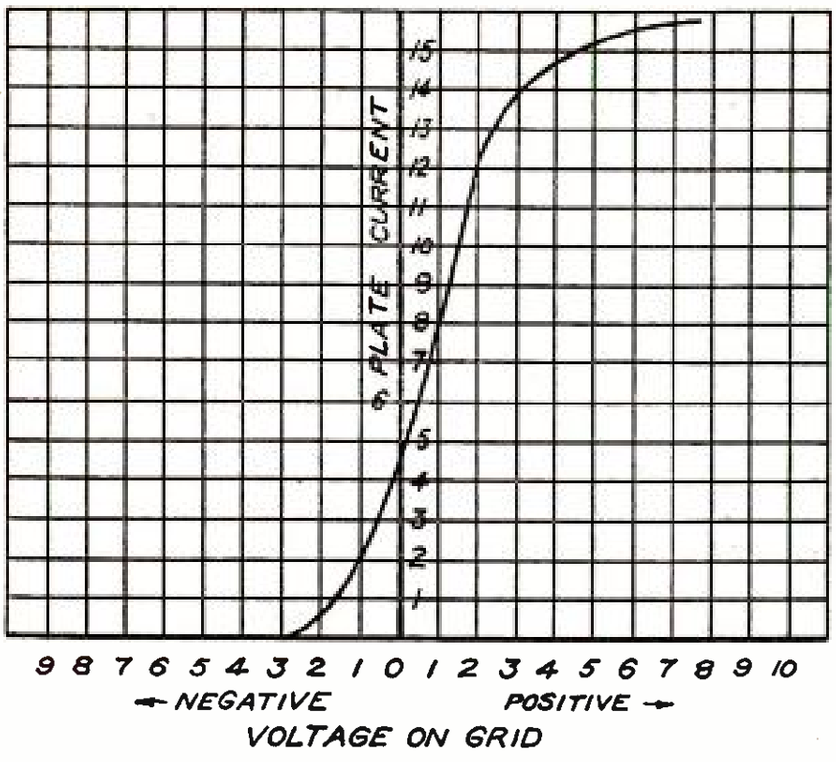


FIGURE 2

The relation of grid voltage to plate current in a hard tube is shown by what is known as the "characteristic curve."

found by projecting it over by eye on the heavy vertical line where the scale of units of plate current is shown. In the case shown the plate current is 2.

If we investigate the value of plate current when the grid voltage is one volt positive we will have to follow the first right-hand line up until it intersects with the curve and the corresponding value of plate current in this case is 8. Similarly, when the grid voltage is zero the plate current has a value of 4.5.

For the sake of simplicity, let us suppose that the value of the grid voltage induced from the radio signal varies between one volt positive and one volt negative, the plate current will increase up to 8 when the grid is positive, drop back to 4.5 when the grid voltage is zero and drop still further to 2 when the grid is one volt negative. The plate current passes through the telephones and when the plate current is increased beyond its normal value the pull on the diaphragm will be increased, producing a "pull" on the diaphragm. When the grid is negative the plate current will drop below its normal value, and by cutting down the pull below normal give the diaphragm a push in effect. On account of the curved shape of the curve, the pull will be stronger than the corresponding push so that the diaphragm will finally move after several cycles have acted upon it, and thus send out a sound wave. If the "curve" had been a straight oblique line, the value of the pull and the push would have been more nearly identical and a lesser effect would have been produced upon the telephone diaphragm. On the other hand, if the curve had been very much more curved or had a sharp break in it, the difference between push and pull would have been much more marked and the pull on the diaphragm would have been even more pronounced with a consequently stronger signal.

The curve shown in Figure 2 was drawn for a hard tube. The high vacuum and the absence of all gas gives a smooth curve and one which usually does not have any very sharp bends in it. Where slight traces of gas are left in the tube the curve is more likely to resemble that shown in Figure 3. From an inspection of this curve it can readily be seen that

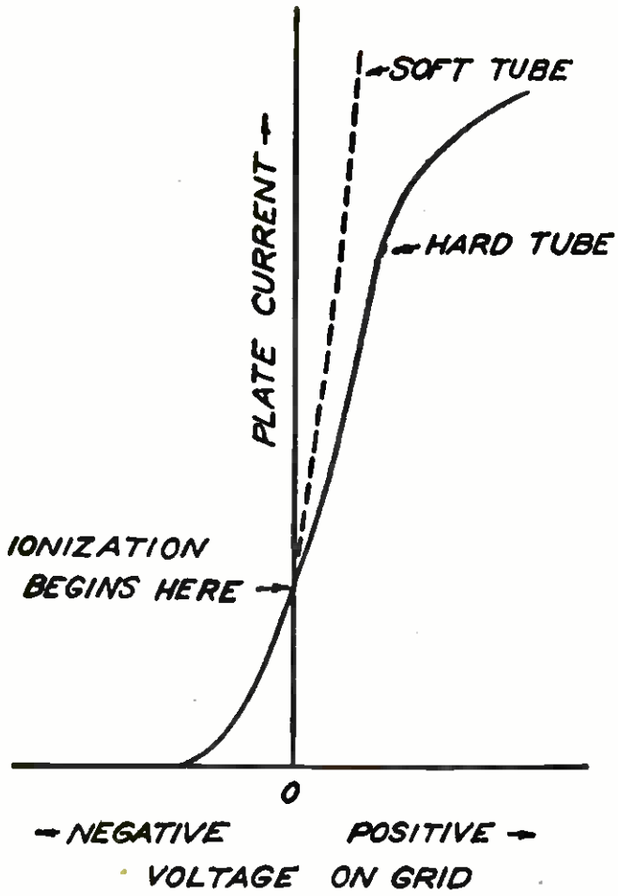


FIGURE 3

The characteristic curves of hard and soft tubes are here compared. Note how the plate current is increased in the soft tube by "ionization."

there will be a large difference between the corresponding pushes and pulls and a correspondingly strong signal in the telephones. The reason for this sudden break in the curve is due to the effects of "ionization by collision."

As the electrons sent off by the filament in a soft tube are drawn over to the plate they collide with some of the gas particles or molecules still left inside the tube. Up to a certain electron speed nothing happens, but when the electron is moving rapidly enough it will break up any gas molecule with which it comes into contact. The gas molecule is composed of a small particle of gas to which are attached small particles of electricity. When the gas molecule is broken up, some of the electricity is set free and moves over with the other electrons to the plate, thus increasing the plate current. This value of speed necessary to break up the gas molecule is quite well defined and the plate current takes a sudden jump just as soon as it is reached. When this ionization action is very intense it causes a blue glow inside the tube. The best adjustment for detector action is very much below the blue glow point and can be best determined by listening in the telephones while gradually increasing the plate voltage and filament current. When a certain point has been reached a hissing and frying sound will be heard in the telephones; this indicates that the first stages of ionization have been reached. Now turn the plate voltage or filament current down until the hissing has just disappeared and the tube should operate at its best point.

There is one difficulty in the operation of soft tubes; they are liable to change their degree of "softness." The metal parts inside the tube have the property of absorbing and giving up gas, depending on what happens to be going on inside the tube. In general, heating either the electrodes inside the tube or the glass walls of the tube will set gas free into the tube. On the other hand, operating a tube at or near the blue glow point has a tendency to absorb some of the free gas and make the tube harder. Tubes usually grow harder in use rather than softer, so that it is sometimes possible to bring them back to their original sensitive condition by carefully heating the glass bulb. The heating of the bulb has the tendency of loosening up some of the gas particles that have become stuck on the sides of the bulb, thus reducing the vacuum to the proper sensitive point.

There is a comparatively simple test which almost any experimenter can make to determine the degree of vacuum inside a soft tube. This test requires a small spark coil which can give about a one-quarter inch spark. Connect one of the high tension terminals to the battery (if not already so connected) and set the coil into operation. Next, grasp the tube in the hand, taking hold of the glass bulb, and take care that no part of the hand

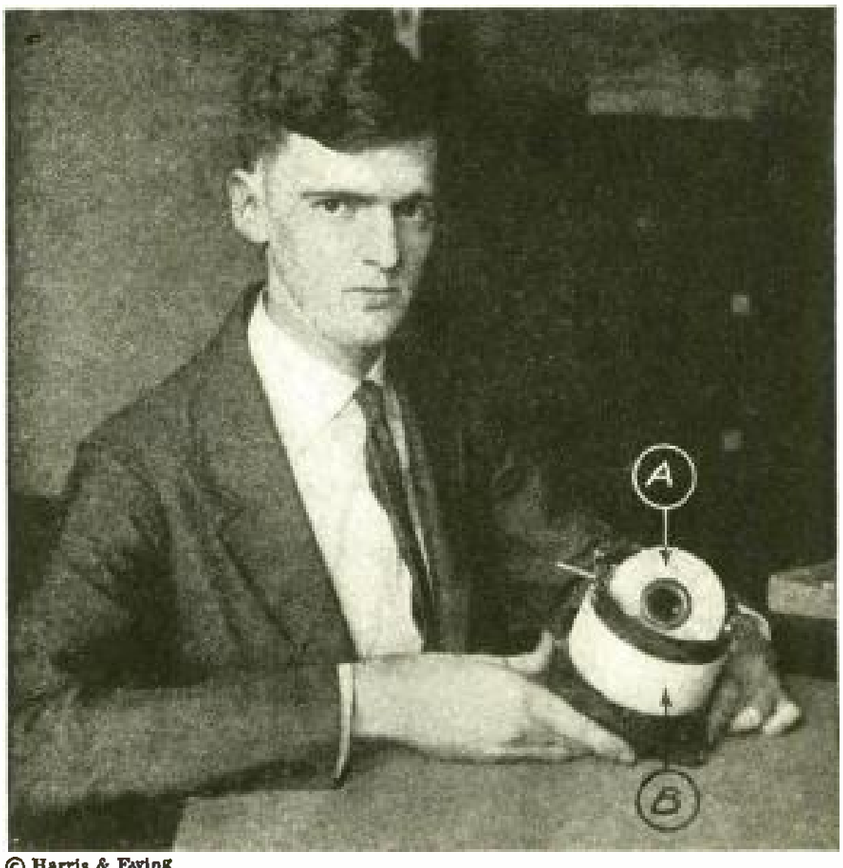
comes nearer than an inch to the metallic base. Touch any of the terminals to the high tension lead of the spark coil and carefully examine the tube for any signs of glow inside it. No glow at all indicates that the tube is either very hard or else that it is full of air. A pale greenish glow which seems to stick on the inside surface of the glass bulb indicates about the right amount of gas for good detector action. It may operate all right when the bulb fills with a pale greenish-blue glow, but if the glow is purple or confined to a small area directly around the plate and filament the probabilities are that there is too much gas inside the tube to give satisfactory detector action because of excessive ionization.

Soft tubes, while undoubtedly more sensitive as detectors, are not particularly reliable and for this reason many experimenters are using hard tubes as detectors and making up the difference in signal by using more amplification. This is particularly true with a regenerative receiver, where the detector circuit losses are eliminated by the feedback action of this circuit.

Kadel and Herbert

A LITTLE EVE DOES A LITTLE EAVESDROPPING

With a miniature radio receiver consisting of a tiny coil and a crystal detector, and with one wire attached to a lamp post as an aerial and another wire attached to an iron window grating as a ground, this young lady, Miss Ellen Hopkins of New York, is finding out what her elders are talking about in the ether. In satisfying such curiosity she differs not at all from several hundred thousand little Adams listening in with their receiving sets throughout the land.



© Harris & Ewing

A VARIOCOUPLER WITH ZERO COUPLING

In this hybrid device the inventor—pictured above—has combined the secondary coil of the spider web tuner (B) with the primary coil of the cylindrical tuner (A).

A NOVEL TUNER FOR

Shutting Out Interference

By S. R. WINTERS

FROM the viewpoint of the practical interests of the novice or amateur in the radio game, selective tuning in the variable coupler is a matter of the greatest moment; the more nearly zero the capacity coupling, the greater the practical value of the coupler in producing selective tuning.

In the Bureau of Engineering of the United States Navy Department there is a radio engineer—Alfred Crossley by name—who has rebelled against the conventional way of designing and building the receiving transformer or coupling arrangement. His creative effort has recently contributed to the radio science a variocoupler of novel conception, for which he claims the ability to achieve absolute zero coupling—an accomplishment not heretofore credited to any variable coupling device.

The coupling arrangement used between primary and secondary radio circuits is generally known as a "tuner." However, it is handed across the counter in radio stores under various designations, "variocoupler," "loose coupler," "honeycomb coils," "lattice-wound coils," "stagger-woven coils," "basket-wound coils," "tuning coil" and "duo-lateral coils."

These various coupling devices have much in common in structural details. The primary coil ordinarily consists of approximately fifty turns of wire, tapped at each five or ten turns. The secondary

coil or circuit contains from thirty to fifty turns of wire, the shape of the latter almost invariably being cylindrical. In addition to the inductive functions of these tuners the primary coil forms one plate of a condenser while the secondary circuit functions as the other plate. This is a detriment to good tuning.

In breaking away from this beaten path Mr. Crossley attacked the problem fundamentally from the standpoint of obtaining a high maximum and low minimum inductance in the coupler, and at the same time a minimum amount of electrostatic capacity.

There are two electrical constants found in a radio circuit—an electromagnetic field and an electrostatic field. Dr. Charles P. Steinmetz, the master electrical genius of the General Electric Company, in disclaiming the existence of ether waves, asserts "that the magnetic and electrostatic fields are usually combined, since where there is a current producing a magnetic field, there is also a voltage producing an electrostatic field." Thus the space surrounding a wire that carries an electric current is disturbed by the combination of a magnetic field and an electrostatic field. Static or frictional electricity—the kind that is produced when a strip of hard rubber is rubbed against a cat's fur, to

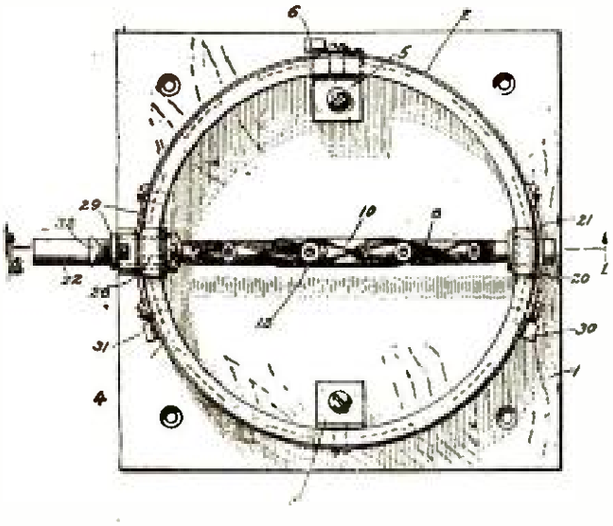


FIGURE 2

In this plan view the rotor is shown in the position of minimum coupling.

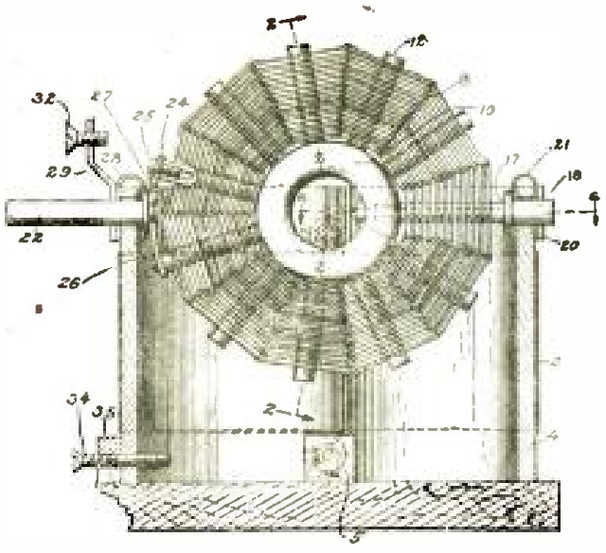


FIGURE 1

The tubular coil is cut away in this diagram to show more clearly the details of the secondary coil.

cite an interesting instance—is a detriment to tuning between radio circuits and it is desirable to reduce it to a minimum value in a tuning instrument.

The efforts in previous designs of "loose" or variocouplers to retain a wide range of inductance and at the same time reduce the electrostatic capacity to a minimum have not as yet met with complete success. Professor L. A. Hazeltine of the Stevens Institute of Technology made a stubborn effort to "kill" the capacity effect between the primary and secondary circuits by substituting grounded windings over the latter circuit. Zero capacity coupling was not fully attained and the plan was abandoned.

Mr. Crossley, in his design of variable coupling, discards the cylindrical form common to prevailing types of secondary coils and substitutes a spider-web rotor. The latter contains a hard rubber hub, with tiny hard rubber spokes radiating from the center. Interwoven in these spokes are the windings of the secondary coil. Approximately forty turns of wire are used in this spider-web rotor. In operation, maximum transfer of electric energy from the antenna circuit to the secondary circuit is effected when the plane of this spider-web winding is at

right angles to the axis of the primary winding. On the other hand, minimum or zero coupling is obtained when the plane of the secondary winding is approximately in line with the axis of the coil or wire constituting the primary circuit.

The winding on the rotor of this newly designed variocoupler is similar in design to the intricate webs fashioned by a spider; hence the designation, spider-web variocoupler. The instrument may be employed in a variety of radio frequency circuits. It is especially applicable for use in radio frequency amplification, a form of radio telephone reception that is becoming increasingly popular in a nation-wide broadcasting service.

This adaptation of the Crossley coupler is established by virtue of the ability of the coupler to reduce to a negligible quantity the passage of electrostatic energy from the antenna to the input circuit of the radio frequency amplifier. The device not only successfully prevents electrostatic coupling, a redeeming feature in itself, but further qualifies its claims to superiority as a coupling arrangement by imparting a maximum electromagnetic coupling. When used in the tuning circuit before a radio frequency amplifier the stator or primary winding is connected in the antenna system proper, and the rotor or secondary winding is connected to the input circuit of the initial stage of radio frequency amplification.

If employed in Major Edwin H. Armstrong's regenerative or super-regenerative circuits, the stator may be connected in the grid circuit with the rotor in the plate circuit, forming the feed-back coupling.

The electrostatic capacity, at minimum coupling between the primary and secondary windings of this new variocoupler, is less than one micro-microfarad. At maximum coupling, the electrostatic capacity between the two windings is five micro-microfarads.

In actual test at Washington when NOF, the Naval Air Station at Anacostia, with an antenna current of thirteen to seventeen amperes, was transmitting, both the primary and secondary circuits, employing this design of receiving transformer, were adjusted to the wavelength of 412 meters. By obtaining zero coupling, this high-power radio telephone broadcasting station was tuned out completely. However, by merely moving the rotor of the coupler one degree or fractional part to the right or left of zero coupling, Anacostia was retuned in vigorous fashion; or, at will, NOF could be tuned out and Pittsburgh, Newark, Schenectady or other far-distant broadcasting stations could be "copied" even while Anacostia continued its high-power broadcasting service.

The selectivity of this tuning device, if we are to accept the claims made and results accomplished in preliminary tests, should be a boon for the reception of radio signals on bands of wavelengths closely approximating each other.

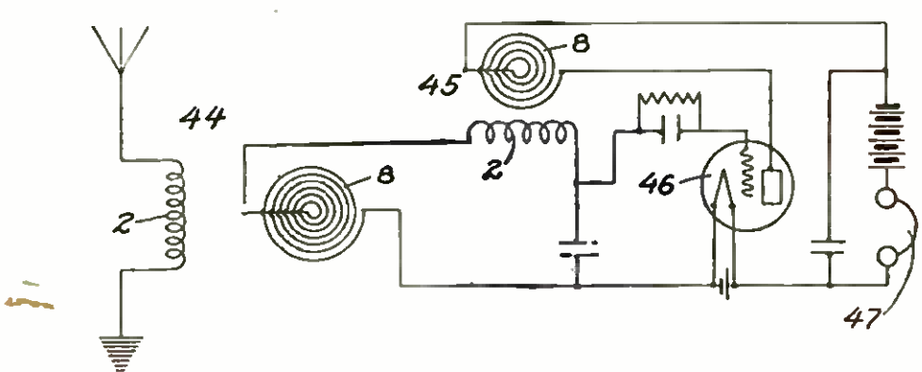


FIGURE 3.

An interesting use may be made of two of these couplers, one as a tuner and the other as a feedback, as shown in this diagram of a regenerative circuit.

From a photograph made for POPULAR RADIO

Every radio fan is familiar with the little black box into which weak signals enter and out of which they come forth strengthened. If you want to know just how the tubes and transformers within the amplifier work together to create this phenomenon, read—

HOW THE

Audio Frequency Amplifier Works

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—NO. 8

By LAURENCE M. COCKADAY, R.E.

THE problem of vacuum tube amplification is somewhat different from that of vacuum tube detection, although the same essential theory of operation of the tube is observed.

The vacuum tube is a potentially operated (voltage controlled) device, as explained in the December issue of this magazine. This same principle is used for amplification.

Dr. Lee De Forest saw the feasibility of using the amplifying qualities of the vacuum tube when he took out his patents on the "cascade amplifier," as he called it. This system uses a number of vacuum tubes connected in cascade, coupled together by means of transformers so that the output circuit of the detector tube is connected to the input circuit of the first amplifier tube, and so on with the second and third amplifier tubes. It is not good practice to use more than

three or four stages of this type of amplification, on account of "tube noises" which are amplified along with the signals and which tend to blur the clarity of reception.

This "cascade amplification" may be divided into two classes:

First, audio frequency amplification.

Second, radio frequency amplification.

Audio frequency amplification is cascade amplification of the rectified impulses which are flowing in the plate circuit of the detector tube. These impulses are of an audio or audible frequency and the successive stages of amplification are coupled together with a transformer called an "audio frequency amplifying transformer," which will step up the voltage of an audio frequency impulse and supply it to the grid or input circuit of the next tube.

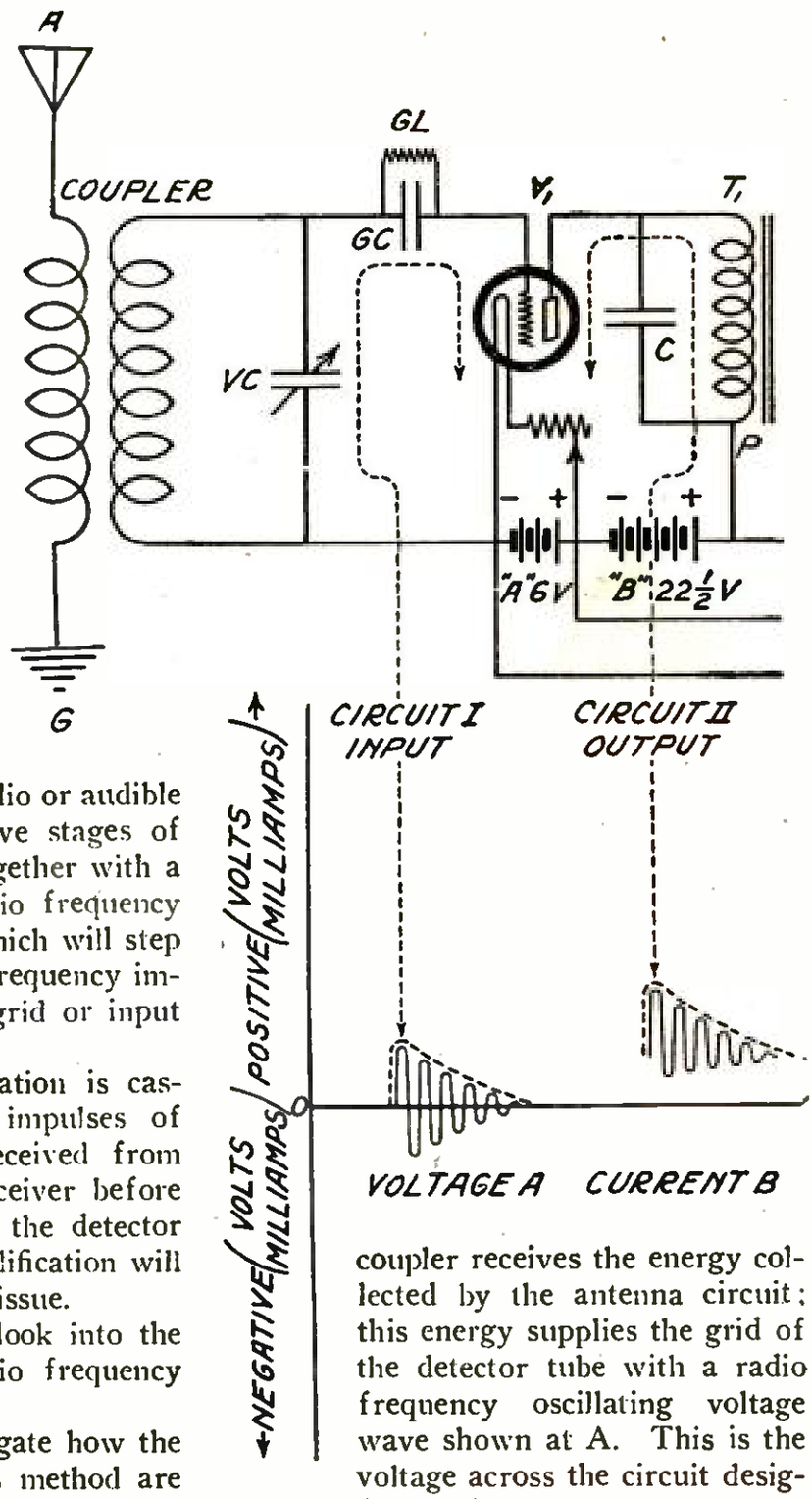
Radio frequency amplification is cascade amplification of the impulses of radio frequency current received from the antenna circuit of a receiver before they have been rectified by the detector tube. Radio frequency amplification will be taken up in a following issue.

For the present we will look into the inner workings of the audio frequency amplifier.

First of all, let us investigate how the series of tubes used in this method are connected.

In Figure 1 we have a standard hook-up for an inductively coupled tuner with a vacuum tube detector; added to this is a two-stage audio frequency amplifier. The first stage consists of a transformer, T^1, and a vacuum tube, V^2; the second stage likewise contains similar instruments, T^2 and V^3.

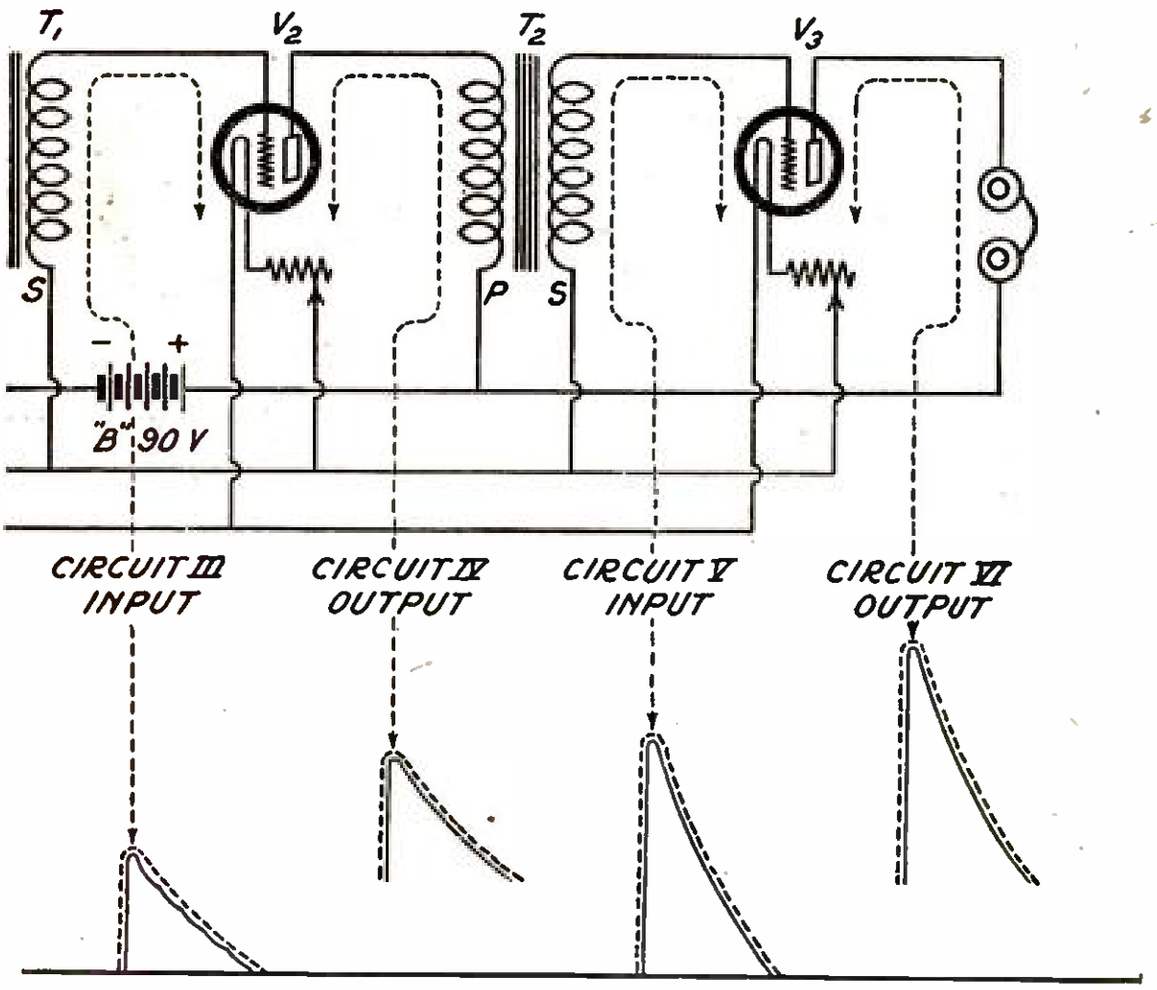
The secondary circuit of the receiving



coupler receives the energy collected by the antenna circuit; this energy supplies the grid of the detector tube with a radio frequency oscillating voltage wave shown at A. This is the voltage across the circuit designated as Circuit 1.

The tube V^1 then acts as a relay and produces an amplified impulse in its plate circuit (Circuit 2), which has the same audio frequency wave form as the original impulses in Circuit 1. These wave forms can be compared by referring to the dotted lines in curves A and B. The radio frequency component of the current B is passed around the transformer

FIGURE 1. *This circuit diagram and chart shows how the successive stages of amplification increase the minute voltages and currents of a received signal until they are strong enough to operate a loudspeaker, thus producing a signal which can be heard throughout the entire house.*



winding P by means of the bypass condenser C, and only the audio frequency component of the current B (which is shown by the dotted lines) passes through the winding P. This current, flowing through P, induces a similar impulse in the secondary winding S, except that the voltage of the impulse induced across the Circuit 3 is higher than the voltage in Circuit 2 on account of the step-up ratio used in the transformer windings.

The voltage in Circuit 3 is shown at A^1. By comparing the voltages A and A^1 we readily see that in A^1 we have a much greater voltage impressed on tube V^2 than the A impressed on V^1. Therefore in the plate circuit of V^2 (Circuit 4) we have a greater current response than in V^1, Circuit 2. Compare the currents B and B^1.

It will be seen that the second tube amplifies the current flowing in the plate circuit of the first tube and supplies this amplified current to a second transformer, T^2, which also steps up the voltage of the impulse as shown in Circuit 5, supplying the grid of tube V^3 with a larger voltage than that applied to tube V^2. Compare A^1 and A^{11}. This in turn produces a still greater response in the plate circuit of tube V^3, Circuit 6, shown at B^{11}.

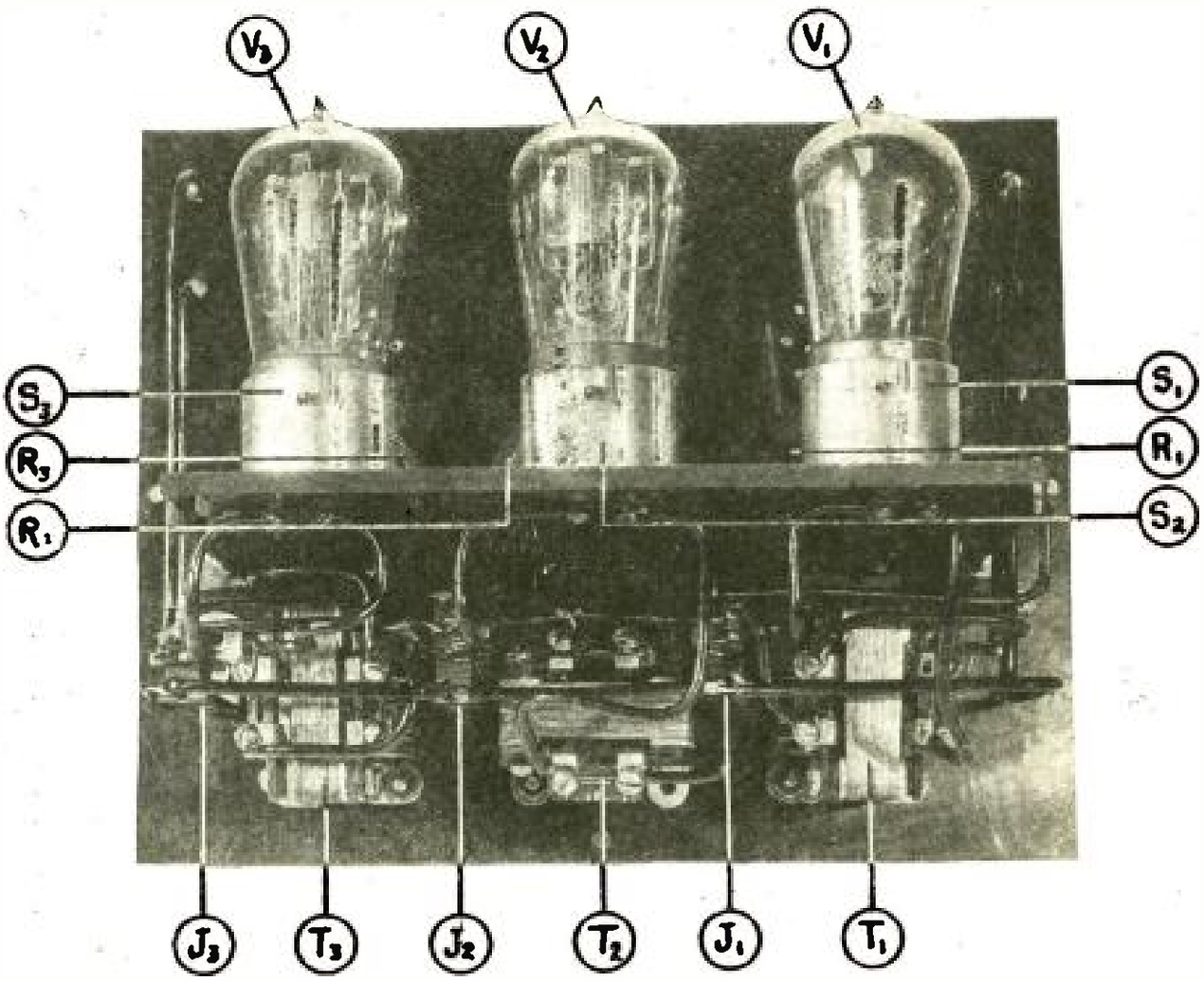
Now, the problem before us is to get the plate current variations as large as possible; that is just what we have done,

as is shown when we compare the currents B, B^1, B^{11} in the plate circuits of the three tubes. They have been getting larger in each additional stage of amplification.

A further analysis of this action should enable us to see clearly that the phenomena in a vacuum tube is purely a case of cause and effect. The cause is the voltage applied to the grid and the effect is the corresponding current which flows in the plate circuit. In our diagram the causes are shown at A, A^1 and A^{11} and the effects at B, B^1 and B^{11}. If we increase the cause as at A^1, we get a greater effect, B^1, and if we further increase the cause as at A^{11}, we get a still greater effect, B^{11} The increase in the cause is accomplished by the transformers which step up the voltage of the succeeding impulses, and the effect is increased by the relay action of the vacuum tubes themselves.

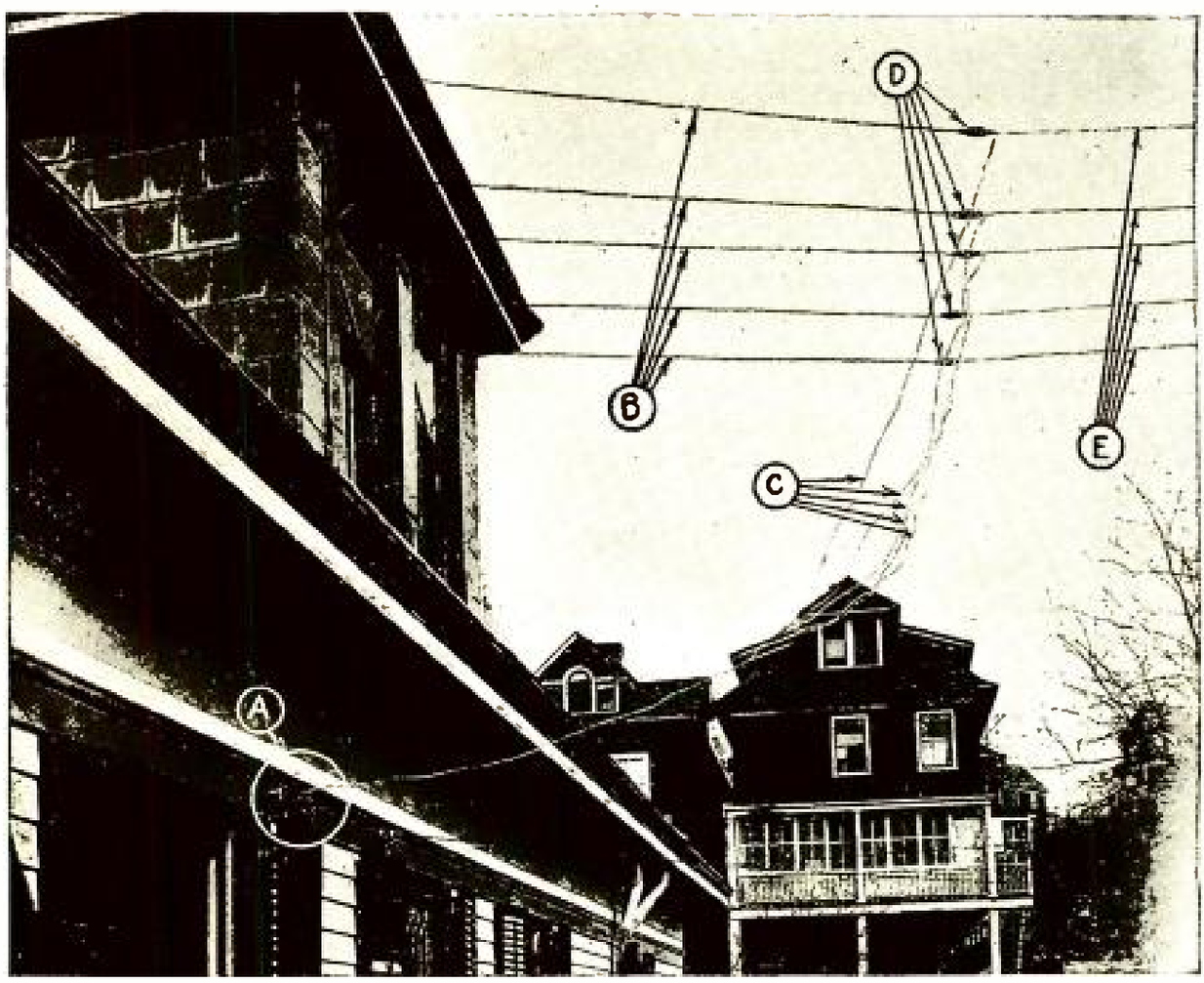
This amplification is done at an audio frequency, because the amplifying transformers pass the audio frequency impulses with facility, but hold back the radio frequency component of the current, not allowing it to flow through their windings.

In our next article we will study the radio frequency method of amplification which has the peculiar property of amplifying weak signals that cannot be heard with audio frequency amplification, no matter how many stages are used.



HOW THE "INSIDES" OF A THREE-STAGE AMPLIFIER ARE MOUNTED

The tubes used are generally mounted on a shelf in back of the panel; they are shown here as V_1, V_2, V_3; they are the tubes for the first, second and third stages, respectively. The sockets are designated as S_1, S_2 and S_3. Only a small portion of the three rheostats can be seen, R_1, R_2 and R_3. The three amplifying transformers, T_1, T_2 and T_3, and the jacks J_1, J_2, J_3, are fastened to the panel underneath the shelf.



THE LEAD-IN END OF A WELL-CONSTRUCTED ANTENNA

A is the lightning switch; B the supporting wires; C the lead-in wires which are joined together to form a common lead-in; D the insulators and E the antenna wires that run to another set of insulators and supporting wires or ropes. It will be noted that the antenna is placed out from the tin roof of the house a distance of at least fifteen feet; this is done by lengthening the wires or ropes B.

Pointers *for* Building Your Aerial

By FRED WOODWARD

AERIALS are the ears and mouth of a radio station. Their position and the way they are hung materially affect the distance from which the radio waves may be received.

The ideal location for an aerial is a low, bare hill, as far as possible from other tall objects such as trees, chimneys, telephone wires or tall buildings.

But these perfect conditions are seldom, if ever, encountered at the particular place at which you are obliged to erect the aerial. In this article, therefore, we will assume that the site of your proposed antenna is the only kind that most often may be taken advantage of —the roof. Two convenient objects to which you can attach the supporting poles are a chimney and the covering to the door leading to the roof. Steady these poles with guy ropes fastened to the coping of the roof or to the roof top itself.

If the aerial is to be a comparatively short one, copper wire will do for the purpose. However, copper wire has a tendency to stretch, so that if you are

lucky enough to be in the position to have an antenna at least 100 feet long a copper-covered steel phosphor-bronze wire would best serve your purpose. As high frequency currents travel mainly on or near the surface of the wires, it is possible to use a steel wire covered with copper.

Be sure to properly insulate the lead-in wire where it passes over the edge of the roof. In order to keep this lead-in as far as possible from the front of the house, carry it from the roof to the end of a six-foot flagpole projecting from the window through which you bring the antenna wire into the house or take off your lead-in joint a little distance from the end of the aerial. See that the insulators on your aerial are strong enough to withstand the strains of supporting the aerial in all weathers.

The flat topped aerial, as shown in the illustration on page 109, is better than the single wire aerial in cases when a great height cannot be obtained.

Remember that all flat topped, or horizontal forms of aerial possess a "directive" tendency. It is advisable, therefore, to have the end of the aerial at which the lead-in is fastened pointing toward the broadcasting station from which you expect to do the most receiving. A good antenna is half the battle.

DON'TS

Don't try to master radio all at once. Begin with the simplest things and work up.

* *

Don't hesitate to ask questions. Ignorance is no disgrace and dealers and manufacturers are glad to give advice.

* *

Don't expect to have as little trouble in summer as in winter. Static is far more troublesome in warm weather than in cold.

* *

Don't listen to the advice of beginner friends who know no more than yourself.

* *

Don't forget that radio is simple but that common sense is as necessary as with anything else.

* *

Don't forget the importance of little things.

* *

Don't be in such a hurry to try your set that you skimp things and make slipshod connections.

* *

Don't try to drive tacks or nails into Bakelite or hard fibre. Drill holes and use screws.

Don't forget that the wires on a coil may be kept evenly spaced by winding cotton twine between the wires.

* *

Don't run wires parallel when making a set.

* *

Don't try to ground a set on an indoor electric light or bell circuit.

* *

Don't forget that the positive pole of the "B" battery is connected to the plate circuit of your tube.

* *

Don't forget that if the tube looks blue you have too much "B" battery.

* *

Don't forget to mark the adjusting knobs or handles when you get the set tuned to a certain station. It will save time in picking it up next time.

* *

Don't fail to learn the dot and dash code. You will get far more pleasure from your set if you can read them.

* *

Don't get wires tangled and snarled. A kink in a wire will cause it to crack or break.

THE GENERATOR THAT SUPPLIES THE ELECTRICAL IMPULSE

It is operated by a propeller-like fan beneath the fusilage; incidentally this device furnishes heat to the uniform of the aviator who flies in high altitudes.

A Radio Helmet for an Aeronaut

By STEPHEN LEE

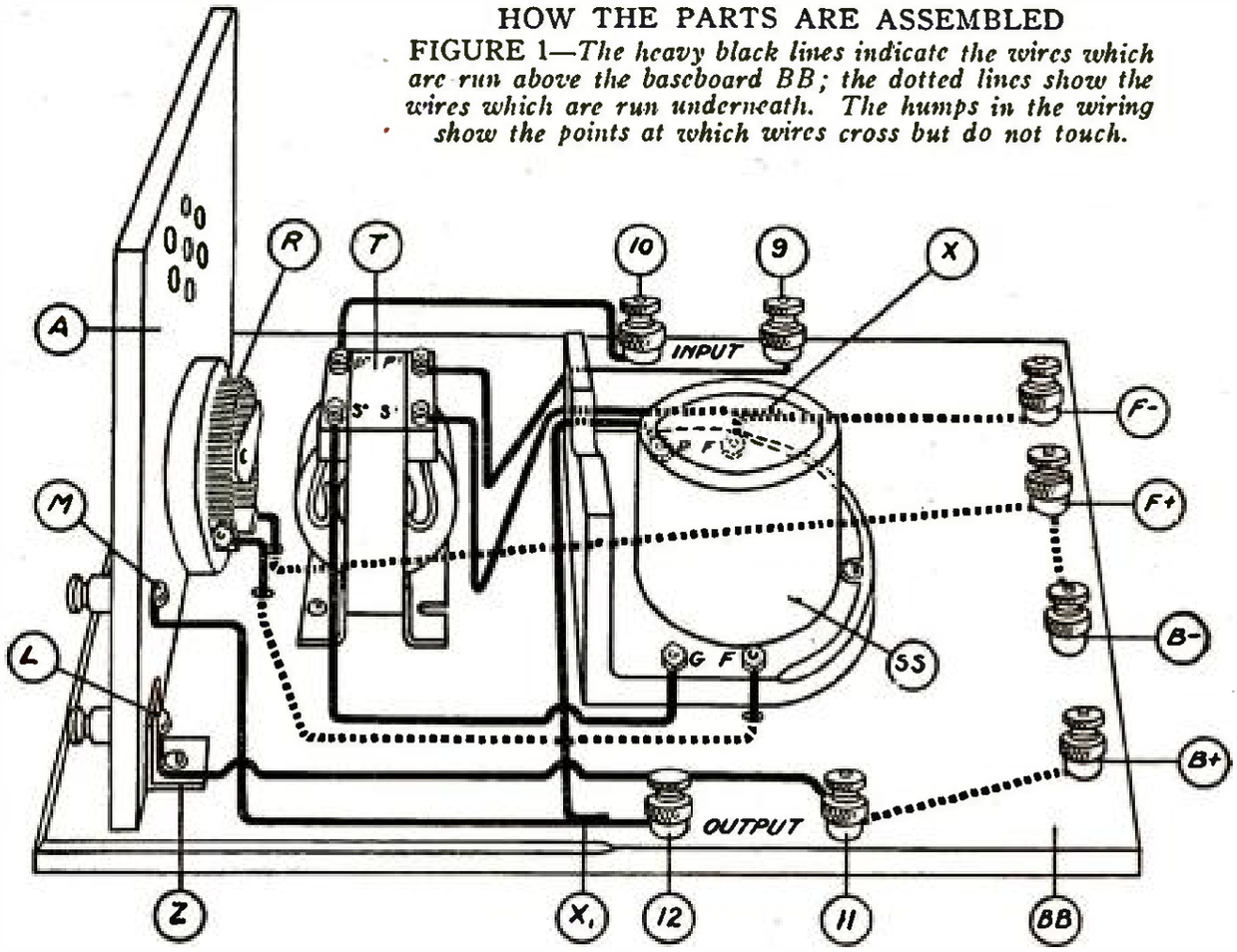
WHEN Lieutenant John A. Macready attempts to shatter the previous sky-climbing record—flying an airplane to a height of 40,800 feet—he will introduce a helmet recently designed by the Air Service of the United States Army. The scientific appliance is at once a means of supplying oxygen necessary in sustaining life at excessive levels in the atmosphere and a mouthpiece that contains a transmitting microphone. Combined with this device are two telephone receivers that are easily adjustable over the ears.

The electrical impulse for the functioning of the radio-telephone equipment is derived from a generator that is actuated by a propeller-like fan affixed beneath the airplane, as illustrated in the accompanying picture. This electrical generator likewise serves the purpose of radiating heat to the Esquimo-like uniform of the aviator, which he wears as protection against the intense cold of this high altitude. The highest attained by Lieutenant Macready may be graphically visualized by his ascension to Mount Everest—the "roof of the world"; this peak is 29,000 feet high, yet the Government aviator climbed two miles in excess of that height.

The newly-designed helmet that couples the functions of supplying oxygen and communication by radio-telephony, is, of course, applicable only when extreme altitudes are the objectives sought. However, the possible use of radio equipment in the atmosphere at such high levels demonstrates still another application of this form of communication, and indicates its practical features for arctic exploration.

HOW THE PARTS ARE ASSEMBLED

FIGURE 1—*The heavy black lines indicate the wires which are run above the baseboard BB; the dotted lines show the wires which are run underneath. The humps in the wiring show the points at which wires cross but do not touch.*



HOW TO ADD TO YOUR SET

AN AUDIO FREQUENCY AMPLIFIER

Do You Want to Dispense with Your Headphones and Use a Loudspeaker? This Article Tells You How to Do It—at a Cost Ranging from $30.05 to $45.30

By DAVID LAY

THE amplifier described in the following directions may be used with the single-circuit radio receiving set described in the May issue of POPULAR RADIO, or with the two-circuit radio receiving set described in the July issue, or with any other tuning device equipped with a detector. The detector may be either a crystal detector or an electron tube detector.

Many radio receiving sets include either a radio frequency or an audio frequency amplifier. A radio frequency amplifier amplifies the radio frequency signal before it is detected (or rectified) by the crystal or electron tube detector, while an audio frequency amplifier amplifies the rectified signal after it leaves the crystal or electron tube detector. The essential parts of either type of amplifier are the amplifying transformer and the electron tube.

These directions tell how to construct an audio frequency amplifier unit—that is, an amplifier that employs a single electron tube. The amplifier unit is used by connecting it to the receiving set in place of the telephone receivers and then

connecting the telephone receivers to the output of the amplifier.

The audio frequency amplifier unit is added to the tuner and detector so that the radio power received by the antenna may be transformed into sound in greater volume than would be possible by the use of a crystal or electron tube detector alone. The use of such an audio frequency amplifier unit increases the receiving radius of the outfits described in previous articles of the series by approximately fifty per cent. Still greater receiving radius may be obtained by adding another amplifier unit just like the first one. It is usually not practical to use more than two stages of audio frequency amplification—that is, two audio frequency amplifier units.

One of these amplifier units added to a regenerative receiving set increases the volume of sound in the telephone receivers.

Since a circuit including a crystal detector or simple electron tube detector will not make continuous-wave signals audible in the telephone receivers, the addition of an audio frequency amplifier to these circuits will not accomplish this result.

The cost of this audio frequency amplifier unit, complete with an electron tube, is between $13.00 and $21.00. This does not include the cost of batteries. If an electron tube detector is used in the receiving set, the same batteries are used for the amplifier unit. If, however, a storage battery for lighting the tube filament is not already available, this item will add from $15.00 to $22.00 to the estimate; and if dry batteries are not already available, the addition of two dry batteries for supplying voltage to the plate of the tube will add from $2.00 to $3.00 to this estimate. The cost of the tuner, crystal detector, telephone receivers and antenna equipment which are usually used with this amplifier is between $11.00 and $23.00. If the electron tube detector unit described in the November number of this magazine is used in place of the crystal detector, the cost of the complete equipment is increased by an amount varying between $7.00 and $13.70.

These directions tell of simple apparatus of satisfactory performance without reference to the possible existence of any patents which might cover parts of the apparatus. Apparatus in general similar to that described can be purchased from responsible manufacturers.

The Amplifier

The audio frequency amplifier unit as shown in Figures 1, 2 and 3 is composed of a baseboard BB and an upright panel A. On the baseboard BB is mounted an electron tube socket SS, an audio frequency amplifier transformer T and eight binding posts. On the upright panel A is mounted a filament rheostat R (the adjusting knob J is shown in Figure 3) and two telephone receiver binding posts, L and M. Figure 2 shows the arrangement of these parts. These directions tell how the various parts are assembled on the baseboard and panel. No description is given of the construction of any of the parts.

The Accessories That You Will Need

Under this heading may be listed a six volt storage battery ("A" battery) with an ampere-hour capacity of about 60, used for lighting the electron tube filament; a 45 volt dry battery ("B" battery) for supplying the electron tube plate voltage, binding posts, stiff copper wire (tinned wire is usually preferable), wood boards for the baseboard and upright panel; two brass angle braces for supporting the upright panel, miscellaneous wood screws and suitable stain and varnish. A composition insulating material panel is sometimes substituted for the wood panel and the amplifier unit enclosed in a wood cabinet with a hinged cover. When the cabinet is added the eight baseboard binding posts are left exposed.

Description of the Parts

The baseboards—(See Figures 1 and 3.) The base BB is any kind of dry, well-seasoned wood about 6¼ inches by 8¼ inches by ½ inch thick. Eight holes are drilled through the base in which the binding posts are fastened. The binding posts are spaced so that they present a neat appearance. The baseboard is arranged so that the three remaining sides and a hinged cover may be added without changing the positions of the binding posts. Under each of the four corners of the baseboard BB rubber or wood feet are fastened in order that the binding-post heads and wiring on the under side of the baseboard will be protected.

Upright panels—(See A, Figures 1 and 3.) The panel A is any suitable dry, seasoned wood about 4½ inches by 5 inches by ⅜ inch thick. In Figure 1 a back view of the panel is shown which brings the two holes for the telephone

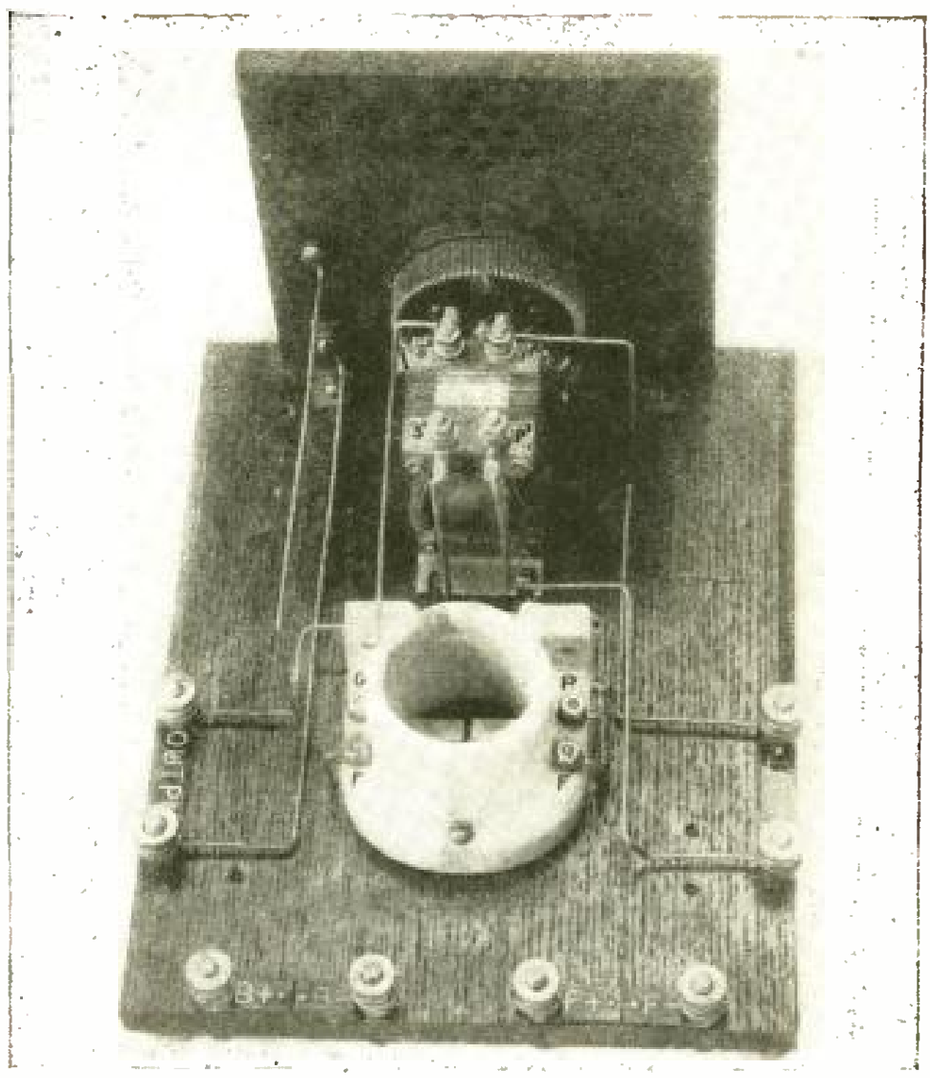


FIGURE 2

Here is shown the rear view of the completed apparatus, with the instruments, binding posts and wiring in place. The amplifier used for this illustration was made with an ordinary set of tools.

receiver binding posts L and M in the lower left corner. (If the panel is viewed from the front these two holes will be at the lower right corner.) This panel is made to present a good appearance, as it is the front panel. Four holes are drilled in the panel A, one for the bolt which fastens the panel to the brace (see Z, Figure 1), two for the telephone receiver binding posts L and M (Figures 1 and 3), and one for the shaft of the filament rheostat R (see Figure 1). The exact location and diameter of the hole for the rheostat shaft is determined from the rheostat itself. It is drilled so that the rheostat occupies as low a position as possible, allowing room enough to do the necessary wiring.

The electron tube—(See Figure 3.) The electron tube is a commercially available tube generally called an amplifier tube or "hard" tube.

The electron tube socket—(See SS, Figures 1 and 3.) The electron tube socket is one of various commercially available types.

The audio frequency amplifier transformer—(See F, Figure 1.) The audio frequency amplifier transformer is one of the various commercially available types.

The binding posts—The binding posts used on the baseboard are 6-32 or 8-32 brass machine screws, each equipped with two nuts and two washers, if regular binding posts are not used. The telephone receiver binding posts, L and M (Figures 1 and 3) are of the set-screw type to admit the tips of the telephone receiver cords.

The filament rheostat—(See R, Figure 1.) The filament rheostat is one of the various commercially available types designed for panel mounting, and has a neat appearing knob and pointer. The rheostat has a resistance of about seven ohms and a current-carrying capacity of about 1½ amperes.

Accessories—The accessory batteries are commercial articles. The purchaser of the six volt storage battery ("A" battery) for lighting the filaments should get full instruc-

tions from the dealer for testing and recharging the battery. The 45 volt "B" battery usually used for the plate circuit cannot be recharged. The normal life of a dry battery of reliable manufacture is about six months. Storage batteries for use as "B" batteries are available. The first cost of these batteries is greater than that of dry batteries, but they may be recharged.

How to Assemble and Wire the Set

Wood finish—It is essential that the wood be protected from moisture. The wood is first dried, and then finished with stain and varnish; a good grade of varnish, preferably insulating varnish, is used. Shellac or other alcohol-dissolved resins are not used. This method of wood finishing is found more satisfactory than treating with paraffin. The exact method of drying and finishing wood depends upon the condition of the wood itself. The wood is usually placed in a warm oven for an hour or so to insure more or less complete drying. The use of lamp black or carbon pigment stains is avoided, and the stain and varnish is thoroughly dried before the apparatus is mounted on the wood baseboard and panel.

The baseboard—(See Figure 1.) The eight brass machine screws or binding posts are put in the holes already drilled in the baseboard. If machine screws are used, the heads are put on the under side of the baseboard with a brass washer between the head and the baseboard. A brass washer and two nuts are then fastened to each screw, on the upper side of the baseboard, with the washer next to the baseboard.

The tube socket, SS, and the transformer T are next screwed to the baseboard. The exact location of these parts varies according to the particular type used. One may get an idea of the relative position of the several parts from Figure 2. The tube socket, SS, is mounted so that the two terminals marked G and P (Figure 1) are nearest the upright panel. Wood blocks are put under the socket SS, when necessary, so that the four terminals of the socket do not touch the wood baseboard. This is done by cutting off two round wood blocks just long enough to raise the socket terminals clear of the base, and mounting them so that the screws which hold the socket to the baseboard will pass through holes in the centers of the blocks.

After the socket SS and the transformer T are mounted, the parts are wired. Number 14 bare (preferably tinned) copper wire is used in wiring; this makes the connections stiff and self-supporting. This wire is ordinarily furnished in rolls and is straightened before being used. This is accomplished by clamping or otherwise fastening one end of the wire solidly and pulling on the other end just hard enough to stretch the wire slightly. All wires are run as directly as possible, consistent with good spacing and neat appearance, and all bends are made at right angles. When a wire is attached to a binding post, a loop or eye is formed on the end of the wire and the wire at the eye flattened with a hammer. This gives more contact surface. Special lugs are sometimes soldered to the ends of the wires before the connections are made.

A small hole is drilled through the baseboard near each of the tube socket terminals marked F (see Figure 1). A short piece of wire is fastened to the right socket terminal marked F and is then led through the small hole in the baseboard to the under side of the baseboard. The same wire is led to the under side of the binding-post marked F—and fastened between the machine screw head and washer underneath the baseboard. All wires which are run on the under side of the baseboard or are hidden by parts of the apparatus are shown by dotted lines. A wire is soldered (at X) to the wire leading from the right socket terminal marked F, just above the baseboard and led to the secondary terminal S of the transformer T and soldered or otherwise fastened to it. This wire is shown as part solid and part dotted. The wires do not touch the wood boards except at the terminals and where the wires pass through holes in the baseboard. The wires may be raised more or less to accomplish this. Another wire is soldered to a primary terminal P′ of the transformer and led to the "input" binding post No. 9. Humps or bends are shown in this and other wires to indicate that the wires cross but do not touch.

A wire is soldered to the other primary terminal P″ of the transformer T and goes from there to the other "input" binding post, No. 10. A similar wire reaches from the other secondary terminal S″ of the transformer to the electron tube socket terminal marked G. The secondary transformer terminal which connects to the terminal G of the electron tube socket is that terminal which is internally connected to the outside end of the secondary coil of the transformer. This is sometimes determined by inspection. In other cases it is necessary to try out the completed amplifier unit as described under "How to Operate the Set." If good results are not obtained, the wire leading from G to S″ is removed from S″ and connected to S′, and the wire leading from X to S′ is removed from S′ and connected to S″.

A wire connects the binding post B plus and the "output" binding post No. 11, on the under side of the baseboard. The remainder of the wiring is left until the upright panel is assembled and fastened to the baseboard.

The upright panel—(See A, Figure 1.) The filament rheostat R is mounted on the upright panel A so that the two terminals will be in a convenient position for wiring. Two binding-posts of the set-screw type, L and M (Figures 1 and 3) are inserted in their proper holes and the upright panel is mounted in position by bolting it to the two brass angle pieces (Z and Z′), shown in Figure 1. One of the telephone receiver binding posts L serves as a bolt. Two small holes are drilled through the baseboard near the two terminals of the filament rheostat R. A wire is run from the "output" binding post No. 11 (Figure 1) along the upper side of the baseboard to the back of the telephone

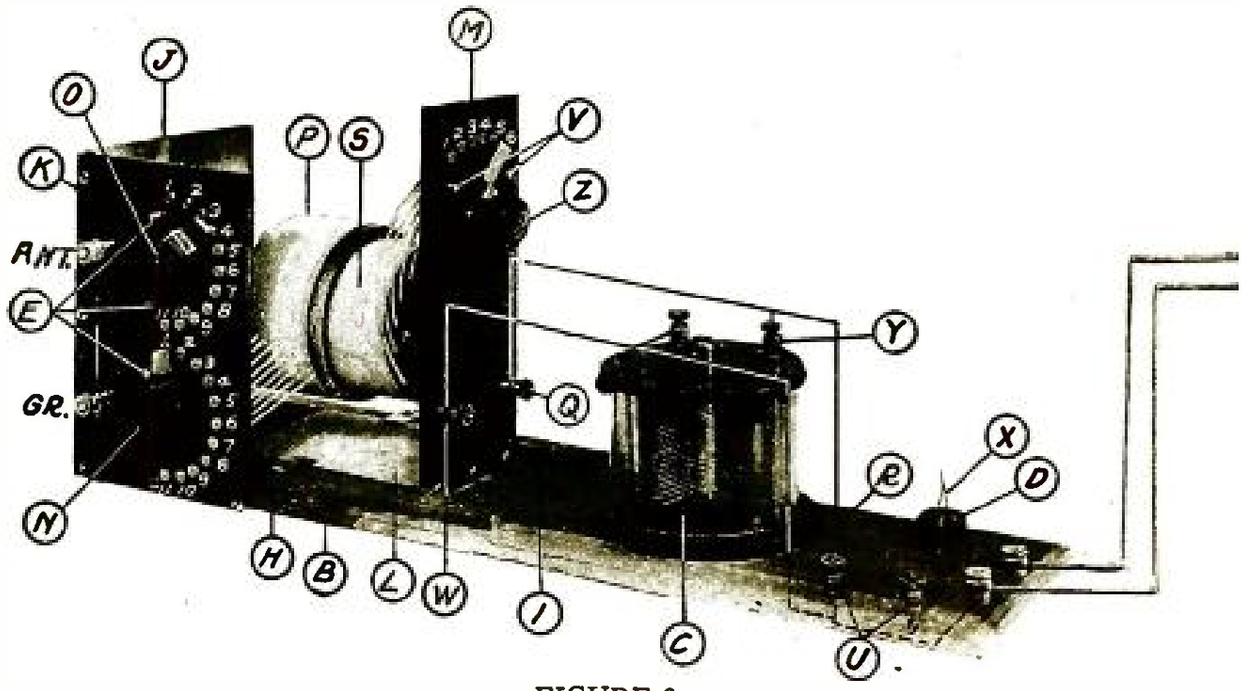


FIGURE 3

On this page and the page opposite is pictured the set complete. Above is the two-circuit tuner; it is connected to the vacuum tube detector shown at the top of the opposite page, and to two stages of audio frequency amplification shown at the bottom of the opposite page. One 6 volt storage "A" battery is used for lighting the filaments of all three tubes and one 22½ volt "B" battery is used on the plate of the detector tube. A separate 45 volt "B" battery is used on the plates of the two amplifier tubes.

receiver binding post marked L. A wire is fastened to the other "output" binding post No. 12 and led to the rear of the upper telephone receiver binding post M. A wire is fastened to the electron tube socket terminal P and led to some convenient point X′ on the wire leading from binding post No. 12 to M. The two wires are soldered together at this point.

A wire is run from one of the filament rheostat binding posts through the hole in the baseboard and thence along the under side of the baseboard to the binding post marked F plus and is continued from F plus, still underneath the baseboard, to the binding post marked B minus. (This wire is shown in Figure 1 by a dotted line.) Likewise a wire is run from the other rheostat binding post, underneath the baseboard and up through the left hole in the baseboard at the rear of the electron tube socket SS and connected to the left binding post marked F. This completes the assembling and wiring of the audio frequency amplifier unit.

How to Make the Connections

If the two-circuit tuner and the electron tube detector are used with the audio frequency amplifier unit, the several parts are arranged and connected as shown in Figure 3. Two amplifier units are shown making a two-stage amplifier. If only one unit is used the connections are correspondingly simple. Increasing the number of "B" batteries used to supply voltage to the plates of the amplifier tubes will usually increase the intensity or loudness of the amplifier radio signals, but at the same time the quality of the tone will be slightly impaired.

The voltage should never be increased to as much as twice the rated plate voltage of the electron tube.

The two-circuit tuner and the tuning condenser C (shown at the left) are described in the July issue of POPULAR RADIO.

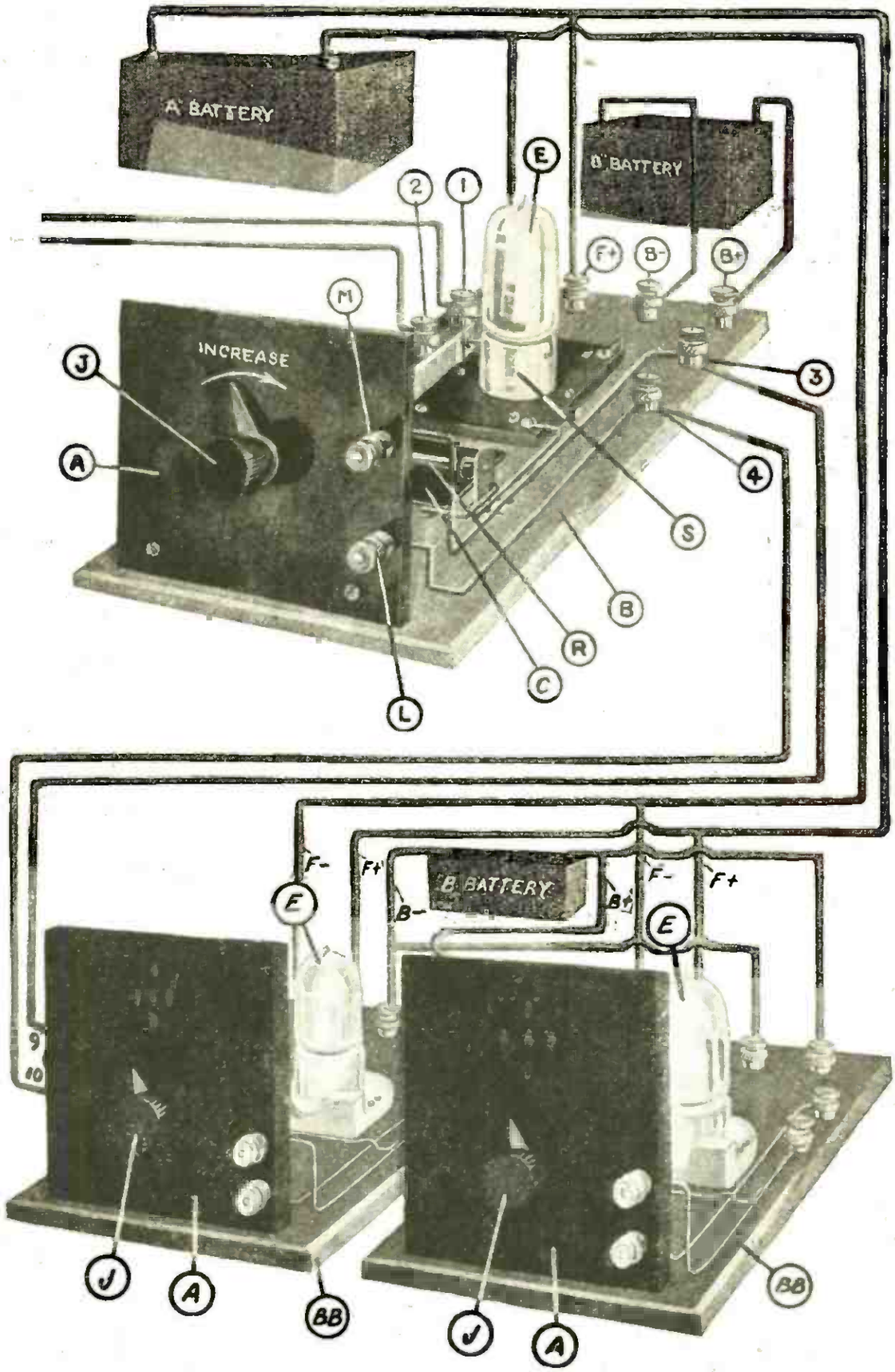
If the single-circuit tuner and electron tube detector are used with the audio frequency amplifier, the arrangement of the parts is also similar to that shown in Figure 3, except that the single-circuit tuner replaces the two-circuit receiving set. The binding posts, 5 and 6, on the single-circuit tuner are connected to the electron tube detector binding posts Nos. 1 and 2 respectively.

The connections to the "A" and "B" batteries are the same as shown in Figure 3. Great care is taken to see that the "B" or plate battery is *not* connected by mistake to the binding posts marked F plus and F minus, This battery has too high a voltage for the electron tube filament and will burn it out.

The antenna and ground wires are connected as shown in Figure 3.

How to Operate the Set

The two filament rheostat knobs marked J (Figure 3) on the two audio frequency amplifier units, and also the filament rheostat knob on the electron tube detector unit, are turned to the extreme left or to the "off" position. Two electron tubes marked E ("hard" or amplifier tubes) are inserted in the sockets of the amplifier units (Nos. 1 and 2) and a third


A BATTERY
B BATTERY
E
2
1
F+
B-
B+
M
INCREASE
J
A
3
4
S
B
R
C
L
F-
F+
B BATTERY
B-
B+
F-
F+
E
E
9
10
J
A
BB
J
A
BB

This Is What the Material *for* the Set Costs

Electron tube ("hard," amplifier)		$ 6.50 to $ 6.50
Electron tube socket		0.25 to 1.50
Filament rheostat		0.50 to 2.50
Audio frequency amplifier transformer		5.00 to 8.00
Ten (10) feet No. 14 bare tinned copper wire (about)		0.10 to 0.10
Eight (8) binding posts, broad contact type		0.40 to 1.20
Two (2) binding posts, set-screw type (for telephone cord tips)		0.15 to 0.40
Miscellaneous wood screws (about)		0.10
Wood (hard, for base and panel)		
One (1) piece 8¼x6¼x½ inches		
One (1) piece 5x4½x⅜ inches		
Four (4) rubber feet (about)		0.05 to 0.10
Wood (for cover)		
Two (2) pieces for sides 7¼x5x½ inches		
One (1) piece for back 5x3¾x½ inches		
One (1) piece for top 7¾x5¼x½ inches		
Two (2) hinges for top, ¾ inch		
Stain and varnish, solder, soldering flux		
		$13.05 to $20.30
"A" storage battery, 6 volt, 60-ampere hour	$15.00 to $22.00	
Two (2) "B" batteries, 22½ volts each	2.00 to 3.00	
		$17.00 to $25.00
Total Cost		$30.05 to $45.30

electron tube (preferably a "soft" or gas tube) is inserted in the socket of the electron tube detector unit. The three filament rheostat knobs are then turned to the right until the filaments of the electron tubes become lighted, the brilliancy depending upon the type of electron tubes used. When one of the telephone receiver terminals is removed from its binding post (either L or M) and again touched to the post, a sharp "click" in the telephone receivers will be an approximate indication that the circuit is in working condition.

When the signals from a desired transmitting station are heard as loud as possible by tuning, the intensity is sometimes improved by adjusting one or more of the knobs on the filament rheostats so as to increase or decrease the filament current (current from the "A" battery). The knobs are kept in the positions of minimum filament currents without reducing the strength of the incoming signals.

If the electron tube detector unit is equipped with a "soft" or "gas" tube, the voltage of the "B" battery is changed until the greatest signal intensity is obtained. This necessitates the use of a tapped "B" battery.

When two audio frequency amplifier units are used a continuous "howl" is sometimes produced in the telephone receivers. In this case the wires leading to the "input" binding posts of one or both of the amplifier units are reversed; that is, binding post 3 is connected to binding post 10, and 4 to 9, and binding post 11 of amplifier No. 1 to binding post 10 of amplifier No. 2 and also 12 to 9.

In case the apparatus fails to operate the trouble may be attributed to a variety of causes. An inspection is first made of the various parts of the receiving equipment to determine if they are properly connected, special care being taken to see that the positive (plus) and negative (minus) terminals of the "A" battery are connected respectively to the binding posts marked F plus and F minus. and that the positive (plus, red) and negative (minus, black) terminals of the "B" battery are connected respectively to the binding posts marked B plus and B minus.

To determine if the various parts of the receiving circuit are in working condition the telephone receivers are removed from the phone binding posts on the amplifier unit and connected to the phone binding posts on the tube detector unit. One of the wires which is connected to one of the "output" binding posts of the electron tube detector unit is temporarily removed and receiving tests made to determine if the electron tube detector is in working condition.

The telephone receivers are next connected to the phone binding posts on amplifier No. 1. the wire reconnected to the "output" binding post of the electron tube detector unit, and one of the wires disconnected from one of the "output" binding posts (11 or 12) of amplifier No. 1. Receiving tests are then made to de-

termine if amplifier No. 1 is working properly.

The telephone receivers are then removed from amplifier No. 1 and attached to amplifier No. 2. The wire is reconnected to the "output" binding post of amplifier No. 1. The connections are now as shown in Figure 3.

If the crystal detector is used the same general scheme of testing is followed.

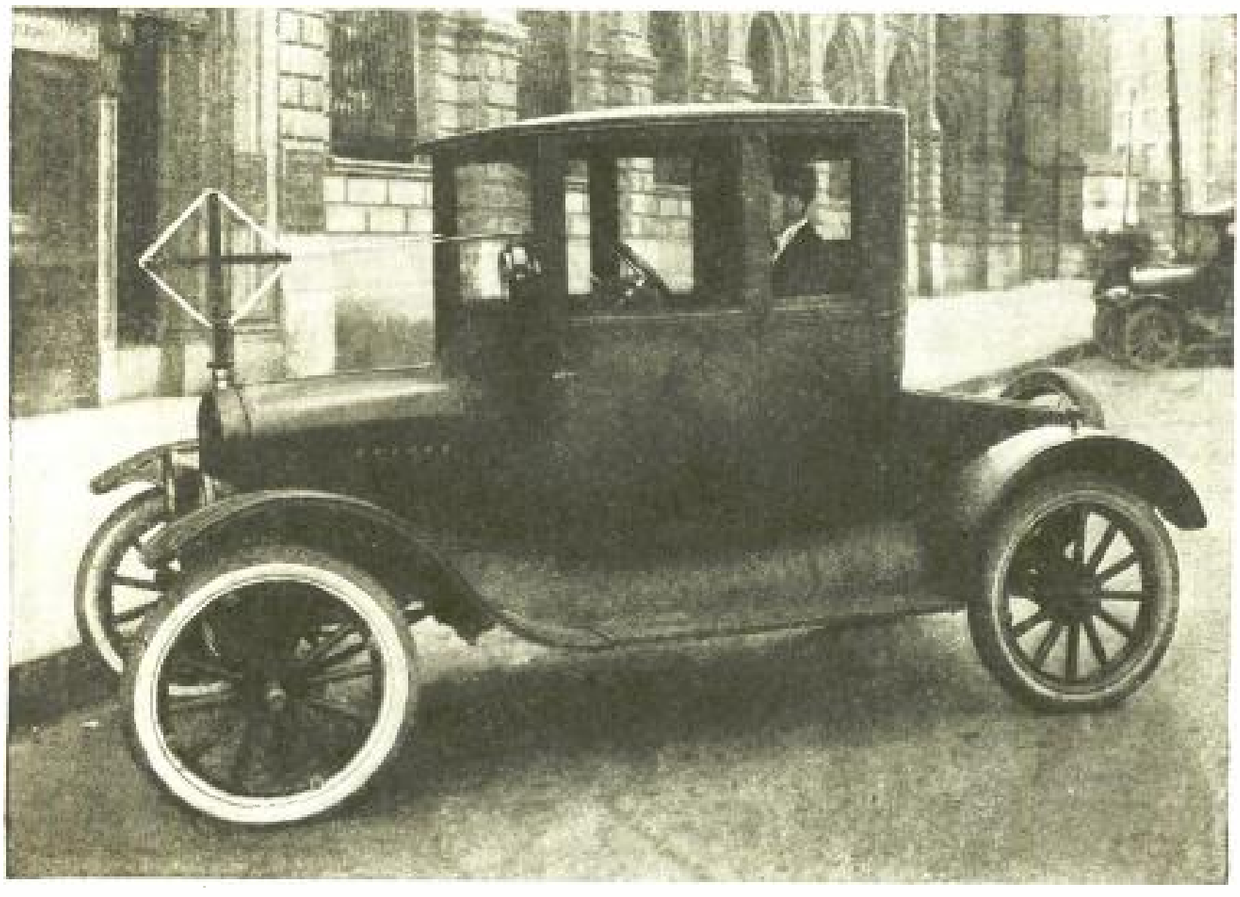
The Approximate Cost of Parts

The list on page 118 gives the cost of parts of one audio frequency amplifier unit and the "A" and "B" batteries; it does not include the cost of the telephone receivers or of any of the other equipment used to make up the outfits described in the previous articles of the series. Some of the parts are the same as listed in the electron tube detector circular with some of the prices revised. If audio frequency amplifier units are used with the electron tube detector unit the same "A" and "B" batteries are used, except that if a single "B" battery is used with the electron tube detector unit, one additional "B" battery is required.

Uncle Sam's "How to Make" Articles for the Amateur

In order that our readers may take full advantage of the plans and specifications for radio apparatus that have been worked out for the special benefit of radio amateurs and novices by the Bureau of Standards in Washington, a complete list of them is here given, together with the issues of Popular Radio in which they have been published:

1. "How to Make and Install Your Own Receiving Set" in *May, 1922.*
2. "How to Make and Operate a Two-Circuit Receiving Set" in *July, 1922.*
3. "How to Add a Vacuum Tube to Your Crystal Set" in *November, 1922.*
4. "How to Make a Series-Antenna Condenser" in *December, 1922.*
5. "How to Make a Telephone Condenser" in *January, 1923.*
6. "How to Add to Your Set an Audio Frequency Amplifier" in *February, 1923.*



A HENRY WITH A NOSE FOR MUSIC

In other and more scientific terms, this illustration shows how a loop antenna may be attached to the hood of a Ford car. In this case the loop is not rotary, and in order to attain direction the car must be pointed toward the sending station.

From a photograph made for POPULAR RADIO

INSTALLING THE MICROPHONE IN THE TRENCHES

The problem of locating the "electrical ear" in an auditorium is of vital importance in the new form of broadcasting. At the Century Theatre it was located among the footlights.

SYMPHONIES *by* TELEGRAPH

How the First Great Concert to Be Broadcast with the Help of Telegraph Wires Was "Picked Up" in One State and Transmitted to Another State to Be Sent Out by Radio

POPULAR RADIO sponsors another unique and successful experiment in broadcasting great programs to a great audience

By GEORGE B. CHADWICK

A SIGNIFICANT feature of the broadcasting of this season's concerts by the great City Symphony Orchestra of New York is the fact that they are being broadcast by the "pick-up" system without the use of telephone wires. And they are being broadcast with a clarity and a power and a quality of tone that marks them as perhaps the most successful symphony concerts ever sent out by radio.

The refusal of the American Telephone & Telegraph Company to furnish the land wires and service for the purpose of broadcasting these concerts from the Westinghouse station WJZ left but two alternatives: either the project had to be abandoned (thereby depriving the radio fans of the East of what have proved to be the most popular symphonic programs ever broadcast) or else means had to be found for carrying out the plan without the telephone company.

The success attained last fall in broadcasting from WJZ the side-line reports of the big football games at the Polo Grounds (a project sponsored by POPULAR RADIO) with the aid of wires obtained from the Western Union Tele-

graph Company, naturally suggested the possibility of using the same methods for broadcasting the concerts. And with the helpful cooperation of the Western Union officials with the Westinghouse experts this plan has been carried into effect with results that have surpassed expectations.

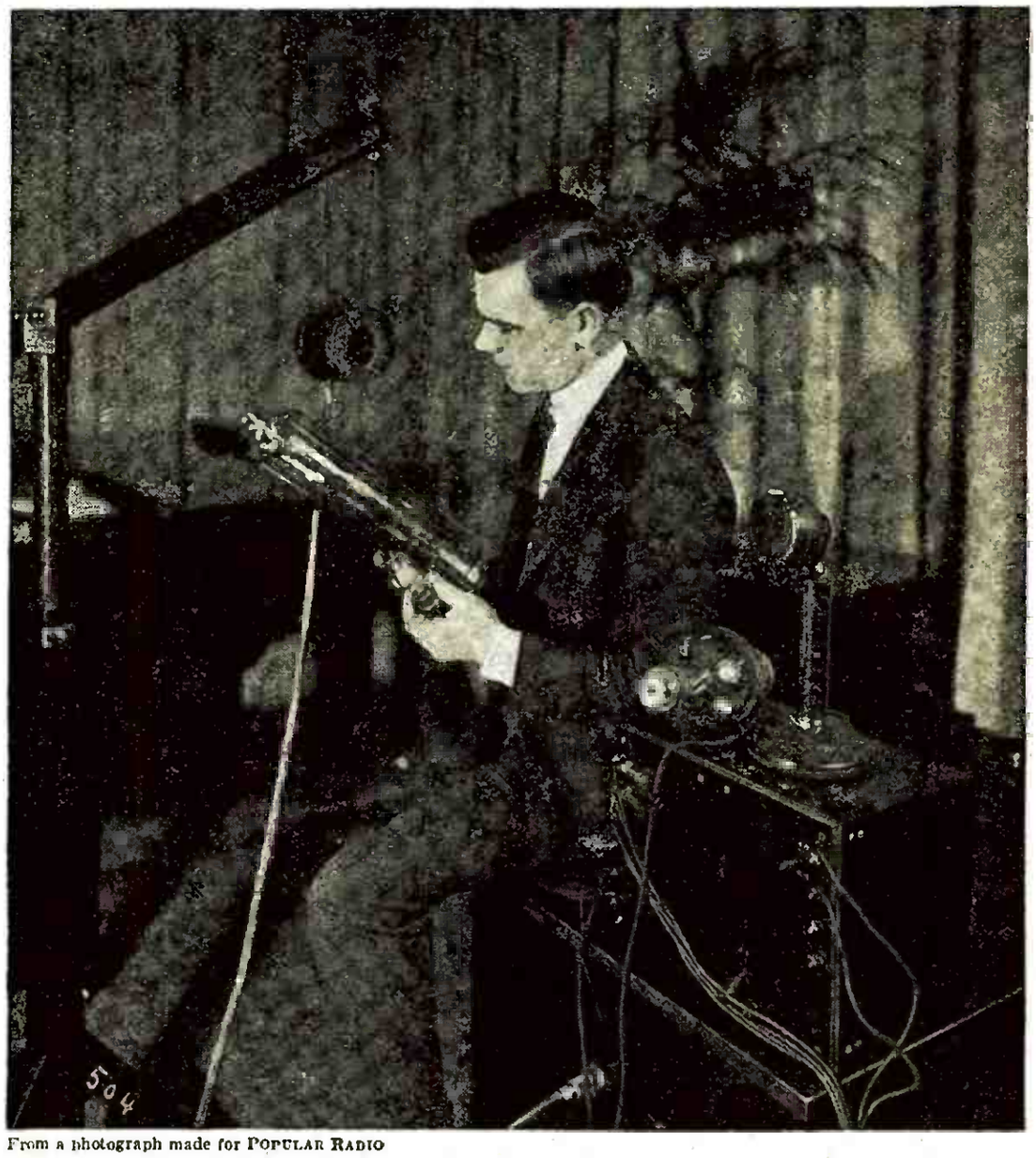
When POPULAR RADIO initiated last summer the project of broadcasting the concerts of the New York Philharmonic Orchestra through WJZ it created a demand for good music and established a precedent that has been met with increasing and encouraging emulation throughout the country. This experiment demonstrated a possibility of radio broadcasting which had not, up to that time, been generally realized. The interest aroused by the Philharmonic concerts spread over the entire United States and stimulated a demand for such classical music as comes within the popular range. It was to meet such a demand that the City Symphony programs were planned, and it is especially fitting, therefore, that the range of its series of "popular concerts" should thus be indefinitely widened to include the largest possible audience—a place which is directly in line with the purpose of the patrons of the new orchestra.

For the City Symphony Orchestra is new; indeed, it is the youngest of the three important organizations of its kind in New York. It was founded by the Musical Society of the City of New York to fill a definite and important need in the musical life of the city—that of bringing music, particularly orchestral music of

From a photograph made for POPULAR RADIO

THE NEWEST INSTRUMENT IN THE ORCHESTRA

This is the amplifying apparatus, which regulates the volume of sound that is sent over the wire from the concert auditoriums to the broadcasting station. The operator (who is located among the musicians) is Raymond M. Guy, better known as announcer OGN at WJZ station.



From a photograph made for POPULAR RADIO

THE NEW VACUUM TUBE USED FOR BROADCASTING THE CONCERTS

This triode was developed by the Westinghouse company for the express use of its broadcasting station. The old type of tube is shown at the elbow of the operator—who is known to radio fans as announcer OBN of WJZ station.

the highest standard, within the reach of the general public. Its personnel consists of eighty-three players. To attain the object of its founders, only a modest admission fee is charged for its concerts, particularly so for the "Pop" concerts, which are being given at three o'clock on Sunday afternoons throughout the winter.

The programs are composed of the gems of the lighter classics, together with short symphonic pieces. Such music, experience has shown, is the best fitted for the general music-loving radio public and meets with the widest approval. And on Sunday afternoon the air is comparatively quiet and people like to gather quietly and listen to good music.

The first concert broadcast was given at the Manhattan Opera House on November 25th; the later concerts are being given at the New Century Theater. The series was inaugurated by a short talk prepared by the editor of POPULAR RADIO.

How the mechanical problem of broadcasting a concert held in one State from a radio station located in another State by means of wires furnished by a tele-

graph company is an interesting story in itself.

First of all, a special wire connecting with one of the regular wires to the Western Union's terminal station at Walker Street was strung to the microphones and the amplifier, located on the stage of the theater. The wire is equipped with a special type of protective device to keep outside interference down to a minimum. From Walker Street the relay is made to WJZ in Newark on a special circuit which has been set aside for broadcasting—the circuit that was used for broadcasting the World Series of baseball games and the Polo Grounds football games. (Details concerning this special circuit were given in the January issue of POPULAR RADIO.) It is safe to say that the helpful experimental work of the Western Union on this circuit has played a considerable part in the splendid transmission of these notable concerts.

At the theater itself are placed four microphones. One is located at the left of the stage in the wings for the operator of the switch box, who also serves as the announcer; a second microphone is placed at the right of the stage, hung about twenty-five feet high and facing the audience in order to catch the applause; a third instrument is located at the outer edge of the orchestra pit for the soloists; and a fourth—the most important of all—is placed at the footlights in front of the orchestra.

The placing of a microphone so that it will most effectively catch the multiplicity of sound that comes from an orchestra of eighty-three pieces, or for that matter the placing of a microphone to catch the sounds of any group music, is a problem still in its infancy. As time goes on there undoubtedly will be rearrangement of the pieces in orchestras to more effectively bring to the microphone the sound waves in their true values. Another problem that has also just begun to be studied is the question of acoustics from a radio standpoint. It is possible that in the building of future concert halls and opera houses this problem will be given special consideration.

The radio signals are amplified at the theater; at the Newark station they are further strengthened by other amplifiers. Here there is also a special filter circuit to improve the quality of sound before it is amplified.

The story of these City Symphony concerts is not a story of long-distance broadcasting. It cannot be, as the daytime broadcasting radius does not extend much over two hundred miles. The development of long-distance broadcasting is one of the big problems before the radio world, but so, too, is the question of the kind and quality of broadcast entertainment, and, though these concerts reach out through a fairly broad radius, the important factor is that they constitute entertainment that can be classed as of permanent cultural value, broadcast over an area occupied by many millions of people—all of whom are at liberty to "plug in." Yet evidence of the widespread interest aroused has come in letters from points as far north as the city of Toronto in Canada, and as far south as Atlanta, Ga.

FOLLOWING the successful broadcasting of the concerts of the New York Philharmonic Symphony Orchestra last summer (a project initiated by POPULAR RADIO) the management requested this magazine to arrange also for the broadcasting of its series of nineteen Educational Concerts during the present season. Provisions for broadcasting them through the Westinghouse station WJZ were blocked, however, by the refusal of the American Telephone & Telegraph Company to furnish the necessary land wires or service. So much pressure was brought to bear from influential sources to carry this project into effect, however, that the telephone company arranged to broadcast about half of the concerts through its own station, WEAF.

—EDITOR

SCOUTS HAVE MADE USE OF RADIO FOR THIRTEEN YEARS

Practical training in signalling and experience with radio enabled thousands of scouts and former scouts to render valuable public service during and since the war.

MAKING GOOD AMERICANS

Via RADIO

How the Younger Generation of Fans Are Being Drilled to Render Service to Uncle Sam

BY ARMSTRONG PERRY

RADIO has been a part of boy scouting ever since the scout idea swept over our country in 1909.

Signalling is a major activity with scouts. They often begin with the semaphore because it is easy to learn and because it requires no apparatus but a pair of arms. But the International Morse or General Service code soon follows. This is wigwagged with flags, tooted on trumpets, ticked on telegraph machines and whee-e-e-d from scout whistles. And sooner or later one or two scouts in each troop graduate into radio.

First class scouts who rise to the dignity of official radio operators for their troops go still further and earn the "merit badge in radio." Their text book is the merit badge pamphlet of the organization, revised and brought up to date by S. Kruse, one of the best known and most popular of American technical radio amateurs, who has tipped the scouts off on the vacuum-tube transmitter and all the latest wrinkles. Before the revision the advice of officials in the Army, Navy, Department of Commerce, Bureau of Standards, Post Office Department, Department of Agriculture and Bureau of Education, and others interested in radio, was secured in order that the radio policy of the scout organization might coordinate with the Government's radio policy and system.

Portable radio sets for field work were features of boy scout rallies long before the war. P. B. Colleson had installed and operated a station at the first boy scout camp in the Interstate Palisades Park, in 1914. Lloyd Espenscheid had instructed scouts at the Brooklyn Central Y.M.C.A. before that.

Navy officers naturally turned to the scout organization when the naval operations suddenly absorbed the entire visible supply of radio operators at the beginning of the war. The scout movement had been operating just about long enough at that time so that boys who had become scouts at twelve, thirteen and fourteen years of age had added enough years and experience to be ready for men's jobs. Boy scouts are not given military training, their routine being directed toward developing a practical patriotism and the ability to think and act and take care of themselves and others in the open, but the way they took hold wherever the nation needed them justified the time, money and methods employed. Luther Weaver of Brooklyn, one of the first radio scouts to volunteer for the Navy, went down with his transport off the coast of France.

On the day that war was declared by the United States all owners and operators of private radio stations were ordered to suspend operations and dismantle their apparatus. Some did. It became necessary to hunt down the rest and enforce the order. Radio was already popular and the job of locating stations that had not complied with the order was too large for the Navy personnel available. Hon. James A. Wilder, formerly United States Consul General at Honolulu, had become Chief Seascout of the Boy Scouts of America. He offered his services to the Intelligence division of the Navy and quietly set his scouts at work. In a few weeks they turned in six hundred reports in one city alone—each indicating the presence of an illegal radio station in the vicinity of a Navy Yard.

The Navy did not have enough investigators to follow up these reports. The scouts who made them were asked to continue their investigations and confirm or remove their suspicions. The Navy investigators dealt with persistent violations.

In 1918, when it became apparent that older men might be needed in the Army and Navy, even though lacking in military training, the editor of the official organ of the Boy Scouts of America took

Keystone View Co.

HE TEACHES SCOUTS HOW TO BUILD THEIR OWN SETS

While Armstrong Perry—the author of this article—may install a handsome receiver in his home, he has taught many a boy scout to construct a simple apparatus that has cost but a trifle. One of his pupils built a set that worked for only 21 cents.

a course in radio in New York. Later, on a Navy transport, he discovered two operators who had received their first radio training in the same Boy Scout troop in New Orleans. They had been members there at different periods and did not know they were troop-mates until they learned it from the scout official.

The editor, convinced by this and other experiences that someone at the national office ought to keep pace with and encourage the radio scouts, installed a receiver at his home on Long Island as soon as war-time restrictions were removed. One night while exploring the ether he discovered the Amateur Broadcast which has been transmitted evenings for three years by the Radio Amateur Bureau connected with the Staff Headquarters of the Third Naval District. From time to time he acknowledged receipt of these broadcasts and after a while called at the District Communication Superintendent's office to express his appreciation of a service so ideally adapted to the needs of scouts and other beginners in radio. The District Communication Superintendent stated that the Radio Amateur Bureau would undertake to broadcast official messages from the National Council office of the scout organization, for the encouragement of boy scout radio.

The offer was promptly accepted. Reporting it at headquarters, the editor was appointed Seascout Radio Commodore and was given the responsibility for interesting the twenty thousand troops throughout the country in maintaining receiving stations and keeping open a radio channel between the national government and the local communities. In return for the Navy's service the scout organization undertook to interest amateur operators in registering with the Radio Amateur Bureau and many hundreds of amateurs have been registered as a result of scout activity. Amateurs send descriptions of their stations to the Seascout Radio Commodore, 200 Fifth Avenue, New York City, and receive keys to the confidential codes which are used in the transmitting of Amateur Broadcasts.

The Seascout Radio Commodore, believing that the development of a system by which the citizens of the nation could hear from the national government directly and daily, began to stir up interest in such a system long before the advent of the radio telephone broadcast created the present furore. In 1919 he suggested to the Secretary of Agriculture that he provide messages to be broadcasted through the Navy and boy scout system, and he did so. Less than a year later the Agricultural Department and the Post Office Department developed their great system which gives to the farmer the up-to-the-minute market reports that place him on an equal footing with the buyer in a dicker about prices. With the approval of the Navy, the scout organization offered to handle the broadcasts for the American Library Association and the American Red Cross and a number were transmitted from the Navy station in New York. The Third Naval District made arrangements with the First Naval District whereby broadcasts of special importance, submitted by the scout authorities, were forwarded by leased wire to Boston and were broadcast from the Navy Station there also. During the scouts' anniversary week, in February of each year, messages from the President of the United States to the whole organization have been broadcasted from Navy stations all along the Atlantic, Lake, Pacific and Gulf coasts. The first list of radio telephone broadcasting stations of the United States given to the public was compiled by the Seascout Radio Commodore several months before the Department of Commerce found it necessary to restrict broadcasting. Copies were left at the White House and at the offices of the Departments most interested in radio. Within a few weeks the White House and the Cabinet offices were equipped with receivers.

The development of boy scout radio became more rapid from that time. Some

UNCLE SAM'S RADIO EXPERTS OF TOMORROW

But Scouts are trained in more than the mere technical details of wireless; they are trained in the ideals of service that can be rendered to their country and to humanity by the use of radio.

individual scouts made remarkable records. One of them served as official operator at a scout camp in 1919; a little later he built a radio telephone transmitter. Anxious to see if it worked, he connected it to his antenna, turned on the juice, and shouted:

"Hello! Hello! Hello! Is this the Naval Air Station?"

He had no more idea of raising that station than he had of getting a reply from China, but a gruff voice came back instantly:

"Yes, this is the Naval Air Station. What do you want?"

The scout stopped right there. Before he opened up again he made some careful measurements of his wavelength, for at that time the Navy station was supposed to be standing by on 800 meters while the longest wave that he could legally use under the terms of his transmitting license was 200 meters! However, the Navy did not resent the intrusion. Not long afterward the Navy called him one night, told him that transmitter trouble prevented them from reaching a vessel near him off the coast, and asked him to relay the message to the ship. He handled the traffic efficiently and received a commendatory acknowledgment from the Navy. Then he went to sea as a commercial operator for two years, served another season in the boy scout camp,

held a job as radio salesman during the first stages of the present radio craze, and received an offer to become the superintendent of a radio manufacturing plant and manage a force of three hundred men. He is not yet old enough to vote, though his experience and appearance make him seem much older.

When the delegation of 375 scouts and scoutleaders embarked on the Army transport *Pocahontas* in 1920 to sail for England and represent America in the International Scout Jamboree, a Miami radio patrol carried its outfit in a trek cart. Seasickness and other troubles interfered somewhat with their plans on shipboard. A member of the delegation sat in a little space outside the ship's radio cabin one night, copying a code message from the Navy station in New York which was sending greetings from the scouts at home to those at sea. The ship's operator was bringing it in loudly enough to be heard twenty feet from the phones, but when a big man in a bathrobe stalked in, his remarks to a friend in civilian clothes created so much interference that the scout unconsciously said:

"Sh-h-h!"

The men went on into the radio cabin. The scout's hair stood on end a moment later when the man in the bathrobe, whom he had tried to hush up, gave unmistakable evidence of being the captain of the ship. But the scout got his message before he slipped out of the door and slid down the iron ladder into the friendly darkness of the lower deck.

The San Diego scouts had two-way radio communication between camp and local headquarters several years ago. In the group of scout camps in the Interstate Parlisades Park, the largest aggregation of boys' camps under one management in America, there has been inter-camp radio communication, and the reception of weather reports, time signals and news from Naval stations has been a feature. Philadelphia scouts worked out a radio mobilization plan two or three years ago. Manhattan Borough, Greater New York, was among the first to have a transmitting set at the local council headquarters, and a training class for scout operators was maintained at this point. In Minneapolis the municipal station is manned by sixteen scout operators. East St. Louis had a scout station with a broadcasting range of a thousand miles.

Washington, D. C., has a scout radio training class in charge of Major P. W. Evans of the United States Army Signal Corps; from his desk in the War Department the Major proudly points to a dozen brother officers who are serving as scoutmasters and interesting scouts in radio. During the past summer the Washington scout camp was in radio communication with its headquarters in the city, using regulation Signal Corps apparatus. Monmouth County, N. J., has half a dozen scout radio patrols.

B. T. B. Hyde of the American Museum of Natural History spends his summers directing boy scout museums in the Kanohwahke Lakes group of camps in the Interstate Palisades Park and assisting other camps with their natural science studies. The headquarters radio station of the scouts is under his jurisdiction and last summer he developed a system of broadcasting messages through the Navy and boy scout system for the purpose of stimulating interest in nature study. To pick up a coded message and discover frogs, butterflies and beetles in it was almost as much fun for the scouts as to capture the bugs themselves.

When police departments broadcast descriptions of stolen automobiles there are sure to be some scouts listening in. A scout operator in New England for days copied the license numbers, colors and engine numbers from WGI, which tells the world about the cars that are stolen in Boston, without results. Then one morning on the way to school he found himself face to face with a car that he had a hunch was on his list. Just to make sure he went over his numbers, then a quick report to the police fin-

Brown Bros.

ON "ACTIVE SERVICE" IN THE FIELD

These up-to-date successors of the knights of Old England are following upon the heels of Young America in extending the use of radio; practical training in installing apparatus and in sending and receiving code messages is an important feature of the course of the 2d Royal Eltham troop of scouts in England.

ished his part in locating a stolen car.

In New Jersey two scouts turned the same trick with a truck, getting the description from Sergt. Pearce who at the time was at the key at the New York police headquarters.

A pair of Pittsburgh seascouts—members of the web-footed branch of the scout organization—put one over on the land wire companies. One of them, before starting on a tour that was to take him from New York to Florida by a coastwise steamer, told his chum to listen for a radio message that he was going to send him *via* the regular commercial service at a specified hour. The boy at home listened in and heard the ship's operator as he transmitted the message to a shore station. The telegraph messenger arrived with the same message thirteen hours later!

The Seascout Radio Commodore travels more or less and usually has a radio receiver with him. A scout came to him a few weeks ago to ask questions about the construction of a receiver. The next day he reported that he was receiving, with apparatus that he had made himself, the time signals from the Navy station at Arlington, some code messages which he believed to be weather forecasts, baseball scores and concerts transmitted by radio telephone. The Commodore asked to see the apparatus. It

consisted of: 1 oatmeal box; a dozen brass paper binders; 6 paper clips; fifty feet of old bell wire; 1 piece of galena; 1 common pin. This receiver, plus antenna and ground wires, and a pair of phones donated by a friendly army officer, were doing the same work that the Commodore was doing with a manufactured set.

The manufactured set cost $25.00: the scout had spent twenty-one cents!

The Third Naval District now has a special list of scout operators who can send and receive at least twenty words per minute. These are given the low numbers on the register at the Radio Amateur Bureau. From this list, in case of emergency, will be called operators who can assume responsibility without further training except what their daily work will give them. These scouts are not obligated to respond to the call. It has been found unnecessary to bring to bear upon scouts any pressure other than that created by their high ideals of citizenship and service. They take the scout oath and live true to the scout law. When their country needs them their only concern is to find the place where they will fit best.

To national and local officials of the Boy Scouts of America have been extended the courtesies of the great commercial broadcasting stations throughout the country. They frequently address local organizations over broad areas. Turn about is fair play and, while favoring no one concern, the organization does many things that help the radio manufacturer and dealer. The Seascout Radio Commodore, keeping in touch with radio literature, following the development of radio apparatus, visiting all sorts of radio stations, talking with scores of radio users, and carrying on an extensive correspondence on radio subjects, is often in a position to give advice which is valued by commercial radio concerns. He has no commercial connections to prejudice him for or against any radio product.

Chambers of Commerce, Boards of Trade and other civic organizations will sometime awake to the fact that they have right at hand the makings of a local radio system that will ensure the reception and local distribution of all the valuable information that is constantly in the air. The attitude of the technical amateur on the one hand and the development of radio as an amusement on the other have obscured the most important possibility of the new means of communication. It would be a simple matter for any city or rural community to establish a complete service that in some ways would be more valuable, because quicker, than that of the local post office and that of the wire lines. There is efficient receiving apparatus in practically every neighborhood. There are operators everywhere who, if not already prepared, could very soon prepare themselves to handle government and other broadcasts for the benefit of the community. They would only need to listen at scheduled hours for the information that the community needs and wants. If it is not in the air there is a strong probability that it would be placed there by some broadcasting station in the territory on request. Once received, the local distribution is only a matter of detail.

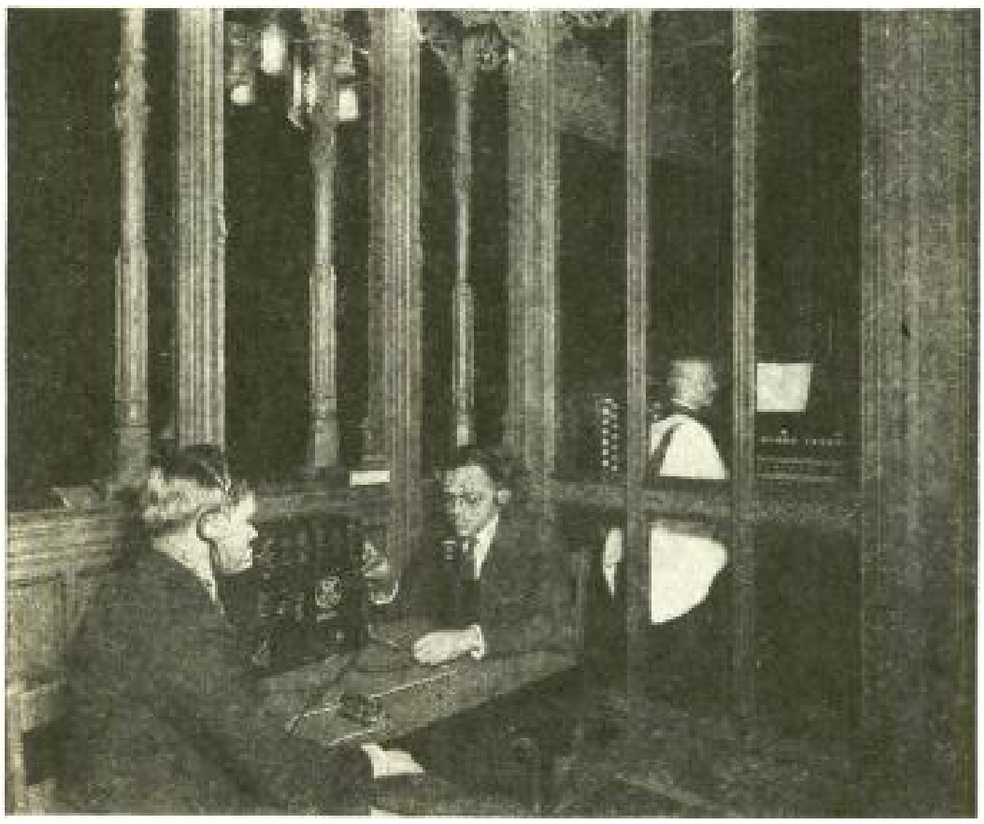
Nationally there is already organization enough. The American Radio Relay League has organized the best technical amateurs into a system that shoots a thousand citizen messages over the whole United States every day. Sometimes these are passed from the Atlantic coast to the Pacific with an expenditure of energy less than is required for lighting a common incandescent lamp. The Atlantic has been crossed by fifty-three amateurs in a single night, and now they have attacked the problem of making the Pacific in one jump. They will do it, too. It needs but the interest of a strong local organization, such as a Chamber of Commerce, to get these experts to pause long enough in their technical work to help to organize a less romantic but more valuable system for the reliable reception

of broadcasts sent by the government.

The boy scout organization, composed of boys averaging between fifteen and sixteen years of age, has not of course either the highly skilled technical men nor the highly developed apparatus to do what the American Radio Relay League can do. But it has the largest uniformed force in America, traditions that are all associated with public service, and well-established systems of cooperation with our National Government.

Now, if a Chamber of Commerce should suggest to a local American Radio Relay League expert that he rig up a receiver that would bring in the broadcasts from the Navy, Army and Post Office stations and act as big brother to a group of scouts until they had enough competent operators to cover the schedule at that station without placing so great a burden upon any one scout that he would have to neglect his home, church or school duties; if the Chamber of Commerce should ask the scout organization to get those broadcasts every day and telephone them or deliver them by scout messenger to the places where they should be displayed to the public gaze; if the Chamber of Commerce would organize this system, and give it proper encouragement to keep it up to a high state of efficiency, it would go a long way to put its city on the radio map.

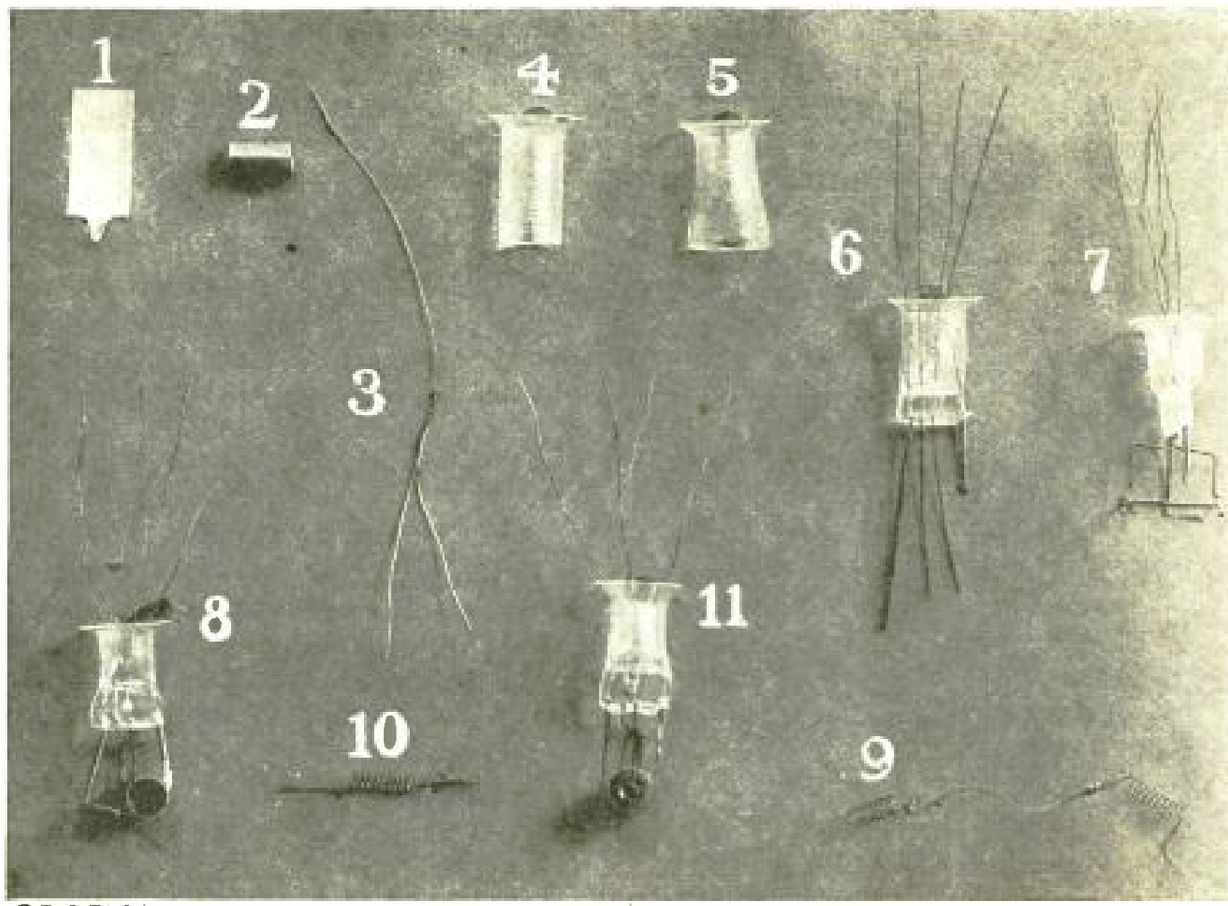
It would do more than that. It would bring up a generation of boys who would realize that doing the same thing every day, unfailingly, just as a railroad sends its expresses over the line on schedule, is a more interesting thing than getting together once a year to hear the mayor tell them what good fellows they are because they put flags on the graves of the soldiers on Decoration Day and held back the crowds along the line of march on the Fourth of July.



Westinghouse

RADIO FANS LISTEN IN ON HIGH SOCIETY AT WORSHIP

When station WJZ broadcast the church services at St. Thomas', located in New York's fashionable social center, microphones were installed at various points in order to transmit every detail, from the sermon to the organ music. The radio apparatus was in charge of Mr. Harry Hiller.



How John Bull Makes His "THERMIONIC VALVES"

Radio broadcasting is about to begin in England. It will be conducted by a broadcasting company acting under the direction of the Post Office department. No one is permitted to receive except those who own licenses—and licenses are issued only to those who operate British-made sets. The demand for British vacuum tubes (or "valves," as John Bull calls them) is consequently on the rise. The process of making such tubes may be explained thus—

No. 1 shows a small bit of metal cut into the correct shape for the plate of the tube.

No. 2 shows this same plate rolled into the form of a small cylinder.

No. 3 shows the assembly of the grid supporting wires.

No. 4 and *No. 5* show the flanged glass support for the tube elements in the process of preparation for assembly.

No. 6 shows the grid supporting wires, and the filament and plate supports firmly and hermetically sealed into the glass while it is heated and in a semi-molten stage.

No. 7 shows the supporting wires bent into the proper shapes for holding the tube filaments.

No. 8 shows how the plate is fastened to its support.

No. 9 and *No. 10* show the grid in the course of preparation. The wire of which the grid is made is wound in a spiral upon a mandrel to insure the correct size to accommodate the filament wire which will be suspended inside of it.

No. 11 shows the complete internal assembly, with the grid coil and the filament wires in their correct places within the cylindrical plate.

No. 12 shows the glass bulb which has been prepared by the glass blower ready for assembly.

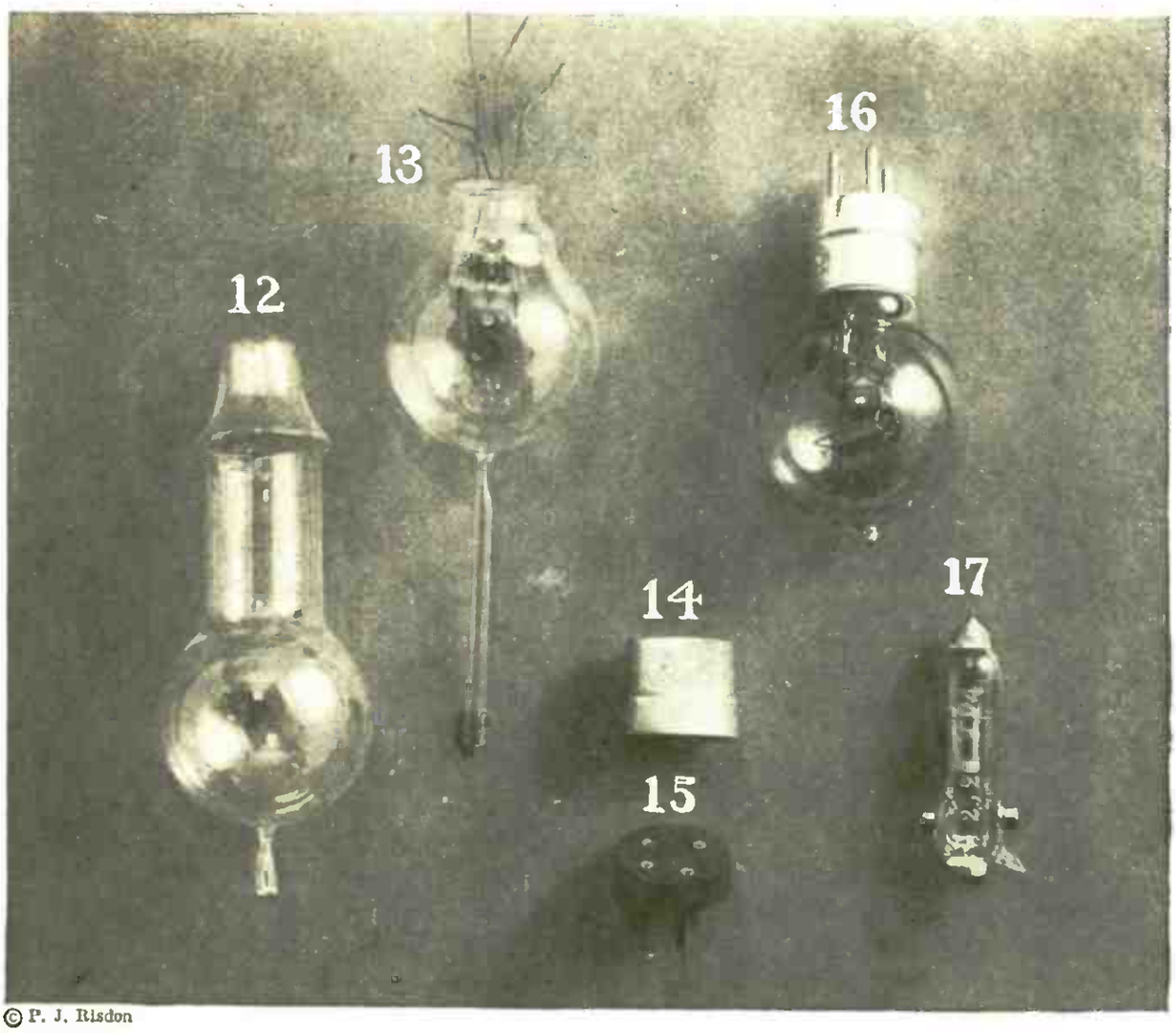
No. 13 shows internal assembly inserted in the bulb and the glass support, and the top end of the bulb welded into an airtight seal. The wire leads to the elements are left sticking out of the top of the bulb. The air is then exhausted through the glass tube attached to the bulb and when the proper vacuum has been obtained, this opening into the tube is also sealed.

No. 14 shows the metal casing, one of the two parts of which the base of the tube consists. This part is fashioned in a stamping machine which bends and cuts the part in a single operation.

No. 15 shows the other part, the contact piece. This is made of a moulded insulating material and the contacts are cast into it with their extremities projecting for the necessary connection with the lead-wires running to the plate, grid and filament inside the tube.

No. 16 shows the tube complete. The lead-wires have been soldered to the contact lugs of the base, and the base has been clamped into position, and—

No. 17 shows another type of vacuum tube, which is particularly adapted for radio frequency amplification; this tube is shown ready to be put into John Bull's British-made set.



THIS *department—conducted by a patent attorney of wide experience in radio work—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.*

Signaling on a .0000001 Meter Wavelength

Patent No. 1,412,385; Theodore W. Case, Scipio, New York.

THIS system of signaling utilizes electromagnetic or light waves of a length varying between .00001 centimeters and .0061 centimeters, a centimeter being a hundredth of a meter and 2.54 centimeters making an inch.

These waves are many times shorter than those which Marconi has recently used in his directive experiments and lectures and certainly much shorter than those of 200 meters assigned by the Secretary of Commerce for use by amateurs. As yet the government has not assigned these very short wavelengths in the electromagnetic spectrum or wavelength band.

For such electromagnetic waves ranging between .000038 centimeters and .000076 centimeters nature provides an anatomical receiver, the eye. The shorter wave produces the sensation of violet and the longer the sensation of red. Hence waves ranging in length as above and which may be seen are the light waves. Waves which are longer than the red and invisible are called infra-red waves and those which are shorter than the violet and also invisible are called ultra-violet waves.

The apparatus illustrated in Figure 1 transmits and receives waves which are visible, the light waves, as well as those which are invisible or beyond the grasp of the eye, the longer infra-red waves and the shorter ultra-violet.

The transmitter 14, which is merely a high powered searchlight, is the high frequency radiator of the system, radiating visible light waves of different lengths (white light) having an average frequency of around six hundred million cycles per second. The signal received however is not seen but heard. Hence the infra-red and ultra-violet waves or rays which cannot be seen may be utilized to affect the receiver and produce a signal. A blind man could use it, provided he could hear.

A characteristic of such very short electromagnetic waves is that they may be directed in straight lines and as a beam of light; the shorter the wave the easier it may be directively used. This is the reason that the short Hertzian waves can be made more directive than the longer ones, as shown by Marconi.

In the system shown in Figure 1 the waves, either visible or invisible, are propagated or transmitted in a sfraight line from the transmitter 14 and are received by the reflector 19, which we may call an aerial or collector. The waves are there reflected upon a member 9 which is in an electrical circuit. The member 9 has the curious property of varying the resistance of the circuit when these short waves strike it, causing current fluctua-

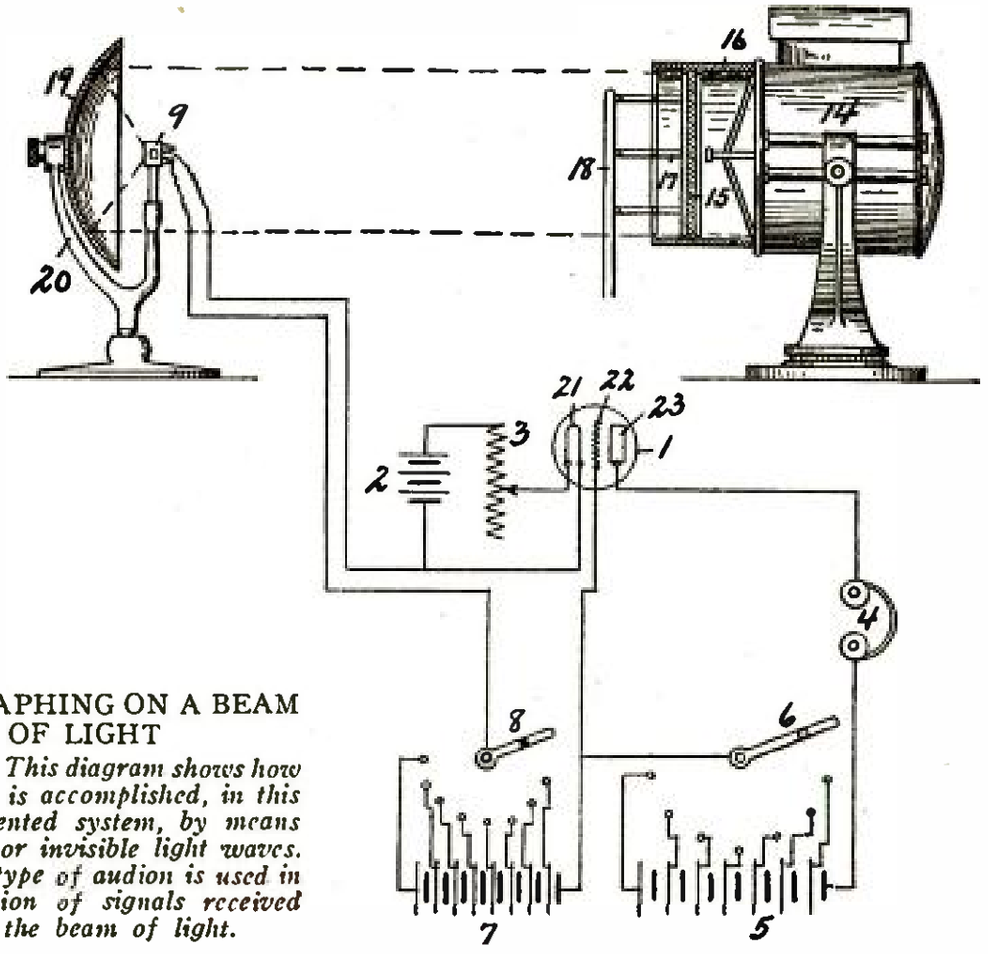
tions which may be detected by means of the phones 4.

Various substances such as selenium or thalium sulphide may be employed as a light responsive device 9. The inventor states that he prefers to use a substance which is sensitive to the invisible rays of the spectrum, a compound of thalium and sulphur being particularly sensitive to the infra-red region of the spectrum while a compound of thalium and iodine is particularly sensitive to the ultra-violet region. By the use of either of these substances signals may be sent and received without detection by the naked eye or with ordinary optical instruments.

It is better to use a substance such as the thalium sulphur compound which is responsive to the infra-red or longer waves, as such waves may be transmitted to greater distances. As a proof of this take a well-known example, a sunset, when the sky is red with the dying day. Why is the sky red at sunset instead of being violet, blue or green? The physical explanation is that only the red rays reach the eye, the shorter waves being absorbed. The same principle applies to the Hertzian waves used in radio communication, the longer waves being transmitted greater distances than the shorter. Hence wavelengths of thousands of meters are employed for transatlantic communication.

Secrecy is possible in the use of this apparatus. For instance a screen 15 of the proper material, such as smoked glass, mounted across the extension 16 of the transmitter 14 will absorb the visible rays and allow only the invisible ultra-violet or infra-red rays to pass. Such invisible rays will however affect the member 9, varying the resistance of the circuit.

The circuit of the member 9 includes a special form of audion 1, having filament 21, grid 22 and plate 23. The plate and



TELEGRAPHING ON A BEAM OF LIGHT

FIGURE 1: *This diagram shows how telegraphy is accomplished, in this newly patented system, by means of visible or invisible light waves. A special type of audion is used in the reception of signals received over the beam of light.*

grid are connected in circuit with a battery 5 and a potential regulating switch 6, the phones 4 being in this circuit, while the grid and filament are connected in circuit with a battery 7 and a potential regulating switch 8, the member 9 being in this circuit. The filament is heated by battery 2 controlled by rheostat 3.

The inventor calls this audion a "pulsation generator." He states in his patent, as his discovery, that when the degree of vacuum in the bulb is properly regulated in accordance with the character of resistance 9 and of the voltage of the batteries, the current in the circuits will pulsate at a desired frequency, as, for instance, an audible frequency or a frequency bordering on audibility. So, upon variation of the resistance 9, a variation in the frequency is produced, audible in the telephone receivers 4.

The bulb 1 differs from the usual type of tube in having a gas therein, such as Argon, under a pressure which may vary from 1/10 to 5 millimeters of mercury, the ordinary tube being more highly exhausted. The bulb as above described is an essential element of the invention.

Signals may be transmitted by means of the opaque shutters 17 and actuating handle 18, which alternately shut off the waves and allow their propagation.

The invention has several advantages. In signaling between friendly ships in time of war the signal cannot be picked up by an enemy unless the latter happens to be located on the line between the transmitter and receiver. If a screen 15 is used there is nothing visible to show that signaling is being carried on. The invention may be adapted for harbor defense by locating the transmitter on one shore and the receiver on the opposite shore in a position to throw an invisible beam across and close to the water. The passage of a boat or even of a periscope of a submarine through the beam would cause a signal.

The circuit shown, being devoid of lumped inductances and capacities, is very sensitive to changes in resistance of the light responsible device 9, causing a variation in pitch of the note in phones.

Could not a similar apparatus be employed to transmit speech or music, utilizing these short electromagnetic waves, popularly called light waves? By inserting a microphone in the circuit of the transmitter, the light might be varied or modulated in accordance with the speech or music variations reproducing the original sound in the receiver. This may be a field for investigation, although it does not appear to be of great practical or remunerative value.

During the World War similar receivers were used by our forces to detect trench attacks. These receivers were operated by the heat radiations, which are similar waves, from the bodies of the enemy. The apparatus consisted of a substance, which varied in resistance when heat radiations struck it, in circuit with tube amplifiers. When the enemy approached, the radiations from the bodies of the soldiers operated the receiver, giving notice of the attack.

CHARLES H. KESLER.

Scientific Facts I Have Discovered About Radio

THAT *once you have become a radio fan you are a goner.*

THAT *Grandma is just as apt to get it as Willie.*

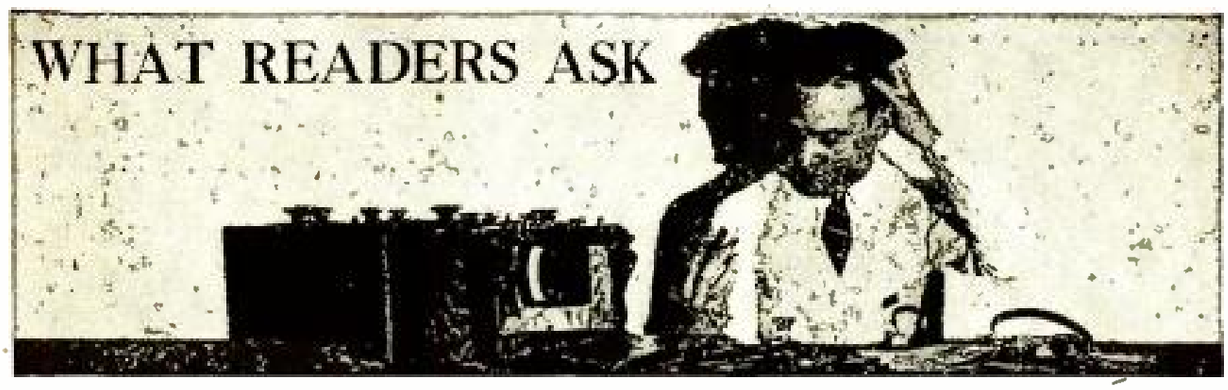
THAT *the shortest wave is the permanent one on the head.*

THAT *the less air in a vacuum tube, and the more in an inner, the farther you will carry.*

THAT *a boy can sit up till two o'clock in the morning receiving and never utter a word of complaint—*

BUT *if his father tells him to stay up and close the furnace—then what an interference!*

HOMER CROY



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 TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor 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 cooperate 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.

In justice to our regular subscribers, the Technical Editor 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.

QUESTION: Please give me a hook-up for using three honeycomb coils or spiderweb coils on a crystal detector. In your July issue of POPULAR RADIO you showed the hook-up for an audion set, but I would like to know what to do with the two extra leads from the tickler coil.

C. M. CONNEL

ANSWER: Spiderweb or honeycomb coils may be used with a crystal detector in the hook-up shown in Figure 1. The tickler coil will be dispensed with. If you have a three coil mounting, leave out the connections for the third coil. Two variable condensers are used for tuning, a .001 mfd. in the antenna circuit and a .0005 mfd. in the secondary circuit. The coupling is varied as usual by changing the relative positions of the two coils.

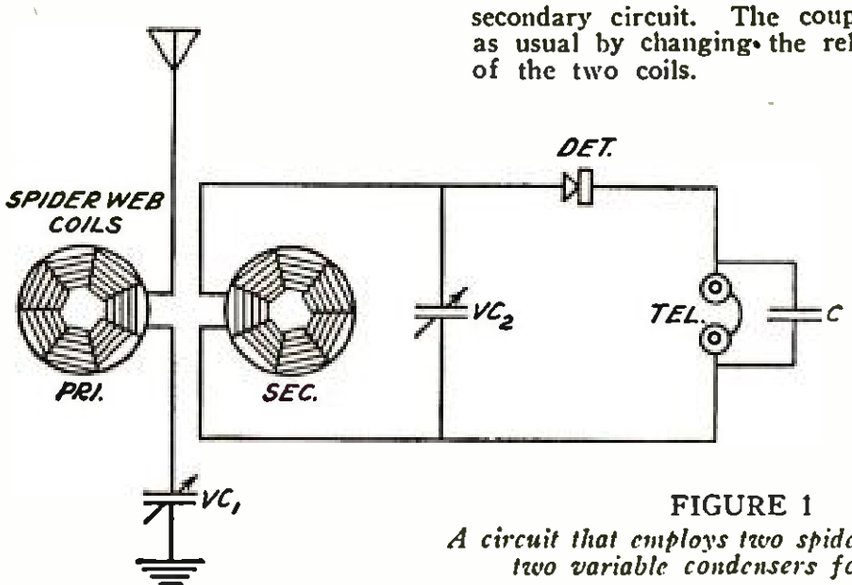
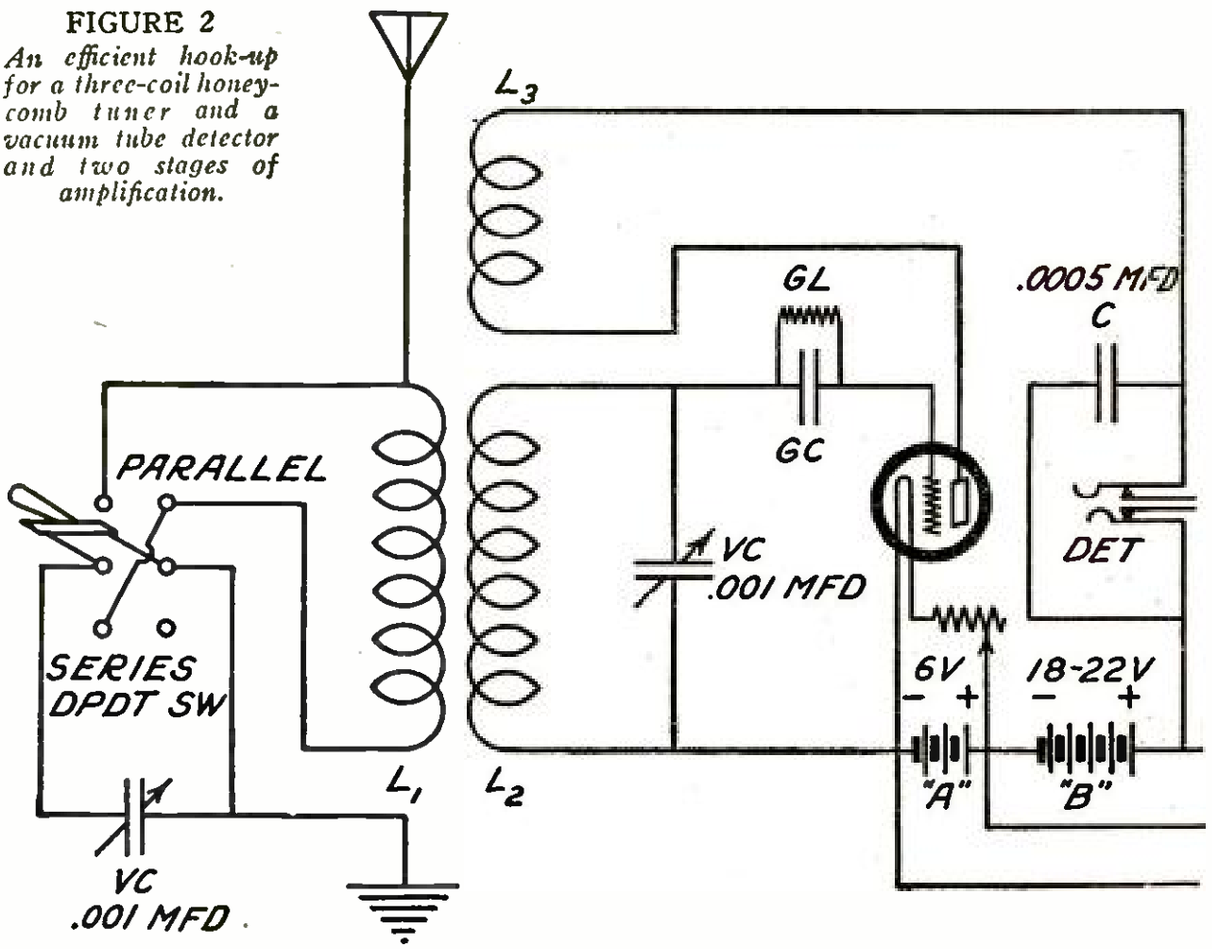


FIGURE 1

A circuit that employs two spiderweb coils and two variable condensers for tuning.

FIGURE 2
An efficient hook-up for a three-coil honeycomb tuner and a vacuum tube detector and two stages of amplification.



QUESTION: I have built a three tube regenerative set, using two variometers, variocoupler, variable condenser, one detector UV-200, and two stages of amplification. I get Cleveland on both stages but am unable to reach out for long distance. I recently heard Detroit, but could not get it clearly; I could hear a whistle, but it did not sound much like music. Can you tell me my trouble? I am anxious to get long distance, especially Detroit and Pittsburgh.

R. P. ROBINSON

ANSWER: Your description of the symptoms are so meagre that it is hard to diagnose your trouble. Is your antenna efficient? It should be approximately 100 feet long, of one or two wires. What you say about the noise you hear would lead us to suspect that you are not familiar with the tuning of a regenerative set, and are using too much regeneration, thus getting the whistle. Consult the article by Mr. Hogan in the November issue of this magazine. Are you sure that you have the correct "B" battery voltage on your detector tube? The UV-200 is critical as to plate potential and this may be part of your trouble. You will find the correct potential to lie somewhere between 16½ and 18 volts.

* * *

QUESTION: Please give me a hook-up for a detector and two-stage audio frequency amplifier, using honeycomb coils, with jacks and plugs for each tube. A series-parallel switch for the primary condenser should be included in the circuit, for changing the wavelength range.

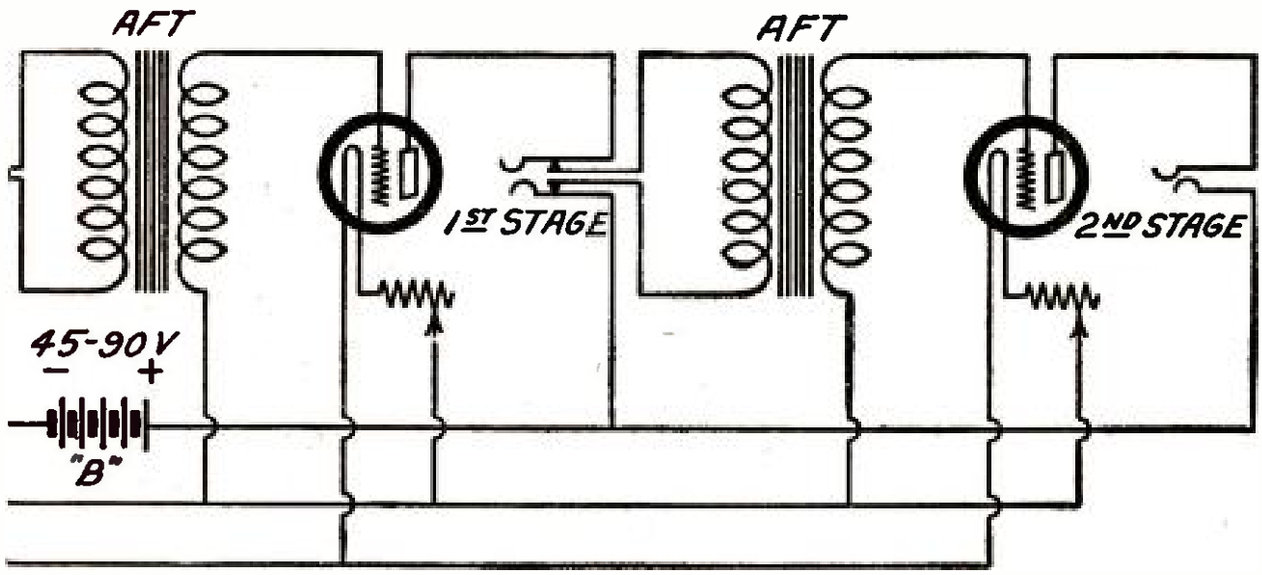
A. F. ROCKEFELLER

ANSWER: In Figure 2 is shown a circuit that will be found efficient and easy to tune; it includes the apparatus that you wish to use. A double-pole double-throw switch is used to connect the primary condenser in series or parallel, as shown in the diagram. The coils L1, L2, L3 are honeycomb coils and are fitted to a standard 3-coil mounting. The primary and secondary circuits are tuned by means of the variable condensers and the coupling. The regenerative action is controlled by means of the coupling between the secondary coil L2. and the tickler coil L3. By using coils of different values, either high waves or low waves may be efficiently received.

QUESTION: I have built a crystal set and also a tube receiver. With the detector alone I have received over a hundred miles. I am interested in the new Armstrong circuit, described in detail in the September issue of POPULAR RADIO. Many friends among the radio amateurs and merchants of San Francisco tell me that the right "dope" concerning this circuit has not been made public by Armstrong; also that few of the sets built by amateurs work successfully. Your article created a great deal of excitement in this vicinity; many of the fans want to start work on such a set immediately. But the radio experts advise us to wait before investing in the necessary materials. Please advise me what to do.

DIXON CHUBBUCK

ANSWER: When Major Armstrong read his paper before the Institute of Radio Engineers and the Radio Club of America he did not hold back any information in regard to the super-regenerative circuit; in fact, he made his talk very plain both as to the construction and operation, even going so far as to recommend the best circuits to use, and specifying the kind and sizes of all the important parts. The modified circuit shown in *Popular Radio* for September gives excellent results if properly constructed and tuned, and if the tubes used are suited for the purpose. We have received many letters that report the wonderful results obtained from sets built in accordance with our instructions. In the hook-up department of our November issue were published a number of hints which should help the man contemplating building a "super" set. There is no doubt but that improvements will be made in adapting the principles of super-regeneration to the uses of the amateur, but why not "get in" on the development work yourself? This is one of the greatest experiences that the amateur can possibly have. We advise you and your friends to begin experimenting with the set now; there is no doubt but that you will get the set working well if you follow the directions.



QUESTION: The filament of my Moorhead detector tube burns all right, but I hear nothing on the phones; when I place a good tube in the socket, the set works O. K. Is it paralyzed or is there a loose connection inside of the tube? This trouble has exasperated me, as I have tried new "B" batteries and have experimented for weeks, trying to find out what was wrong. Can you advise me what it is?

C. T. BUSBY

ANSWER: Any one of the following faults could be the matter with your tube or circuit:

1—The prongs on the bottom of the tube may be short in length, so that proper connection is not made with the contacts of the socket;

2—The prongs may be dirty, causing the same trouble;

3—There may be a loose connection in the base of the tube;

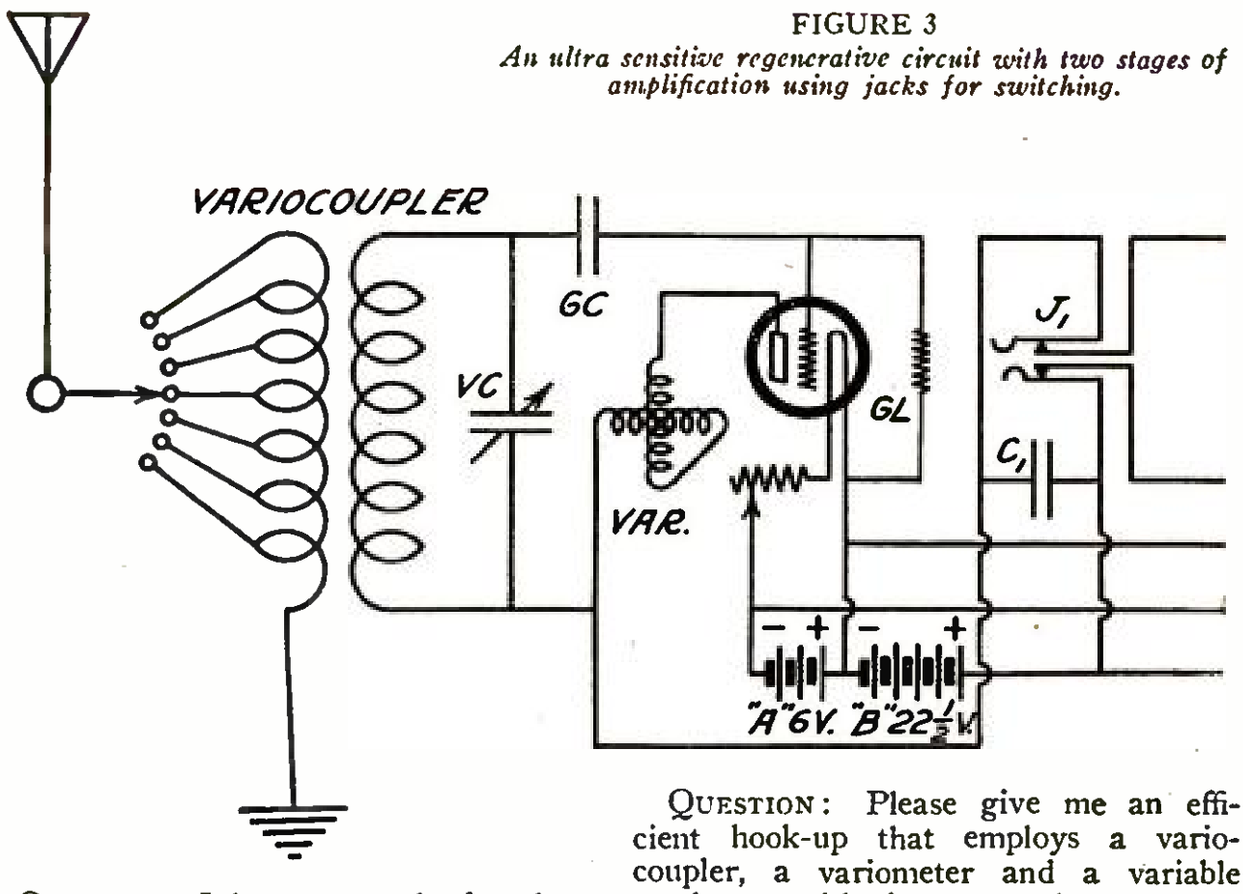
4—The filament may be leaning against the grid of the tube;

5—You may be using too high a plate voltage on the tube.

It is likely that you will find that one of the above points covers your trouble. If it is any one of them (except the fourth) you can remedy it yourself, but if it is the fourth, the tube is defective and you had better send it back to the manufacturer.

FIGURE 3

An ultra sensitive regenerative circuit with two stages of amplification using jacks for switching.



QUESTION: I have a panel of walnut (black) ¼ inch thick, which is fifty years old and thoroughly cured and dried. Can I use this in place of the Bakelite usually used? Also how do I connect aluminum sheets behind the panel for shielding the variocoupler and variometers? I have 1/16 inch lead sheet; will this do instead?

E. W. LONOVAN

ANSWER: The walnut panel will be suitable if well dried. The aluminum or lead sheet may be cut the size of the panel and screwed or glued to it. Care must be used so that the lead sheet does not touch or make contact with the instruments that are mounted on the panel, however. Cut out small circles in the sheet where the instruments are fastened or where binding posts pass through the panel. If glue is used be sure it does not spread in between the instruments, as this would cause leakage. The sheet should be connected to the ground binding posts.

* * *

QUESTION: Is the crystal detector as good as the vacuum tube for short distances?

HENRY E. WADE

ANSWER: The crystal is suitable as a detector up to 25 miles, but not as efficient as the vacuum tube.

QUESTION: Please give me an efficient hook-up that employs a variocoupler, a variometer and a variable condenser with detector and two stages of audio frequency amplification.

W. F. HAMMER

ANSWER: In Figure 3 you will find the information you require. The circuit there shown is arranged so that one, two, or three tubes may be used, as necessitated by the strength of signal required, by plugging into the correct jack. The small fixed condenser connected across the first jack is used to pass the radio frequency currents around the telephones or the primary winding of the amplifying transformer in the regenerative circuit.

* * *

QUESTION: How may I make moisture-proof some wood that I intend to use for the supports on the ends of a loose-coupler that I am building?

C. S.

ANSWER: You may drive out all moisture by placing the wood in a bath of melted paraffine, which is kept at a temperature above 100 degrees centigrade. Keep the wood in the paraffine until all bubbling ceases; at that point all the moisture will have been boiled out of it. Then hang the pieces of wood up to dry in a cool place. When they are cooled off sufficiently they will be ready to use without fear of leakage due to moisture. It is not good practice to use parrafine on coils, however.

QUESTION: Does the WD11 1½ volt vacuum tube work as an amplifier or can it be used only as a detector? What "B" battery voltage should be used with it if it will work as an amplifier?

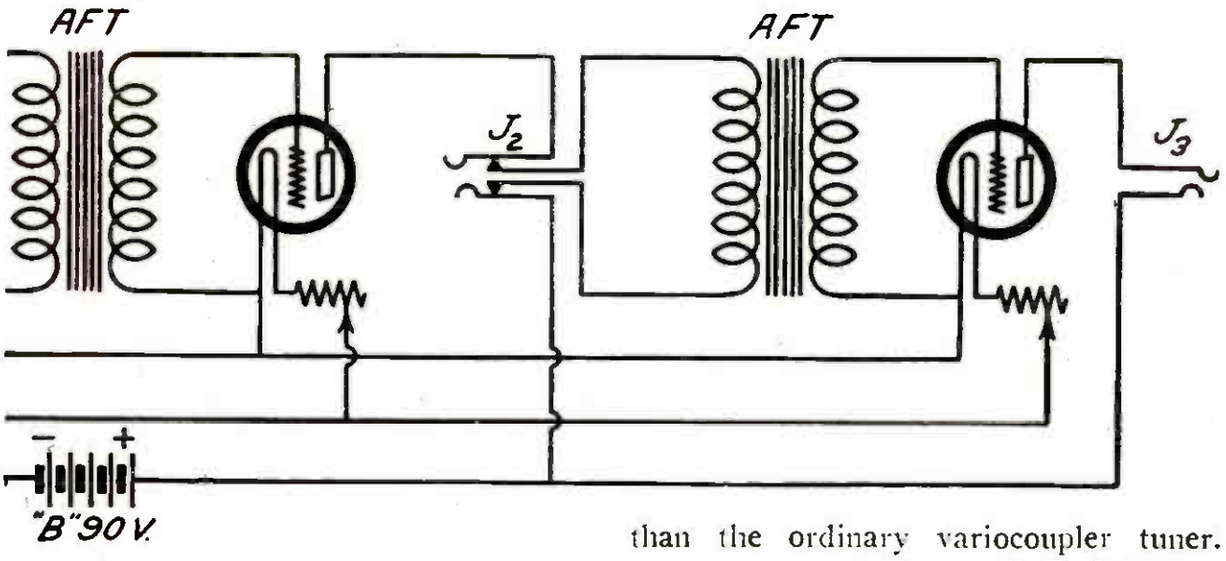
PAUL A. GERHARDT

ANSWER: This tube can be used as an amplifier with good results. The "B" battery potential should be about 45 volts for this purpose, although the tube will stand as much as 100 volts with slight increase of signal strength. The "A" battery required is one dry cell.

* * *

QUESTION: With a Remler No. 400 three-coil mounting, how many turns should the QSA inductances have, to tune to 360 meters, with the ordinary tickler feedback regenerative circuit? I want to use the plug-mounted coils rather than the ordinary variocoupler tuner.

F. E. SMITH



ANSWER: The following coils should be suitable for your purpose:
Primary; 35 turns
Secondary; 50 turns
Tickler; 50 or 75 turns

* * *

QUESTION: Kindly give me a hook-up for a variocoupler, a condenser (variable), a small condenser (fixed), a grid-leak-condenser, vacuum tube, phones and "A" and "B" batteries.

E. PRICE

ANSWER: The circuit shown in Figure 4 is efficient and easily put together.

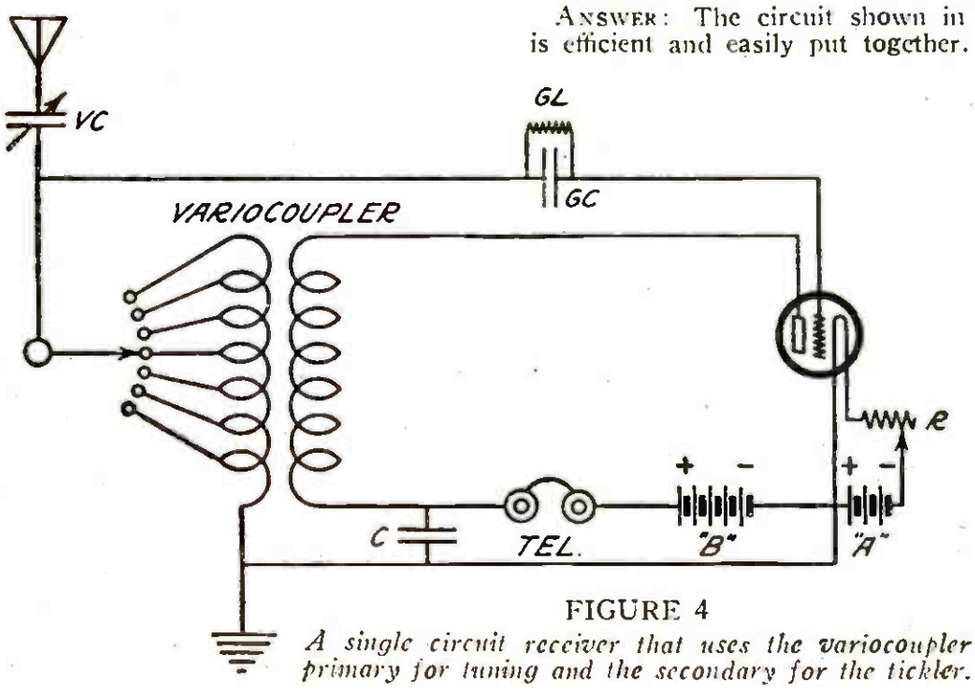
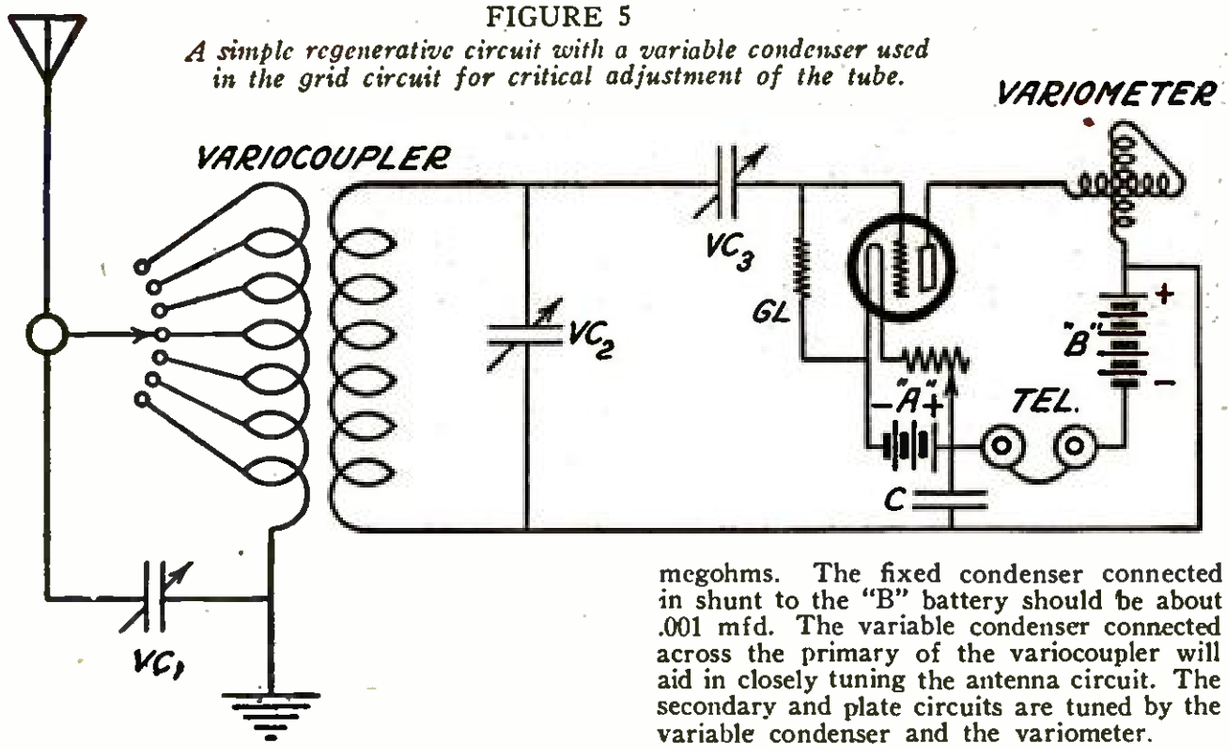


FIGURE 4

A single circuit receiver that uses the variocoupler primary for tuning and the secondary for the tickler.

FIGURE 5

A simple regenerative circuit with a variable condenser used in the grid circuit for critical adjustment of the tube.



QUESTION: Kindly give me a good circuit that employs three .0005 mfd. variable condensers and a variometer, to be used with an audion detector.

THOMAS FUNK

ANSWER: In Figure 5 is shown a regenerative circuit which should give you good results.

It will be noticed that the grid condenser is a variable condenser and the capacity can be varied until the best results are obtained. The grid leak should be about 1 or 2 megohms. The fixed condenser connected in shunt to the "B" battery should be about .001 mfd. The variable condenser connected across the primary of the variocoupler will aid in closely tuning the antenna circuit. The secondary and plate circuits are tuned by the variable condenser and the variometer.

* * *

QUESTION: Please give me a diagram showing a hook-up for one stage of radio frequency amplification on a two-circuit crystal receiver.

HARRY R. SCHULTZ

ANSWER: The circuit is shown in Figure 6. The parts required are the following:

2 variable condensers, .001 mfd.
1 tapped tuning coil
1 filament rheostat
1 potentiometer, 200 ohms
1 loose coupler or variocoupler
1 crystal detector
1 pair head telephones
1 fixed telephone condenser
"A" and "B" batteries

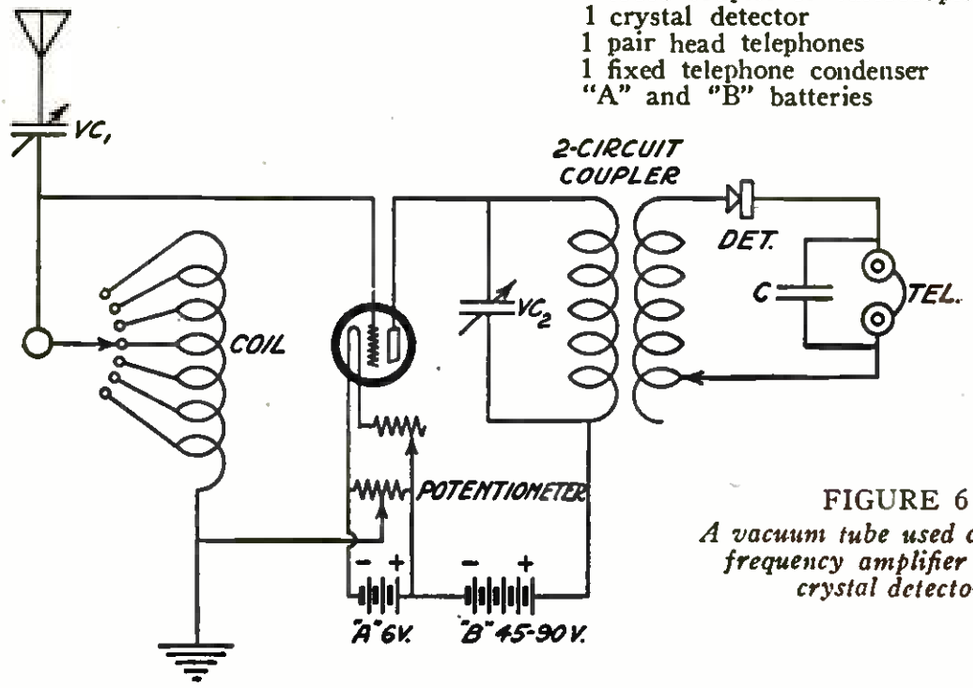
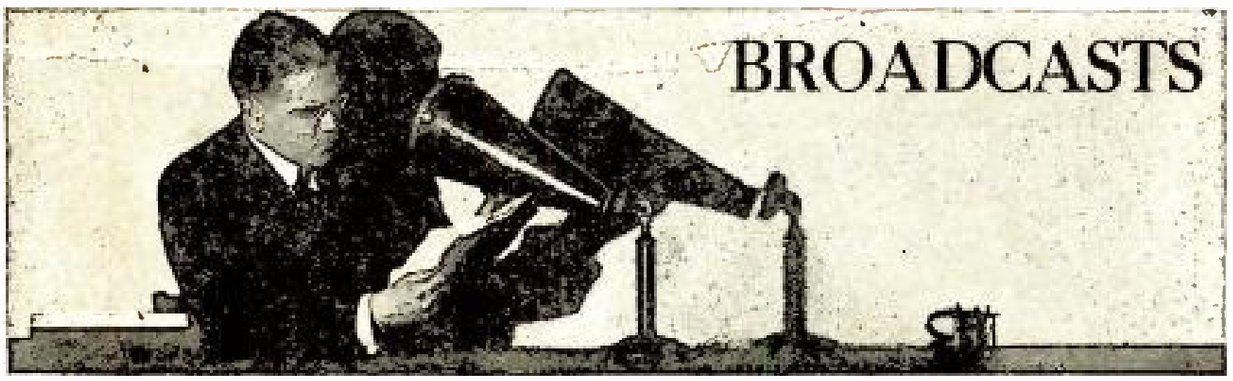


FIGURE 6

A vacuum tube used as a radio frequency amplifier with a crystal detector.



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

86,000,000 Square Miles of Church Service

A RECENTLY-COMPLETED study of the broadcasting situation by the National Radio Chamber of Commerce reveals that there are 83 radio stations in the United States that are broadcasting religious services, and that they cover a territory that represents 65.2 per cent of the area of the United States.

* * *

The Metronome as a Solo Instrument

SOME of the broadcasting stations have adopted a clever scheme for letting listeners in know that they are still tuned in during the brief intervals of silence between numbers on the programs. As soon as a number is concluded, a metronome—a small ticking instrument used by pupils of music for keeping the tempo—is set in motion until the next announcement is made. This ticking keeps the radio fan informed that he is still "on the ether."

* * *

A Chance for American Fans to Hear Paris

IT is not unlikely that by the time this issue of POPULAR RADIO reaches its readers some of them will have picked up radio telephone messages from the Eiffel Tower, which recently began transmitting at 5:10 A.M., 7:20 A.M. and 11:15 A.M., Greenwich mean time. It was announced that the power would be increased shortly.

* * *

Jurors Are Warned Against Radio

JURORS, who have long been admonished by judges not to read newspaper accounts of the law cases on which they are engaged, are now threatened with another hardship. Prospective jurors in a Pacific coast murder trial have been warned not even to listen in to radio broadcast accounts of the case.

* * *

Broadcasting Historic Chimes

THE music of the carillan of Malines Cathedral in Belgium, the seat of Cardinal Mercier, is now being broadcast from a radio outfit installed in the belfry. Radio fans in Belgium and in the surrounding countries may now listen to the music of this famed battery of bells.

A Ship's Set Spans the Pacific

EACH morning on a recent voyage across the Pacific to San Francisco the steamer *Matsonia* held radio communication with KHK, the radio station at Apia, British Samoa. The last talk took place at a distance of 4,050 miles, at 8:30 o'clock in the morning the day before the steamer reached port. The radiophone work was done on a 550-meter wavelength.

* * *

An Aerial 700 Yards Underground

TESTS recently made in Birmingham, England, in transmitting messages from the interior of the Baggeridge Colliery to the pit mouth, proved of value to experimenters. From a depth of more than a third of a mile signals were clearly received, but the telephony was weak, due, it was conjectured, to the absorbing effect on the radio waves of the carbon particles in suspension in the air underground.

* * *

The New "Radio Letter"

A PLAN that will undoubtedly lead to closer ties between the United States and certain foreign countries has just been inaugurated by the Radio Corporation of America, which has established a rate of six cents a word for "radio letters" to England and Germany. At the present any person in any city or town in the United States can write a letter to a person in London or Germany with the envelope marked "Radio Letter," addressed to the Radio Corporation of America in New York. The message will be sent direct by radio to the Carnarvon, Wales, receiving station, which is in direct connection with London. If the letter is for a point in Germany, the message is flashed to Nauen, which is connected by special wires with the Post Office in Berlin.

Radio letters are transmitted across the ocean on Saturdays and Sundays and are delivered the following Monday.

* * *

Long-Distance Dancing by Radio

A RADIO fan, Charles William Taussig, recently gave a dance at his home in New York, for which the music was supplied by an orchestra playing in Chicago. The music is re-

ported to have come, not spasmodically, as is frequently the case in long-distance reception with low-power stations, but continuously loud for more than two hours. No outside aerial wires were used, just a three-foot loop antenna.

* * *

Radio Set Makes Its Debut in a Will

THE first recorded instance of a radio receiving set being specified in a will was revealed when the will of James J. O'Heir was probated in New York. In it he bequeathed "radio sets and tools, valued at $500," to William Watson.

* * *

Will We Pick Up S.O.S. Calls from Air Ships?

THE time is coming near when every aircraft will be required by law to carry radio equipment. At the first public session of the International Commission for Aerial Navigation it was agreed that all aircraft engaged in public transportation must carry a set; at present the law applies only to aircraft that carry ten or more persons.

* * *

Why There Is So Much Interference

"THERE are entirely too many broadcasting stations operating in this country," is the gist of a report by the National Radio Chamber of Commerce. From other sources it is learned that the number is close to 600. A little figuring reveals that these stations cover an area of 179,500,000 square miles—which is 135.2 per cent of the area of the country. In other words, while some portions of the country are not covered by broadcasting service, other sections are covered by too much.

Radio Gives First Aid to Land Wires

FOR the first time in history radio telegraphy was utilized last month to transmit a full press association news report across the Continent. Due to severe sleet, snow and wind storms in the Rocky Mountain region and the crippled service on land lines, the International News Service transmitted a full election service from New York to San Francisco by radio. Messages were transmitted efficiently to the newspaper offices in San Francisco and came through as fast as those obtained over land lines under ordinary conditions.

* * *

Are Marriages by Radio Legal?

THE next time you contemplate getting married by radio, find out whether or not the laws of your State accept such a marriage as legal. Attorney-General Charles D. Newton has just announced that the laws of New York State do not.

"I am of the opinion," he ruled, "that any attempt by a clergyman or magistrate to perform a marriage ceremony without being actually present with the contracting parties, witness or witnesses, would not comply with the mandate of the statutes of this State. The words, 'in the presence,' as contained in the domestic relation law, mean an actual and not a constructive presence. It is as essential that the witnesses and person officiating should be immediately at hand as it is that the contracting parties to the marriage should be in view of each other. The importance and sanctity of the marriage relation require a strict rather than a liberal interpretation of the safeguards which the Legislature has set up in the State."

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PUTTING THE SHIP'S ORCHESTRA IN THE RECEIVER'S HANDS

When the Washington Choral Society of Washington, D. C., chartered the Steamer "St. John" for an excursion trip it saved the money that might have gone to hired musicians and used instead a sensitive receiver that worked on a loop antenna, by means of radio and audio frequency amplifiers. And the party danced to music furnished by WGY, WSB, NOF and WMU.

In setting up a radio station it will be well to remember not to run the antenna lead-in wire and the ground wire close to each other or parallel to each other for any distance, as this will materially decrease the efficiency of the receiving or transmitting sets attached thereto.

* * *

When you attach more than one pair of receivers to your receiving set, be sure that the receivers have the same value of resistance and are connected in parallel. For instance; if the operator uses a pair of 3,000 ohm telephones, and wants another pair so that a second person may listen in at the same time, he should purchase telephones of the same resistance (3,000 ohms) and connect them in parallel. If a pair of 3,000 ohm receivers are connected in parallel with a pair of 2,000 ohm receivers, the lower resistance pair will take most of the current and the higher resistance pair will not respond with their regular strength.

When telephones of unequal resistance are used, it is usually better to connect them in series.

* * *

Many amateurs who build their own receiving apparatus have experienced this peculiar trouble; when listening to distant stations on a single detector tube they receive signals fairly well, but when they turn on their amplifiers to increase the strength of the signals they find that the set refuses to oscillate and they lose the signals altogether; often they are not able to pick them up again while the amplifiers are in use. This is particularly true in the case of C. W. signals.

This trouble may easily be remedied by connecting a fixed telephone condenser across the primary of the first amplifying transformer. The function of this condenser (called a "bypass" condenser) is to pass the radio frequency currents flowing in the plate circuit of the first tube around the high impedence windings of the amplifying transformer and thus enable the first tube to oscillate properly. This simple expedient is usually neglected, but it is a really efficient addition to any amplifier set not now so equipped. When only one tube is used, however, the capacity between the two wires in the telephone cords, which are in the plate circuit, is usually enough to act as a substitute for this condenser.

* * *

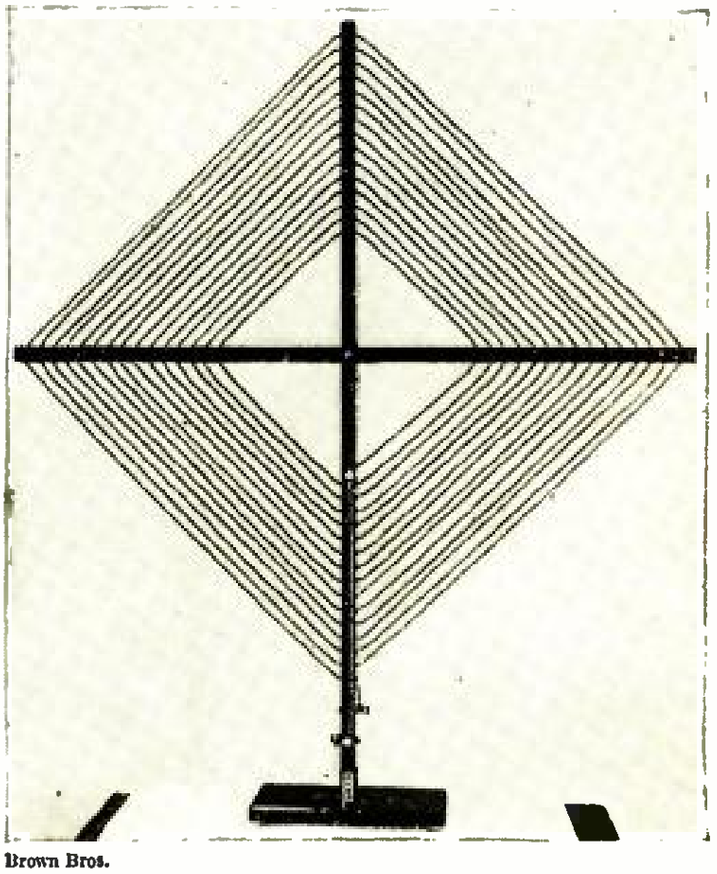
Vacuum tubes sometimes vary in their characteristics, and often the results obtained in a radio receiving set can be improved by placing the tubes in different places in a set. Of course a soft detector tube cannot be used successfully as an amplifier with a high-plate voltage, but where three hard tubes are used in a regenerative set for both detection and amplification, it would be well for the operator to switch the tubes around in their sockets—trying first one tube as detector and the others as amplifiers. Then the tubes should be moved up into other positions, and the results compared. A number of combinations can thus be obtained with a regenerative set and a two-stage audio frequency amplifier.

THE loop antenna, when used with suitable vacuum tube circuits in which some form of radio frequency amplification, or a combination of radio frequency and audio frequency amplification is used, will be found to be efficient and will help to eliminate static and directional interference to a large extent.

For those who have such a set or who contemplate building or purchasing one, the question sometimes arises as to whether the wire used or contemplated for use on the loop should be bare copper wire or insulated, whether it should be solid, stranded or tubular.

After careful tests on all types of wire or cable for this purpose it has been found that the best cable for this purpose is a tubular hollow-center cable. This cable is made of a number of flat ribbons of pure copper, braided into a tubular shape of approximately a quarter inch in diameter. Of course, it has been already proved that the tubular shaped conductors are the most efficient for radio frequency currents. The results obtained from a conductor of this type have proved far in advance of the results obtained from any other type of cable or wire.

Another feature which makes this cable particularly adaptable for use on a loop is its extremely light weight, which prevents the loops from becoming top-heavy. A square-spiral loop of from seven to fifteen turns, spaced ½ inch between turns with the outside turn about two feet square, has been found satisfactory for use below 450 meters. If the loop is made of tubular braided wire, the slots in the supports will have to be spaced about ¾ inch from center to center to obtain a spacing of ½ inch. A loop of this type is shown in the illustration below.



Brown Bros.

A LOOP ANTENNA THAT YOU CAN MAKE AT HOME

This loop consists of 15 turns of tubular braided cable wound on three-foot hardwood sticks that have been slotted to take the cable. The turns are spaced ¾ inch, center to center. Fahnstock clips are connected to every other turn of wire; these are mounted on the back of the vertical stick and are used to select the proper number of turns of cable.

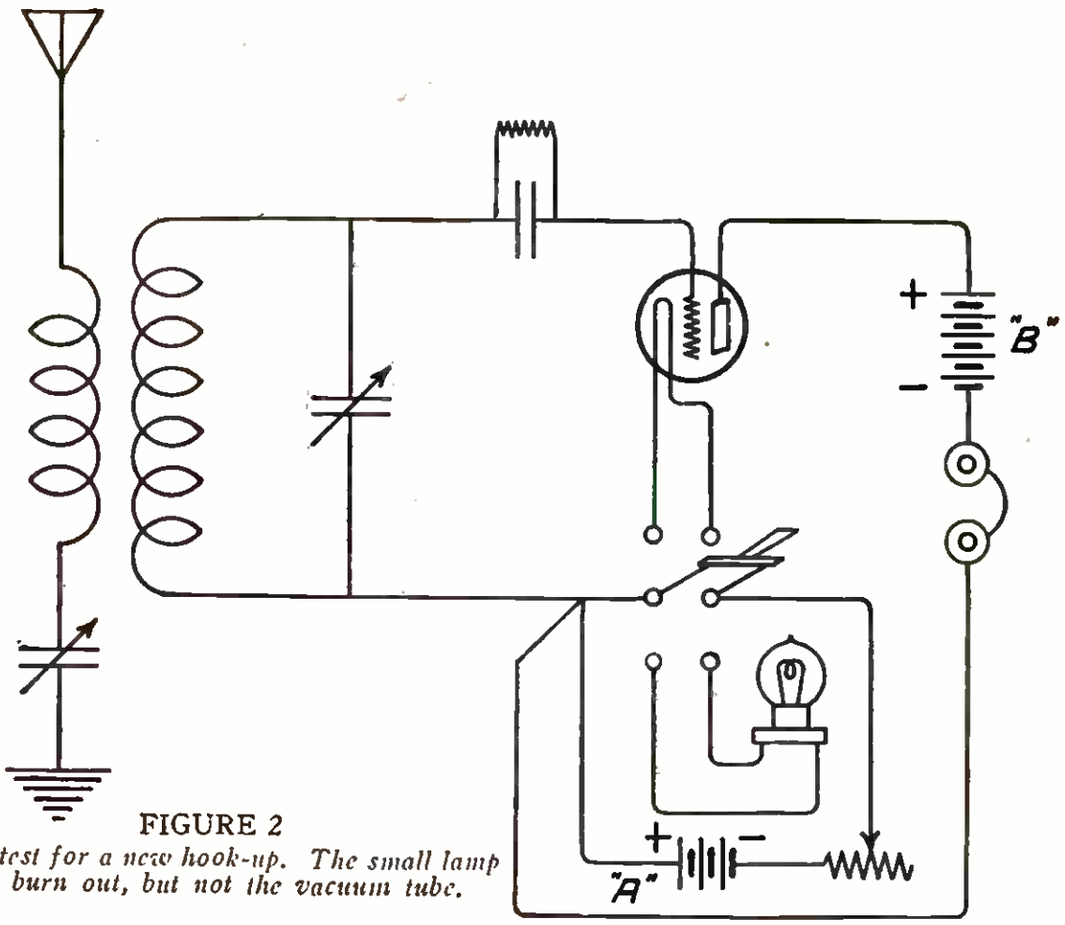


FIGURE 2

A safe test for a new hook-up. The small lamp may burn out, but not the vacuum tube.

For the experimenter who is trying different receiving circuits and who wants to protect his audion tube, the following suggestion will be of value and may at some future time prevent the blowing out of the tube on account of some unforeseen accident.

The two wires leading to the filament are brought to a double throw switch. At the other end of the switch a 6-volt lamp is connected. The blades of the switch are connected to the battery. When the experimenter wants to try some other hook-up, he makes the change with the battery connected to the 6-volt lamp; then when the change is made he knows if the lamp burns with the correct brilliancy that the wiring is not short-circuited or that the "B" battery is not connected across the filament. If the connection should be wrong and the 6-volt lamp is burned out, he has protected the audion from the same fate. The 6-volt lamp costs only about 30 cents; the audion costs $5.00 or more. (See Figure 2.)

Bakelite panels may be given a dull satin finish by rubbing with smooth sandpaper and a light oil. Rub the surface in one direction, back and forth, but not in circles. Keep on rubbing until the surface is perfectly smooth and all the little indentations are removed; then wipe off with a dry clean cloth and the panel for the new set will have the same finish as the large panels used in commercial radio apparatus. Never use water to clean bakelite panels; use oil.

* * *

In Testing out a variometer to determine if there is a loose connection in the leads joining the rotor to the stator windings, connect a buzzer and a battery in series with the variometer; the buzzer should buzz steadily. If upon turning the knob of the variometer the buzzer works intermittently, you will know there is a poor connection, and will be able to make repairs without tearing the rest of the set apart while looking for faults elsewhere.

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.*

Should Broadcasting Stations "Lay Off" Occasionally?

THE idea put forward by the following correspondent is not new. The question is whether or not radio fans approve of it in sufficient numbers to influence the big stations to keep silent once in a while. What do you think?

I believe that radio enthusiasts with small sets and long-range equipment will join with me in this suggestion that the management of broadcasting stations, by localities, arrange with each other and agree upon a one-night layoff each week for the following reasons:

First—It will give operators and artists the equivalent of a Sunday rest.

Second—It will permit a tryout of receiving stations in any locality to determine their range and the variety of adjustments necessary to pick up out-of-town sending stations.

I live in Chicago almost in the shadow of several large antennas. With great care I have built up an elaborate 5-tube set in anticipation of some opportunity to try it out during the winter evening hours. But with two high-powered broadcasting stations and half a dozen smaller sets waiting like hawks for their turn at the air or even sometimes doubling their dissimilar wave bands, how can a chap expect to get out of his own backyard, so to speak? I like to go visiting occasionally. I would like to hear someone else besides homefolks.

Recently, in a thirty-minute period of relief from local disturbances during the early evening broadcasting hour, I was able to clearly tune in just six stations: Detroit, Louisville, Kansas City, Waco, Oklahoma City, Denver, Schenectady, and that popular Southern station, *The Atlanta Journal.* All of these stations furnished a wide variety of program readily available for selection, but all too quickly spoiled by a local carrier wave. I experienced more real thrills in that thirty minutes than during the whole of the rest of the week. Pleading for a night off, and, as a basis for an agreement, I suggest that the New England States and New York City close up absolutely tight on Monday night of each week between the hours of 7 P. M. and 10 P. M., local time; that the Pittsburgh and the Buffalo longitude close Tuesday nights; that Detroit, Chicago, Indianapolis, etc., close Wednesday nights; that St. Louis, Kansas City, Omaha, etc., close Thursday nights; that Denver and that longitude close Friday nights; and that the Pacific Coast observe Saturday nights—each area to observe the same hours—7 to 10 P. M. —in its own local time.

WM. P. BEAR

* * *

400 Miles for a Dollar

OF the many reports that have reached this magazine concerning the exploits of home-made crystal sets, this one from Indianapolis holds the record for low cost for the mileage received:

My wife and I have made several crystal sets, but we like the last one we made the best. This set consists of a ten-tap coil, crystal and phones, no condenser. It can be made for less than a dollar.

With this set we have been getting the following stations: WGY, KDKA, WLW, WOC, WHAS, WSB, WGM, WOAI, WWJ, KYW, NOF, and the *Kansas City Star.* One tap gives up 360, one 400, one 485, and the others the code stations. When on the 360 tap, the code stations do not interfere.

We are using a single wire aerial 135 feet long, 25 feet high, No. 9 solid copper, pointed northwest.

Our loudspeaker is made from an old honk! honk! horn, fixed so that we can clamp our receivers on it.

EARL C. THOMPSON

A Half-Inch Copper Strip Strengthens My Signals

ARE you troubled with "weak signals?" Maybe the experience of 2AWW in reducing the resistance in his ground connections will help you to overcome this trouble:

In most of the installations which I have seen the earth connection is taken from the nearest pipe available to the set. If you should trace the lead from the ground post of your receiver to the point where it enters the earth and see the indirect route, with all the couplings and elbows in the pipe, you would realize that all this resistance must necessarily cause weak signals.

The earth connection should be a conductor of high conductivity and as direct as possible to the earth; a half-inch copper strip will serve the purpose very well. This should be connected to as much surface in the earth as it is possible to obtain. An old boiler buried about four feet deep and clamped around tight with copper strip and soldered in three or four places will give good results. If the strip is connected to the street side of the water pipe and any gas, electric or steam pipe is connected with it (thus adding more surface), this may also be used with good results. If the station is situated in the mountains or some dry place where a good damp ground cannot be obtained, a capacity ground (counterpoise) is recommended.

A counterpoise, too, requires as much surface as possible. It should consist of one thousand or more feet of seven strand No. 22 wire or No. 14 hard-drawn wire and placed directly under the aerial about seven feet high, well insulated from the ground. This type of capacity ground has proven successful around the armatures for both transmission and reception.

If care is exercised in running a ground system instead of twisting a wire around a pipe and taking it for granted that everything is O. K., the received signals freed from the burden of resistance in their path will show a considerable increase in strength.

GEORGE JOHNSON (2 AWW)

Sport-Commercial

A GLIMPSE INTO THE WARFARE OF THE FUTURE

A significant demonstration has been made in Washington of the uses of radio for controlling the movements of a number of tanks during experimental maneuvers. In these tests the commanding officer maintained personal communication with the operator of each unit. It is probable that tanks will eventually be placed under direct radio control, as has already been done with working models.

The Burial of the Loop Antenna

SCIENTISTS have been telling us that the familiar aerial, rising like a mast above the home of the radio fan, is doomed. Now they are burying the more modern loop antenna also—not, however, because it is obsolete, but because placing it underground increases its efficiency, as Mr. Dodge points out:

During the World War the United States Signal Corps and the Bureau of Standards made an exhaustive study of the properties of the loop aerial, and it is chiefly due to their development work that the loop aerial is used so much today. In their research work the Bureau of Standards discovered that the loop antenna was the best kind of aerial for diminishing atmospheric disturbances, or static, which sometimes renders a receiving station almost useless.

One successful method of eliminating these strays is the use of buried loops. In this method of lessening static a movable loop aerial is suspended in an underground room. When this is done the receiving set must also be placed in the underground room.

A regular aerial may be used with the underground loop and this is connected to the primary of the receiving transformer which is connected to the earth. The secondary of the instrument is connected to the rest of the apparatus with the underground loop hooked up in series with one side of this circuit. It is interesting to note that the loops may be under water as well as under land, the liquid acting as a shield and having the same effect as the earth.

Underwood & Underwood

A SHOPPING-BAG RADIO SET

Compact as this outfit is, it is a cumbersome piece of work in comparison to the pocket-set that we will some day carry about with us as commonly as we now carry watches.

Not only may messages be received by means of the loops, but signals have been transmitted up to certain distances. With an ordinary antenna the transmitted waves are materially affected by surrounding objects, such as trees, mountains, buildings. This distorts the static or magnetic field, or both, and causes a variation of the determined direction from the true direction. The shielded underground loop greatly reduces the error resulting from this cause.

There is a great field for amateur experimentation in the use of buried aerials. Without going to the trouble of erecting a loop aerial, the interested amateur may simply dig a trench about a foot deep and lay some number fourteen insulated copper wire in the excavation and lead one end of the wire to the receiver. Signals with great directional effect can be heard with an antenna of this sort. Of course, in preparing for reception from a certain station, the underground wire should be pointed in that direction, that is, it should be laid out in a straight line with the lead-in wire at the end pointing to the station to be received.

Not only may messages be copied with insulated wire, but experiments prove that *bare* wire can be used. This seems astounding because in this case the wire is grounded, but still radio waves can be detected; and little difficulty should be experienced in picking up signals up to one hundred miles, employing one audion tube.

In the summer time when the static is bad, excellent results may be obtained in receiving the long-distance, high-powered land stations by making use of the directional property of the underground aerial or loop with a two- or three-step amplifier. It is much simpler to operate the underground loop than the buried aerial, as it is easily rotated on a pivot to the proper direction for maximum reception; in the case of the buried aerial the amateur has to constantly change the direction of the wire to secure the proper intensity of the signal.

Of all the different types of aerials used, the loop offers the greatest field for amateur research work. In time to come, when radio will possibly be developed so that two persons may converse by voice and not be overheard by anyone, the loop aerial will undoubtedly play an important part. The loops are being used more and more every day, especially by persons living in apartments in the city where overhead wires are "taboo." There may come a time when all amateur and commercial aerials will be constructed beneath the earth, with no exposed wires at all.

HERBERT WARREN DODGE

From a photograph made for POPULAR RADIO

HE MADE A "MISTAKE" THAT LED TO A DISCOVERY

When Ashley Hewitt found that he could receive signals with the antenna disconnected, he started experiments that brought results described below.

THE combination of ingenuity and a bit of luck sometimes leads to interesting results. Here is a letter from a fan who is not afraid to experiment:

Like most amateurs, I had been bothered a great deal by the larger wireless stations, particularly NAH and WNY, which broke in on the broadcasting and on the amateur work. I was unable to tune them out.

However, my problem is now solved, and, as is often the case with novices, I arrived at the solution entirely by accident. When I set up my two stage amplifying set, I used as a ground the discontinued city gas line which was left intact when electricity was put in the house. This seemed to work perfectly well, but I was still annoyed by NAH and others.

I was working with another amateur, trying to receive his signals, but was unable to get him; he suggested that I would get better results in any case if I grounded on the city water line. Accordingly I did this and found the strength of the signals vastly improved, as well as the clearness. Still I was bothered by the same trouble.

It was while listening to the 2XJ-KDOW tests that I made my "economical" mistake. I noticed that I could hear NAH with the antenna disconnected and the set tuned in.

This started me fooling with the antenna and ground connections. Trying everything that I could, just to see what would happen, I put the wire which I had attached to the gas-pipe on the antenna terminal while the ground terminal was connected to the city water line. NAH was going at the time as well as 2XJ, but as soon as I made this accidental connection they both disappeared. On tuning up a little higher I heard 2XJ clearly but not NAH. The signal was a little weaker but it was worth it to have all the interference out.

Attaching the gas-pipe to the antenna in this way seems to have the effect of putting a condenser of great capacity in the antenna circuit.

There are several other effects that should be spoken of in case anyone else wishes to try it. First, it reverses the tuning of the Vernier condenser—that is, instead of tuning around 0 to 20 degrees, I have to start from the other end at 100 and tune towards 80. It also shifts the point of tuning on the regenerative dial; this moves upwards about 20 degrees. The wavelength is also moved up higher about 3 degrees. Another advantage is that it increases the sharpness of tuning enormously; I find that in the amateur range I can practically cut all signals except those on identically the same wavelength. The adjustment is so fine that I will have to put micrometer adjusting screws on the dial to be able to get the signals I want.

I am using this hook-up entirely now.

ASHLEY HEWITT

Re-Making Lumber Jacks by Radio

THE old Bible adage "And the waste places shall be glad of their coming, and the wilderness shall blossom as the rose" has seldom been given more apt illustration than in the way that radio is bringing the advantages of civilization into the backwoods. For example:

The lumberjack of the densely forested Pacific Northwest timber belt is now a radio fan. The click of poker chips is being supplanted by the voice of the radiophone. Evenings in the Northwest camps are now spent constructively, listening to news of the day, instructive talks and music.

Giant tree-tops are used almost universally to anchor antennas. Many of the forest antennas are more than 300 feet high, swaying with the willowings of the trees. The Hammond camp, at Kerry, Ore., boasts a single wire aerial 1000 feet long. To fasten these antennas it is necessary for a "high climber" to scale the trees selected for masts, a feat calling for both nerve and skill. A lone coil of rope is thrown about the tree and by flipping the rope up the trunk a foot at a time, the climber pursues his way to the swaying top.

Logging camp managers declare that since the incursion of radio into the lumber camps the spirit and tenor of the lumberjack has changed materially for the better. As a class, shrinking from the society of cities, the lumberjack nevertheless possesses that innate craving for music and the better things of life which embellish metropolitan culture. Radio gratifies that desire without the embarrassment of physical contact with the part of civilization which is strange to him. The radiophone is a permanent fixture in lumbercamps that are too small to support a motion-picture show and has become a potent factor in the Northwest timber belt. Recognizing the beneficial results of radio installations, several large camps are now constructing recreation halls capable of accommodating several hundred persons, in which daily programs will be given to audiences through power amplifiers. Dances will be held in the heart of the wooded wilderness to the tune of city jazz orchestras. Lumber operators freely admit that radio has raised the morale of the timber workers and that by its educational influences a changed order of woodsmen is being evolved.

MEL WHARTON

BETTER THAN BOX SEATS AT THE OPERA

The introduction of radio into the timber regions has given the backwoodsmen one inestimable boon—the privilege of listening to good entertainment without the necessity of putting on store clothes!

How to Find the Relation Between Frequency and Wavelength

SOONER or later the radio fan with an investigating turn of mind is puzzled by this question of relationship between frequency and wavelength. How the problem was worked out by one amateur and expressed in a simple formula is told as follows:

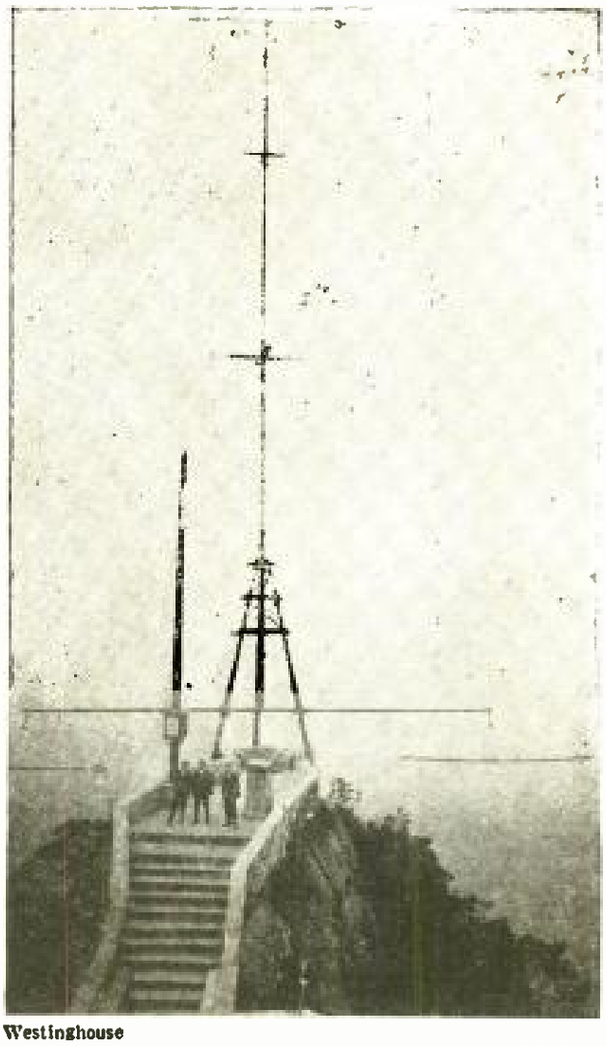
A real baseball fan is not content to know merely the score of a baseball game; he wants to know how every run was made, what players were responsible for winning or losing, indeed every move of the players throughout the game.

So it is with the radio fan. He is not satisfied with being able to hook-up the various units of his set and to tune the different stations in and out; he loves to speculate on the mystery of it all, to picture the waves coming in, producing currents in the aerial, to follow them as they surge through the apparatus, causing the little electrons to rush around through the coils and onto the plates of the condensers and back again several hundred thousand times every second. But in pondering over these mysteries there comes at some time to every amateur one puzzling question that will continue to trouble him until he finds a satisfactory explanation. It is the relationship between frequency and wavelength.

Nearly every amateur realizes that some relationship between these two exists. Some of us know that the lower the frequency the longer the wavelength, and the higher the frequency the shorter the wavelength. This relationship would be more easily understood if expressed by a formula similar to that of Ohm's Law. Frequency is defined as the number of cycles a second, a cycle being an electrical impulse in one direction followed by another impulse in the opposite direction. A complete cycle transmits one complete wavelength.

Now, it is an established fact that these magnetic impulses which carry the radio messages, travel at the rate of 186,330 miles per second. As wavelength is always given in meters we will express this distance in meters. If we multiply 186,330 by 5,280 (feet per mile) we have 983.822,400 feet per second; dividing by 3.28 (feet per meter) we have 299,945,853 meters per second. If we say 300,000,000 in round numbers it will simplify matters; it is accurate to within a small error of about thirty-four miles and will be near enough for practical purposes.

It is evident that if the message travels 300,000,000 meters per second and travels in waves and that if there are, say, 200,000 waves per second, we can find the wavelength by dividing 300.000,000 by 200,000. This gives us 1,500 meters. Any other wavelength may be found in the same manner



Westinghouse

AN ANTENNA ON TOP OF THE WORLD

This new and unusual radio station, SPC, is perched on the summit of Mt. Corcovada in Brazil. It forges another link in the radio chain that encircles the earth.

by dividing 300,000,000 by the frequency (cycles per second). On the other hand, if we know the wavelength and desire to know the frequency we divide 300,000,000 by the wavelength in meters and we have the number of cycles a second of the current which is necessary to produce a wave of given dimensions.

The formula may be stated thus:

$$\text{Wavelength} = \frac{300,000,000}{\text{frequency}}$$

$$\text{or, frequency} = \frac{300,000,000}{\text{Wavelength}}$$

This is even simpler, in a way, than Ohm's Law, as in the latter we have three quantities, any one of which may be the unknown quantity. In the present problem we have only two, as the speed which is represented by the 300,000,000 meters is constant. A clear understanding of this phenomenon can be obtained from this simple formula; thus this puzzling question is answered and the mystery cleared away.

GUY PRENTICE BLESSING

Broadcasting a Voice from a Photograph

EVERY day opens up new and amazing possibilities for the use of radio; one of the latest applications forces one to speculate what kind of a world our grandchildren will live in. For instance:

Holiday greetings to the people of the United States from Vice-President Calvin Coolidge, from Secretary of War Weeks, and from Secretary of Navy Denby, were broadcast from WGY, at Schenectady, N. Y. This was the first time that three leading executives of the country ever attempted to extend their greetings in a way that reached the four corners of the country simultaneously.

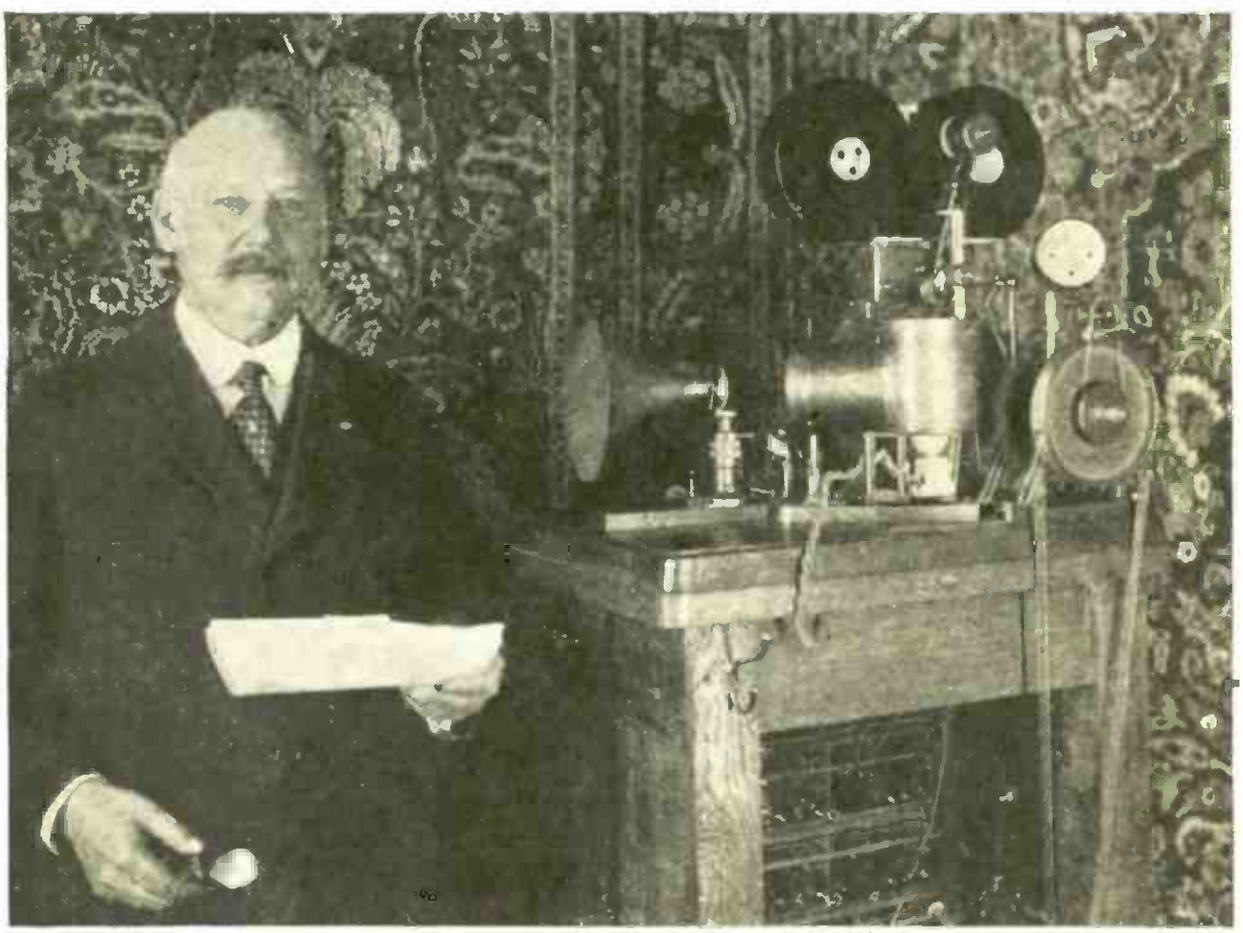
This feat was made possible by use of the "pallophotophone," the new General Electric device for photographing the voice and later reproducing it with perfect clearness. The machine was set up in a hotel in Washington ten days before. The Vice-President and the War and Navy Secretaries spoke into a small recording horn; as they did so their voices caused a small diaphragm to vibrate. To this diaphragm was attached a tiny mirror, scarcely smaller than the head of a pin. This oscillation or flickering of the mirror reflected a beam of light upon a moving photographic film, thus recording the human voice accurately with the overtones, the delicate shadings of speech and other characteristics which make one voice sound different from another.

The film thus made was taken to Schenectady and was broadcast twice on the same evening from the WGY studio.

In reproducing, the film is passed before a strong ray of light and the zigzag markings on it that the sound waves photographed create electric waves which pass through an arrangement of vacuum tubes and produce sound waves again which are sent directly into the radio broadcasting apparatus without the use of a microphone or any sort of a pick-up device ordinarily used.

This feat of recording the speech of a person in a distant city is believed to have introduced an entirely new element in radio broadcasting, the possibility of making a master record and broadcasting it days or weeks later from any radio station in the country.

B. S. BEACH



General Electric

THE SECRETARY OF WAR HAS HIS VOICE PHOTOGRAPHED

By means of this "pallophotophone" a film record was made of the sound waves, which were re-converted at the broadcasting station into radio waves.

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

A Seal on a Radio Cabin Saves Me from a Firing Squad

THE Destiny that looks after children and violators of the Volstead Act sometimes casts a friendly glance in the direction of radio men also. Certainly Destiny spread himself a bit in the following instance, which is cited by a ship's operator who served in the war zone during the U-boat days:

During the early stages of the World War, before the United States was involved in it, we were sending ships laden with cotton to Bremen through the Allied lines. Ships that flew the American flag did not go through the British Channel; they went around the northern end of the British Isles and down the coast through the east side of the North Sea.

Whenever a ship stopped for examination in an Allied port, the radio cabin was sealed up tight. The Germans even went the Allies one better; they removed the transformer and receiving apparatus before they sealed the radio room.

On one occasion we had discharged our cotton, dodged the mines in the North Sea. been examined at Kirkwall and were wending our way back to New York when a storm came up. As the ship was light, the Captain thought it wise to put into a small port on the northwest end of Scotland. Immediately upon dropping anchor the usual crowd of officials swarmed aboard and commenced sealing everything up, in compliance with war-time regulations.

Four or five of these officials stayed aboard until the storm had abated. Before leaving they gave us warning not to work the radio until outside the three-mile limit. I broke the seal on the door as soon as we were clear of the harbor and tried to get in communication with a sister ship about twelve hours behind us. As soon as I raised the other ship, I told her our experience and then went out on deck.

But as soon as I put my head outside the door, I received a real shock. The storm had come up again with greater intensity than ever and we were headed back to the harbor. which lay to the east, not half a mile distant!

I went in the ship's office to do some tall thinking—for I had seen three or four patrol boats with radio in the harbor and didn't know but what I might be apprehended for a German spy. Visions of a firing squad danced before me and the thought was not pleasant.

As I sat there something on the Captain's desk caught my eye. Joy came over me; one of the inspection squad had left his seal, sealing wax and about ten yards of red tape on the desk.

With it I quickly sealed up the radio room again; to make sure that I did a good job. I threw the seal and the rest of the works overboard. Then I assumed a detached air. When we dropped anchor this time about fifteen officials came aboard. The captain was asked by what right he used the radio within the three-mile limit. The officers wouldn't be convinced that we had not used it until they examined the seals. Finding them intact, they prepared to depart, with the usual super-Scotch blank looks on their faces.

I had just begun to take full breaths again, and my blood pressure had about returned to normal. when one of the visitors turned back and asked if he had left his official seal behind.

But somehow a thorough search failed to reveal it.

H. B. COWAN

What Awakened Me?

SOMETIMES Destiny appears to knock on our doors loud enough to awaken the sleepers. Certainly in this Adventure, which comes from an old-time ship operator, some power other than mere chance seems to have stepped in to help rescue lives at sea:

On the night of the 18th of January, 1913, while on the *SS Nigeria*, of the Elder Dempster Line, bound for the West Coast of Africa, I had copied the usual nightly bulletin from the high powered station at Poldhu, Cornwall, and afterward had a talk with operators whom I knew on the vessels in the vicinity. My bunk was alongside the operating table and along about 2:00 A. M., feeling sleepy, I turned in.

Exactly two and a half hours later I suddenly sat up in my bunk, wide awake and alert. I was certain that someone had called me. I got out of bed, went to the door and looked outside, but could see no one. I jumped into bed again but could not go off to sleep; I tossed about for ten minutes and then decided that I might as well listen in and see if there was anyone working.

I wound up the magnetic detector, put the telephones on and settled back on the pillows. I did not have them on my head more than three minutes when I heard "SOS, SOS," the call with which I was to become so familiar in later years.

Leaping out of bed and seizing paper and pencil I jotted this down:

SOS, SOS. Here SS "Veronese" on rocks off Leixoes.

We were then passing within 75 miles of Leixoes, Portugal.

I immediately started up the motor and answered "R," in acknowledgment of his call.

Without waiting to put on shoes or clothes I rushed along to the bridge and aroused the skipper, who changed our course at once and made for Leixoes.

Going back to the cabin I started up again and called the *Veronese*, but he did not answer. The steamer *Highland Laddie* then called me and said he was about thirty miles from the *Veronese* and was going at once to her assistance.

The *SS Vauban* then called both the *Highland Laddie* and myself and said he was in sight of the *Veronese* and would be able to take care of her. I so informed the commander, whereupon we changed our course again and proceeded on our voyage.

At Las Palmas we were informed that the passengers were taken off by breeches buoy erected between the ship and the shore. At an early hour of the rescue the wireless was put out of commission by a steel hawser that was thrown across the antenna.

The radio operator stayed on the bridge and kept communication with the shore by means of a Morse light. He and the captain were the last to leave the ship.

T. W. MURRAY

Old Pals Reunited by Radio

HOW radio reunited two long-lost friends is told in the following Adventure, which comes in the form of a story within a story. Incidentally, the newspaper account of the occurrence won a prize of a Ford car for the woman who wrote it up—who was the wife of one of the principals:

A remarkable incident was credited to radio when two old army pals were united and an old debt "paid in full." The true story of the exploit which won the automobile was reported as follows:

REUNITED BY RADIO

"When Professor Connor of Emerson College, Boston, gave his readings by radio from WGI broadcasting station near Boston last Wednesday evening, he was not aware that among his audience was a man whom he had been seeking for over three years, a pal of his army days. They had parted at the great army hospital on Staten Island and had gone their separate ways without having had an opportunity to shake hands in parting. Neither had heard of the other until Sergeant Kepple, listening in at Wilkensburgh, Pennsylvania, to the radio program heard the voice of his army chum with the result that the following night-letter was received by Mr. Connor the next morning:

PROFESSOR JOSEPH E. CONNOR,
Mansfield, Massachusetts.
Been trying to locate you since discharged from army. Last night heard your radio readings. Am sending postal order amount one hundred dollars paying your kind loan at Army Hospital, Staten Island. Many thanks, old son-of-a-gun. Didn't know you were professor. Would have borrowed two hundred.
Your erstwhile Sergeant,
KEPPLE

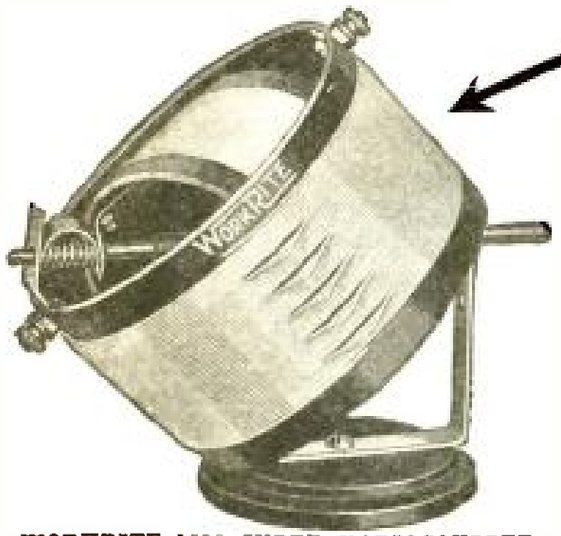
"Mr. Connor says he is going to use the one hundred dollars for railroad fare to Wilkensburgh in a visit to Sergeant Kepple."

The author of this item is Mrs. Marguerite P. Connor, who feels well satisfied with the compensation which her husband secured as the result of his participation in a radio program, as he became richer by one hundred dollars, a touring car, a lost friend found and the gratification of the general public.

H. M. TAYLOR

"WORKRITE" REDUCES PRICES

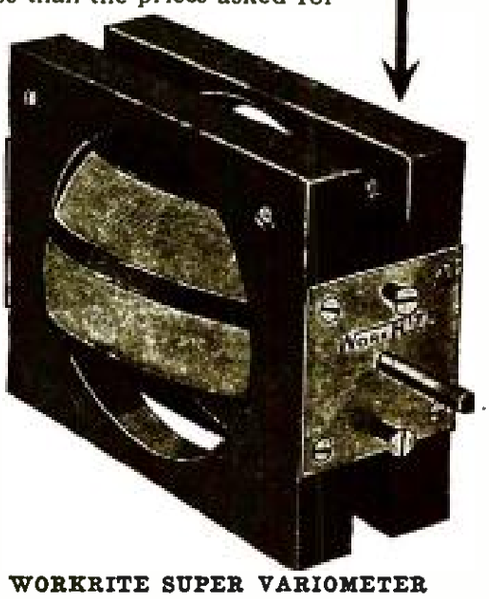
$3.50



WORKRITE 180° SUPER VARIOCOUPLER

RADIO FANS!

You have wanted to equip your set with WorkRite Quality Radio parts but have hesitated because of the cost. Now you can get WorkRite instruments at less than the prices asked for inferior unknown parts. Don't delay! Send in your order right away.

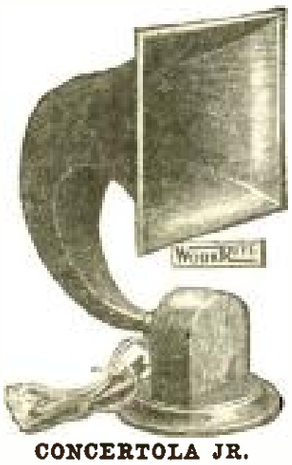


WORKRITE SUPER VARIOMETER

THIS IS A BIG CUT

The new WorkRite Super Variometer and WorkRite 180° Super Variocoupler with 12 taps and wound with green silk are now $3.50 each. Last spring they were $6.00. We have made this reduction because of our faith in you. We must sell 10 instruments where we previously sold one. Will you help us? We know you will. Remember the prices: WorkRite Super Variometer $3.50. WorkRite 180° Super Variocoupler $3.50.

WORKRITE CONCERTOLAS



CONCERTOLA JR.

These instruments are becoming very popular with radio fans. Thousands of them are in use all over the country. Read the following letter received from one of the "WorkRite" fans:

> "Regarding the WorkRite Concertola received some time ago I wish to advise that it is the best $12.00 worth I have ever bought. Stations in the following cities have all come in very QSA, even on warm nights, with the Concertola: St. Louis, Louisville, Pittsburgh, Detroit. Schenectady, Dallas, Tex., Fort Worth. Tex., Atlanta Ga., Havana, Cuba, Charlotte, N. C., Chicago, Cleveland and many others.
>
> These stations can be heard all over the room with ease on warm nights, and all over the house on colder nights. With ever a good word for the Concertola, I am,
>
> "Earl E. Daesch, 1103 Columbia Terrace, Parkersburg, W. Va."

Three-Day Trial! If after you have tried the Concertola on your set you find that it does not work satisfactorily, return it and we will refund your money.

These instruments are intended for use with vacuum tube sets having two-stage amplification **WorkRite Concertola Jr., complete with cord and phone unit, $12.00. WorkRite Concertola Sr., complete with cord and phone unit, $24.00.**

LET US HELP YOU BUILD YOUR SET

THE WORKRITE MANUFACTURING CO.

5547 Euclid Ave. (Branch Offices, 2204 Michigan Ave., Chicago) **Cleveland, Ohio**

Hearing is believing!

Bel-Canto

The Superlative Loud Speaker

Don't judge the Bel-Canto Loud Speaker by its beauty alone, or by the fact that it is the only loud speaker endorsed by the world-famous musician Paderewski. Don't judge it by its low price compared to other loud speakers.

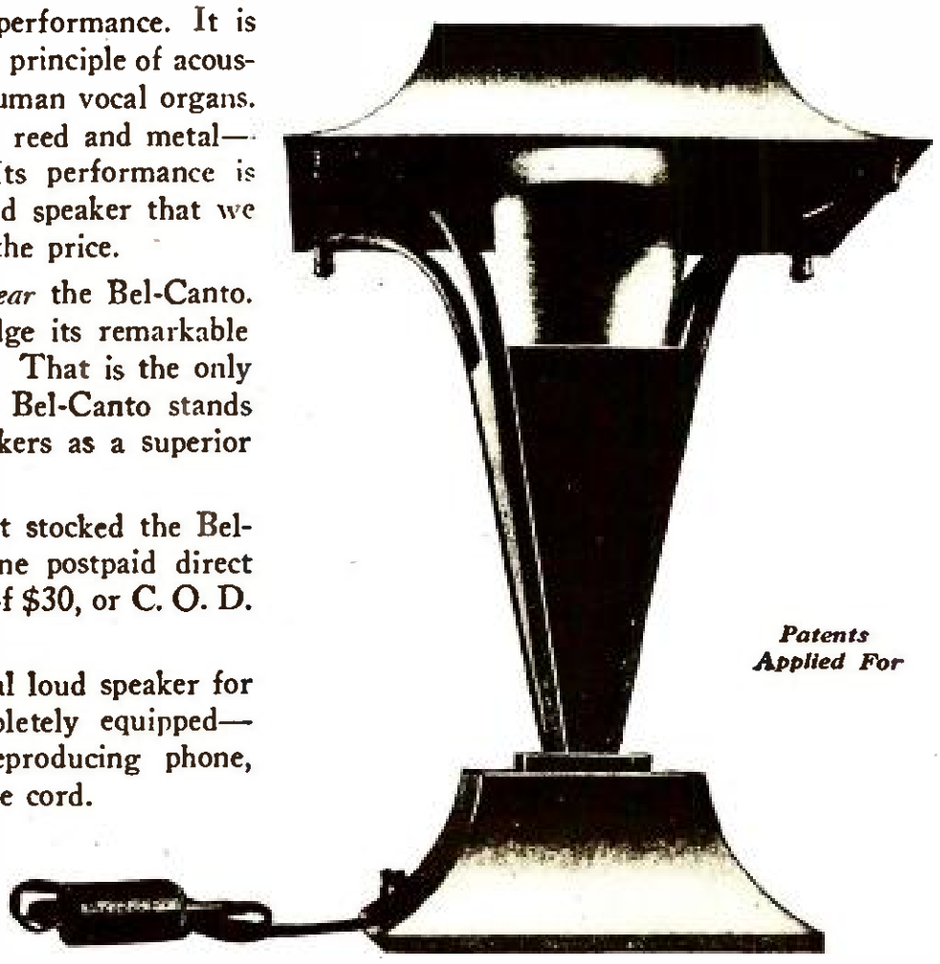
The way to judge the Bel-Canto, like any other fine musical instrument, is by *hearing* it—by hearing its warmth and mellowness of tone, its pure, distortionless reproduction of music.

Hear the Bel-Canto, then you will easily understand why we speak of the Bel-Canto as being in no sense of the word an ordinary loud speaker. The Bel-Canto is *different* in principle, construction and performance. It is designed on the most perfect principle of acoustics known to science, the human vocal organs. It is constructed entirely of reed and metal—absolutely distortionless. Its performance is unequaled by any other loud speaker that we know of—no matter what the price.

Go to your dealer and *hear* the Bel-Canto. That's the only way to judge its remarkable volume and clarity of tone. That is the only way to appreciate why the Bel-Canto stands apart from other loud speakers as a superior musical instrument.

If your dealer has not yet stocked the Bel-Canto, we will ship you one postpaid direct from the factory on receipt of $30, or C. O. D. if you prefer.

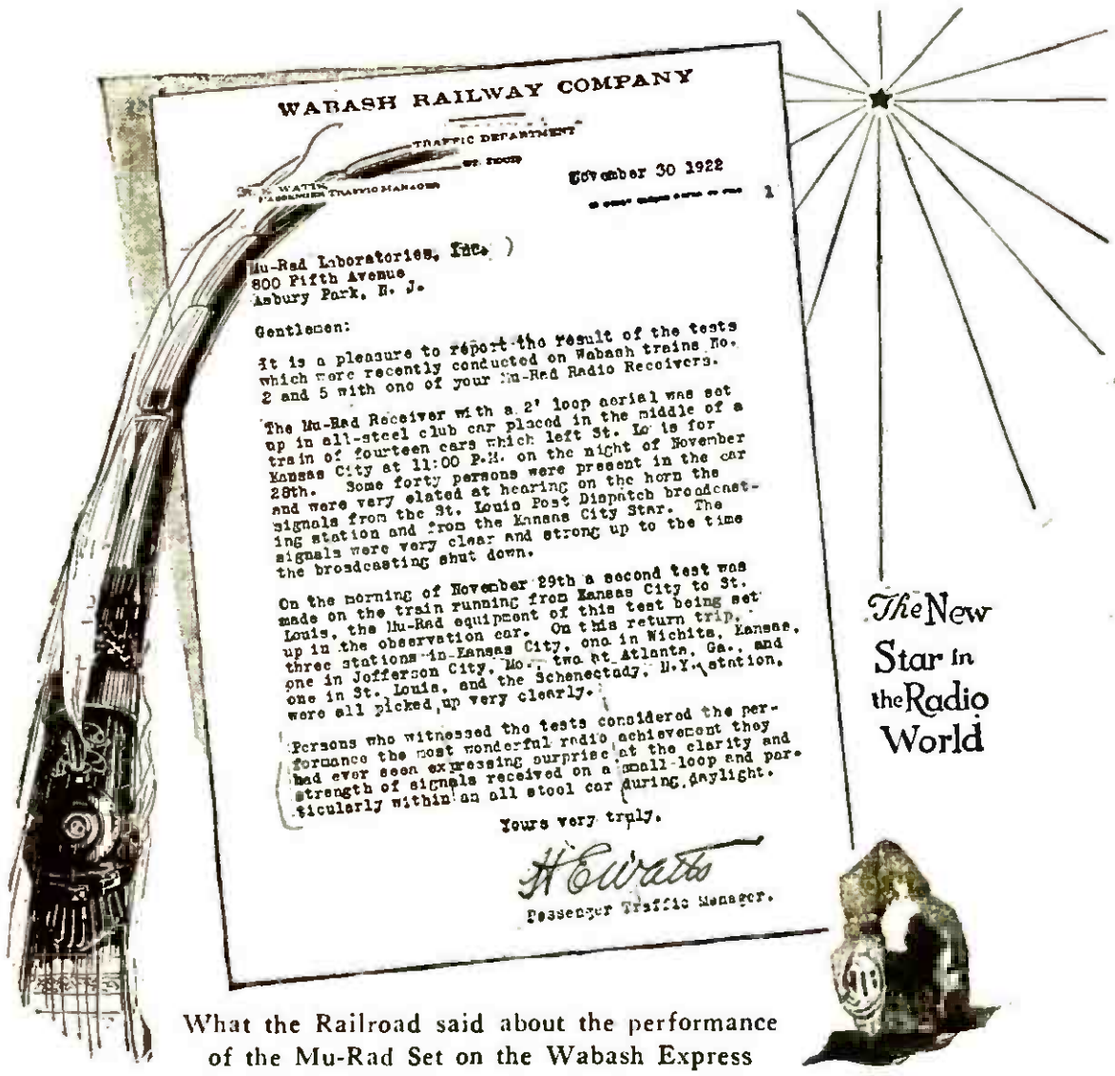
The Bel-Canto is the ideal loud speaker for the home. It comes completely equipped—including extra-sensitive reproducing phone, hard-rubber plug, and ample cord.



Patents Applied For

BEL-CANTO CORPORATION, 417 EAST 34th STREET, NEW YORK

Jobbers and dealers write for proposition



The New Star in the Radio World

What the Railroad said about the performance of the Mu-Rad Set on the Wabash Express

MU-RAD

Radio Frequency Amplification

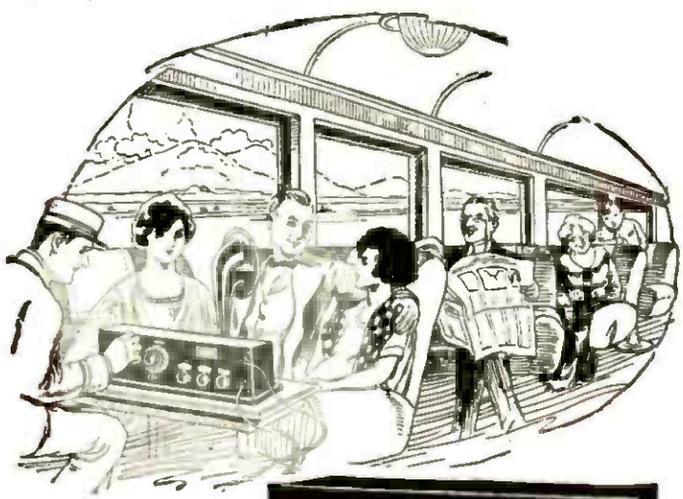
Triumphs in Test on Express Train

"They copied all they could copy,
But they could not copy our mind;
We left them tearing and swearing
A thousand miles behind."
—Kipling.

THE entire radio world is agog at this latest supreme achievement—the reception of radio programs inside a steel car, with no outside aerial or ground, moving at express speed—the severest test ever given any receiving apparatus.

A striking demonstration of the great *sensitivity*, extremely *accurate selectivity* and absolute *simplicity of operation* of Mu-Rad Receivers.

The difference between Mu-Rad and other apparatus is great enough to be worth your while insisting on Mu-Rad Receivers. Guaranteed reception of 1000 miles.



Type MA 12
3 stages R.F. and detector, price, $128.

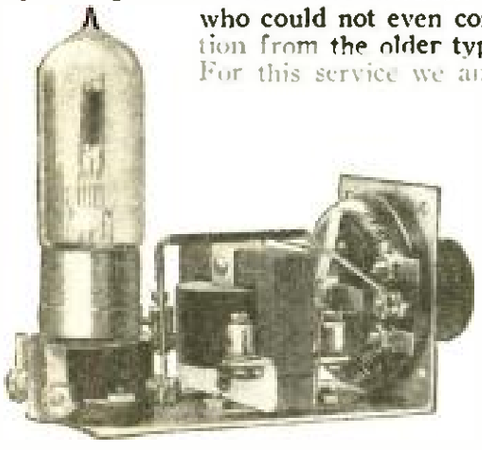
Type MA 13
3 stages R.F., and detector and 2 stages A.F., $160.

DEALERS, write for interesting proposition!

Mu-Rad Laboratories, Inc.
809 Fifth Ave., Asbury Park, N. J.

NO MORE STORAGE BATTERIES

The new WD-11 vacuum tubes requiring but a single dry cell to heat the filament have opened up a whole new field in radio. Sets are now brought within the reach of vast numbers who could not even consider them before. These new tubes differ in construction from the older types of tubes and require different associated instruments. For this service we announce the following:



TYPE 300-A AMPLIFIER UNIT

A compact unit consisting of our Type 231-A Amplifying Transformer, Type 225, Filament Rheostat and Type 282 WD-11 Tube Socket mounted on a nickel finished brass mounting. These parts are all wired ready for the external connections. The mounting is so designed that the unit may be used on a table or mounted behind a panel with only the rheostat knob projecting.

Price $7.50

TYPE 282 WD-11 TUBE SOCKET

A socket of molded bakelite arranged with positive contact springs to take the WD-11 tubes. This is a socket in itself, not an adapter.

Price . . . . . 80 Cents

TYPE 255 RHEOSTAT

A rheostat of molded bakelite, not a substitute, for panel or table mounting, smooth in operation and attractive in appearance. Resistance 6 ohms, with current carrying capacity of 1.25 amperes.

Price $1.00

TYPE 247 CONDENSERS

These already popular condensers may now be equipped with gear and pinion providing a vernier adjustment with but a single setting. A low loss condenser with a micrometer adjustment at a fair price. Used in large quantities by such representative organizations as the Western Electric Company. Made in eight types.

Prices . . . $3.25 to $7.75

TYPE 231-A AMPLIFYING TRANSFORMER

Remember that this transformer is particularly suited to the WD-11 tubes.

Price $5.00

Send for NEW FREE RADIO BULLETIN 913-U and learn about these instruments

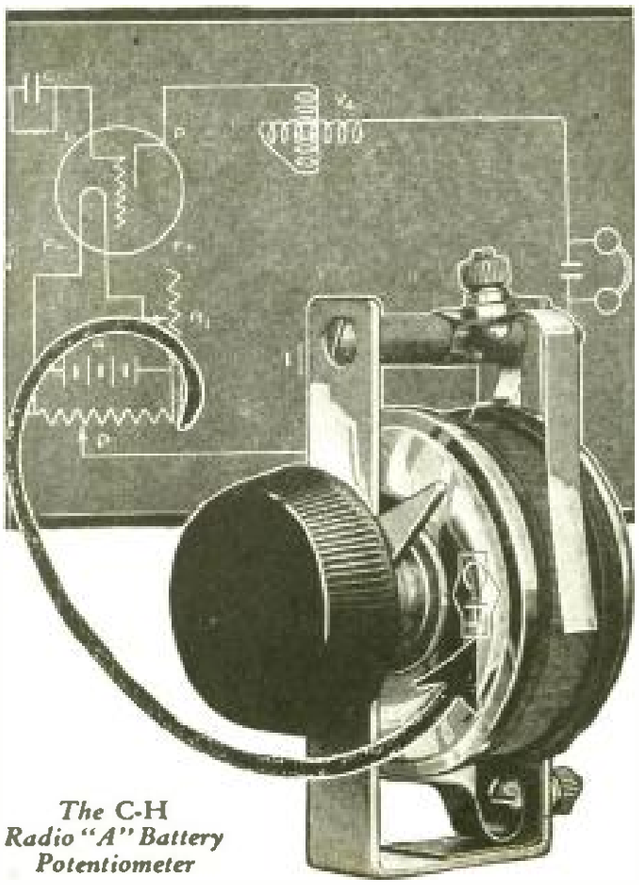
GENERAL RADIO COMPANY

MASSACHUSETTS AVENUE AND WINDSOR STREET

CAMBRIDGE 39 MASSACHUSETTS

Do not confuse the products of the GENERAL RADIO CO. with those of other concerns using the words "General Radio." The General Radio Co. has been manufacturing radio and scientific, instruments for many years. It has no affiliation with any other company.

Standardize on General Radio Equipment Throughout



The C-H Radio "A" Battery Potentiometer

Another Opportunity to Demand C-H Protection

The C-H trade mark has made its place in the history of radio. More than a quarter million rheostats engraved with this mark of the master builder of rheostatic control apparatus are today giving satisfaction to an army of enthusiasts.

The new "A" Battery Potentiometer gives the same assurance of satisfaction in any equally vital part of your receiving circuit—the same assurance that has for more than thirty years made engineers the world over demand the C-H trade mark for protection.

This new potentiometer matches exactly the C-H Radio Rheostats in both appearance and performance. It is of the revolving drum type with a total resistance of 300 ohms. It is designed for panel mounting and finished in satin nickel and ebony black. A comfortable knob of genuine Thermoplax and a highly nickeled pointer provide easy and positive control.

To be certain of results demand the C-H trade mark—it is your guarantee of satisfaction.

THE CUTLER-HAMMER MFG. CO.

Member Radio Section, Associated Manufacturers of Electrical Supplies

MILWAUKEE - WISCONSIN

Over a Quarter Million C-H Radio Rheostats Now in Use

C-H RADIO "A" BATTERY **POTENTIOMETER**

Loud Speaker $1

$1

Adapter

Hear all broad-casting 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 Baldwin or Brandes type head-set and attaches to tone-arm of ANY phonograph. Made of soft, pure gum rubber. Quickly attached and removed. Thousands in use. Absolutely no voice distortion. For single receiver..... .75

For pair of receivers (more than twice the volume) $1

Amplitone Loud Speaker

An inexpensive, loud speaking horn especially adapted for home use. Ample volume. Quality tones. Throat of horn consists of successive sound expansion chambers. Each chamber amplifies previous one. Furnished either with single or double B-R Phonadapter. Price only..... $8

Bell Horn

A Bell Horn with ball swivel. Turns up, down, to side—any angle desired. Automatic adjustment. Very simple. No screws, thumb nuts, etc. Black finish. Complete, with phone, ready to attach to two stage amplifier..... $15

The Beckley-Ralston Co.
1825 So. Michigan Ave.
Chicago, Ill.

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 dealer.

Both Selling Fast Because the Price is Right!

Variocoupler $3.00

Variometer $4.00

Set of Three

2 Variometers $8.00
1 Variocoupler $3.00
~~$11.00~~

a "Chi-Rad" *Special* $10.00

Send Your Order in To-day

OUR NAME PROTECTS YOU

CHICAGO RADIO APPARATUS Co.

415 So. Dearborn Chicago.

If you had a dozen ears

You would need them all to hear what you get nowadays with a single circuit receiver.

With several hundred powerful broadcasting stations, all operating on one narrow wave band, it takes real selectivity and sensitivity to get a satisfactory radio programme.

The Paragon three-circuit receiver gives you any station you want when you want it — and no other. Clear, complete programmes without interruption or disturbance. A modern, high-grade, scientific instrument built right to give results.

Ask some experienced amateur what he knows about

PARAGON

Reg. U. S. Pat. Off.

RADIO PRODUCTS

The amateur will tell you that the Paragon three-circuit receiver, because of its greatly superior selectivity and sensitivity, can pick and choose between broadcasting stations of about the same signal strength with less than one per cent differential.

This means that with a Paragon receiver you get what you want when you want it—complete messages and clear music from the station you tune in on, without interruption and jamming. Until you have listened in with a Paragon three-circuit receiver, you cannot guess the real pleasure and fascination of radio.

Long before broadcasting popularized radio with the general public, Paragon equipment was the choice of the experienced amateur. He will tell you today that if you want quality and satisfaction, Paragon Radio Products are the best and safest buy on the market.

An illustrated Catalog of Paragon Radio Products Is Yours For the Asking

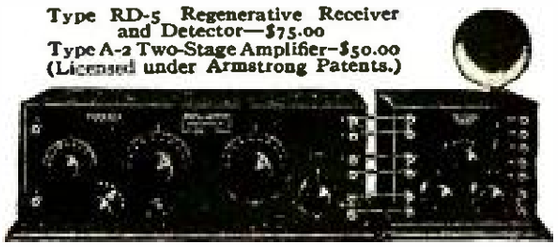
DEALERS—The Adams-Morgan Company has an interesting proposition to make to reputable radio dealers who believe in quality merchandise. Details on request.

ADAMS-MORGAN COMPANY
20 Alvin Ave., Upper Montclair, N. J.

Also Manufacturers of PARAGON

Radio Telephone Transmitters	Amplifier Transformers
V. T. Control Units	Control Dials
Rheostats	Amplifiers
Potentiometers	Receivers
V. T. Sockets	Switches
Detectors	Variometers

Type RD-5 Regenerative Receiver and Detector—$75.00
Type A-2 Two-Stage Amplifier—$50.00
(Licensed under Armstrong Patents.)



Radio Catalogue FREE

One copy of this complete Catalogue of Radio Outfits, parts, Dictionary of Radio Terms, Instruction Book, and Guide to Successful Radio Work—one copy is yours Free.

Simply write us a post card and we will mail the complete book to you Free, by return mail.

It quotes the lowest prices, amazingly low prices on everything for the expert and the amateur. Every improved part, the most up-to-date outfits, everything that is needed of the most modern type—at the lowest possible prices.

It gives a list of broadcasting stations, and gives much information about radio construction and operation. Every one interested in Radio needs this complete catalogue and book of instruction.

Why Pay Higher Prices?

Montgomery Ward & Co. has for fifty years dealt on a Money-Back basis, absolutely guaranteeing everything they sell. With quality absolutely assured, why pay higher prices elsewhere? Write today for this Free Radio Book and see for yourself the Saving it will bring you.

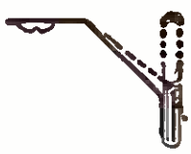
One copy is yours Free. You need only write us a post card.

Write to the house nearest you.
ADDRESS DEPARTMENT 38-R

Chicago Kansas City St. Paul
Fort Worth Portland, Ore.

Montgomery Ward & Co.

The Oldest Mail Order House is Today the Most Progressive



It's the contact that counts

The special phosphor bronze clips of the Na-ald W. D. 11 Socket maintain perfect contact regardless of any variation in tube prongs and bases.

Moulded from genuine Condensite, these sockets are made for use with the famous W. D. 11 tubes, operated by a single cell battery.

The Na-ald De Luxe V. T. Socket is of highest quality throughout. Its laminated phosphor bronze strips press firmly with a side wipe action on the contact pins, keeping surface clean and insuring perfect contact.

These sockets retail at 75c each

ALDEN-NAPIER CO.
Dept. C 52 Willow Street
Springfield, Mass.

NA-ALD

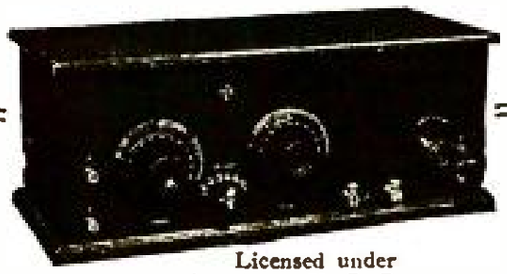
Have we received your order for the 1923 Ace Radio Broadcast Receiver?

If not, you still have an opportunity to get immediate delivery if you place your order NOW!

Let us send you our booklet, "Radio in your home."

Address Dept. XM

THE PRECISION EQUIPMENT CO.
2437 Gilbert Avenue Cincinnati, Ohio



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

BRILLIANTONE RADIO PRODUCTS

Dept. C—874 Columbus Ave., New York

$1.00 Brings any one of these Combinations quickly to you

No. 1
100 Feet No. 14 hard-drawn antenna wire.
4 Porcelain insulators.
1 Solid copper approved ground clamp.
1 Single-pole, double-throw approved lighting switch.
20 Feet No. 14 weatherproof insulated lead-in wire.

No. 2
1 Wound Enameled wire coil, 8 inches long, 3½" Diam.
2 Brass rods, 9 inches long, with evenly drilled holes.
2 Brass sliders to fit the above rods.
4 Nickel-plated brass binding posts.

No. 3
2 60-cent switches (1½-inch lever).
20 Nickel-plated brass contact points with nuts.
4 Nickel-plated brass stops with nuts.
4 Nickel-plated brass binding posts.
1 Detector stand unmounted includes: Adjustable cup, adjustable cat-whisker (any position), 2 extra binding posts, 2 connections from cup and detector to binding posts.
1 Drilled fiber base for mounting same.

No. 4
1 Nest of 4 radio tubes, 8 inches long by 3, 3½, 4, 4½ inches in diameter.
1 Spool No. 24 cotton covered wire, 375 feet.
1 Hardwood Rotor.
All the above merchandise guaranteed or money refunded.

CUT HERE

Please Check Before Items Desired—Fillin Coupon and Mail

A FEW OF OUR SPECIALS

B. R. P. PRODUCTS

☐	B.R.P. Rheostats, fibre base (Tapered Type)	$ .50
☐	B.R.P. Rheostats, porcelain base	.75
☐	B.R.P. Potentiometer (200 ohms)	1.00
☐	B.R.P. Moulded Sockets (unbreakable)	1.00
☐	B.R.P. Audio Frequency Transformers (11 to 1)	4.00
☐	B.R.P. Radio Frequency Transformers (150 to 500 M.)	3.00
☐	B.R.P. Variometer (to 800 meters)	3.00
☐	B.R.P. Variocouplers (Panel and Laboratory Type in one)	3.50

B. R. P. Variable Condensers Guaranteed Capacity Tested by the Rubican Laboratories, Phila., Pa.

TYPE "A"—MOULDED ENDS

☐	3 Plate, capacity .00005	$1.50
☐	7 Plate, capacity .0001	2.00
☐	11 Plate, capacity .0003	2.50
☐	23 Plate, capacity .0005	3.00
☐	43 Plate, capacity .001	3.50

TYPE "B"—ALUMINUM ENDS

☐	3 Plate, capacity .00005	$1.00
☐	7 Plate, capacity .0001	1.25
☐	11 Plate, capacity .0003	1.50
☐	23 Plate, capacity .0005	1.75
☐	43 Plate, capacity .001	2.25

STANDARD MERCHANDISE AT REDUCED PRICES

☐	$4.50 Thordarson Amp. Transformers (Audio)	$3.00
☐	$7.00 UV712 Audio Frequency Transformers (Radio Corp.)	6.00
☐	$6.50 UV1714 Radio Frequency Transformers (Radio Corp.)	5.50
☐	ZETA Radio Frequency Transformer	3.50
☐	Brandes "Superior" (2200 ohms)	6.75
☐	Murdock (3000 ohms)	5.00
☐	Federal (2200 ohms)	6.50
☐	Klosner Vernier Rheostat	1.00
☐	Bradleystat (Best Vernier)	1.65
☐	Jacks, single, open or closed (Firth)	.35
☐	Jacks, double, closed (Firth)	.50
☐	Plugs, bulldog grip (Firth)	1.00
☐	.002 and .005 Mica-Bakelite Condensers	.25
☐	.0005 and .00025 Condensers with Var. Leak	.25
☐	.0005 and .001 Fixed Mica-Bakelite Condensers	.20
☐	Flewelling super-regenerative diagram	free

BRILLIANTONE RADIO PRODUCTS
Dept. C, 874 Columbus Avenue, New York

Enclosed find money order for articles ordered. I agree to pay parcel post charges when delivered.

Name .....

Address .....

City .....

BEST

A word I hate to use

ALL of you know what it means. No explanation is necessary and it conveys the idea quickly. Yet, "best" is a word that most ad writers hesitate to use because it has been so often used that it is discounted by readers. Personally, I detest it; yet when I was gathering the data for this advertisement, talking to the men who visioned, planned and are building Kennedy radio equipment, their enthusiasm and sincerity was so catching that they convinced me that Kennedy radio is the best. After investigating their claims as to the best design, the best material, the best workmanship, by talking with radio people outside of the Kennedy Company, I am still convinced that it is the best. Yet, I cannot conscientiously pass my opinion on to you who read this advertisement.

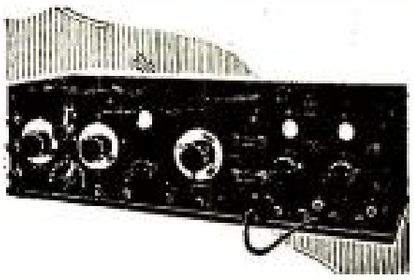
I spent a week at the Chicago Radio Show and was truly surprised at the number of people that came into the Kennedy booth and voluntarily lauded Kennedy radio equipment in terms that I should certainly hesitate to use in talking to you. For instance, one day I came upon a "ham" operator standing in front of a Kennedy 110 Universal Receiver, praising it to himself and fondling it as if it were a jewel. Upon asking him what he thought of it he answered: "This makes my set look sick. I have been in the radio game nine years. Four years ago I was an operator on a Lake steamer. I have built a set of my own and I considered it a wonder. It cost me over $600, much more than a Kennedy outfit, and it's nowheres near so good in either performance or appearance. Kennedy is the best I have ever seen and I have seen a lot of them."

One afternoon a telegrapher, or "brass pounder," as he called himself, came in and after looking over various equipment said: "I have been through every booth at the Show, and have not seen anything to compare with the Kennedy sets. They certainly are the best at the Show."

On that same afternoon a man volunteered the information that while he knew very little about radio, as a shop foreman in the employ of a large electrical manufacturer he was a competent judge of good workmanship. He said: "You people certainly must employ considerable care in your shop methods. This wiring is as good as any I have ever seen anywhere; a whole lot better than that employed by most radio manufacturers. The coils are beauties and I don't think the cabinet work could be improved on. It's the best radio equipment that I ever ran across."

So, while I personally detest the use of the word, I am heading this advertisement "Best," because it is not my opinion I am expressing, and apparently the people whose comments I have quoted have no aversion to the word "best"—at least not when they refer to Kennedy radio equipment.

The Ad Writer



For broadcasting service

Kennedy Type 281 Short-wave Receiving Set. Tuning range, 175 to 620 meters. Highly efficient for receiving from broadcasting and amateur stations. Designed throughout in accordance with the most advanced radio engineering practice. Inductively coupled circuits permit elimination of interference. Solid mahogany cabinet, hand-rubbed finish. An ideal set for home entertainment. Price, including amplifier, $145.

All Kennedy Regenerative Receivers are licensed under Armstrong United States Patent No. 1,113,149.

THE COLIN B. KENNEDY CO.
SAINT LOUIS SAN FRANCISCO

KENNEDY

0120-6

From BARCELONA to TOKIO The MUSIC MASTER Wins Approval

Two-thirds the way around the world radio enthusiasts are learning to appreciate the superiority of the Music Master Radio Amplifier. You ought to see it . . . . Our plan makes both seeing and hearing easy. Any reputable dealer will demonstrate the Music Master in your home.

Send us his name and we will make sure that he has one on hand to show you.

Fourteen-inch aperture (Home Model) **$30**

Twenty-one-inch (Concert, Dancing, etc.) **$35**

Complete ready to attach in place of headphones. No tubes or batteries required.

True tone at last: Music Master Horn Conquers Screech, Snarl and Howl and makes listening a joy.

Jobbers and Dealers

Sample Horn shipped to responsible members of the Radio or Phonograph trade with *full privilege of return.* List-prices and full details on request.

"Geraco" is the brand name

which absolutely guarantees the merit of every Radio product upon which it is placed. Complete data, including prices and literature, on request.

The Geraco Phonograph Attachment makes your Victor or Columbia into an excellent Radio Speaker. No head-sets needed — interchangeable with sound-box **$10**

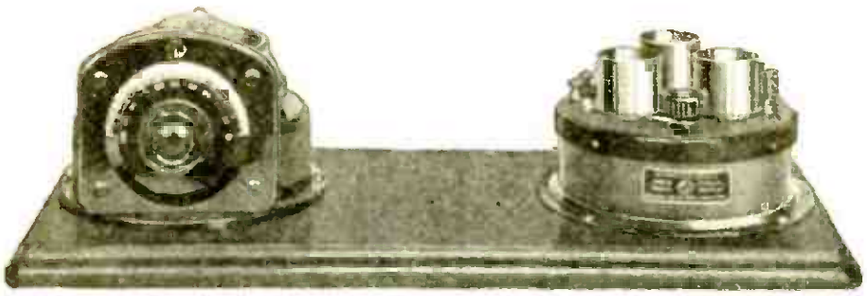
GENERAL RADIO CORPORATION
Makers and Distributors of High Grade Radio Apparatus
624-628 Market Street, Philadelphia

Chicago Pittsburgh

GERACO
PROVEN RADIO PRODUCTS

ATWATER KENT

RADIO RECEIVING SET



THE above set, consisting of Coupled Circuit Tuner and Detector 2-Stage Amplifier, is an ideal set for either phone or loud speaker use. Note that this set includes two stages of audio frequency amplification.

Complete Outfit, as above, wired, $35.50

The Mounted Variometer carries through the standard quality of ATWATER KENT products. For an open set it supplies a finished instrument unsurpassed in appearance and performance.

Mounted Variometer, $10.00

ATWATER KENT MANUFACTURING COMPANY

4933 STENTON AVE. *Radio Dept.* PHILADELPHIA, PA.

PERFECT ELECTRIC CONTROL

RESIST-O-METER

TRADE MARK

With adjustable brackets for mounting.

Diameter 2⅜"
Depth from panel 1⅛"

Perfect Control of the "B" Battery

A RHEOSTAT for finding the exact, correct voltage for the plate of your detector tube. Instead of trying to find the nearest correct plate voltage in 1½-volt jumps, use a type "B" Resist-O-Meter in series with your "B" batteries and you can adjust the "B" battery voltage until your vacuum tube will detect at its absolute maximum efficiency.

The type "B" Resist-O-Meter is a variable resistance, its range being from 50 to 25,000 ohms. To concentrate a variable resistance, which is continuously variable without jumps, in such a small space, is possible only by using the Rojas system of which The Scholes Radio & Manufacturing Corporation are the exclusive licensees.

Further information will be gladly furnished by requesting circular RM.

The Scholes Radio & Manufacturing Corporation holds the sole license to manufacture this type of current control, under patents granted Mr. F. A. Rojas, Nos. 15478 and 1366945, other patents pending. It is sold only under trade name "Resist-O-Meter." Ask your dealer to supply you.

Type A—Filament
Price $1.80

Type B—"B" Battery
Price $2.00

We manufacture the following:

RESIST-O-METERS

Type A—Filament
Type B—"B" Battery
Type C—Potentiometer

TEST-RITE CONDENSERS in the following capacities:

Phone	.001	mfd.
Grid	.00025	"
Grid	.0005	"
Grid Leak	.0005	" 1-meg.

V. T. Sockets
Engraved Binding Posts
Accessories

Write Mr. C. W. Preston

The Scholes Radio & Manufacturing Corporation
32-36 West 18th Street **New York City**

BURGESS
RADIO BATTERIES

Are the accepted standard for radio circuits. Leading manufacturers recommend Burgess Batteries and they are specified by radio engineers. Being designed and built by radio engineers brings a guarantee of satisfactory service to you.

BURGESS "B" BATTERIES

Burgess "B" Batteries can be furnished in several types or styles and in varying capacities. Drop in to your dealer's store today. Select the Burgess "B" best fitted to the requirements of your set and invest confidently, knowing that in the judgment of thousands of users the Burgess is the one best radio battery.

BURGESS No. 6 BATTERIES

Are recommended and have proven highly satisfactory for use in "A" or filament circuits where the 1½ volt vacuum tubes are used.

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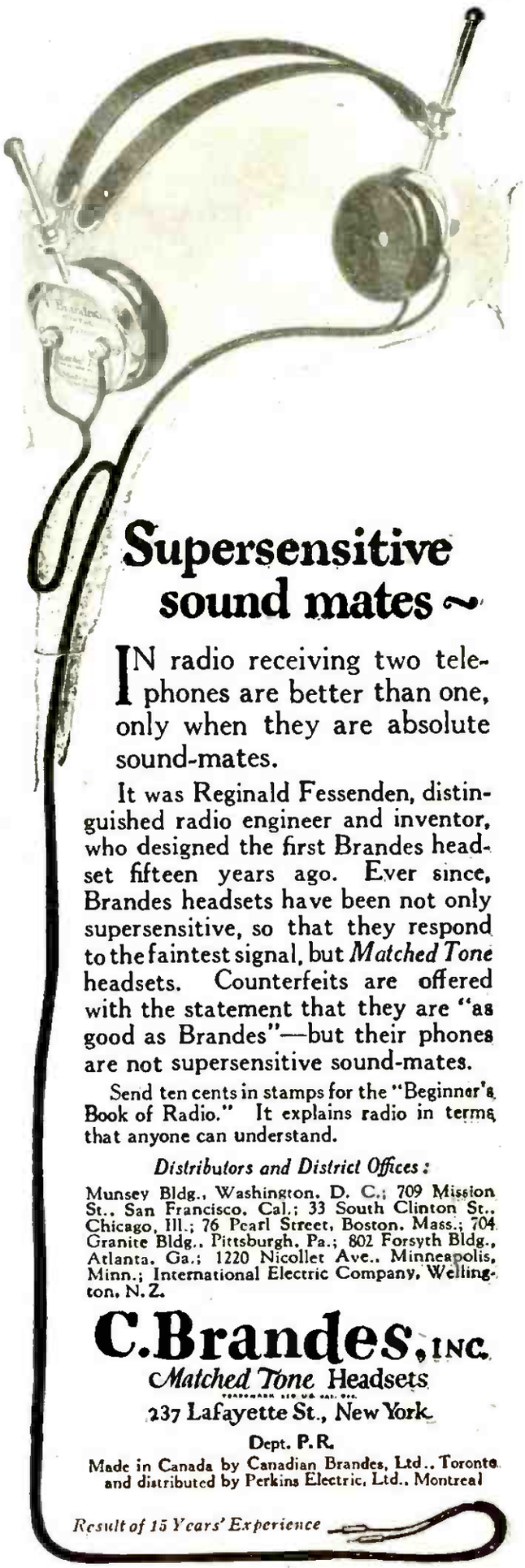
BURGESS
RADIO BATTERIES
"ASK ANY RADIO ENGINEER"



Supersensitive sound mates ~

IN radio receiving two telephones are better than one, only when they are absolute sound-mates.

It was Reginald Fessenden, distinguished radio engineer and inventor, who designed the first Brandes headset fifteen years ago. Ever since, Brandes headsets have been not only supersensitive, so that they respond to the faintest signal, but *Matched Tone* headsets. Counterfeits are offered with the statement that they are "as good as Brandes"—but their phones are not supersensitive sound-mates.

Send ten cents in stamps for the "Beginner's Book of Radio." It explains radio in terms that anyone can understand.

Distributors and District Offices:

Munsey Bldg., Washington, D. C.; 709 Mission St., San Francisco, Cal.; 33 South Clinton St., Chicago, Ill.; 76 Pearl Street, Boston, Mass.; 704 Granite Bldg., Pittsburgh, Pa.; 802 Forsyth Bldg., Atlanta, Ga.; 1220 Nicollet Ave., Minneapolis, Minn.; International Electric Company, Wellington, N. Z.

C. Brandes, INC.
Matched Tone Headsets
237 Lafayette St., New York
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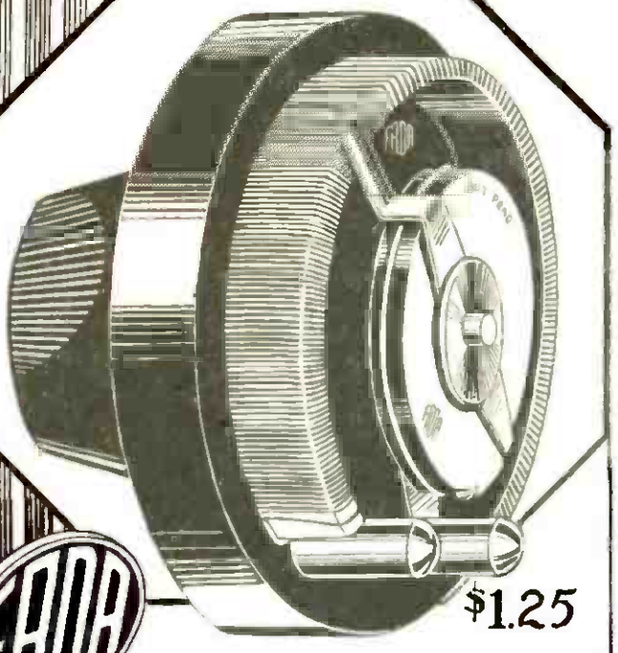
Made in Canada by Canadian Brandes, Ltd., Toronto and distributed by Perkins Electric, Ltd., Montreal

Result of 15 Years' Experience



$1.25

VERNIER RHEOSTAT

A brand new Fada necessity. A vernier arrangement added to regular Fada rheostats. Allows ultra-delicate tube filament current control—brings in long distant signals.

Fada Vernier Attachment, *the biggest little thing in radio*, instantly makes any rheostat with 3/16" shaft into vernier type.

50¢

75¢

Send 10c for Fada Handbook. Plumb full of radio facts.

F. A. D. ANDREA
1581-D Jerome Ave., New York City

FADA VERNIER RHEOSTAT

Etherphonette

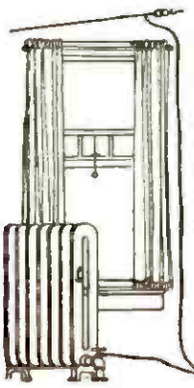
The last word in RADIO

Receiving Set *and* Head Phone *Combined!*

HERE is the most unique "listening in" outfit in the field of Radio. *In the Etherphonette the receiving instrument is built right into the head phone.* No extra equipment is needed. Simply connect to single wire aerial (40 to 75 feet long) inside or outside the home or to lamp socket antenna plug, and ground to radiator, gas or water pipe. Then "tune in."

One shell of the Etherphonette contains a 1500 ohm phone—the other an efficient tuner and concealed crystal detector. Catwhisker, crystal and tuning controlled by outside adjustment knobs. A special eight-foot cord with five foot split ends, and clips for aerial and ground connections, completes the set. Entire Etherphonette is no larger and no heavier than ordinary head phone.

The Etherphonette is not a toy but a practical, scientifically built, radio receiving set. Receives any broadcasting station, sending on 200 to 450 meters, within 18 to 20 miles.



Price $12.50

If your dealer does not have the Etherphonette in stock order direct from us. We will ship complete Etherphonette parcel post, on receipt of check or money order, or C. O. D., if desired. Money back for your Etherphonette, if within ten days, you are not satisfied.

Order today—be the first in your neighborhood to get the unique Etherphonette.

RADIO APPARATUS CO.
Manufacturers of
"Etherphone" Radio Equipment
40 W. Montcalm St., Detroit, Mich.

Kellogg Radio Equipment for Better Results

Easy to Mount—Simple to Operate

Variometer

The stator and rotor are of Kellogg Bakelite, with properly proportioned windings of well insulated copper wire.

Two terminals are provided for the rotor and three for the stator, permitting the variometer to be used in all the known variometer circuits.

Kellogg variometers have no sliding contacts; nothing to wear or "short." A spring takes up all play and allows the rotor to turn with a smooth, even motion.

No. 501.....Each $8.00

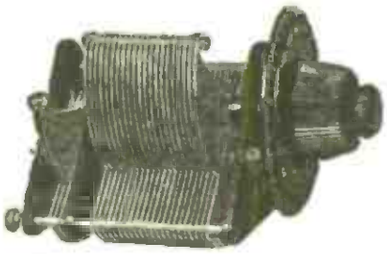
Rheostat

The Kellogg rheostat is of simple design, having but one moving part.

It is so arranged that a maximum contact surface is provided, making perfect contact. To assure perfect current to the most critical tube, the rheostat operates on the half turn of the resistance element.

No. 501.....Each $1.50

Variable Condenser



The Kellogg variable condenser is of the decremeter type and is unusually well built throughout. A customer writes: "It is in a class by itself."

No. 601. 11 plate with 5 plate Vernier Knob and 4 in. Dial Each.....$6.75

No. 602. 11 plate without Vernier. Less Knob and Dial. Each.....$4.50

No. 603. 23 plate with 5 plate Vernier. Knob and 4 in. Dial. Each.....$7.75

No. 604. 23 plate without Vernier. Less Knob and Dial Each.....$5.50

No. 605. 43 plate with 5 plate Vernier. Knob and 4 in. Dial. Each.....$8.75

No. 606. 43 plate without Vernier. Less Knob and Dial. Each.....$6.50

KELLOGG SWITCHBOARD & SUPPLY COMPANY, CHICAGO

Phono-Phane Permanent Radio Detector

The only fixed radio detector requiring no adjustment. Used in place of crystal or vacuum tube detector. Gives excellent quality of sound without distortion. Detects telegraph signals at several thousand miles. Detects broadcasted music more clearly than vacuum tube detector, and requires no amplification where the incoming signal has sufficient strength to actuate the sensitive phones.

Handsome, substantial, suitable for assembly in the finest radio equipment. Guaranteed against imperfection or faulty operation. List, each.. **$3.50**

Ajax Socket Rheostat

A device for which amateurs and professionals have long been waiting. Eliminates wiring between socket and rheostat. List each **$2.00**

Pruden Reliable Radio Specialties

FOR GOOD RESULTS!

THE name "Pruden" back of standard Radio Equipment is a guarantee of mechanical excellence, perfection of workmanship and scientific correctness of design.

Now, more than ever, when the market is flooded with inferior goods, it pays to buy standard trade marked products.

You can pin your faith to "Pruden." Money-back unconditionally if you do not get complete satisfaction.

Just a few leaders of Pruden Reliable Products shown here that will give you better radio results at no greater cost.

Everything sent F. O. B. Jersey City. Send money by registered mail, post office or express money order.

Dealers write today for our interesting proposition

FREDERICK H. PRUDEN Inc.

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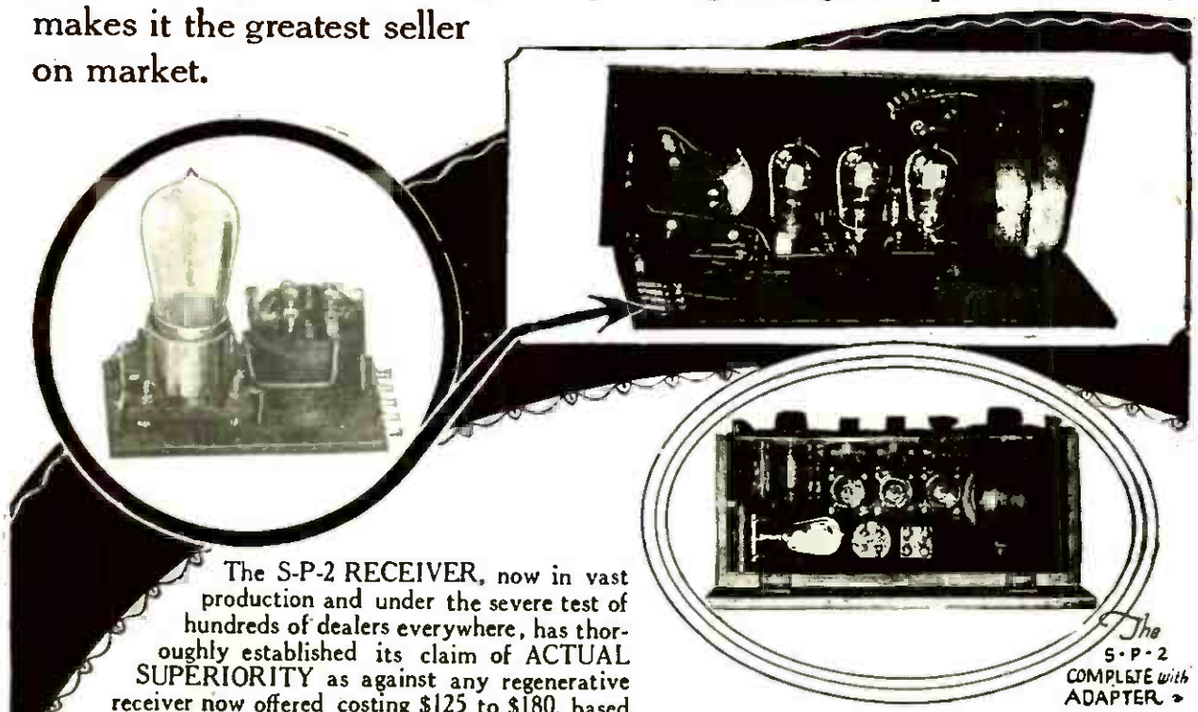
TREMENDOUS DEALER ENTHUSIASM OVER REMARKABLE S-P-2 RECEIVER!

Demonstrated superiority against regenerative receivers, with list price of just $85. Popularity with public, growing in leaps and bounds, makes it the greatest seller on market.



The S-P-2 COMPLETE with ADAPTER

The S-P-2 RECEIVER, now in vast production and under the severe test of hundreds of dealers everywhere, has thoroughly established its claim of ACTUAL SUPERIORITY as against any regenerative receiver now offered costing $125 to $180, based on actual comparisons. THE LIST PRICE OF THE S-P-2 IS BUT $85, WITH AN ADDITIONAL CHARGE OF $15 FOR THE ADAPTER.

The S-P-2 is a complete Receiver of radio-telephone and radio-telegraph signals over a wavelength range of from 180 to 650 meters, using three tubes, viz:: detector, one stage of radio frequency amplification and one stage of audio frequency amplification.

An Adapter representing an additional stage of audio frequency amplification, added to the S-P-2 Receiver AS SIMPLY AS INSERTING A TUBE INTO A SOCKET. Without necessitating the change of a single binding post, wire or batteries or headphones! The S-P-2 Adapter is a basic patent and is thoroughly covered.

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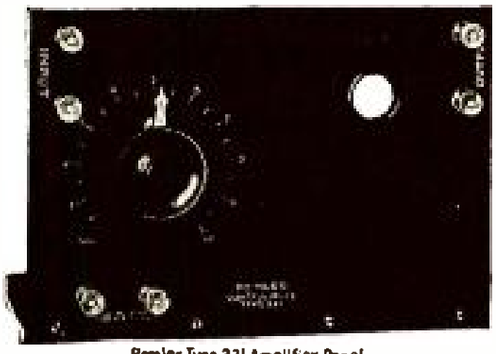
REMLER Cunningham

Remler Type 505 Panel Mounted Vario-Coupler Price $12.00

Remler Type 502 Panel Mounted Variometer Price $10.50

Remler Type 330 Detector Panel Price $8.50

Remler Type 333 Amplifier Panel less transformer Price $9.00



Remler Type 331 Amplifier Panel less transformer Price $6.00

Remler Panels Make An Ideal, Economical Receiving Set

In placing these panels on the market Remler has put a high quality receiving set within the financial reach of everyone.

When designing these Remler panel-units, Remler engineers combined every point necessary for efficiency in receiving, together with special features of construction for the convenience of the user. No process of manufacturing that would make these panels efficient in operation, beautiful and uniform in appearance has been neglected. Each panel is a complete unit mounted on a hardwood base for table use but so designed that any number of panels may be easily mounted in a single cabinet.

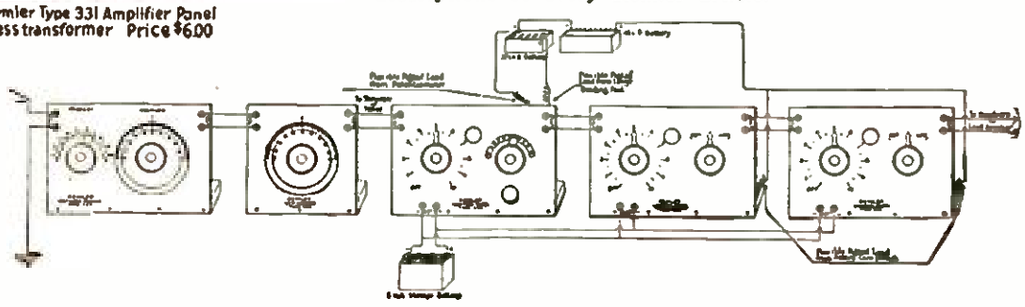
Remler standard parts are used exclusively in their assembly—hence it is possible, by using combinations of Remler panel units, to obtain a complete receiving set, using the same circuit employed in the most expensive receiving set on the market, at only a fraction of the cost.

You can Start with only three panels:

A complete and efficient receiving set for local work is obtained by connecting together Remler panels types 505-502 and 330. For long distance receptions other panels may be added one at a time to suit the convenience of the owner until the most complete and efficient circuit possible is obtained. The cost is nominal.

The diagram below shows five Remler panels connected to form a complete inductively coupled receiving set and two-stage Amplifier.

Send 10c for new Remler 40-page catalog giving prices and complete descriptions of every Remler article.

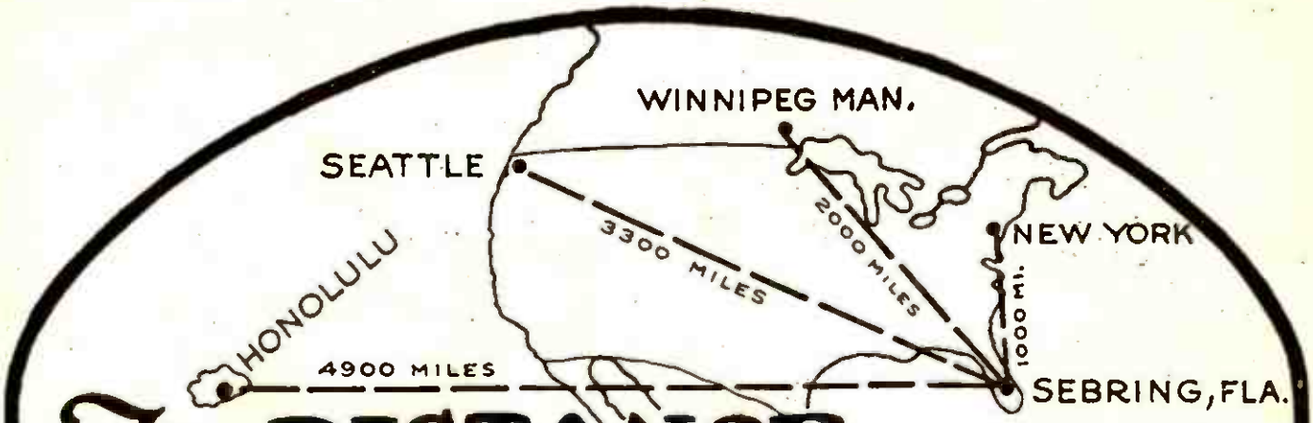


The Remler Technical Bureau is at your Service. Address your problems to Dept. O

REMLER RADIO MFG. COMPANY

Factory and Home Office
248 FIRST STREET, San Francisco, California

Eastern Sales Office
154 W. LAKE STREET, Chicago, Illinois



For DISTANCE HERE is a RECORD

"Crosley Manufacturing Company,
Cincinnati, Ohio.
Gentlemen:

After a thorough trial, and observation of other radio receiving instruments, I wish to state that the Crosley Model X is giving better results than anything else I have ever tried, not only in Sebring, but in Tampa and Jacksonville as well. We are receiving from all the standard stations, North, East and West, with the exception of the New England states, New York city being the farthest we have received in that direction. But we have received from a station announcing itself as Winnipeg, Canada, letters not plain, another from Seattle, Washington, and one night we received three selections and two announcements from KDYX, at Honolulu, Hawaii.

Very truly yours,
SEBRING GARAGE,
Sebring, Florida."

The Crosley Model X Radio Receiver, pictured below, is a four tube outfit, consisting of tuner, one stage of Crosley tuned radio frequency amplification, (the feature that has made this set so popular), detector and two stages of audio frequency amplification. This is a beautiful mahogany cabinet. It will bring in distant stations loud and clear. An Ohio woman recently heard Hawaii and a Pittsburg owner has heard Mexico City.

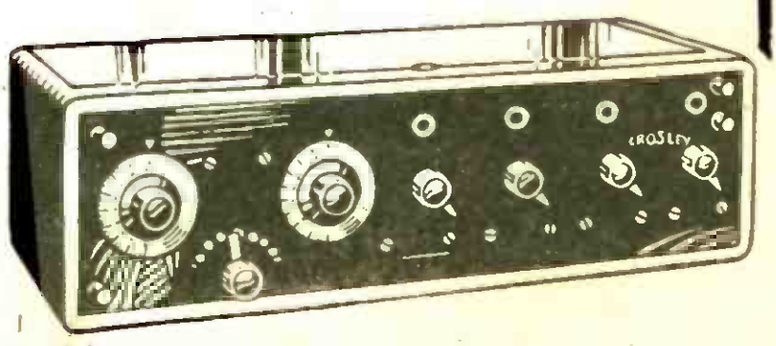
Price, Without Tubes, Batteries or Phones—$55.00

This Crosley Model X, a four tube set for $55.00, illustrates the value of Crosley receiving outfits, which range from $25 to $150.

Send for catalog

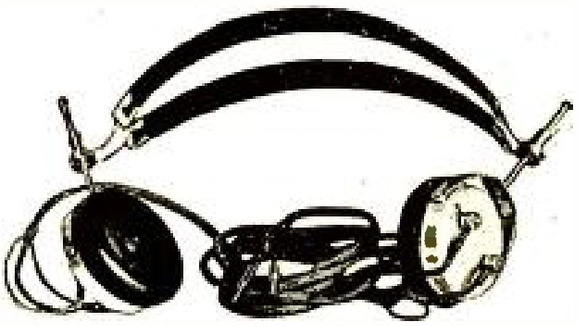
Crosley Manufacturing Company

216 Alfred Street
CINCINNATI OHIO



Teleradio

SUPER SENSITIVE PHONES



Growing Popularity—Increasing sales prove it is the ***performance*** of Teleradio phones that really counts. "Correctly Balanced"—manufactured on a scale consistent with good workmanship. Type C 2000 ohms, **$6.50.** Type B 2200 ohms, **$7.50.** Type A 3000 ohms, **$9.00.** Write for our trial offer and convince yourself.

FILAMENT PROTECTOR

List Price 60c.

Here is the **cheapest** vacuum tube insurance you can buy.

The Teleradio Tube Protector complete sells for 60c and extra fuses for 10c apiece. Not much to pay when you figure that each time you blow out a 10c fuse you save the price of a $5 or $6 tube.

TUBE SOCKET

List Price 60c.

A well-constructed, durable socket. Shell made of drawn aluminum. Hygrade insulated base. Legs not current carrying. Contacts made of phosphor bronze. All parts nickel-plated.

APPROVED LIGHTNING ARRESTOR

List Price $1.00

Approved by National Board of Fire Underwriters.

Electrical No. 5837

The only approved arrestor that retails at $1. Build it into your set.

OTHER TELERADIO PRODUCTS

Rheostats, $1.00. Variable Condensers—3, 11, 23 and 43 Plates. $1.50, $2.50, $3.00 and $4.00, respectively. Fixed Phone and Grid Condensers and Grid Leak Condensers.

If your dealer has not yet stocked Teleradio Products, order direct and mention your dealer's name. Dealers: Ask us about our "Dealer's Stock Order" proposition.

TELERADIO ENGINEERING CORPORATION

484-490 BROOME STREET, NEW YORK

CHARLES FRANCIS PRESS, NEW YORK

AMPLIFIES AS IT DETECTS

Cunningham tubes

Give Clearest Reception

Cunningham Tubes used in any standard receiving set will enable you and your friends to listen to news reports at breakfast, stock market quotations at lunch, and in the evening sit in your comfortable living-room by the fireside and enjoy the finest music and entertainment of the day.

Send 5c for new 32-page Cunningham Tube catalog, containing detailed instruction for the operation of Cunningham Tubes as well as numerous circuit diagrams and graphic illustrations of tube action.

The Cunningham Technical Bureau is at your Service. Address your problems to Dept. O

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San Francisco, Calif.

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Eastern Representatives:
154 West Lake St.
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Patent Notice

Cunningham tubes are covered by patents dated 11-7-05. 1-15-07, 2-18-08 and others issued and pending. Licensed only for amateur or experimental uses in radio communication. Any other use will be an infringement.

TYPE C-300
Super-Sensitive
DETECTOR
$5.00

TYPE C-301
Distortionless
AMPLIFIER
$6.50

The trade mark GE is the guarantee of these quality tubes. Each tube is built to most rigid specifications.