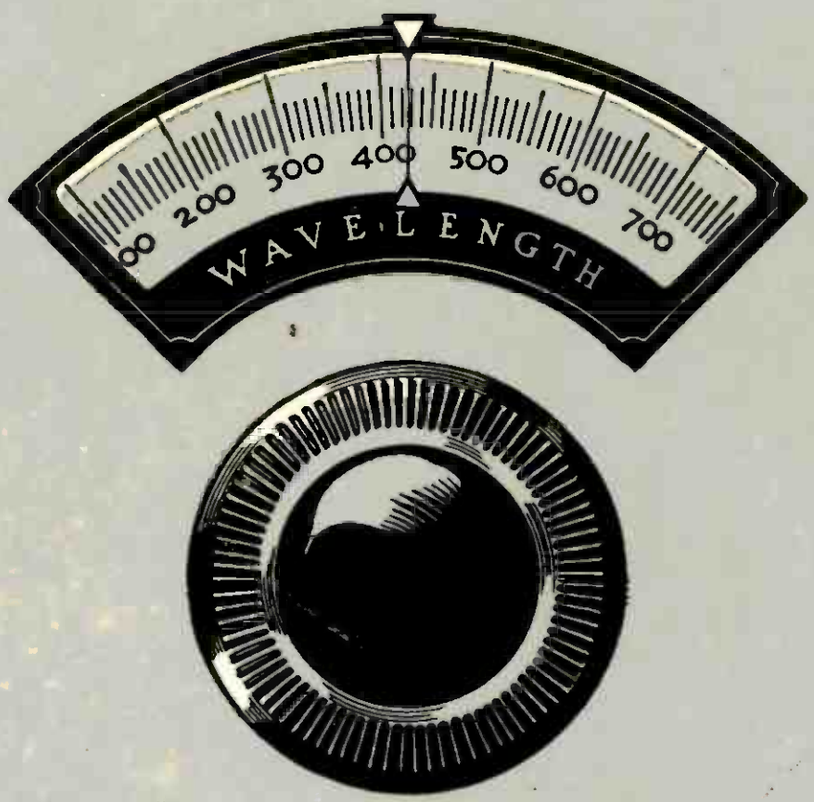
Popular Radio

25¢

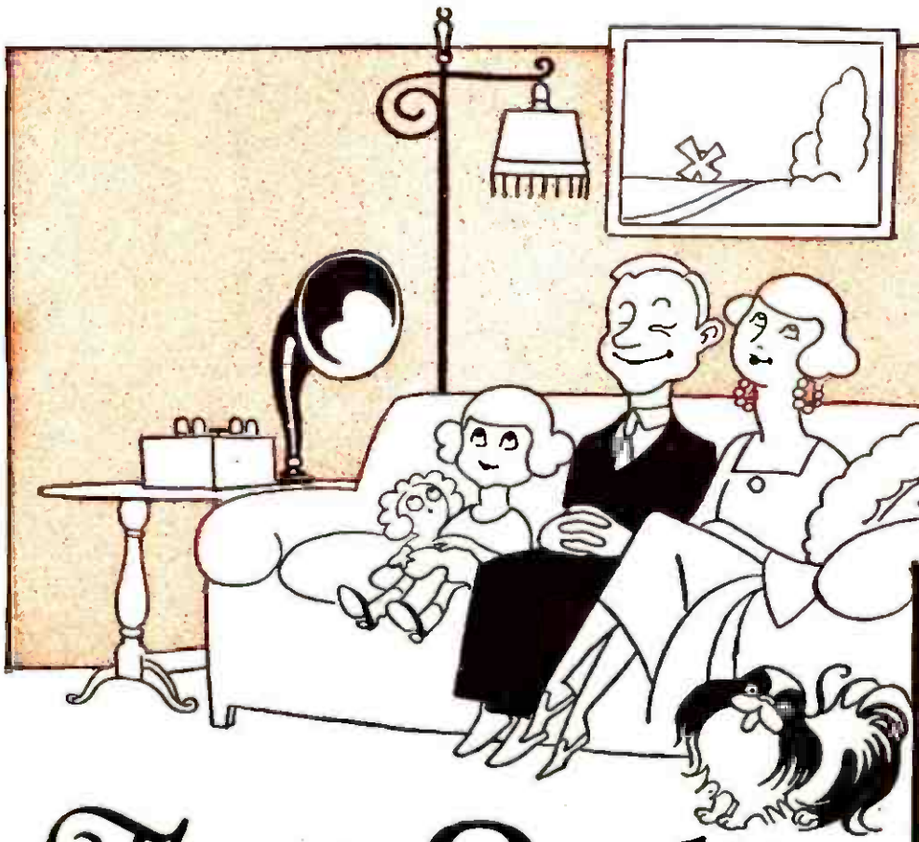
Edited by KENDALL BANNING

★ APRIL 1925

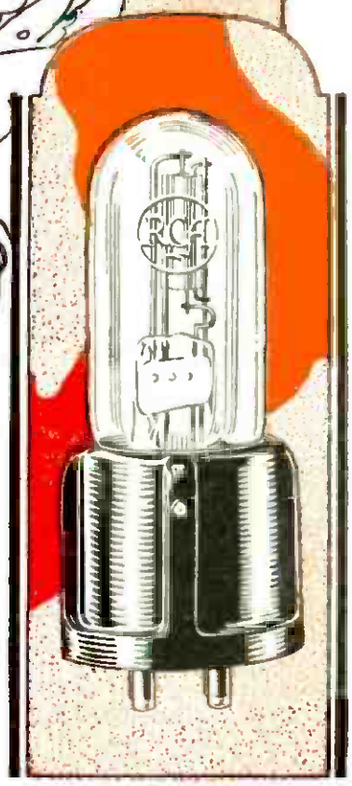


In this Issue—

SINGLE-CONTROL RECEIVERS



There's Quality *in everything*



IN everything from a binding post to a vacuum tube, there is quality. But quality counts most in the vacuum tube. A radio set can be built for distance, for clear tone, for volume. But to get the best out of any hookup —you want to fit it with genuine Radiotrons.

No matter what type of set you have—or what type of circuit you are buying tubes for — ask for Radiotrons by name — and make sure you get the genuine by looking on the tube for the word Radiotron and the RCA mark. Quality counts!

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This symbol of quality is your protection

POPULAR RADIO

EDITED *by* KENDALL BANNING

CONTENTS *for* APRIL, 1925

(Cover design by Frank B. Masters)

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LAURENCE M. COCKADAY, *Technical Editor*

E. E. FREE, Ph.D., *Contributing Editor* — JOHN V. L. HOGAN, *Contributing Editor*

The GREBE SYNCHROPHASE

TRADE MARK

It is written:

"If there be no faith in our words, of what use are they?"

It is easy to prove the claims made for the Synchrophase.

IF you have once operated a Synchrophase you will not be satisfied with any other type of receiver, because Grebe exclusive and fundamental features provide reception that is unsurpassed.

Binocular Coils, which keep the set balanced against local interference, provide greater selectivity and sensitivity.

S-L-F (straight line frequency) ***Condensers*** make tuning-in quick, easy and positive. All stations are spaced at equal intervals around the dials; short-wave stations are not crowded onto the lower numbers.

Grebe Volume Control gives six gradations of sound without reducing tube current; thus maintaining the true character and shading of every note.

Unlike sets made up of assembled parts, where the assembler has no control over their design and quality, every detail of the Synchrophase is designed and built in the Grebe factory so that all parts coordinate perfectly. This makes possible the unsurpassed performance of the Synchrophase.

This excellence extends also to the Synchrophase cabinet. It is beautifully designed and built of solid mahogany, highly polished and with delicately embossed gold escutcheons.

Compare all sets before you buy, but be sure to have the Synchrophase demonstrated by your dealer.

Ask your dealer or write us for full information

A. H. Grebe & Co., Inc.

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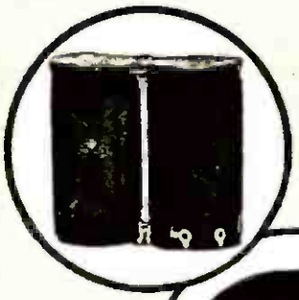
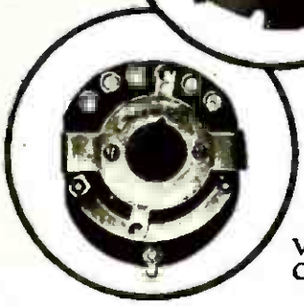
This company owns and operates station WAHG

No other receiver has these features:



Binocular Coils

S-L-F Condensers



Volume Control

All Grebe apparatus is covered by patents granted and pending.

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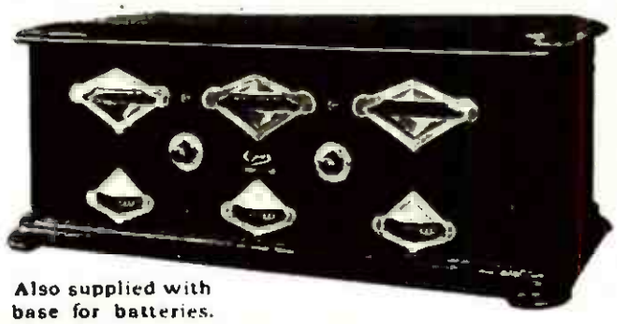


Also supplied with base for batteries.

PAGES WITH THE EDITOR

WITH the next issue—May—POPULAR RADIO celebrates its third birthday with an Anniversary Number.

* * *

A NEW and significant invention that promises relief to those afflicted with deafness (and which incidentally may lead to developments of far-reaching importance in the equipment of auditoriums, theaters, churches, and other public meeting places) is announced for the first time on page 311 of this issue of POPULAR RADIO.

* * *

THE fact that this invention involves the use of apparatus that has been developed by radio brings this remarkable device within the scope of this magazine. Besides it furnishes further evidence of the tremendous influence that radio has had and is destined to have in the onward march of civilization.

* * *

"EVERY effort will be brought to bear to assist the medical profession in the study of the application of this invention to deafness," states the scientist-inventor, Dr. Byron Eldred. "Demonstration rooms have been equipped at 331 Madison Avenue, New York, where physicians may come with patients for test and report."

* * *

"ON page 218 there is a picture of a hockey game between the Boston Bruins and Ottawa," writes Mr. N. Longley of Tornoto, Can. "You state that this was the first hockey game to be broadcast by radio. Station CFCA broadcast hockey games at Toronto during the winter of 1922-23. It also broadcast most of the games played by the Toronto Granites, the Canadian Olympic Team in 1923-24, before they went to France to compete in the Oympic games. On several occasions they relayed the game from Hamilton, forty miles away, by telephone and broadcast it from Toronto. I listened to most of these games myself."

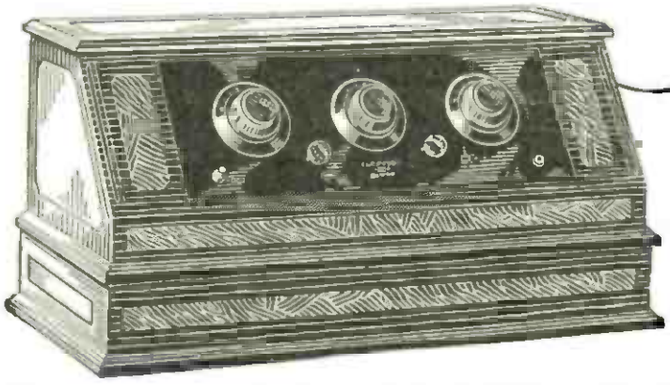
(*Continued on page* 6)

WHERE *POPULAR RADIO* TESTS READY-MADE SETS

The technical staff of the POPULAR RADIO LABORATORY—*(a corner of which is shown in this picture)—have for several months been experimenting with the ready-made receivers that are now on the market, with the specific purpose of finding out just how the owners can get the maximum efficiency out of them. The results of these investigations are embodied in the series of articles* "HOW TO GET THE MOST OUT OF YOUR READY-MADE RECEIVER," *now running in this magazine. The order in which these sets are selected for attention is determined by the popular demand of our readers themselves. What set would* YOU *like to see described next?*

Thompson Tone--

a quality of naturalness never before attained in radio reception



THE THOMPSON CONCERT GRAND
The Only 6-Tube Neutrodyne

IMAGINE a Radio Receiver so capable as to fill a Concert Hall seating 1,500 people, and the quality of tone so natural as to carry no suggestion of mechanical or electrical reproduction!

The Thompson Concert Grand (Model S-70) is seldom used at full power; yet when the occasion requires, it will fill a Ball Room, Concert Hall, or other large gathering place, with speech or music, and at no sacrifice of tonal quality. In fact it provides a quality of tone never before attained in radio reception.

The reason for the remarkable performance is due to the use of exclusive Thompson audio transformers. Three stages of audio amplification without distortion is a distinct achievement in radio engineering.

Eminent radio authorities have acknowledged the Concert Grand Model as the latest and most important achievement in the development of Home Radio Receiving sets.

The beautiful two-tone mahogany finished cabinet, with sloping panel and special compartment for all dry batteries is an outstanding example of the cabinet maker's art. Equipped for either dry or storage battery operation. The Thompson Concert Grand (Model S-70) is $180 without accessories.

For fifteen years the Armies, Navies and big Commercial Companies of the world have used radio apparatus produced by the Thompson Organization. This experience pre-eminently places it in position to supply the best for Home Radio Purposes.

THOMPSON RADIO NEUTRODYNE

VARIOUS MODELS
$125 to $180
Embodying Exclusive and Important Features
West of Rocky Mountains $130 to $185

On request, an interesting booklet will be forwarded

R. E. THOMPSON MANUFACTURING COMPANY
30 CHURCH STREET, NEW YORK, N. Y.

A creation that reaches the highest pinnacle of TONE REPRODUCTION *the*

THOMPSON SPEAKER

THE Thompson Speaker was designed by famous engineers with wide experience in acoustics and sound reproduction.

It has the most natural tone of any speaker on the market today—and a greater capacity for volume.

An efficient speaker is necessary in combination with a radio receiving set to secure desirable results. Any good receiving set is limited if a first-class speaker is not used.

Many people, unfortunately, not realizing the importance of owning a first-class radio speaker, are sacrificing the richness and sweetness of tone through the use of an inferior speaker, whose only appeal rests in its low price.

The Thompson Speaker has seven unusual features which combine to make tone reproduction beautifully satisfying in its Trueness and Fidelity to every musical pitch and tone.

The Thompson Speaker is the only speaker—within its price range—that can function efficiently on sets using five or more tubes.

Regardless of price o type, a Thompson Speaker will improve the tonal reproduction of your receiving set.

NOW ONLY $28

West of Rocky Mountains $30

PAGES WITH THE EDITOR

(*Continued from page* 4)

DOES the broadcasting of concerts by the big stars of the musical world increase or decrease their value to themselves and to the gramophone manufacturers?

* * *

To answer this problem the Victor Talking Machine Co. made a series of experiments, beginning with radio recitals by artists who are under contract to it. The list included Lucrezia Bori, John McCormack, the Flonzaley Quartet, Mme. Alda and others of equal fame.

* * *

ACCORDING to the newspaper reports and to rumors that circulated up and down Broadway, the experiments ranged from brilliant successes (one rumor stated that 158,000 McCormack records were sold immediately following his recital) to dismal failures. So the Editor went direct to the head of the Victor company to get an authoritative statement. This is his reply:

* * *

"THERE is a strong indication that very largely increased record sales have been made by the trade, particularly of some of the numbers which appeared upon these programs, and there is no doubt but what there will be an ever-increasing demand for certain catalog numbers which may be broadcast in the programs of the future."

* * *

WHICH would seem to prove that the broadcasting of entertainment by the world's great artists is good for the artist, for his manager, for the gramophone people—and for the radio fan, the radio dealer, and the radio manufacturer.

* * *

"I THINK about as much about radio as I do about a new kind of can opener—and that goes for any form of mechanistic science," is the sage pronouncement of Louis Wolheim, an actor, at a recent meeting of the Drama League in New York. "It is a serious question whether any form of mechanistic science has really done much for mankind. Rather have they worked against the spiritual development of mankind."

* * *

MR. WOLHEIM used to be a student at Cornell University, but as that distinguished institution of learning boasts of one of the best courses in electrical engineering in the country, it is more likely that Mr. Wolheim found his conclusions in the purlieus of Broadway than within the classic halls at Ithaca.

* * *

Now that Louis Wolheim has dismissed radio by classifying it with a can opener and William J. Bryan has declared that there is nothing in the theory of evolution and the Rev. Dr. Voliva has proclaimed the world flat, there apparently isn't much left for the scientists to do but pack up and seek jobs where brains are not a requisite.

* * *

IF anyone claims that the "How-to-Build" series of articles in POPULAR RADIO is difficult for a beginner to follow, just show him this letter to Laurence M. Cockaday from Mabon Kingsley of Chicago—particularly the last paragraph!

* * *

"THIS is merely a simple, honest expression of appreciation to you for your article in the January number of POPULAR RADIO, featuring your 8-Tube Superheterodyne Reflex Receiver," he writes.

* * *

"I PURCHASED the parts for this model on January 9th. I soldered the last connection on January 16th, using spare time after a nine-hour working day. Stations came in immediately, and except for adjusting the grid condenser I have done nothing but enjoy the instrument ever since. I have one leg of the 'round-the-continent' excursion to complete, but I have logged Montreal, Boston, New York, Washington, D. C., Atlanta, Havana, San Antonio, Los Angeles and San Francisco regularly through Chicago locals, and need only a good northwestern station to complete the circuit. The intervening territory is quite thoroughly covered.

* * *

"BEFORE building this set, the sum total time I have spent beside a radio would be less than one hour. I never built nor owned another of any description. Not being mechanically inclined, credit goes entirely to you for writing what might be a very complicated article in such an understandable way that a novice could not have trouble. My thanks!"

* * *

LEAVE it to a sergeant in the Regulars to correct a mistake! Serg't. H. F. Hekel, of the 38th Reg't. Infantry, U. S. A. writes: "In your February issue, on page 206, you printed an article by Andrew Sesselmann entitled 'Music from a Weak Battery.' The story was O. K. but the author was a little off on the regiment of which the corporal was a member. The 16th Infantry was not, is not and might never be a regiment composed of colored troops."

* * *

CORRECT you are, sir! Mr. Sesselmann probably had in mind the 15th Infantry of New York, which was, is and presumably always will be a colored outfit—and a good one, too.

* * *

NEXT month is the time to start assembling that portable receiving set for use this spring and summer. And in the coming issue of POPULAR RADIO—for May—will appear a complete "How to Build" description of just such a set developed in the POPULAR RADIO LABORATORY.

Kendall Banning

Editor, POPULAR RADIO

Radio Corp. of America

"An Authoritative Radio Magazine"

I BELIEVE *that* POPULAR RADIO *is doing a splendid job in disseminating timely and authentic information about radio among the American public.*

J. G. Harbord

MAJOR GENERAL, U. S. ARMY (RETIRED)
PRESIDENT, RADIO CORPORATION OF AMERICA

From a photograph made for POPULAR RADIO

A Superheterodyne Receiver With a Single Control

Simplification in tuning multi-tube receivers is now considered so important a development for future receiving apparatus, that this is becoming one of the most important problems now confronting the engineering staffs of the radio manufacturers. One of the pioneers in the work of applying this principle to the superheterodyne, Mr. J. L. McLaughlin, is here shown in his laboratory with the latest model of his single-control superheterodyne. In the background stands another completed model which shows clearly the single knob directly in the middle of the panel.

Popular Radio

VOLUME VII APRIL, 1925 NUMBER 4

HOW A LOUDSPEAKER DEVICE BRINGS

HEARING TO THE DEAF

By BYRON E. ELDRED, D.Sc.

MY work on audition was inaugurated as the result of riding in a closed automobile with a deaf friend to whom I was accustomed to speak in a very loud tone of voice. While riding in the car, he informed me that he could hear a whisper. This was demonstrated to be true; and he informed me further that he considered his hearing practically normal under certain noise conditions. After stopping and starting the car several times in an endeavor to judge of the probable frequency of the air wave vibration that produced this effect, I concluded the effective wave to be one of substantially inaudible frequency, either above or below the limits of normal hearing.

Immediately after this experience laboratory work was undertaken to discover the effective wave and to produce suitable means for its generation.

—THE AUTHOR

WHEN considering the subject of hearing, let us set down this rule to be kept in mind:

The controlling factor in hearing is the amplitude or magnitude of air wave vibration impressed upon the drumskin, or tympanum of the ear.

This rule applies to deaf ears as well as normal. Of course, every rule must have its exception. Many people hear well without eardrums (tympanum) and numerous other exceptions may be justly applied to general statements of this kind.

First I will describe the new method of employing a sensitizing wave for correcting audition.

This sensitizing wave, or air vibration, which has afforded satisfactory results in many cases of deafness, is a sustained air wave of suitable predetermined character and of inaudible frequency, or one approaching the limits of normal hearing.

When such a wave is generated in a room, church or theater, many persons of defective hearing located within this area find their ears responsive to reception of sounds such as are provided for persons of normal hearing. The effect of the wave, while unnoticed by either the deaf persons or others, is to sensitize deaf ears to the reception of sounds which would not otherwise be heard, or which if heard, would be unintelligible, like the confused jumble of distorted radio reception.

The wave is preferably of a low fre-

quency and of suitable amplitude to suit the peculiar case of deafness that is to be relieved; but for applications in churches or theaters a wave of suitable average character is supplied.

When the application of the wave is made to an individual case, the peculiar condition should be carefully studied to obtain the best results. The wave best suited for a particular condition of hearing is determined by experiment and test, and is prescribed as the oculist prescribes lenses for correcting defective vision. The wave generators are then installed at the office or home of the deaf person for use as the special case demands. A remarkable result that is evidenced in some cases is that the relief afforded by the sensitizing wave persists as a "carry-over" effect. Many deaf people leave the presence of the wave in their homes (for shopping expeditions, for example, or to attend a theater) and again reach home before the return of deafness. As a general rule the use of the sensitizing wave is for half-hour periods, and is discontinued until deafness returns.

The "carry-over" phenomenon, while gratifying in the extreme, offers a confusing problem. This odd effect lasted as long as forty-eight hours in one case; in another case a woman who was profoundly deaf, after an hour under the wave influence, traveled by train the entire night and next day reported hearing her baby's voice for the first time.

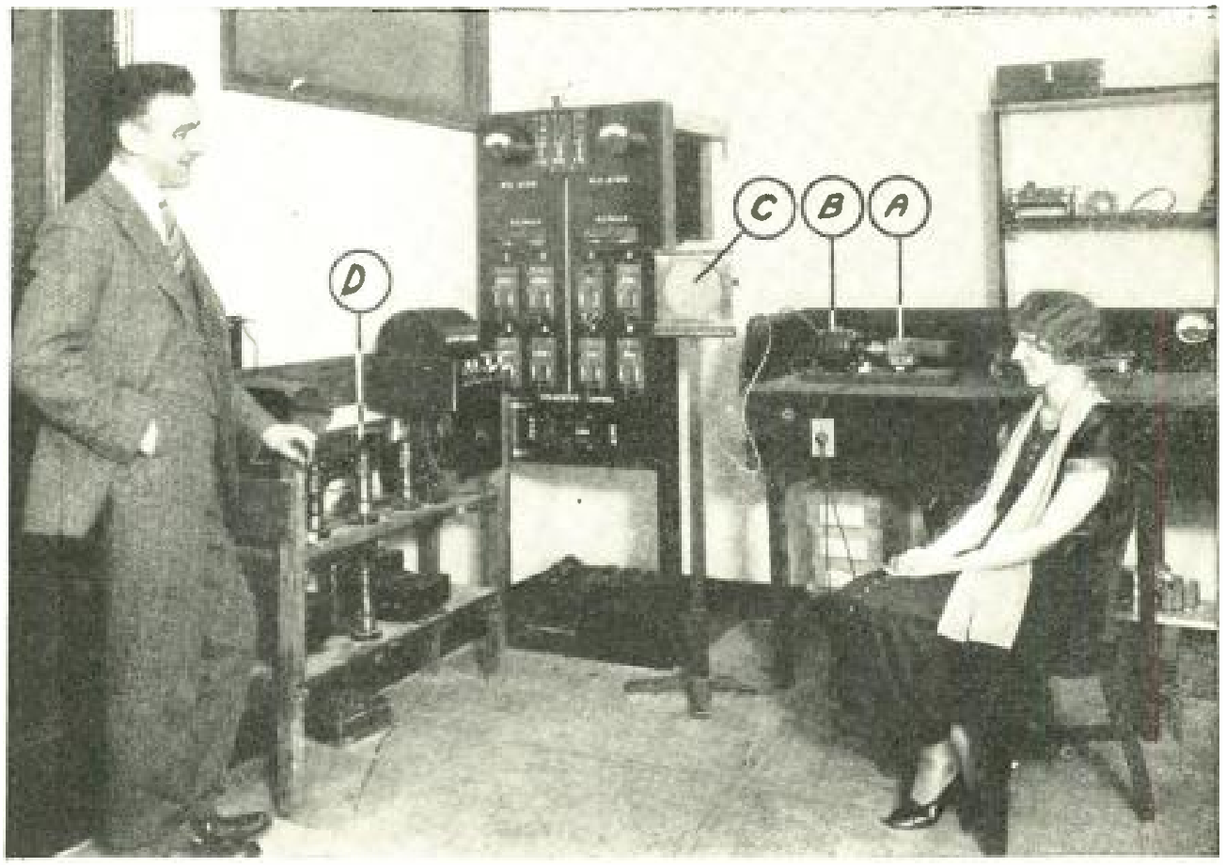
After extended research I was impressed with the fact that each case requires special attention to produce best results. A difficult problem was presented in making accurate tests of defective hearing, because, while it may be perfectly evident to others present, the deaf person hears or does not hear and cannot quite be satisfied that hearing ability is not due to increased magnitude of the voice.

A test that quite convinces the deaf person was fortunately suggested by Prof. Robert W. Wood of Johns Hopkins University, whose hearty co-opera-

From a photograph made for POPULAR RADIO

HOW THE WAVE PRODUCER IS INSTALLED IN AN OFFICE

The business man who is handicapped with imperfect hearing finds himself on equal footing with his interviewers when he has the new "hearing" device installed unobtrusively at his elbow.



From a photograph made for POPULAR RADIO

A DEAF PERSON UNDER "TREATMENT"

FIGURE 1: *The motor B drives the low-frequency alternator A, which generates the currents that actuate the wave-producing device C. D is a vacuum-tube oscillator that can also be used to generate the currents that operate the device C.*

tion has provided many valuable suggestions. We placed two deaf persons before a phonograph that reproduced a spoken record descriptive of an opera. After allowing the subjects to become thoroughly familiar with the record, and to seat themselves in front of the phonograph at distances which they determined as the maximum for distinguishing the words clearly, measurement showed these respective distances as five and a half and six feet.

The chairs were then removed six inches farther and both people reported that no words were intelligible.

This fine distinction of distance for intelligible reception of sound proves a valuable aid and is quite remarkable.

The wave was then turned on and clear reception of sound was immediately experienced by the two deaf subjects of the test. The two persons were then asked to move away from the phonograph to distances at which they could again just distinguish the sounds clearly. The result was that they *moved to the end of the room which was twenty feet long.*

The greater distance at which the subjects demonstrated reception ability shows more than 1,000 percent increased audition for this particular given volume of sound. Such a test affords an accurate measure because sound waves decrease in inverse proportion to the square of the distance.

In Figure 1 is shown some of the earlier apparatus employed, which consisted essentially of a vacuum-tube generator D. This generator was used to produce an electric wave alternation of 5,000 to 35,000 cycles. It was used in connection with a singing arc, later in connection with a special type of loudspeaker for generating the sound wave.

Later, the General Electric Company designed and built the complete apparatus as shown with sides removed in Figure 3. This consists of the whole vacuum-tube oscillator assembly that is mounted on a truck and equipped with a special loudspeaker type of sound wave generator (located on top).

In Figure 2 are shown two more recent developments. The large board set up on the table contains a new wave generator (or loudspeaker) which offers great possibilities for sensitizing waves of both high and low range. In this same photograph is shown the inventor demonstrating the latest unit for generating the sound wave, which also operates on an electromagnetic principle, but which uses a cone-shaped diaphragm for generating the wave proper.

Referring to Figure 1 again, we find the three essential parts of a regular installation for a small room or for an office. This installation consists of A, the driving motor; B, the low-frequency alternator, which generates the currents for energizing the wave-producer C. The motor-generator unit is preferably installed at some remote convenient place.

Experiments with this device have determined to a great extent the effects produced by the sensitizing wave, but there is much yet to be explained. Some cases of deafness respond almost immediately, while others are slowly affected. A few defective auditory organs have been apparently brought to a degree of sensitivity which affords abnormally acute hearing throughout the useful range, whereas other cases which were made apparently sensitive to normal voice speech, were not improved to any measurable degree for the reception of low amplitude sounds.

This is, I believe, a natural effect. The great wonder is that we hear as we do, when one realizes the minute inertia exerted even by a loud voice-wave upon the tympanum, or sound collecting diaphragm of our ears. If the delicate hearing mechanism offers but the slightest resistance, one may readily conceive that the minute force imparted may be largely wasted.

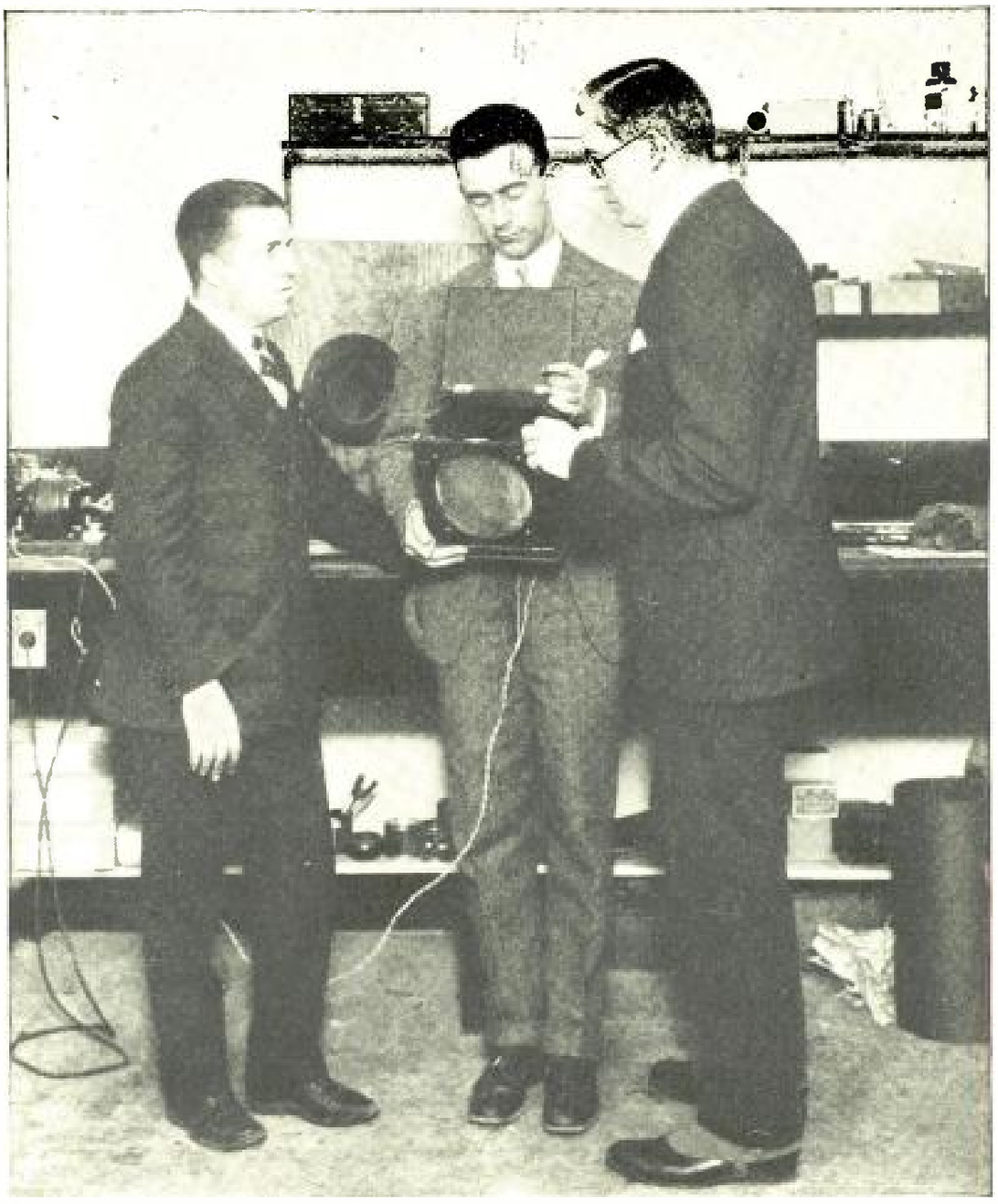
The sensitizing wave should be classed as a corrective means for improving audition. Its effect is to clear up reception and not amplify sound. All former means for improving hearing have embodied the principle of increasing the force of the communication and should be classed as *aids* to audition. Doubtless the first aid, the cupping of the hand held behind the ear, suggesting the ear trumpet, similarly but more effectively concentrates a larger volume of the sound wave to the ear. The telephone doubtless suggested the portable microphones which have afforded such great relief, and will continue to do so.

Many persons who have resorted to the amplifying aids have been so relieved by the sensitizing wave that the wearing of this device became no longer necessary. Other, however, who experienced a lesser degree of relief have found that their hearing was greatly improved while using the microphone device, and it has been especially noticeable that the area of reception for such devices has been greatly increased. Again, it has been found that persons who felt that they could not use a microphone device with comfort, were at ease in the presence of the sensitizing wave.

The conditions may be compared to distant radio reception, where the incidental necessary amplification of accompanying extraneous noise militates against the clarity of reception.

Anyone who desires to study the subject of hearing will do well to read and digest what the great Helmholtz set down in his work "Sensations of Tone" which was published first in 1862. Helmholtz combined in one mind the trained anatomist with the skilled physicist. One pertinent fact presented by Helmholtz is stated as follows:

"The mechanical problem which the apparatus within the drum of the ear had to



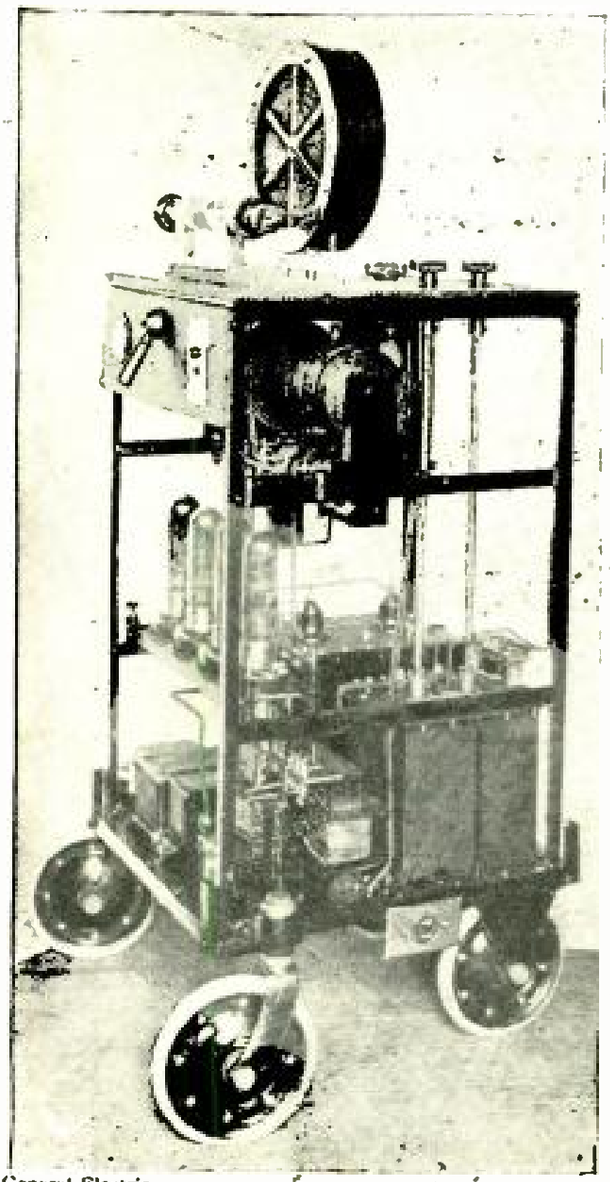
From a photograph made for POPULAR RADIO

THE WAVE PRODUCER WORKS LIKE A LOUDSPEAKER

FIGURE 2: *The inventor, Dr. Eldred, explains how the wave-producing device, that is in effect a special form of loudspeaker, creates electromagnetically the vibrations that stimulate the ear mechanism. Mounted on the board in the background may be seen another and larger wave-producer that also operates like a loudspeaker.*

solve, was to transform a motion of great amplitude and little force, such as impinges on the drumskin, into a motion of small amplitude and great force, such as had to be communicated to the fluid of the labyrinth."

Helmholtz observed, in the transference of vibration to the fluid of the labyrinth, that the particles of air communicated to the drumskin have in themselves comparatively large amplitudes of vibration, yet, because of their low density, they have no great amount of inertia; and consequently when their motion is impeded by the drumskin of the ear, they are not capable of exerting any sensible pressure against it. Similar physical problems in mechanics are solved on the lever principle, or by the principles employed in hydraulics and



General Electric

THE "EAR" ON WHEELS

FIGURE 3: *Another apparatus is shown above which has a vacuum-tube oscillator instead of an alternator for the low-frequency source and a loudspeaker modification on top for the wave-producing device. This is a portable affair for treatment of deaf persons.*

steam practice where energy imparted to one surface is concentrated on a smaller surface, thereby increasing the pressure per unit area in inverse proportion to the ratio of area of plungers or diaphragms. Inefficient power transformation explains middle-ear deafness.

The drum system, which includes the ossicular chain, is a power-transforming device; and middle-ear deafness is caused by inefficient power transformation in this drum system. This explains why normal moderate sounds are heard when the sensitizing wave adds efficiency to the transformer, whereas sound waves of lesser magnitude may not produce a response in the middle ear in like degree.

The usual tests that are employed by aurists determine largely the threshold of hearing. These tests are doubtless of great value for discovering the region of deafness, but when tuning fork tests are applied to determine the benefit derived from the sensitizing wave, they are wholly inadequate and confusing. The inadequacy of these tests is probably accounted for by the fact that the wave may primarily function to clear up reception for sounds above a certain range of magnitude only, yet continued use of the wave generally broadens not only this range but the frequency range of reception as well. It is certain that, unlike any method heretofore proposed, the sensitizing wave does not in any degree increase the amplitude or force of the communication upon the drumskin, but it rather accepts what is naturally received, and conditions the ear mechanism for more efficient delivery of these vibrations to the delicate inner ear organs, which may be likened to the radio detector.

A peculiar unexplained condition of hearing in deaf persons has long been recognized but not satisfactorily explained. In fact, many aurists have recently endeavored to set aside the idea of this condition by refusing to admit its existence as a fact. This condition is designated by the name "paracusis," a term that has been accepted to describe the ability of certain deaf persons to hear while surrounded by noise or vibrating conditions, such for example, as when they are riding in a train or in an automobile. Any person with defective hearing who experiences this sensation may be confident of relief by a suitably adjusted sensitizing wave.

In making a study of the condition that is called paracusis, I have yet to learn of a case where increased hearing ability persisted after the person affected

was removed from the influence. Although my studies point convincingly to the conclusion that the sensitizing wave functions similarly to the vibrations of the train and motor, I can only surmise that the quality of the sensitizing wave is responsible for the "carry-over" effect.

No harm can possibly be done to deaf persons by the application of the wave because it is one that human ears are always unconsciously receiving. The value of the wave can be fully obtained only by intelligent application.

Especial attention will be paid to devising means which will allow aurists to fit the wave with the like degree of satisfaction that the oculist derives from fitting lenses for correcting defective vision.

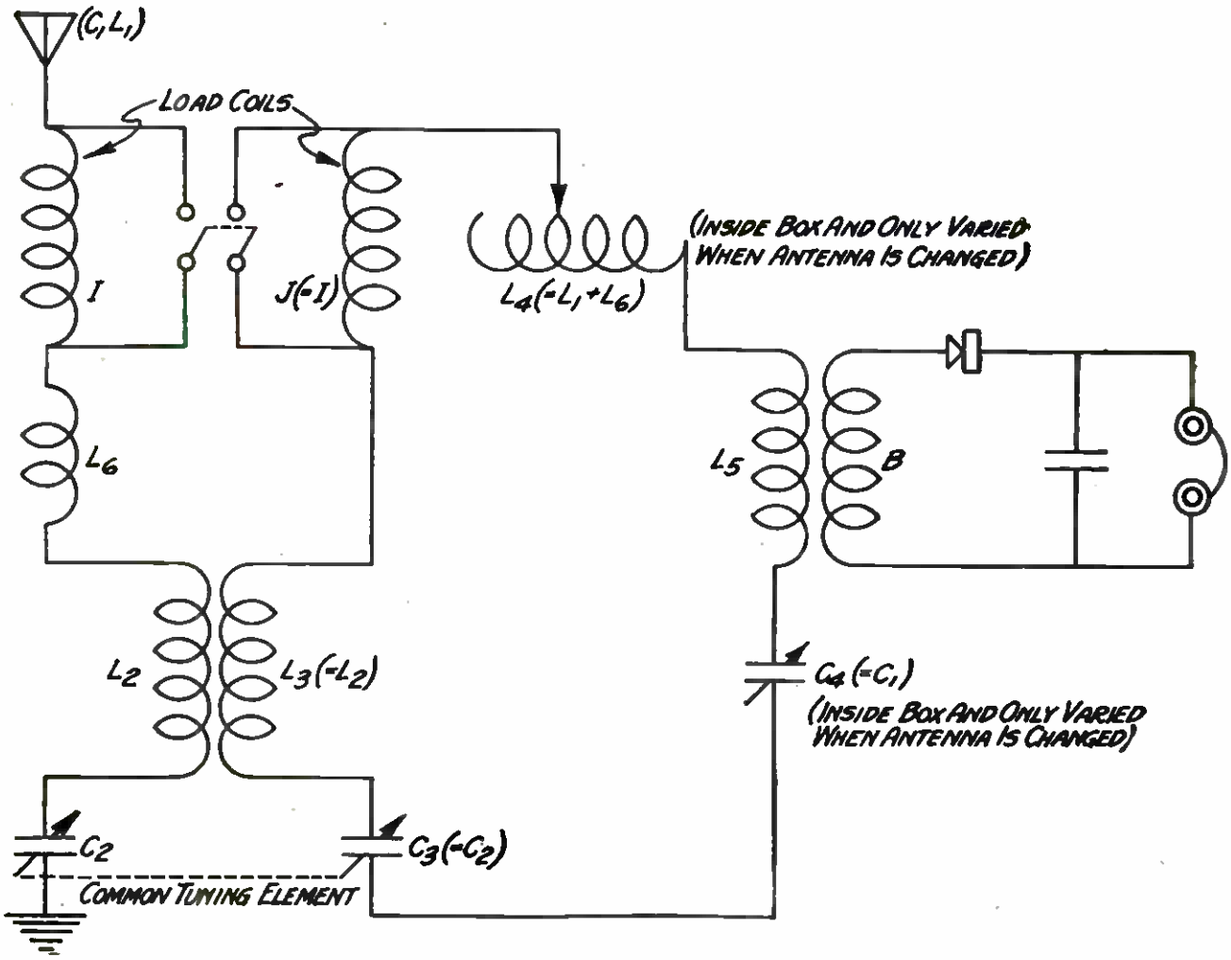
It is anticipated that many aurists will misunderstandingly disagree with my theories, but I feel compelled, because of results obtained and the co-operation of several eminent authorities, to give to the world an idea which I fully recognize as requiring further effort to obtain ultimate results.

While I have experienced the greatest satisfaction from results obtained, it must be understood that there have been accompanying disappointments. Above all things I do not wish to arouse false hopes. Many prominent otologists have made the same remark to me when discussing the invention; "It seems too good to be true." But its truth has been demonstrated irrefutably in many cases even in creating good hearing and normal-toned speech in a child of six, who had been classed as a deaf mute.

Pacific & Atlantic

THE NEW METHOD WILL REPLACE THIS

The new wave-producing device does not require the use of headphones such as are used with the systems in which the speaker's voice is amplified in a microphone that is placed before him and sent through wire connections to telephone receivers that are worn by a deaf audience. With the Eldred system a person may move about.



ONE OF THE FIRST SINGLE-CONTROL SYSTEMS

FIGURE 1: *This wiring diagram demonstrates one of the earlier schemes for tuning two resonant circuits by means of a common capacity tuning element that is adjusted by a single knob.*

SINGLE-CONTROL RECEIVERS

This latest development is the receiver of the future—and the immediate future sets, no matter what circuit they employ, must be simplified in control if radio is to be introduced into practically every home in our country

By LAURENCE M. COCKADAY

UP to three or four years ago the men and boys who were interested in radio receiving and transmitting apparatus were relatively few in number. Their interest was of quite an experimental and scientific nature.

But with the advent of popular broadcasting and its development from that time to this, there have been literally millions of people who have been drawn into the radio game by either its recreational appeal or by its educational features.

The vast majority of those who have been attracted to the field are broadcast listeners with little or no technical training and without much interest in scientific matters. However, these people

have a lively interest in receiving apparatus, although they know little about its intricacies. It is, therefore, not extraordinary that the modern trend of receiver design is one of simplification in control.

The early receivers that employed some of the more complicated and sensitive circuits contained, in some instances, as many as ten to fifteen tuning controls for selecting between signals transmitted on various wavelengths. During the last two years, however, the tuning of the more popular receivers has been reduced to not more than three to five controls. This means that most of the modern sets have no more than that many dials or knobs on the panel.

An interesting system that indicates great foresight and ingenuity on the part of the inventor, and a significant one, for reducing the number of controls in receivers, was devised some fourteen years ago by John V. L. Hogan, the well-known radio engineer. In his patent* Mr. Hogan describes a method for tuning various circuits to resonance by means of a number of associated tuning elements mounted on a single shaft or controlled by a single dial although connected electrically in different circuits.

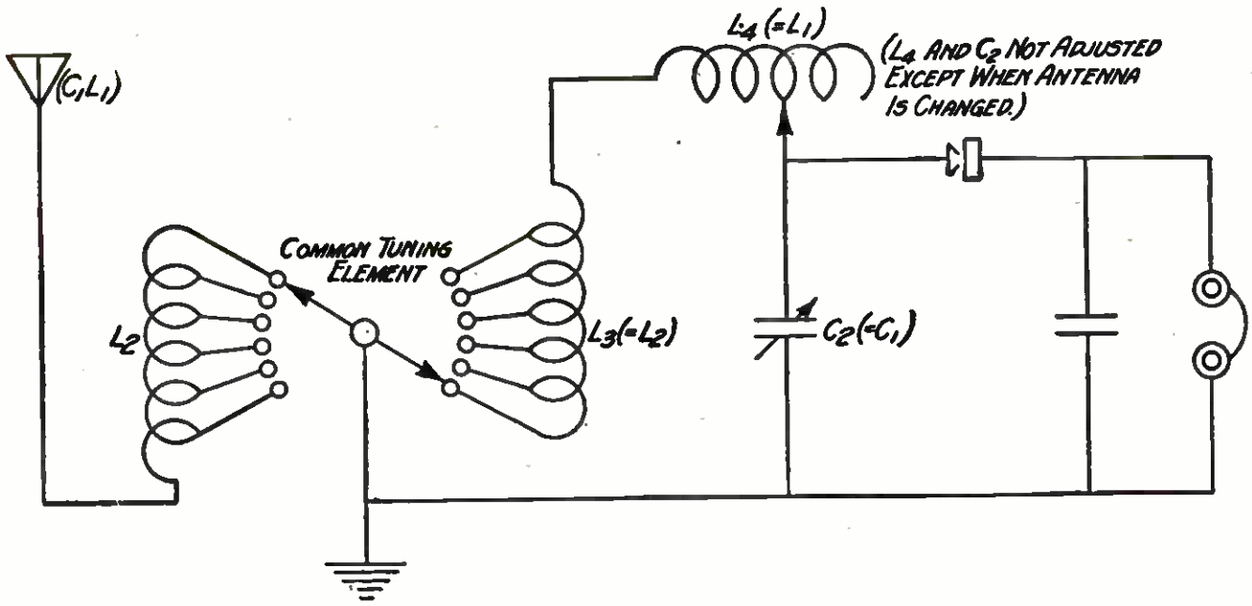
The object of this scheme is, briefly, to tune a number of resonant circuits by rotating a single control knob.

The significance of this method has only recently been apparent.

In Figure 1 we find a wiring diagram of the early Hogan single-control receiver that employs two tuned circuits that are controlled by a common tuning element.

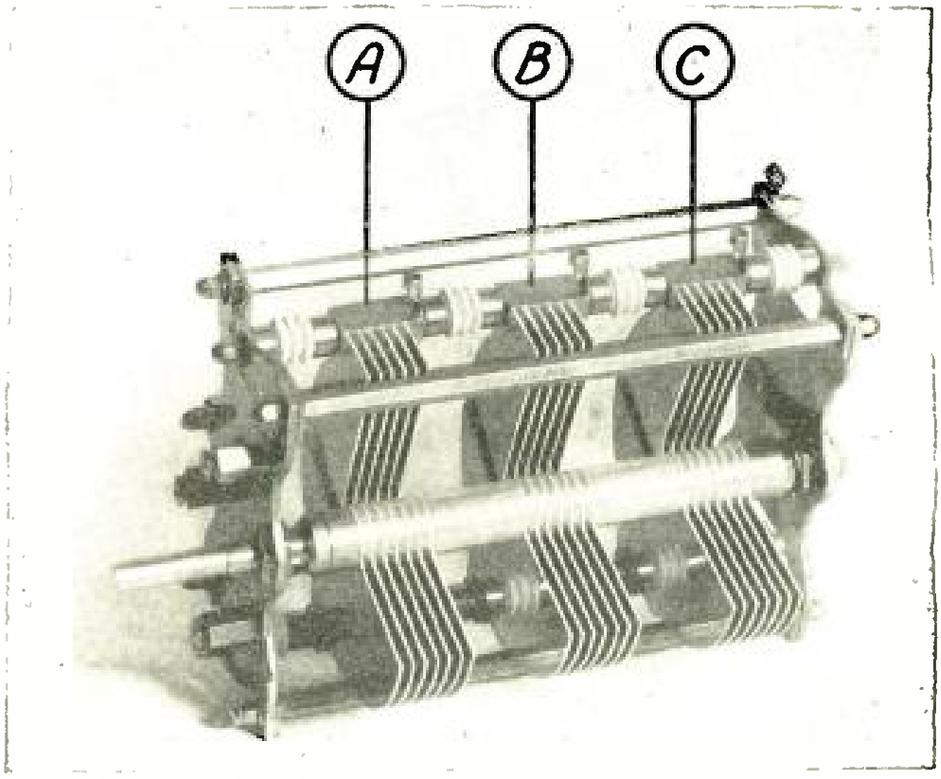
The common tuning element consists of two variable condensers, C2 and C3, which, of course, must be of equal capacity and must contain the same capacity ratio of maximum to minimum. These two condensers are arranged on the same shaft on which they revolve at exactly the same rate, and as the rate varies, the capacity of each one is always approximately equal to the other. The two inductances L2 and L3 are also of equal fixed values of inductance. The condenser C4, which was contained inside the receiver, was set only once to balance the capacity of the antenna. The coil L4, also a variable instrument that is inside the cabinet, is varied to equal the

* U. S. Patent No. 1,014,002.



AN EARLY SINGLE-CONTROL METHOD FOR AN INDUCTIVELY-TUNED CIRCUIT

FIGURE 2: *One of the early methods of tuning two resonant circuits by means of a common inductance tuning element that is rotated by a single dial or knob.*

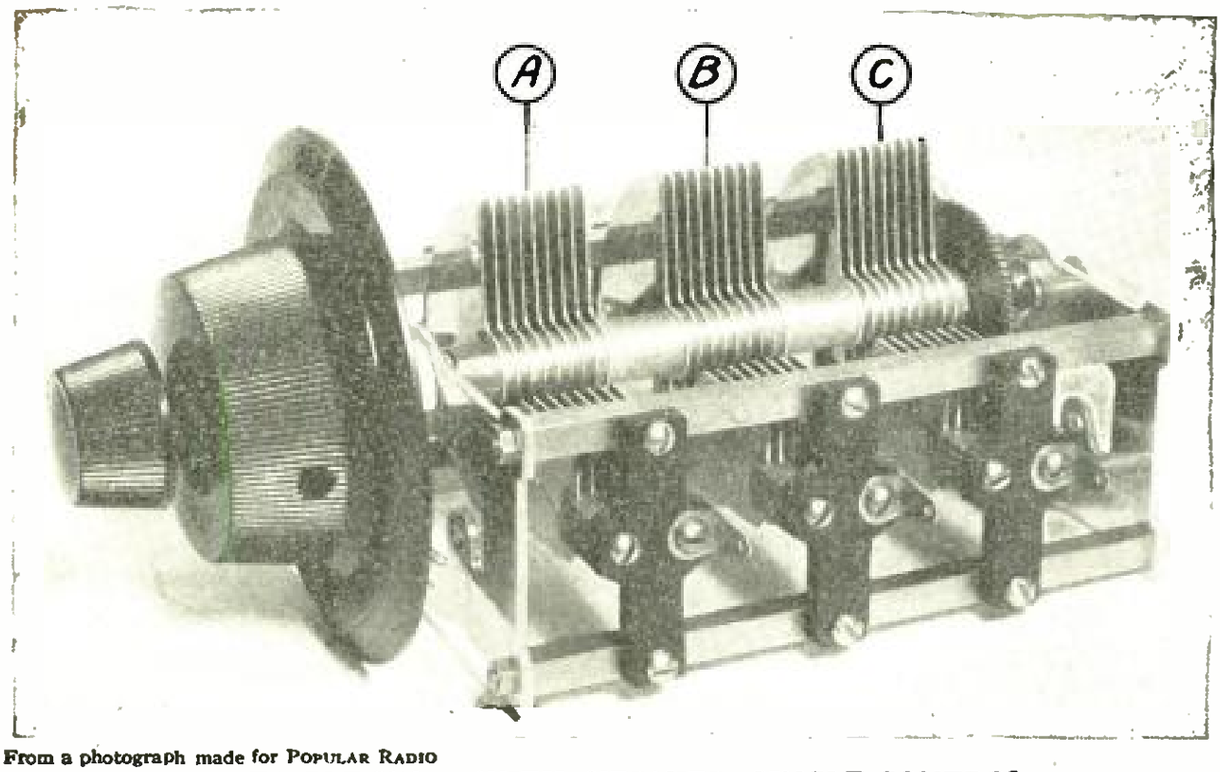


From a photograph made for POPULAR RADIO

A TRIPLE-UNIT CONDENSER

FIGURE 3: *This picture shows a triple-unit condenser.* The three units A, B and C may be used for tuning three resonant circuits. This condenser would be suitable for a two-stage tuned radio-frequency receiver.*

* General Instrument Co.

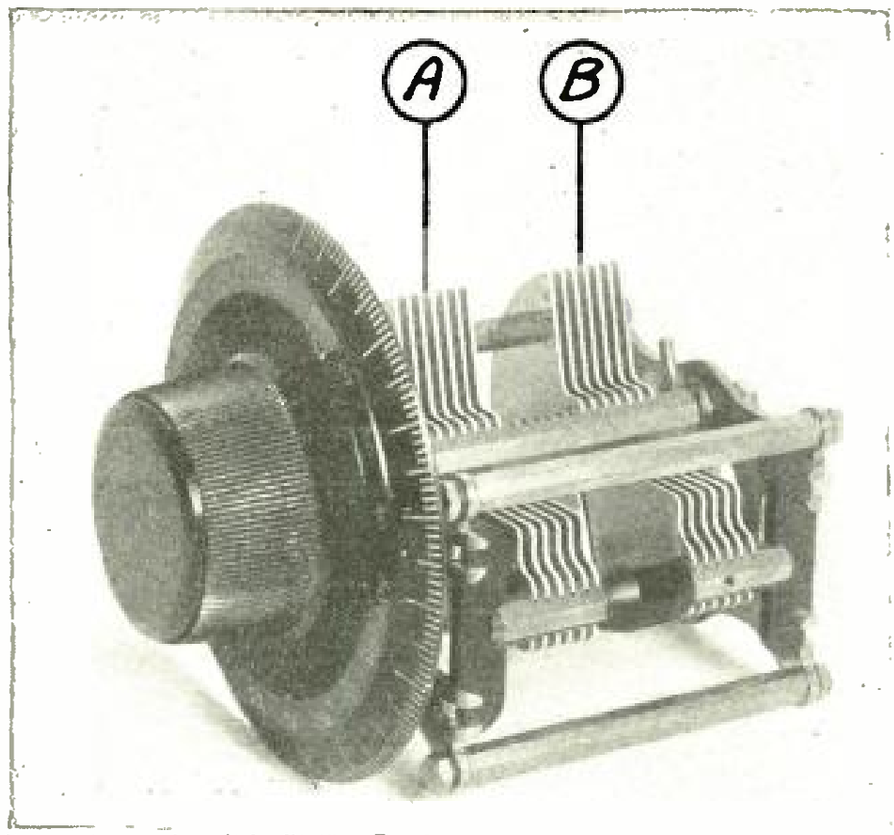


From a photograph made for POPULAR RADIO

A TRIPLE-UNIT WITH VERNIER SINGLE-CONTROL

FIGURE 4: *Another make of common tuning element, a triple vernier condenser,* is shown here. In this unit, the three sections A, B and C are all controlled by the single knob. The insulation of the unit is composed of six pieces of hard rubber.*

* Lombardi Radio Mfg. Co.

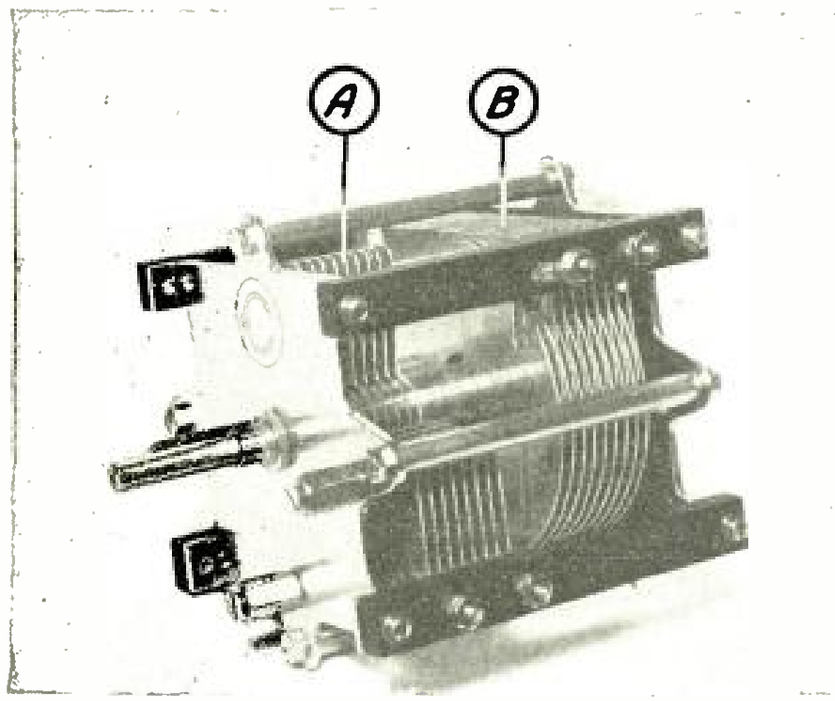


From a photograph made for POPULAR RADIO

A DOUBLE-UNIT FOR SINGLE-CONTROL

FIGURE 5: *This picture shows a double-unit condenser* which consists of two units A and B. This unit can be adapted to a single-control, four-circuit tuner or a single-control superheterodyne. It could also be used for tuning a single-stage, radio-frequency receiver.*

* Amsco Products, Inc.



From a photograph made for POPULAR RADIO

A LARGE CAPACITY DOUBLE-UNIT

FIGURE 6: *This double-unit* is also composed of two condensers A and B mounted on the same shaft.*

* Allen D. Cardwell Mfg. Corp.

inductance of the antenna plus the inductance of the coil L6.

In this early type of single-control receiver, when the two circuits were balanced up as indicated, the two condensers that formed the common tuning element could be rotated by a single knob and still the two circuits would be kept in resonance through the whole-wavelength scale. When this condition was established, a practical single-control receiver was evolved.

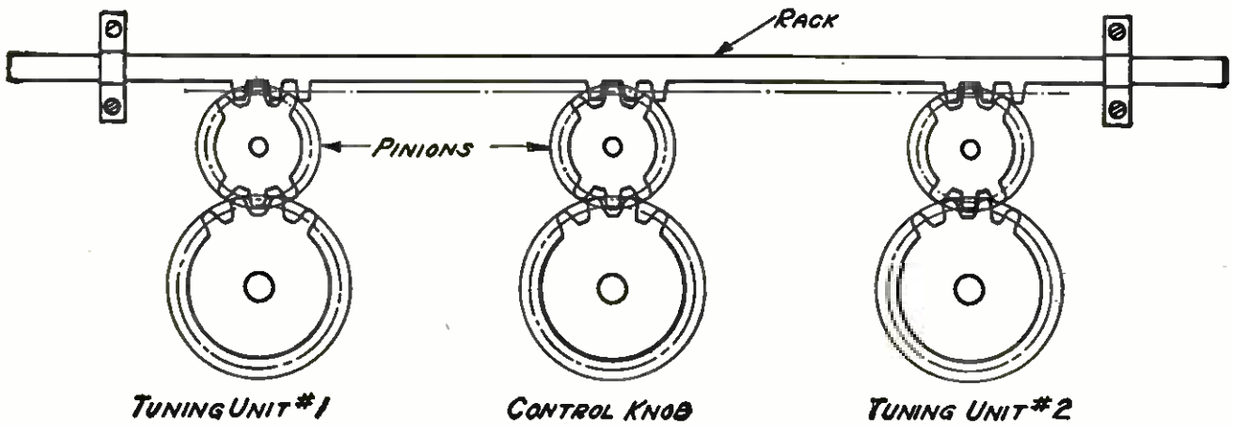
This specific instance demonstrates the idea of using condensers as a common tuning element.

The inventor also described and used a circuit shown in Figure 2 in which he incorporated variable inductances as a means for accomplishing the same results. This receiver is shown diagrammatically in Figure 2, in which the inductances in the two tuned circuits are varied in steps of equal amounts in both circuits by a single control knob. These two inductances are shown in the diagram as L2 and L3.

Additional inductances and capacities L4 and C2 are used inside the cabinet and these are adjusted only when the set is first connected to a new antenna. These two elements are used to compensate for the capacity and inductance of the antenna indicated as C1 and L1. When this initial adjustment has been made, the various wavelengths may be tuned in by adjusting the inductance tuning-element knob.

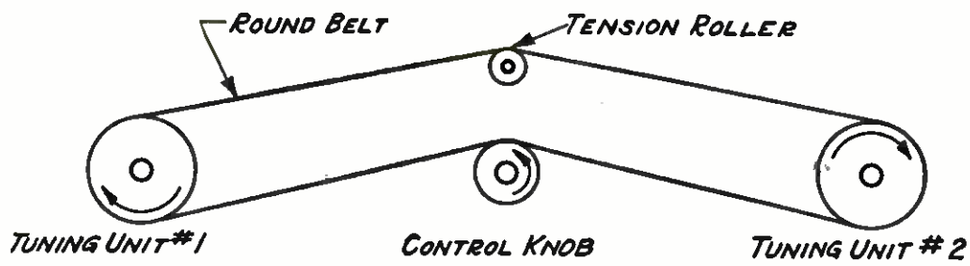
Either of these two simple plans for obtaining a single-control receiver may be used with the more complicated and effective receivers, such as used today.

During the last five years most of the engineering work on receiving sets has been directed toward circuit development, and, during that time, we have had four major types of circuits which have come into general use. These may be enumerated as follows:



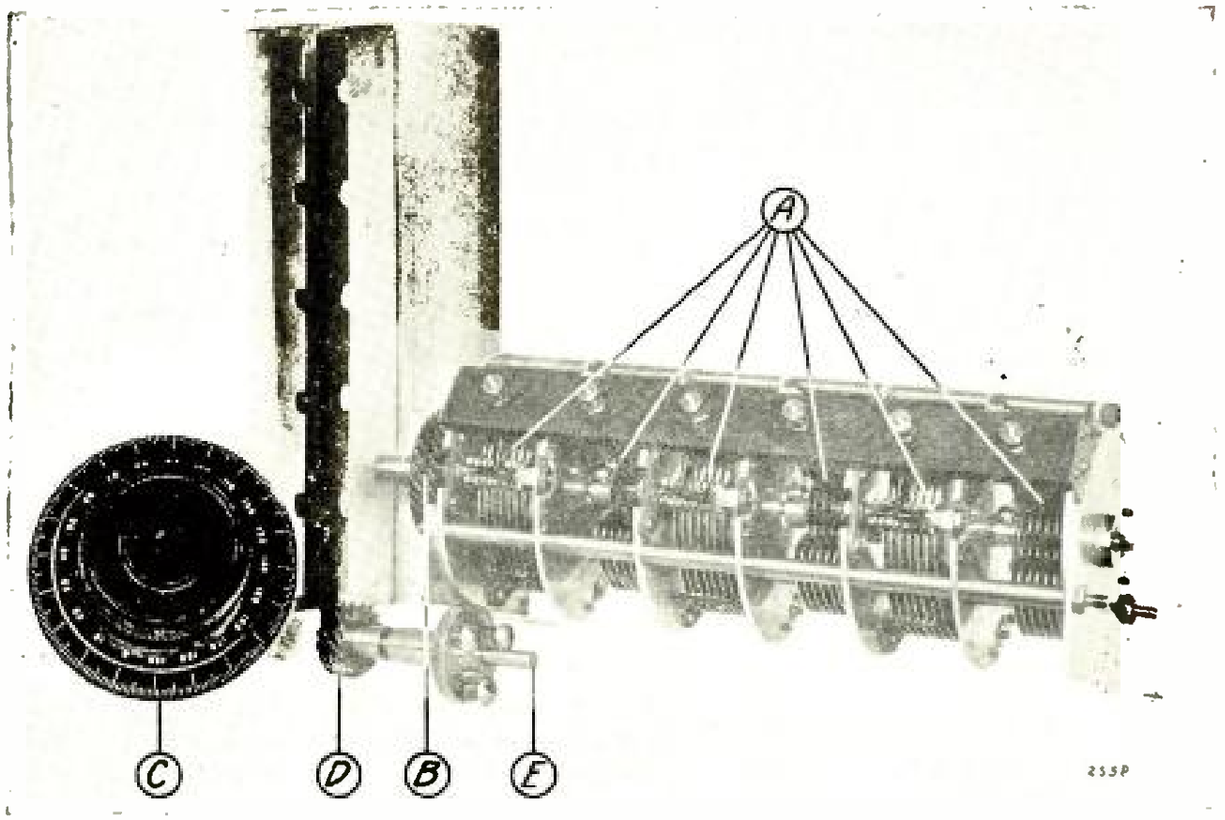
A RACK AND PINION CONTROL SYSTEM

FIGURE 7: *A method for controlling two tuning units by means of a rack and pinions. The control knob is indicated as attached to the center gear.*



A BELT-OPERATED CONTROL SCHEME

FIGURE 8: *Another method that has been used for the single control of two units. The control knob rotates the units in synchronism by means of a belt and rollers.*



From a photograph made for POPULAR RADIO

A SIX-UNIT, SINGLE-CONTROL CONDENSER

FIGURE 9: *A complete unit* consisting of six condensers A which are all fitted to the same shaft and controlled by a single dial C. The dial is attached to an auxiliary shaft E which operates the condensers through the bevelled gears D and B. Six resonant circuits may be tuned with this single unit.*

1. Regenerative circuit;
2. Transformer-coupled, radio-frequency circuits;
3. Tuned radio-frequency circuits;
4. Superheterodyne circuits.

The development of receivers along these four lines has been merely a refinement of circuit design and circuit stabilization. This work has resulted in some really excellent receivers and in some cases, the ease of control has been greatly improved over the earlier circuits of the same classes. The second class, No. 2, we can neglect, as only one circuit is tuned. However, by the application of the Hogan scheme to the other three of these types or classes of receivers, a receiver will be produced that the least informed novice can tune with ease. Such a receiver will contain only a single knob for adjustment, and it will give better results than the more complicated sets in the hands of the ordinary broadcast listener.

An application, then, of this scheme will be the most important single factor in the future development of sets; and it will make radio really accessible to the average American.

Applying the Single-control Principle

The first step in modifying these types of receivers to combine and unify the tuning control, is to select the type of mechanical arrangement to be used. There are three general methods that can be employed:

1. The use of a combined shaft;
2. The use of a gear arrangement;
3. The use of a belt arrangement.

All three of these methods present specific advantages and problems. In Figures 3, 4, 5, 6, 9 and 12 are shown a number of makes of multiple con-

* General Radio units assembled by Golden-Leutz, Inc.

densers that embrace the combined shaft principle. All four of these are of the finest workmanship and construction, and are being used in the newest types of sets that are built by some of the more forward-looking manufacturers.

The utilization of the second method allows for the use of separate condensers or inductive tuning units of the ordinary type with the familiar "rack and pinion" coupling between shafts. This scheme is shown diagrammatically in Figure 7. With this arrangement it is extremely important that the train of gears fit snugly and that there be not too much friction.

The third arrangement, which also has its supporters, employs separate condensers or inductive-tuning units which are caused to turn in unison by means of rollers and a belt.

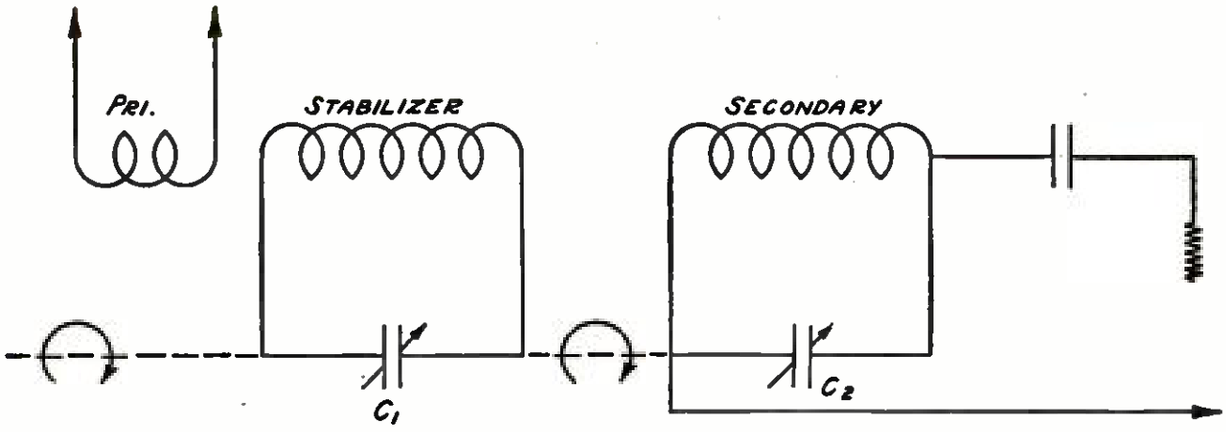
An idler pulley is usually used to take up slack so that the belt will not slip and thereby keep the units in proper relative position to each other. This method is shown diagrammatically in Figure 8.

Any of these methods may be employed, but for personal preference and simplicity of explanation we will consider only the first one.

The Single-control Regenerative Circuit

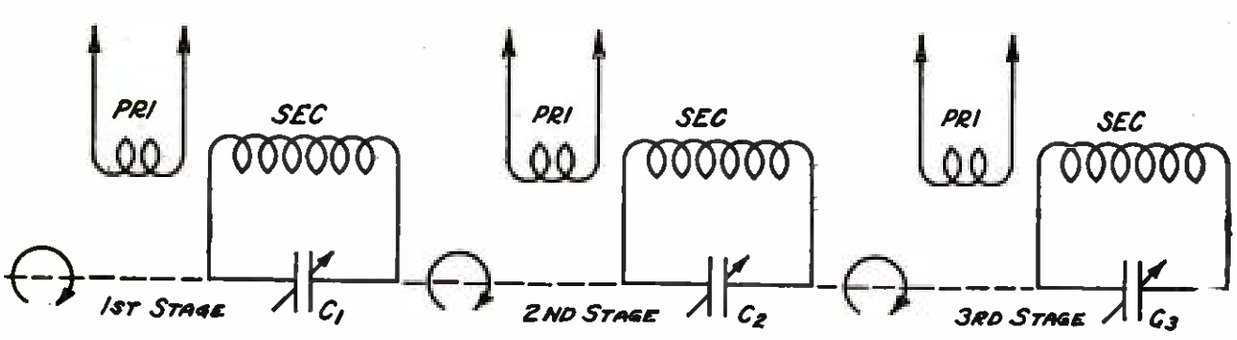
There are not many regenerative circuits that permit the application of the principle of single-control. The one regenerative receiver that probably stands out as the most suitable for such use is the Four-circuit Tuner.

In this type of receiver the two circuits that control tuning and regeneration are rotated in unison. Both dials are ro-



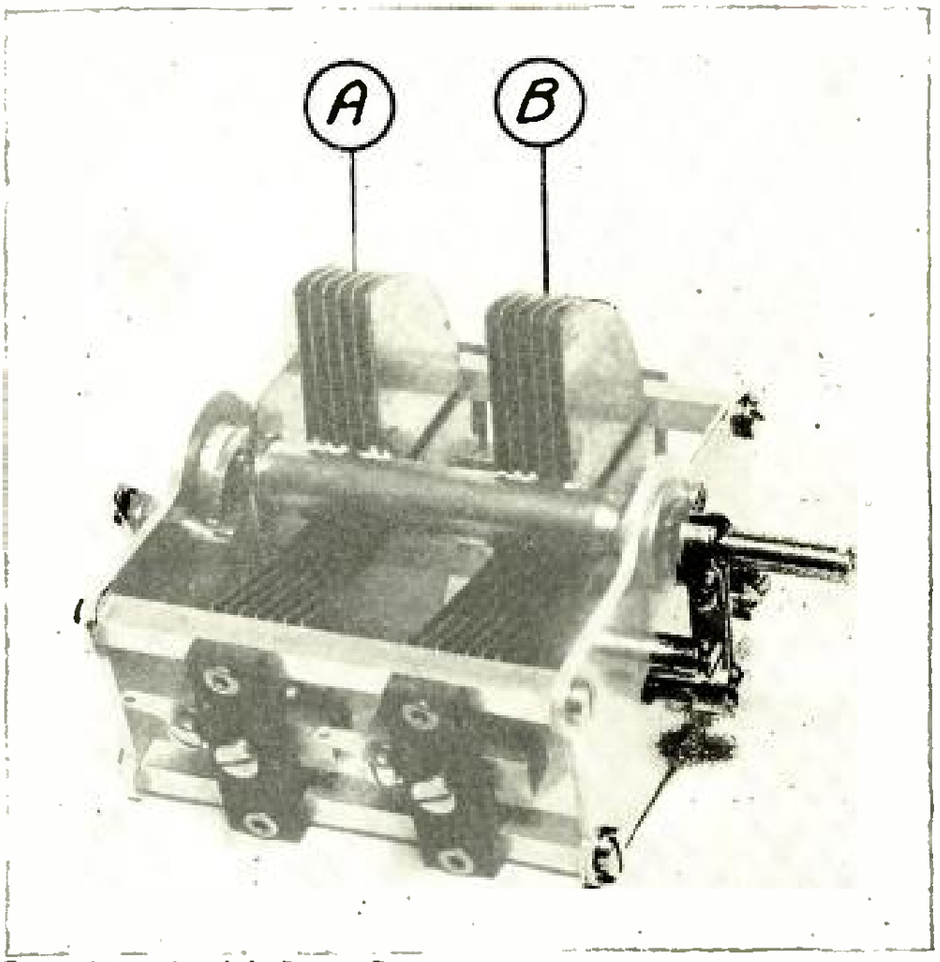
SINGLE-CONTROL ADAPTATION FOR A FOUR-CIRCUIT TUNER

FIGURE 10: *The control method shown in this diagram indicates how two condensers C1 and C2, when mounted on the same shaft and controlled by a single knob, can be employed in a four-circuit tuner.*



HOW THE SINGLE-CONTROL CAN BE APPLIED TO A TUNED RADIO-FREQUENCY CIRCUIT

FIGURE 11: *This diagram shows how the tuning of a two-stage, tuned radio-frequency receiver may be reduced to a single-control. The three condensers, C1, C2 and C3 are mounted on the same shaft and are controlled by a single knob or dial.*



From a photograph made for POPULAR RADIO

A DOUBLE-UNIT WITH STATORS MOUNTED ON HARD RUBBER STRIPS

FIGURE 12: *The double unit condenser* pictured above has two units, A and B. The stator plates are mounted on two strips of hard rubber insulation; both of the rotor sections are mounted on the same shaft. This unit may be used in the same manner as the two units shown in Figures 5 and 6.*

tated throughout the wavelength range at the same rate and both should always read the same in dial settings.

By using a double-unit condenser combination in place of the usual two condensers, the two circuits (the stabilizer and the secondary) may be adjusted by a single dial. This is shown diagrammatically in Figure 10. C1 would be one section of the condenser and C2 would be the second section. These would both be mounted on a single shaft and rotated in unison.

The Single-control, Tuned Radio-frequency Circuit

The application of the single-control idea to the tuned radio-frequency circuit is almost as simple as its application to the Four-circuit Tuner.

In Figure 11 are shown the primary and secondary coils which are used to couple two stages of amplification. Connected across their secondaries are variable condensers C1, C2 and C3, in the usual manner, except that these three condensers have a common shaft and a single dial as indicated by the dotted lines and the arrows. This arrangement is for condenser-tuned receivers.

For inductively-tuned receivers of the tuned radio-frequency type, the general layout or scheme might be as shown in Figure 13. Here the common tuning element is composed of a variable inductive winding. These are shown in the diagram as variometers at L1, L2

* Hammarlund Mfg. Co.

and L3. They are each connected in the various stages, but they are all connected on a single shaft as indicated by the dotted lines and arrows, and are all operated from a single dial.

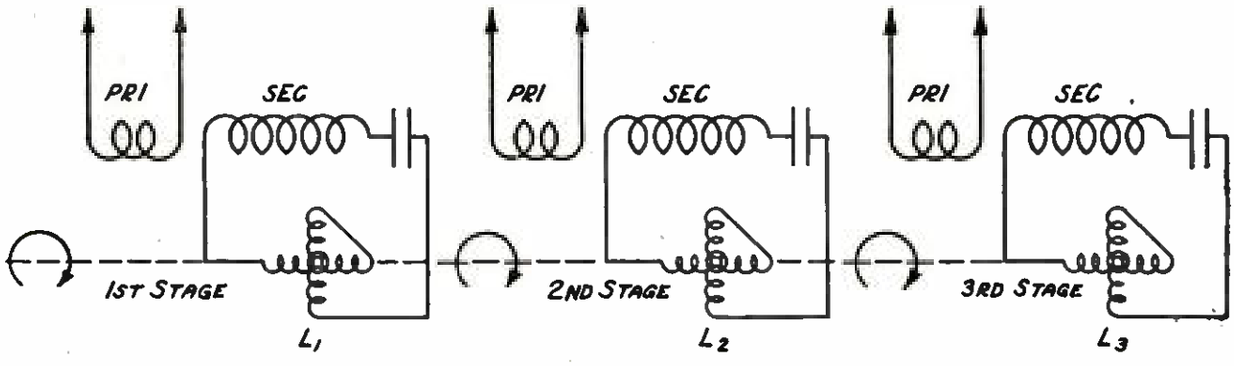
Both of these two schemes maintain resonance in the three tuned circuits over the whole wavelength range.

It is important that the elements themselves be exactly the same as each other and that they have the same curve of increase of capacity (or inductance) with rotation. It is also important that all three instruments be set in exactly the same position. considered in degrees of rotation. on the common shaft.

Some schemes to make up for discrepancies in the exact values of the instruments will probably be formulated when production on a large scale is contemplated. A small vernier condenser or inductance has been suggested. Another method would be to make two of the stages tune rather broadly and leave one stage sharply tuned by such schemes as the use of regeneration in one stage. Some satisfactory way to do it will be adopted. Our laboratory has found several methods.

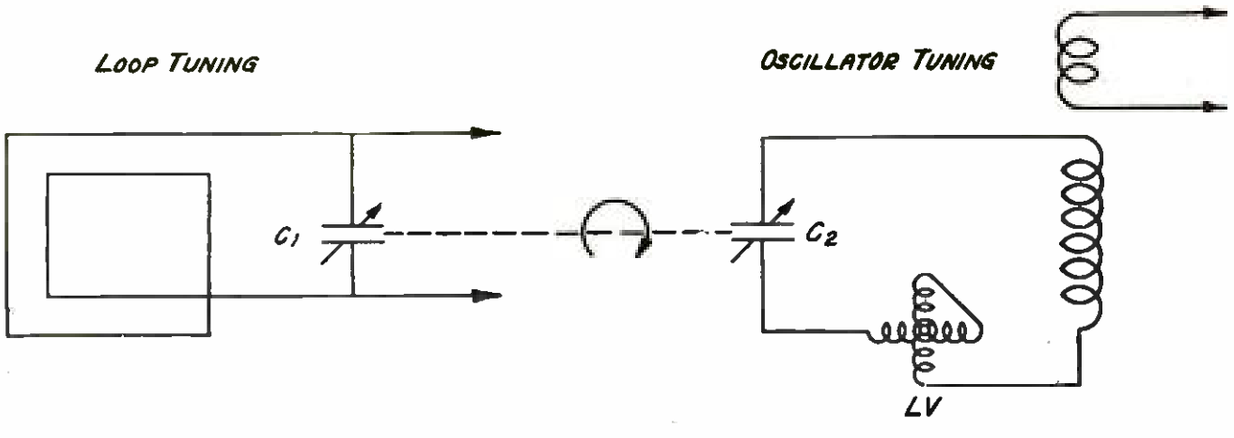
The Single-control Superheterodyne

Now we come to the consideration of adopting the single-control principle to the superheterodyne. A few years ago, engineers would have thought this rather a wild dream. However, this application of single-control has been made by a number of engineers.



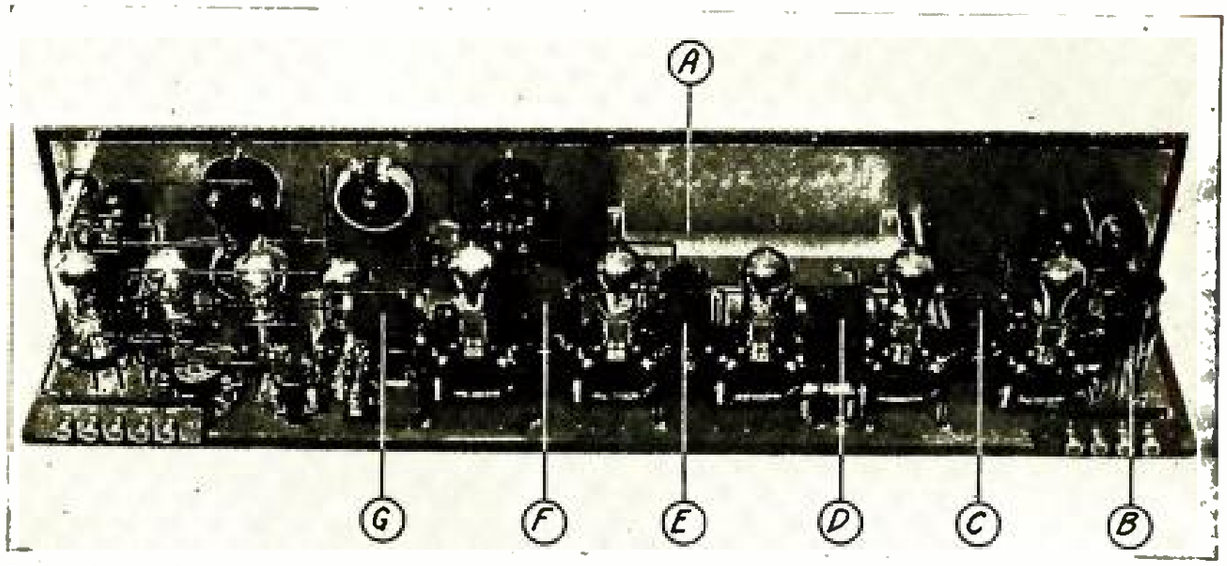
SINGLE-CONTROL APPLIED TO AN INDUCTIVELY-TUNED RECEIVER

FIGURE 13: *A method whereby a tuned radio-frequency receiver may be tuned by means of three variable inductances, L1, L2 and L3 mounted on the same shaft and controlled by a single dial.*



HOW SINGLE-CONTROL MAY BE USED IN THE "SUPER"

FIGURE 14: *This diagram shows how the loop tuning and the oscillator tuning in a superheterodyne receiver may be simplified. The two condensers C1 and C2 of the proper capacities may be mounted on the same shaft and controlled by a single dial. In this case, however, a small variable inductance unit LV should be used for exact settings on distant signals.*



From a photograph made for POPULAR RADIO

A RECEIVER WITH ONE DIAL THAT TUNES SIX CIRCUITS

FIGURE 15: *This picture shows a rear view of a super-pliodyne receiver* in which the multiple tuning unit shown in Figure 9 is used. This unit appears at A, and is enclosed in a metal shield. It tunes simultaneously the six transformers B, C, D, E, F and G, which are connected to as many stages of radio-frequency amplification.*

Stating the method generally, the two tuning elements C1, which controls the loop tuning, and C2, which controls the oscillator tuning (see Figure 14) can be arranged, by choosing the right values of inductance in the circuit, so that they will vary with the wavelength substantially at the same settings. This means that they can be also connected by the same shaft and controlled by a single dial. Any slight variation at the ends of the scale can be adjusted easily by a vernier variometer or other vernier device as indicated in the diagram at LV. One engineer has already experienced very fine results from such a combination.†

In summing up, we find that the single-control idea for controlling the more complicated, and therefore the more sensitive and selective circuits, has a number of great advantages and strong points not among the least of which we have found to be:

1. The simplest method of tuning;
2. The calibrated or "logged" dial;
3. The speediest method of tuning;
4. The most accurate method of tuning;
5. Elimination of body capacity;
6. Better looking sets;
7. Sets that the novice will not hold in awe;
8. Much better sales value.

The simple tuning, including the calibrated feature that tells the user at just what point to set the one dial to bring in the station wanted, is sure to be popular. Besides, a set that a novice can tune as readily as the experienced radio fan is a great development.

Finally, sets that do not have so many "little dials and knobs and gadgets" to turn, to make squeals with, and to collect dust, are sure to be more popular with the women and the children and the man without technical interest.

In other words, in single-control receivers we will have the first sets that will enjoy an overwhelming popularity with the larger public consisting of men, women and children who want to listen without any fuss and without having to study technical information before they learn the particular tricks of the particular make of receiver they happen to own.

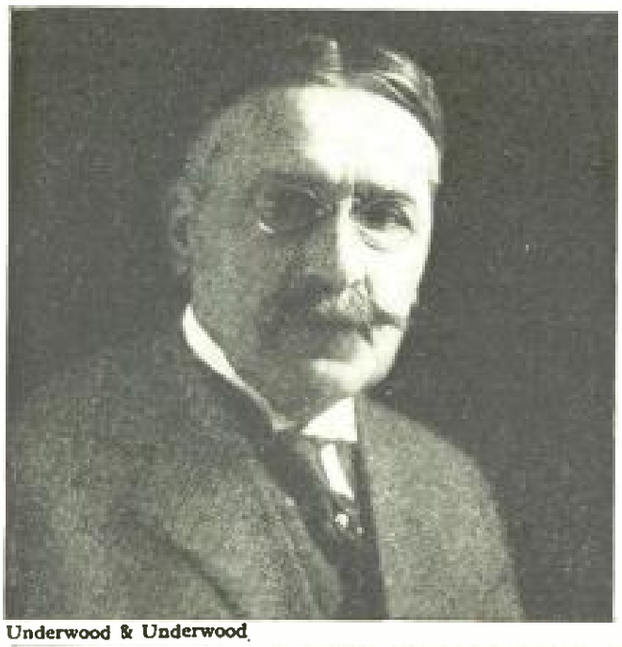
These are the reasons why the single-control receiver is fast coming into vogue and why it will stay.

* Golden-Leutz, Inc.

† J. L. McLaughlin, Precise Mfg. Co.

The MEN WHO

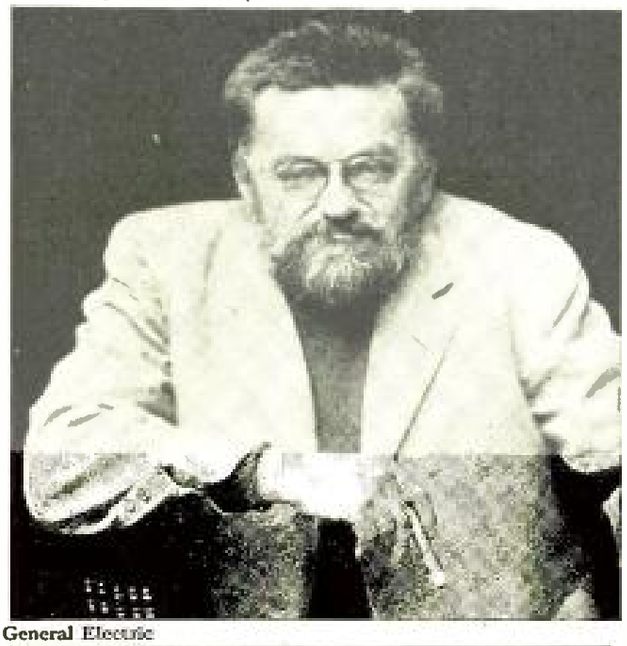
5th Installment



Underwood & Underwood

ONE OF THE FIRST SCIENTISTS TO EXPOUND A PRACTICAL TUNING METHOD

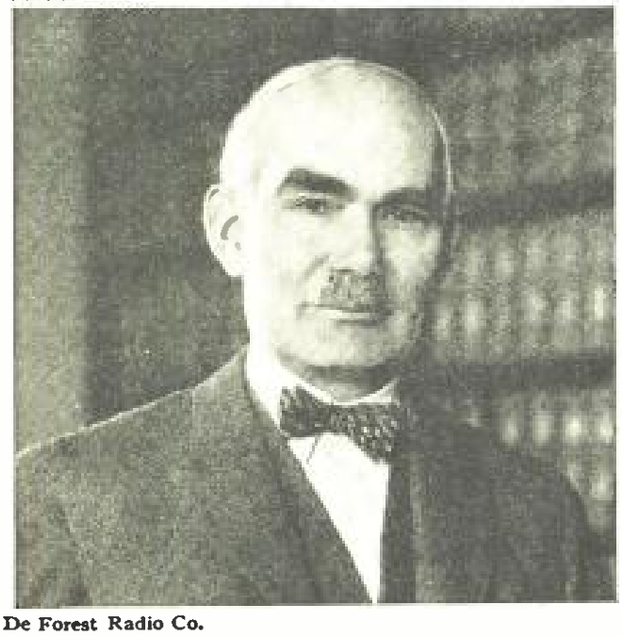
PROFESSOR MICHAEL I. PUPIN *of Columbia University, New York, is known to the engineering world for his loading coil which made long distance wire telephony possible. In 1894 he stated the principle of tuning or electrical resonance as applied to driving and radiating circuits before the introduction of radio telegraphy. His ideas with improvements were applied soon afterwards to practical radio work.*



General Electric

RADIO'S GREATEST MATHEMATICIAN

CHARLES P. STEINMETZ, *who was perhaps the world's greatest electrical mathematician, made distinct contributions to radio science through his experiments with high-frequency currents and through his formulas based on these laboratory observations. Many of Steinmetz's calculations are the basis for some of the most important phases of radio-telephone engineering.*



De Forest Radio Co.

THE CREATOR OF THE THREE-ELECTRODE VACUUM TUBE

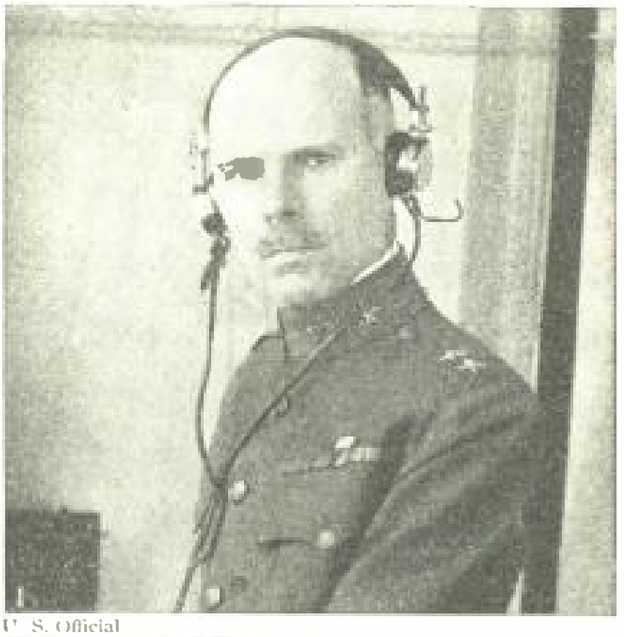
IN *1904* DR. LEE DE FOREST *began experiments with flames used as rectifiers of high-frequency currents. This work was followed in 1906 by the invention of the audion, a vacuum tube with three electrodes, that turned out to be a practical radio receiving and transmitting device, whereas its predecessor, the Fleming "valve," with two electrodes, had been used mainly for receiving. This tube with a "grid," the third electrode, proved also to be the most sensitive radio detector then in existence.*

MADE RADIO

General Electric

THE MAN WHO MADE POSSIBLE COMMERICAL TRANSATLANTIC RADIO COMMUNICATION

WHEN *Fessenden built his famous continuous wave alternator with which he communicated by radio telephone for a short distance,* E. F. W. ALEXANDERSON *assisted him. Later, in 1917, Alexanderson built a 200-kilowatt alternator which became the basis for transoceanic communication of the present day.*



U. S. Official

THE "FATHER OF WIRED WIRELESS"

MAJOR GENERAL GEORGE O. SQUIER, *who had the good fortune to be an assistant to Sir William Preece in his later radio experiments, became interested in the behavior of electromagnetic waves that could be made to follow wires. About 1912, General Squier developed a system in which high-frequency waves are guided by wires so that several of these impulses may traverse a single wire at the same instant whether the bare conductor be over or under ground or water.*

Bachrach

THE FOREMOST INVENTOR OF CRYSTAL DETECTORS

IN *1906* G. W. PICKARD *invented a detector of electromagnetic waves. It proved to be practically as sensitive as Fessenden's liquid detector and was more economical than Fleming's "valve" or vacuum-tube detector that was still unperfected at that time. Pickard used silicon, galena and iron pyrites for his detector crystals, and these are still widely used.*

From a photograph made for POPULAR RADIO

THIS TYPE OF FLAT-TOP ANTENNA IS THE BEST FOR ALL-ROUND USE

When tuned primary circuits are used, it is advantageous to have a parallel-wire antenna instead of the long, single wire that has become so popular for broadcast reception.

HOW TO IMPROVE Broadcast Reception

VI: Increasing the Selecting Power of Your Receiver

This series of tuning-circuit articles was prepared by one of the most experienced radio engineers in the world *for the special benefit of the broadcast listener.* The preceding five articles of this series include: "The Effects That Occur in the Transmitting Station," August, 1924; "Helpful Hints on Tuning," September, 1924; "Oscillations in the Receiver," October, 1924; "Noises That Come in With the Waves," January, 1925; "Cutting Down Spark Interference," February, 1925.

By JOHN V. L. HOGAN

IN concluding the previous article* some suggestions were given that should have assisted in improving the selectiveness of any single-tuned-circuit crystal receiver. Such receivers are the least selective of all the types that are in large use, and consequently they need the most improvement. It was pointed out that to get the utmost selective power of which a crystal receiver is capable, one must adopt the double-tuned-circuit arrangement, which in general is much superior to any single-circuit arrangement.

Of course, the object for which we are striving is the elimination (or, at least, the reduction) of interference that troubles us in the reception of broadcast programs.

We have considered spark or code interference most specifically, and we saw that, although some improvement may

* "Cutting Down Spark Interference," in POPULAR RADIO for February, 1925.

be expected as a result of the reduction of the number of radio code messages being sent on waves that lie within the broadcasting range, we must go farther than this to get the desired relief. The situation will be greatly aided by the installation and operation of higher-powered broadcasting transmitters, for the reasons that were explained in some detail in the earlier article. But, it will take time to get these stations into operation. Meantime, we should improve our receivers so that they will better discriminate between the music and the speech and the undesirable code interference. This improvement must naturally be sought through increasing the selective power of our receiving sets.

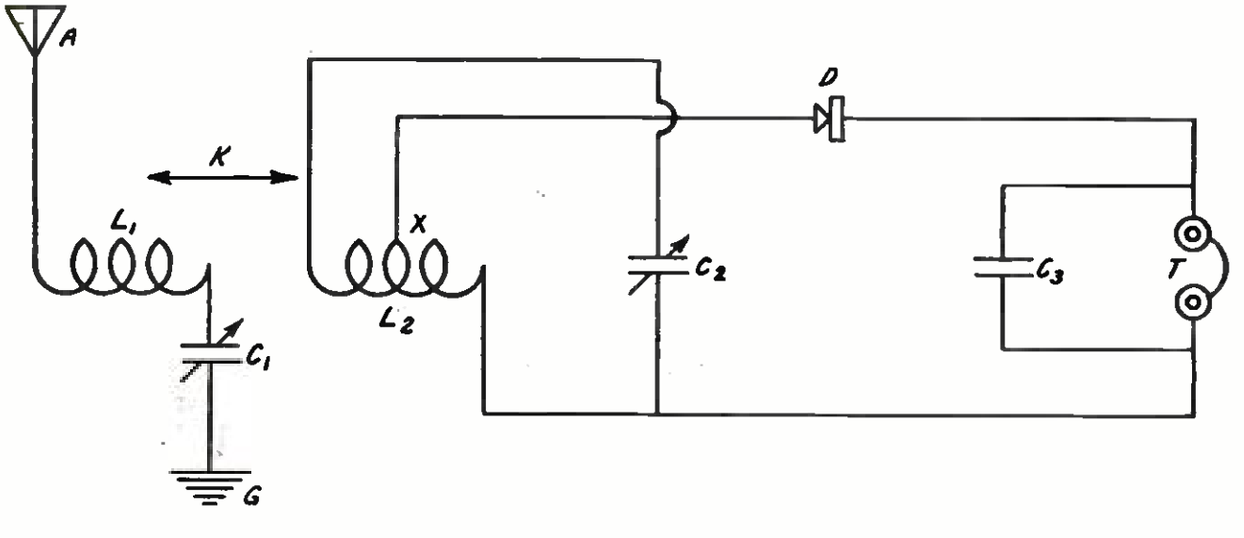
Sparks Cannot be Completely Excluded

It is well to remember that even the most nearly ideal radio receiver, from the point of view of selectiveness, will not entirely exclude interfering signals sent out by powerful and nearby spark transmitters. Nevertheless, most of the radio receivers in use are of types that can be substantially improved in their capacity to cut out spark signals, and, what makes the improvement of added value, they will at the same time become better able to choose between the signals of different broadcasting stations that operate on adjacent waves. Thus, while we are attempting to get more satisfactory conditions for listening to broadcast programs without interruption from ship or shore spark transmitters, we will simultaneously be reducing our troubles from "cross talk" or direct program interference between broadcasting stations.

We should consider next the way in which two-tuned circuits may be used with crystal receivers.

The most satisfactory arrangement is to tune the antenna-to-ground circuit separately and to couple it transformer-fashion with a second tuned circuit to which the detector is directly connected. Such a receiver is shown in Figure 1, in which the first or antenna-to-ground circuit is shown at the left extending from the antenna A through the primary coil L_1 and the primary tuning condenser C_1 to the ground connection G. The size of the coil and condenser, to give best results, will depend upon the size of the antenna to be used. As a general rule, the larger the antenna is, the smaller the coil may be and the larger the tuning condenser that may be used.

For this sort of circuit it is desirable to use an antenna that is not too long and which is large or has great capacity



A CIRCUIT THAT WILL IMPROVE THE CRYSTAL RECEIVER

FIGURE 1: *This hook-up with a crystal detector will give high selectivity because of the coupled circuits and the method of tapping the secondary coil.*

through its umbrella-rib or parallel wire formation. If you have a single tall flagpole or similar support, an umbrella antenna constructed on it is very effective. The individual wires should not be over 75 or 100 feet long, and all of them should be of the same length, including the downlead to the receiver. If you have available two masts or points of support you will get good results from four parallel wires, each of which should be not more than 50 or 60 feet long, and hung at least three feet apart between spreaders.

The Primary Coil and Condenser

With a fair-sized antenna of the sort just described, the primary condenser C_1 may be of .0005 or even of .001 mfd. capacity, and the coil L_1 may be chosen by trial so that the broadcasting waves come at intervals that spread well over the scale of the condenser. A good coil to begin with would have 100 turns of No. 22 DCC copper wire wound on a tube three and a half or four inches in diameter. If the antenna is of fairly high capacity, it may be found that the long-wave broadcasters "tune in" too far down the condenser scale. If, for instance, WEAF (610 kc or 492 meters) tunes at less than 70 or 80 divisions on a 100-part scale, it is an indication that the number of turns on the coil may be reduced to advantage. The same indication may, of course, be obtained by noting the tuning point of any of the lower-frequency (longer-wave) stations such as KSD, KYW, WNYC, WCX or WIP. What is sought is to make the coil of such size that the lower frequencies tune at the maximum-capacity end of the condenser scale, because then the tuning adjustment will be most effective over a large part of broadcast wavelengths.

If the coil L_1 has too few turns for the antenna you are using, or, in other words, if the antenna is too small for the coil, you have the option of adding more wires to the antenna (it is not so good to increase its length) or of increasing the coil.

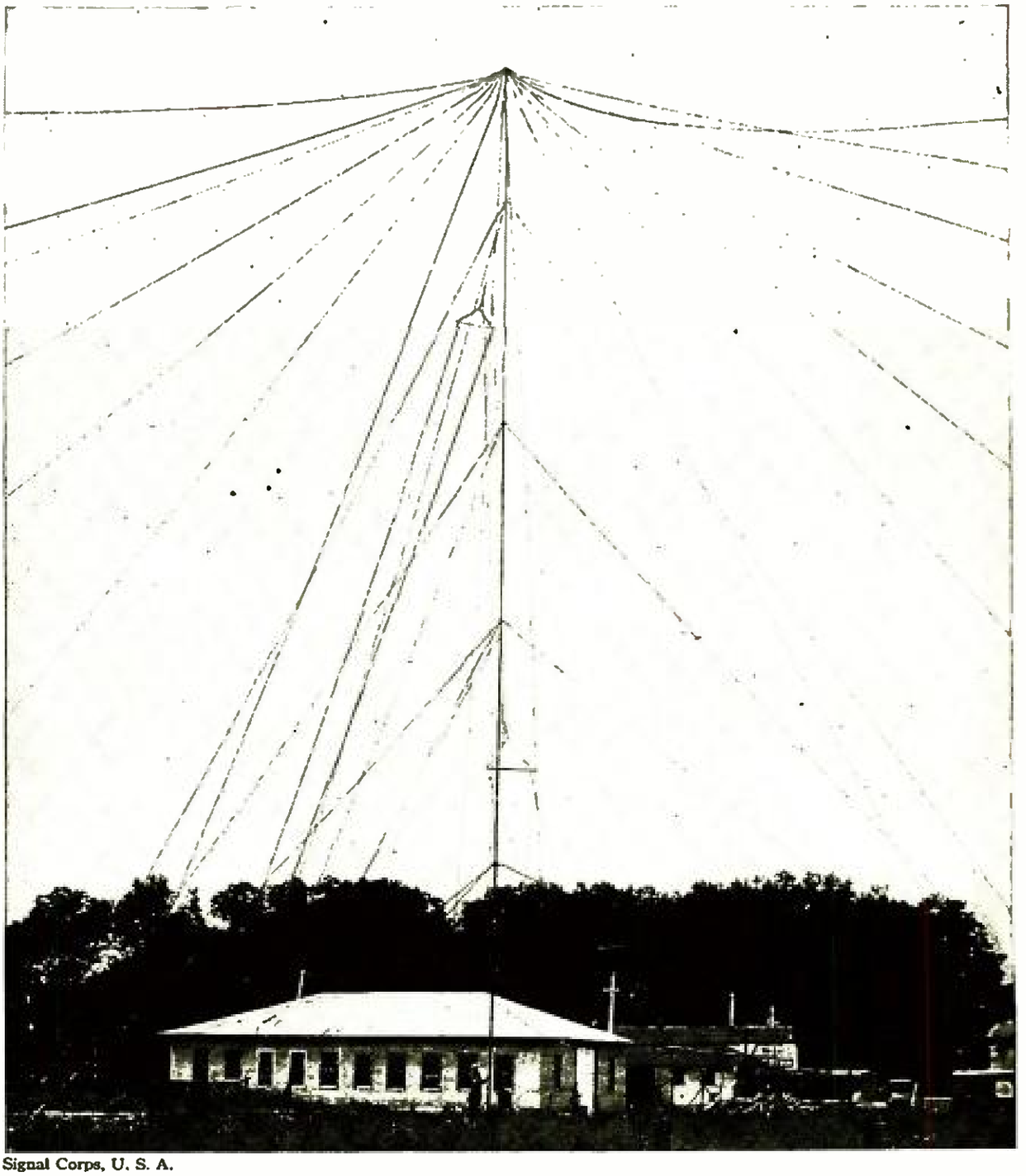
As a general rule, it is better to enlarge the antenna than to use more than 100 turns on the coil. You can, of course, tell whether the coil or the antenna is too small, because the medium-wave stations such as WJY, WGY or WFI will tune at the high-capacity end of the condenser scale instead of near the middle. Thus, if you cannot reach the longer-wave stations on your condenser dial, you will have to add turns to your coil or else increase the size of the antenna. Sometimes the use of a larger tuning condenser will do the trick. However, because the effective capacity of the whole circuit is limited by the capacity of the antenna, this does not help as directly as an increase in the coil would.

The Secondary Circuit

The tuned, secondary circuit consists of the secondary coil L_2 and the secondary tuning condenser C_2.

This is a simple closed circuit the tuning range of which depends almost entirely upon the size of the coil and the condenser. Forty turns of No. 22 DCC on a three and a half inch tube as the coil will ordinarily work quite well in connection with a variable condenser of .0005 mfd. maximum for C_2. In making this coil you should tap it at the tenth, twentieth (midpoint) and thirtieth turns so that the detector connection may be attached, as will be described later. It may be that your present receiver contains the parts necessary for this secondary circuit. Some sets have a coil and a variable condenser in series with it for tuning the antenna circuit; and, if yours is one of these, you need only connect the antenna and ground binding posts together by a short piece of wire. Then, if the detector is connected across the coil within the set, your outfit will be like the secondary circuit of Figure 1, except that the lead from the detector will be connected to the left-hand end of the secondary coil instead of to the tap X.

Of course, your antenna and ground are to be disconnected from the set and



Signal Corps, U. S. A.

THE UMBRELLA ANTENNA HAS NO DIRECTIONAL EFFECT

This type of aerial has a large electrostatic capacity on account of its numerous wires. The individual wires should be not more than 100 feet, and all of them should be as near the same length as possible. The down-lead should not be longer than the antenna wires.

connected to a separately tuned primary coil and condenser as described in the preceding paragraphs.

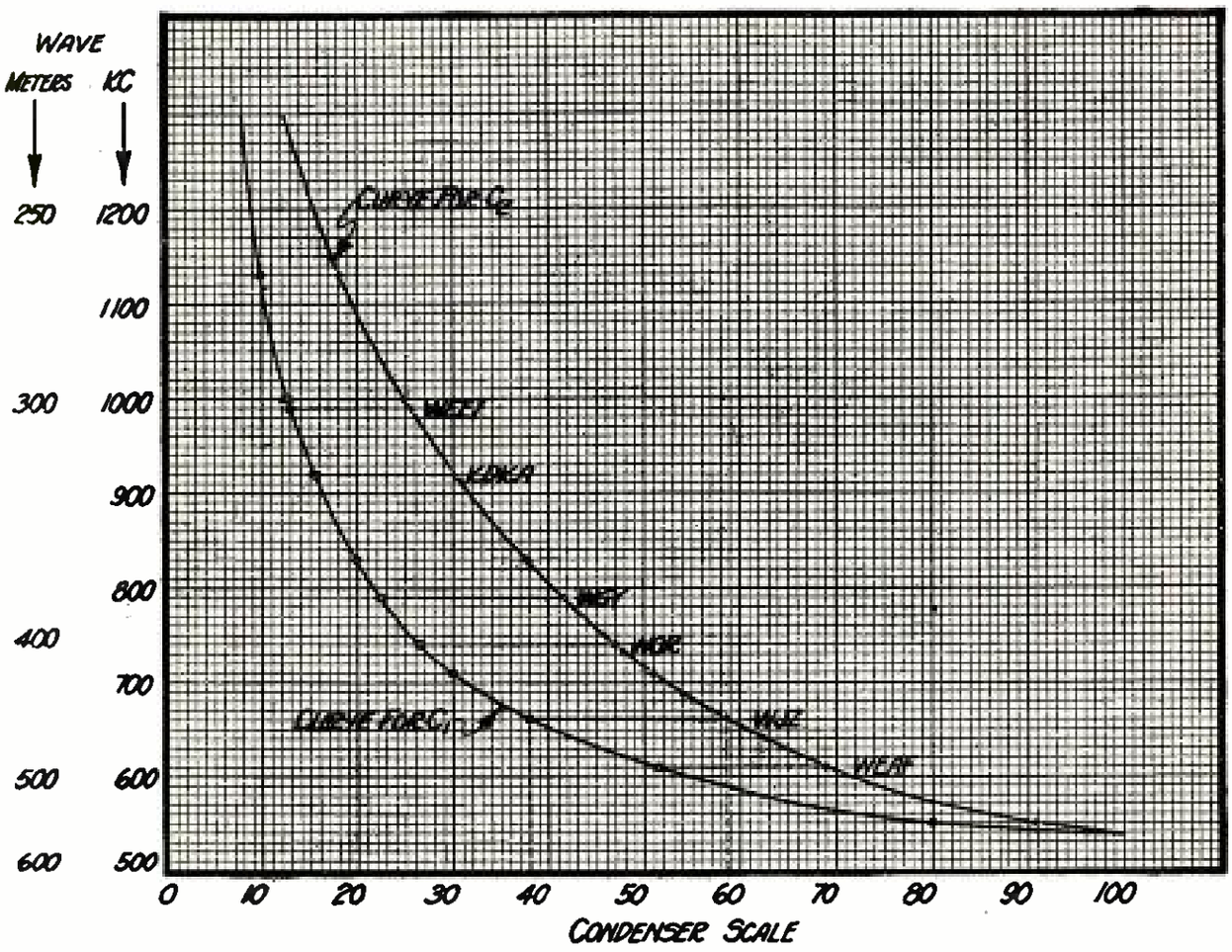
How to Connect the Detector

The detector circuit of Figure 1 consists simply of the crystal detector itself, at D, an accumulating condenser of .001 or .002 mfd. (the size of this condenser is not particularly important) and the headphones.

The detector is not connected across the entire secondary coil, but instead its upper lead-wire runs to a tap on that

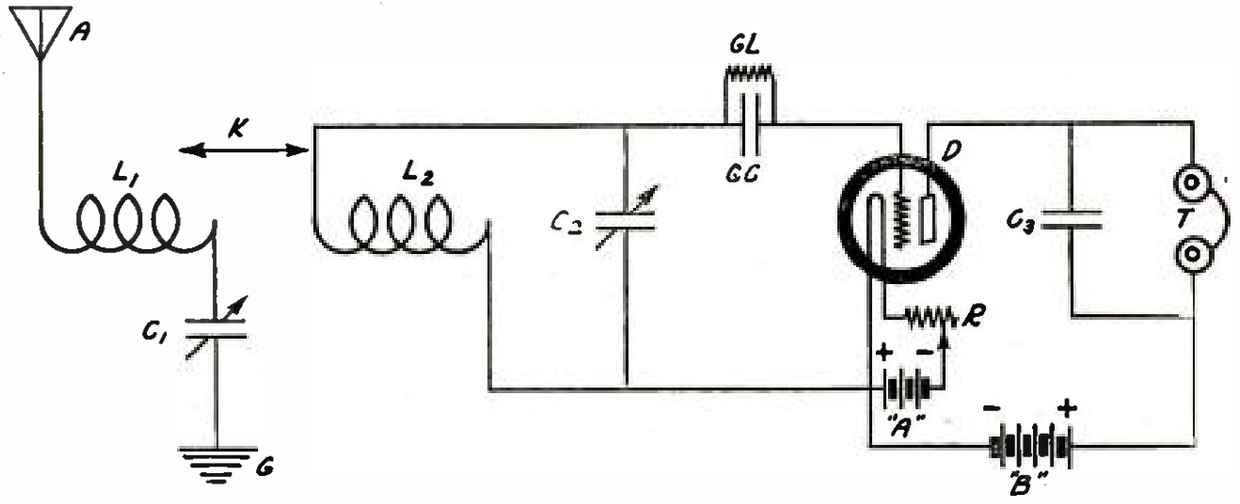
coil as indicated at X. Ordinarily about half-way down the coil there will be the best average position for this tap, but, if still greater selectivity is desired in tuning to strong signals, less than half the turns may be included between X and the right-hand end of the coil leading to C_3. The greater the number of turns you place between X and the right-hand end, the louder the signals may be, but you will obtain less selectivity. Under some conditions the use of the midpoint tap will give not only greater selective power, but also louder signals than a position for X including more turns in the branch circuit containing the detector. This, however, is a matter that must be determined by trial under your particular working conditions.

The only factor that remains to be considered is the coupling between the primary and secondary coils, which is indicated by the double-ended arrow marked K. This shows that the coils are intended to be relatively movable along the line of their common axis; you may fix L_2 in position and arrange L_1 so that you may slide it back and forth. It should be possible to move the coils together into the abutting or end-to-end position, or to separate them so that two or three inches of free space will separate their nearer ends. It is not necessary to make one coil slide within the other, as has been done in many old designs of couplers. Ordinarily the circuit will show very poor selective qualities with the coils in this position.



TUNING CHART FOR A SIMPLE-COUPLED RECEIVER

FIGURE 2: *The settings for any station may be found from this curve. For instance: WJZ at 660 kilocycles (455 meters) will tune at 39 on the primary and at 58 on the secondary. It is most convenient to plot these curves in kilocycles, as they are expressed in tens.*



A SIMPLE VACUUM-TUBE HOOK-UP

FIGURE 3: *This is a type of selective circuit that employs tuned antenna and secondary circuits. If a WD-11 or WD-12 tube is used, the "A" battery need be only a single dry-cell and the "B" battery a small 22½-volt block.*

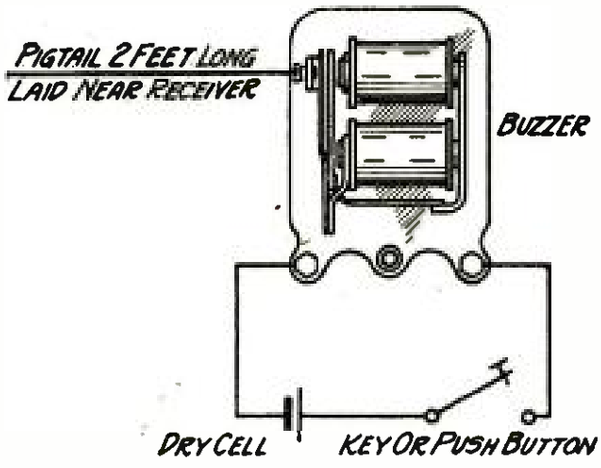
How to Adjust the Receiver

Having set up the circuit in accordance with the above suggestions, you will find it rather different in behavior from (and far superior to) the usual crystal receiver. To learn to use this improved receiver, it is well to begin with the two coils abutting and at a time when you are certain that several broadcasting stations in your neighborhood are transmitting. Also, you will need a test buzzer to make sure that your crystal is adjusted to a sensitive point. With the ordinary crystal set you will hear something as soon as you start to adjust your detector, and, thereafter, tuning adjustments will merely improve or hinder matters a little. With this outfit you should hear nothing unless your crystal is in sensitive condition and both your tuning condensers are properly set.

Therefore, begin by making your crystal respond strongly to the test buzzer, and slide the two coils close together. Listen in the headphones carefully, set the antenna or primary tuning condenser at 100 and then swing the secondary condenser slowly back and forth between, say, 60 and 100. If you hear nothing, set the primary condenser at 95 and search again with the secondary condenser. Continue to reduce the primary condenser in five scale-reading steps and swing the secondary condenser more widely through its scale as the primary setting becomes smaller. If your set is working and if there is any station that is transmitting within your range, you should "pick it up" without difficulty. Once you hear a station, find the best positions for both condensers and *write them down.* Try to get similar records for a number of stations throughout the wavelength range that your set covers. It may help you the first time you attempt to pick up these stations if you connect the detector across the entire secondary coil. If you have to do so, you should then tune for the same stations again and record the tuning settings when the midpoint tap X is used. You will be surprised by the improvement in tuning sharpness that the use of this X tap produces.

The Effect of Reducing Coupling

Having prepared a list of stations and their best tuning settings as above, mark it "K maximum" (indicating that it applies when the coils are as close together as possible — i.e., with the maximum coupling) and then go through the process again with the ends of the two coils one inch apart. This will shift the tuning positions on both condensers somewhat, but the earlier records should



THE TEST BUZZER ARRANGEMENT

An old electric door bell will perform the necessary work if the clapper is cut off and wired up, as shown above. When the buzzer is operated, an electromagnetic field around the pigtail will affect the receiving circuit; this affect will be heard in the headphones if the crystal detector is properly adjusted.

be of considerable help to you in locating the stations under this new condition of looser coupling.

You will observe that the tuning will have sharpened up a good deal, and the signals in some cases may be a little weaker. Make a list of the settings for the several stations with "K one inch," for future reference. If this separation of the coils gives you adequate freedom from interference, you need experiment no further. You may find it worth while, nevertheless, to try a coupling distance of two inches or even more, and to reduce the number of turns in the detector portion of the secondary coil.

For your antenna and detector you will find some coupling and X tap position that give the best all around results; and that is where you should conclude your tests. If you "log" the tuning settings for a number of stations under these conditions you can draw a tuning curve such as is shown in Figure 2, which will be of great assistance to you in locating the adjustments for other stations of which you know the wave-frequencies or wavelengths.

Using Coupled Circuits with Vacuum Tubes

You will see at once that the foregoing instructions for operating a two-tuned-circuit receiver apply when you have built up the secondary circuit with a coil such as that described or when you are using the circuit of your old receiver as a secondary. You may have to use some ingenuity in mounting the antenna-circuit coil if you have utilized the old receiver, but this should present no real difficulty if you remember that it is to be arranged next to the secondary coil and with a common center line or axis.

It is perhaps not so obvious that the same general arrangement may be used with a simple or non-regenerative vacuum-tube detector. The vacuum tube is two or three times as sensitive as the crystal, and requires no adjustment of contact points; consequently its use is often well worth while, even though it is more expensive and requires two sets of batteries.

Figure 3 shows a very simple single-tube receiver circuit corresponding to Figure 1 except for the change in the detector. The tap X has been left out, because the vacuum tube ordinarily does not affect sharpness of tuning in the secondary circuit as much as the crystal does; thus it becomes possible to connect its grid-filament circuit across the entire coil without much if any loss.

How to Simplify the Tuning Adjustments

The principle of tuning and loosely coupling the antenna circuit may be applied to practically any receiver from the simplest crystal set, such as that described, to the most complicated super-heterodyne. In most cases the change is well worth while, because of the freedom from spark interference and cross-talk that it gives, even though, as ordinarily applied, it requires the tuning of an additional condenser. With the large number of broadcasting stations now in operation, and with the coming of higher

powered transmitters, increased selectivity is particularly valuable.

It is feasible, moreover, to tune the antenna circuit at the same time and with the same motion that tunes the secondary or closed circuit by using equalized and simultaneously variable, double condensers. That invention (which I described some ten or twelve years ago in connection with commercial radio receivers) provides the ease of tuning that is characteristic of single circuits and besides the high selectivity of multiple-tuned circuits.

In the forthcoming articles of this series I will explain the application of single-control tuning to broadcast receivers of several types in conjunction with the discussions of how to avoid various types of station interference.

The Radio Grouch

THE complaint is now made that free broadcasting is killing the theater. The death radio!

❦

THEY cannot raise money for broadcasting by taxing my patience. My solution to the problem would be to charge saxophonists a dollar a toot.

❦

WITH the movies taking me out at night and the radio keeping me at home, I am always of two minds. And I don't need either of them much. It's a long time between thinks.

❦

I RECENTLY saw a headline, "Explorer MacMillan Breaks Radio Record." Yes, they're making the things more like phonographs every day.

❦

MISS BORI, the opera singer, says she was scared when she faced the microphone for the first time. Introducing to the profession a brand new ailment called "offstage fright."

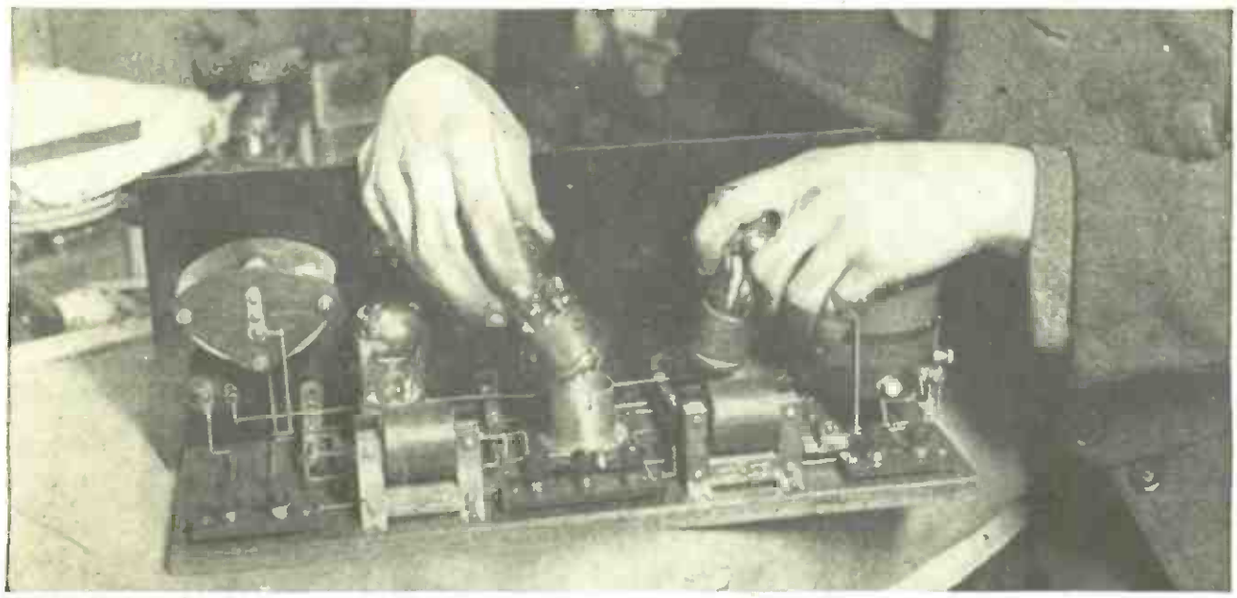
❦

A JOY-KILLING professor foresees the time when "laughter, like alcohol, will have no place in America." This sounds like the dark-brown pessimism of one who has just been listening in on a humorous monologue.

❦

MANY a man who tries to sell himself to his unseen audience only succeeds in giving himself away.

—HOWARD BRUBAKER

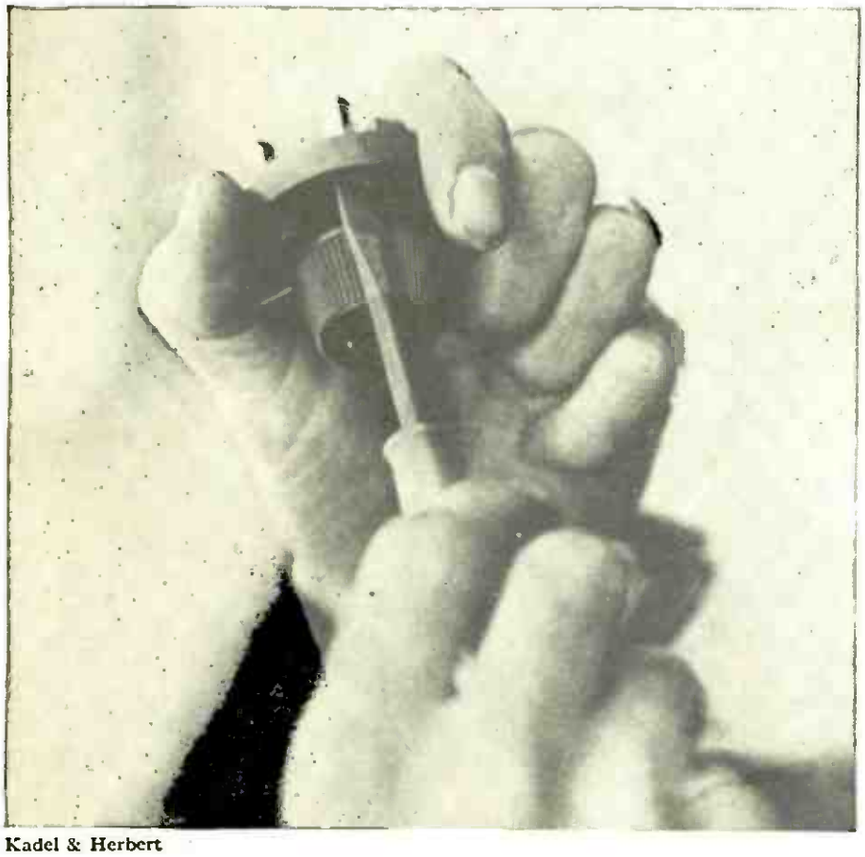


Kadel & Herbert

PUT YOUR TUBES WHERE THEY WORK BEST

1 *By changing your tubes around in the sockets, you will often find some that work better as detectors and others as amplifiers. To avoid mistakes, unscrew two tubes at a time as shown above and interchange them without letting them out of your hands.*

FOUR RADIO WRINKLES



Kadel & Herbert

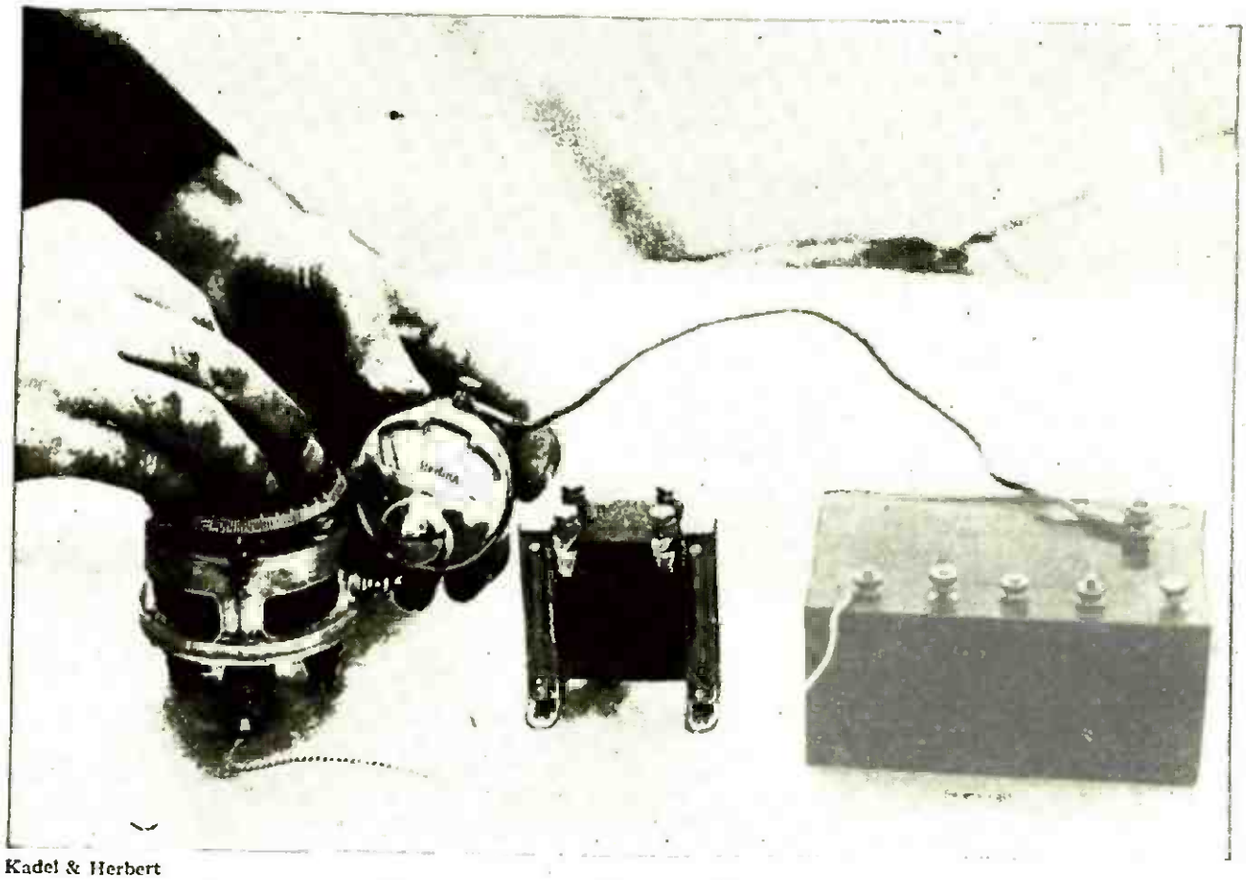
KEEP YOUR RHEOSTAT SCREW-CONTACTS TIGHT

2 *Many rattles in a loudspeaker can be traced to poor connections in a rheostat. When possible, unmount your rheostats and tighten the screws that hold the terminals—as demonstrated in the picture at the left.*

Kadel & Herbert

BEND UPWARD YOUR SOCKET PRONGS OCCASIONALLY

3 *Removing and replacing tubes gradually weakens the tension of the socket prongs against the tube legs. By bending the prongs upward with a screw-driver, as shown in the picture at the right, you will prevent current losses that cut down the range of your receiver.*



Kadel & Herbert

WATCH FOR "SHORTS" IN YOUR VARIABLE CONDENSERS

4 *It is a wise precaution to test the plates of your variable condensers in the manner shown in the picture. Attach a battery in series with a voltmeter, and stator and rotor plates; then rotate the condenser dial very gradually. Watch the meter needle. Should it deflect, you will know that your condenser plates are making contact at the point indicated by the condenser dial.*

From a photograph made for POPULAR RADIO

TUNING THE TRIRDYN

The two controls conveniently placed allow for easy tuning. The small knob in the center of the panel controls regeneration and seldom has to be reset.

HOW TO GET THE MOST OUT OF YOUR READY-MADE RECEIVER

No. 4: THE CROSLEY TRIRDYN

This series of articles explains the theory, operation, equipment and care of standard receiving sets

This series does not indorse the product of any manufacturer or make comparisons between receivers. The sets already described include: No. 1, the Eagle Neutrodyne; No. 2, the Radiola Superheterodyne; No. 3, the Melco Supreme Receiver.

By S. GORDON TAYLOR

THE Trirdyn is a receiver that is especially designed for economy in first cost and in upkeep. The circuit of this set is so arranged that three vacuum tubes perform the function of five, thus saving the cost of two tubes and greatly reducing the battery current consumption. This saving in tubes is accomplished through the use of both the regenerative and reflex principles.

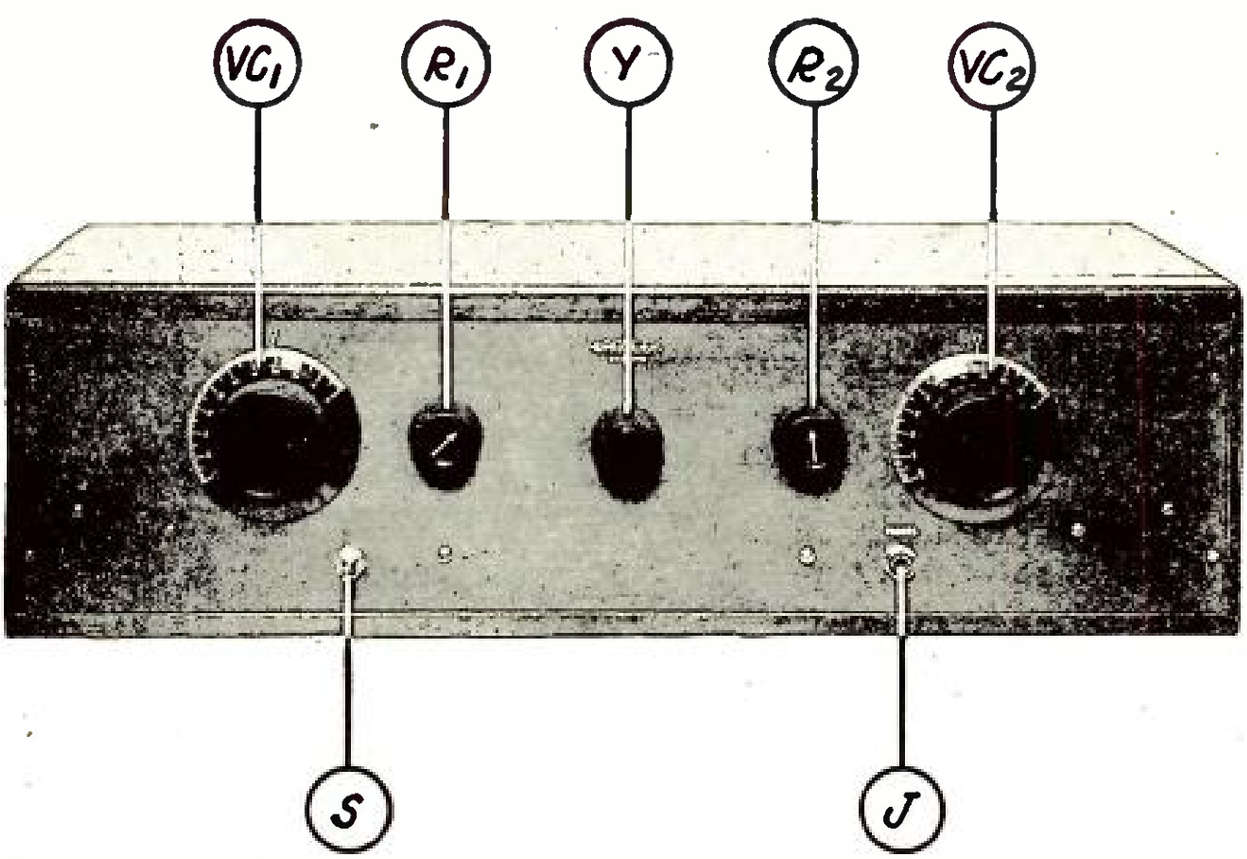
In Figure 2 you will notice that the antenna binding post 1 is connected to one end of the coil L1 while the other end of this coil goes to the ground connection. Thus the radio energy, which is intercepted by the antenna, passes through coil L1 and thence to the ground. The energy from the antenna does not pass directly through the entire receiver, but only through this one coil. However, coil L2 is within the magnetic field of coil L1, and by induction, a cur-

rent flow is set up in L2. This induced current in L2 makes the first vacuum tube function through the connection to the grid (the zig-zag line of VT1).

By the action within a vacuum tube a small amount of energy in the grid circuit is amplified so that the plate-circuit current becomes much greater. The tube itself cannot supply this additional current, but it does control the flow of current from a high-voltage battery that is called the "B" battery. The supply of current to the grid circuit of VT1 is therefore amplified, the amplified current flowing from the 90-volt "B" battery, through the primary of AFT2 and coil L3, to the plate of the tube.

As L4 is in inductive relation to L3, it has a current set up in it, which provides the input energy for VT2. By this somewhat indirect method the input energy to VT2 is much greater than the energy obtained from the antenna, because VT1 amplifies this current. VC1 and VC2 are put in the set so that the circuits may be tuned to resonance with the frequency (or wavelength) of a transmitting station, and thus prevent interference from other stations. VT2 is the detector tube, and the grid-condenser and grid-leak shown at C1 and R3 are provided to facilitate the detecting action of this tube.

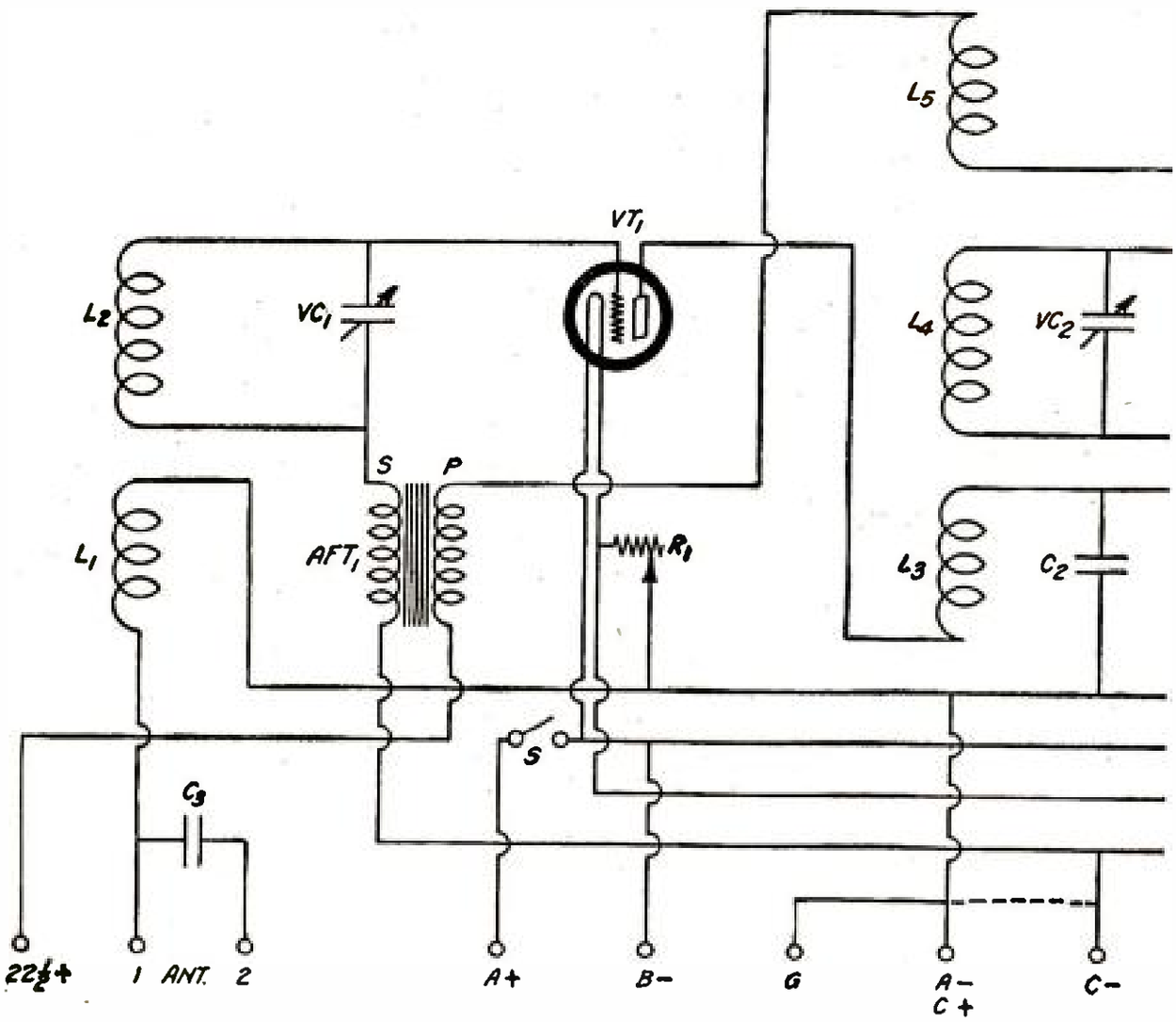
Before the energy from an incoming wave reaches the detector tube, it is a high-frequency alternating current with a frequency from 500,000 to 1,500,000 cycles (alternations a second). What this frequency is depends upon the frequency of the transmitter to which the receiver is tuned. These frequencies are far above the band of audible frequencies. However, the detector's function is to change this high-frequency alter-



From a photograph made for POPULAR RADIO

FRONT VIEW OF THE SET

FIGURE 1: *The symbols used are the same as those used in Figure 2, except that in this case they indicate the dials and knobs which control the instruments represented by the symbols. The only variation is in the case of the knob Y, which is provided for the purpose of varying the coupling between coils L4 and L5.*



nating current into a somewhat different form so that it becomes capable of operating the electrical mechanism of a headphone or loudspeaker—instruments that convert electrical energy into sound energy. When headphones are connected into the plate circuit of a detector tube, the received signals become audible, although, of course, comparatively weak.

By a process known as regeneration, energy is transferred from the plate circuit of the detector back to the grid circuit of the same tube and through the tube again; in this way the volume of the signals is built up through the amplifying action of the vacuum tube.

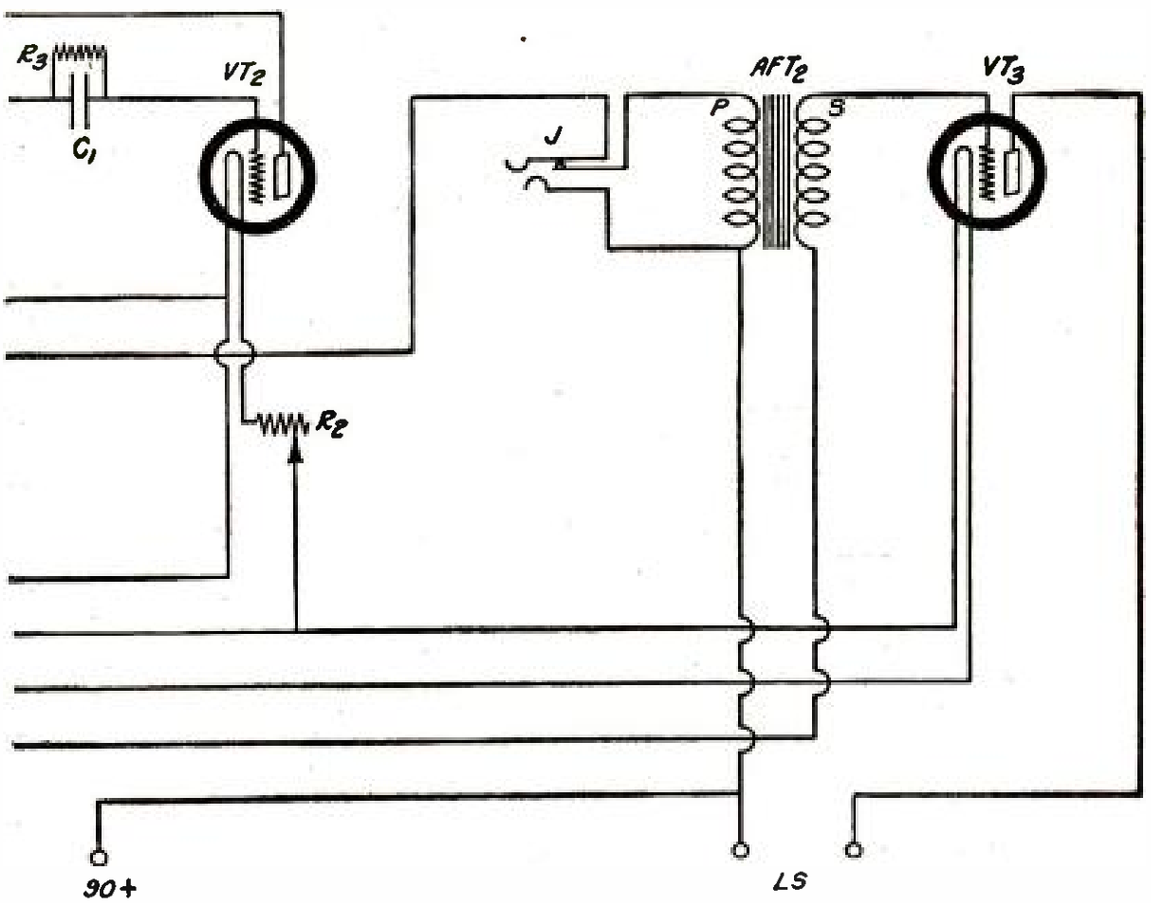
In the Trirdyn receiver this is done by means of coil L5, in the detector plate circuit, which is placed in inductive relation to coil L4 of the grid circuit. This energy is passed through the detector tube over and over again, within practical limits. The amount of "feedback" is regulated by varying the coupling between the coils L4 and L5.

Coupling that is too close permits too much energy to feed back which causes oscillation (a condition which evidences itself by distortion, noise and whistling in the loudspeaker or headphones). On the other hand, if the coupling between L4 and L5 is too loose, there will be little "feed back" or regenerative action. Proper adjustment of the coil L5, that is accomplished by moving the knob Y in Figure 1 in or out, gives a good degree of amplification. Through this process the detector tube becomes equivalent to two tubes—a detector and an amplifier.

The use of the regenerative principle not only increases the volume of signals

HOOK-UP OF TRIRDYN RECEIVER

FIGURE 2: *This is a schematic wiring diagram of the receiver. The symbols shown for the various instruments correspond with those shown in the illustrations.*



(audio-amplification) but also makes the receiver much more sensitive, and permits greater distances to be covered. In this latter respect regeneration also produces radio-frequency amplification.

Regeneration, therefore, provides somewhat the same advantage as two extra tubes—one an audio amplifier and the other a radio-frequency amplifier.

Instead of connecting headphones in the plate circuit of the detector tube, the primary of an audio-frequency transformer is connected there. This is an instrument used to provide coupling between the detector and audio-amplifier tube and to step up the voltage of the detector output circuit, thus contributing to the amplification.

In the case of the Trirdyn the primary of the transformer is shown at P of AFT1 in Figure 2. By induction the energy is transferred to the secondary S of this transformer and is then impressed on the grid of the first audio-amplifier tube VT1. Thus VT1, which serves as a radio-frequency amplifier before detection, is also made to serve as an audio-frequency amplifier after detection. This is the reflex principle that dispenses with one more tube in this receiver.

From the plate of VT1 the audio-frequency current flows through the coil L3 to the jack J and at this point the headphones may be inserted if desired. If the headphones are not inserted in the jack, however, the middle arm of the jack makes contact with the top arm and the current flows on and through the primary of the second audio-frequency transformer AFT2. The voltage induced in the secondary S is then impressed on the grid of the last tube VT3, where further audio amplification occurs. The

loudspeaker is connected to the binding posts marked LS and the output of VT3 passes through the loudspeaker mechanism, and audible signals of good loudspeaker volume are produced.

Figure 11 shows a schematic arrangement of this tube-saving circuit in which the radio-frequency unit and the detector unit do double duty. Figure 10 shows a schematic layout of a similar circuit where each function is performed by a separate unit. This provides a good "picture" of the reflex and regenerative principles.

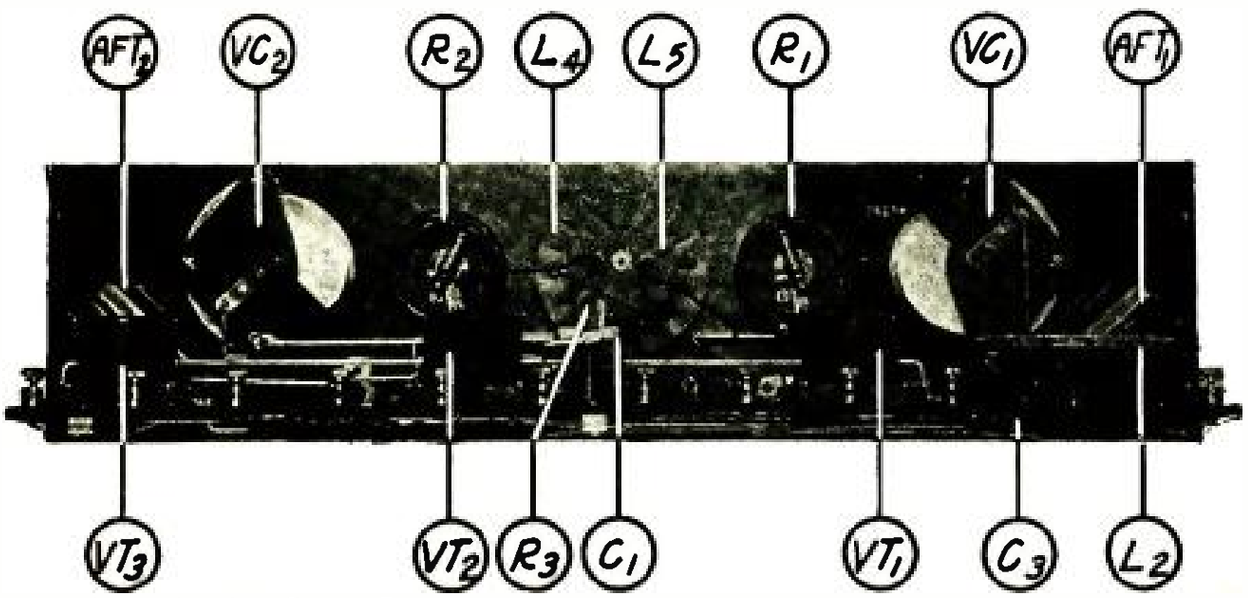
The Trirdyn receiver is constructed with simplicity and economy for a goal, which you can readily see in Figures 1 and 4 where the "works" are shown when removed from the cabinet. The batteries, antenna, ground and loudspeaker are connected to the binding posts on the sub-panel at the rear of the receiver. The leads for these connections enter the receiver through holes in the back of the cabinet through which scheme no wires are visible at the front of the receiver—not even the usual loudspeaker cord.

The coils of the Trirdyn are specially wound and are of the so-called "pancake" or "spider-web" type. Coils L1 and L2 are wound on a single form, and L3 and L4 on another one. L5 is on a form by itself. It is mounted with its plane parallel to that of L3 and L4, and is so arranged that it may be moved toward or away from L3 and L4. In this manner the necessary variation of coupling to control regeneration is accomplished as explained above.

The rheostats R1 and R2 are used to control the current flow from the "A" battery through the filaments of the vacuum tubes. R1 controls the filaments of VT1 and VT3, while R2 controls that of VT2. The battery switch S turns off the receiver by disconnecting it from the batteries. The rheostats do not need to be turned off.

The Trirdyn receiver is designed primarily for use with an outdoor antenna. It can also be used with an indoor antenna, but reduced volume and sensitivity will result.

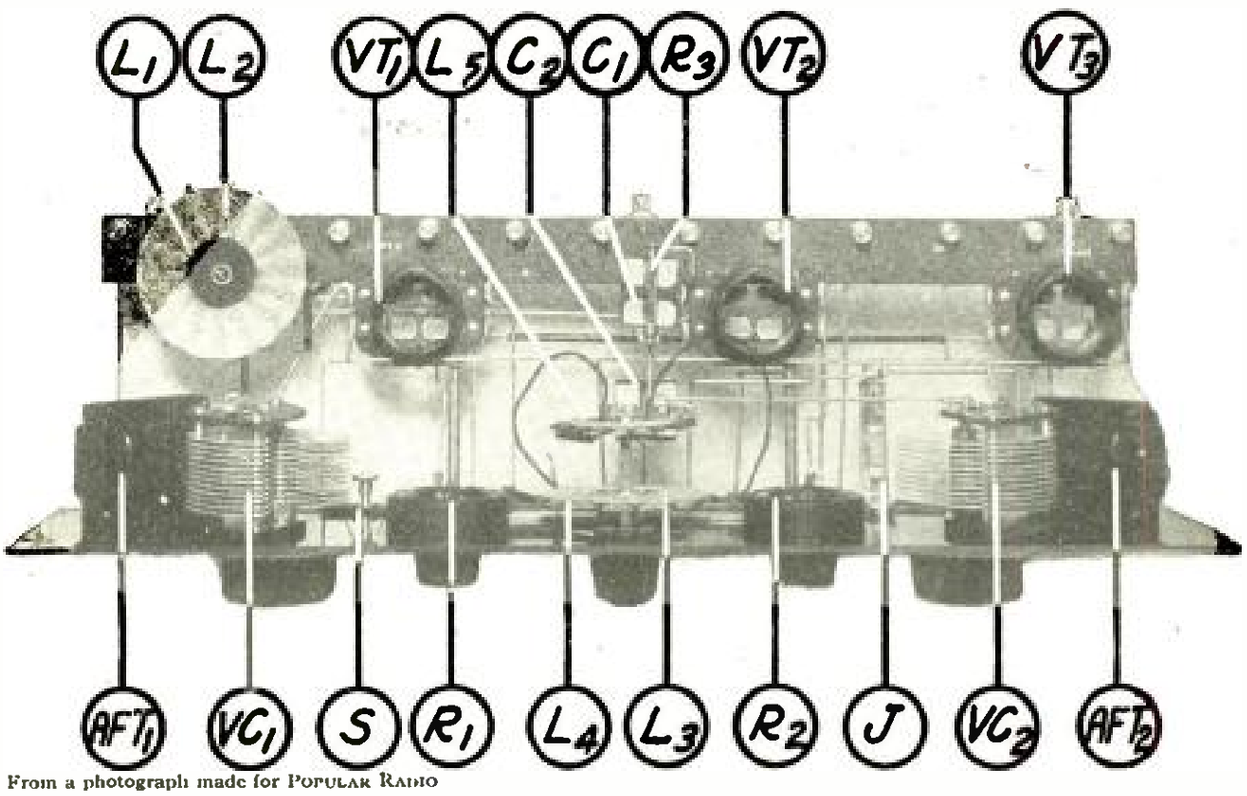
A single-wire antenna from 75 to 150 feet in length will give excellent results but length will depend very largely on a particular set of conditions. An antenna of 100 feet or more in length used with many receivers tends to broaden tuning



From a photograph made for POPULAR RADIO

THE REAR VIEW OF THE RECEIVER

FIGURE 3: *As the set looks when removed from its cabinet. By comparing this illustration and its symbols with Figure 2 you will have a good idea of the function of each of the parts of the receiver.*



From a photograph made for POPULAR RADIO

AS SEEN FROM ABOVE

FIGURE 4: *The top view of the receiver that shows the actual location of the instruments and arrangement of the interior.*

to the extent that a powerful local station will be heard even when the receiver is tuned to the wavelength of another station. In the Trirdyn this is overcome by two connections for the antenna. Ordinarily the antenna binding post 1 is used. With it volume and distance will be best.

However, if there is interference from local stations, the antenna can be shifted over to binding post 2. Tuning will then be sharpened so that even distant stations may be heard without interference from local stations. This advantage is obtained because, by attaching the antenna to binding post 2, condenser C3 is put in series with the antenna. This change in the circuit has the same effect as reducing the length of the antenna. If you use a short outdoor or indoor antenna, attach it to binding post 1.

A suggested layout for an outdoor antenna is given in Figure 5. In this diagram the end of the antenna is shown fastened to a support erected on a roof so as to give the antenna a greater average height. In such a case the lead-in may be brought down parallel with the wall of the house, but not nearer than six inches and preferably two or three feet from the wall. The length of the antenna is measured from the insulator at the far end to the point where the lead-in is taken off. In the antenna illustrated in Figure 5, the length would be measured from one insulator to the other.

The binding post G at the back of the receiver is to be connected to the ground. The ground connection may be made satisfactorily to any metal connection with the earth. A cold-water pipe serves this purpose as well as anything, because it runs through the ground before entering the house. A steam radiator and a hot-water pipe are usually good also, as these connect to the cold-water pipe line at the boiler. If nothing like these are available, bury a quantity of heavy copper wire in moist ground, or drive an iron pipe about six feet into the ground.

Although the chance that lightning will strike the antenna is remote, it is nevertheless advisable to play safe by installing a lightning arrester, which costs about $1.00. By means of the arrester the lightning, if it should happen to strike the antenna will pass through the arrester down to the ground without touching the receiver. An arrester is shown in Figure 5.

Any standard, hard vacuum tube may be used in this receiver, providing the proper "A" battery is used in conjunction with it. Best results will be obtained with UV-201-a or C-301-a tubes because they give greater efficiency and considerably greater volume than dry-cell tubes. These tubes operate on a storage "A" battery.

WD-12 or C-12 tubes may also be used with this set as the sockets in it are standard. If UV-199 or C-299 tubes are used, however, it will be necessary to use adapters to furnish the proper connections between these tubes and the standard sockets. These adapters can be purchased in any radio store for a small sum. They are slipped into the sockets before the tubes are inserted.

APPROXIMATE LIFE OF "B" BATTERIES WITH THE TRIRDYN RECEIVER

"C" Battery Voltage	"B" Battery Voltage	
	67½ Volts	90 Volts
None	1.95	1
1½	3.11	1.44
3	5.53	2.21
4½	10.84	3.06

THE COMPARATIVE LIFE OF "B" BATTERIES

The life of the "B" batteries is shortest with no "C" battery when 90 volts is used. Using the same "B" battery voltage, but connecting the 4½-volt "C" battery increases the "B" battery life over three times. Or if only 67½ volts of "B" battery is used without a "C" battery the "B" battery life will be almost double that when 90 volts is used without the "C" battery. These figures do not take into account the deterioration of the battery when not in use but they give a good idea of the economy of using as low "B" battery voltage, and as high "C" battery voltage, as will still permit proper volume of signals. The life of the "B" battery when 90 volts is used without a "C" battery should be approximately four months, if the receiver is used an average of two hours a day.

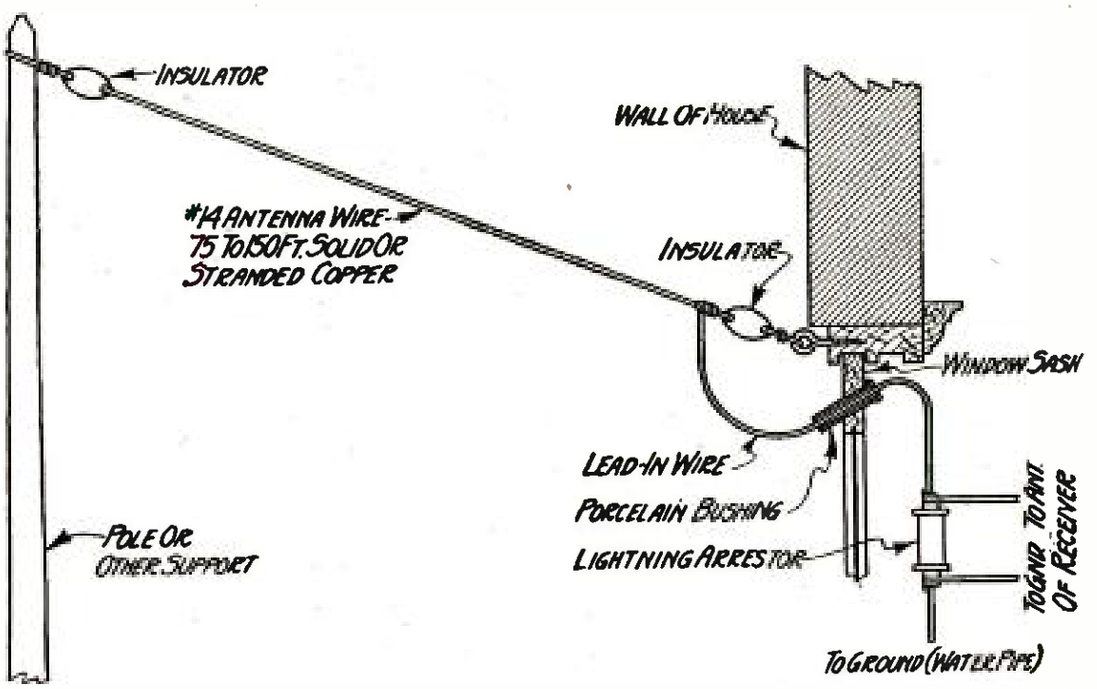
After the receiver is in operation, and a broadcasting station is tuned in, you should shift the tubes around from one socket to another until each of the three tubes has been tried in each of the sockets. You will sometimes find that one tube will work better in one socket than in another, and by changing tubes around in this manner you will discover the best combination. It is understood, of course, that the three tubes must all be of the same type, for, it is impossible to use one UV-201-a in the first socket, a UV-199 in another, and so on. However, there is no objection to using UV-201-a with C-301-a tubes.

Three types of batteries are used in this set. They are called the "A," "B" and "C" batteries.

Assuming that UV-201-a or C-301-a tubes are used in the receiver, the "A" battery must be a 6-volt storage type with a rated capacity of from 75 to 150 ampere hours. Lower capacity batteries such as the 75 ampere-hour type, which are low in cost, are quite suitable for this receiver because the current consumption of the tubes used is low.

An important storage-battery accessory is a hydrometer—which is much like a fountain pen filler except that it is considerably larger and contains a small float that has a graduated scale on it.

To test the condition of charge of the battery, you insert the nozzle of the hydrometer through one of the holes at the top of the battery and into the liquid within. By squeezing the hydrometer bulb and then releasing it, some of the battery liquid will be drawn up into the glass tube. The graduated scale inside the hydrometer tube will then be found to float. If the battery is fully charged, the scale marking on a level with the top of the liquid should be approximate-



HOW TO INSTALL THE ANTENNA

FIGURE 5: *This is a suggested antenna arrangement for use with this receiver. The antenna should be kept as clear from trees and surrounding buildings as possible. If necessary the antenna may be supported between two poles on the roof, preferably not less than ten feet above the roof. In such a case arrangement should be made to hold the lead-in at least three feet out from the wall.*

ly 1,285. A fully-discharged battery will give a reading of about 1,150. The battery should never be allowed to run down to the point where it is fully discharged. When the hydrometer reading is down near 1,200, you should charge your battery. Try to keep it charged enough so that the hydrometer will register between 1.200 and 1,285. If this is done the life of a good battery should be several years.

The battery may be taken to a local battery charging station to be recharged, but the most practical plan is to do the charging at home, if the house is supplied with electric lighting current. Where the lighting current is alternating (AC) it will be necessary to purchase a standard charger, an instrument which rectifies the alternating current and steps it down to the proper voltage. The method of connecting this rectifier with the house current and the storage battery is explained in Figure 6.

If the house lighting current is direct (DC), however, it is only necessary to use a sufficient charging resistance. Such a resistance may be purchased, or a bank of electric lamps may be used as shown on page 269 of the March, 1925, issue of POPULAR RADIO.

The liquid in the storage battery is a strong solution of sulphuric acid and water. Precautions should therefore be taken to prevent it from spilling on rugs, floors or furniture. A good plan is to stand the battery on a small rubber mat to protect the floor. If any of the electrolyte, as the battery fluid is called, should spill, it will fall on the rubber mat which it cannot injure. With the exercise of a little care there is little likelihood of damage to anything from the battery.

When UV-199 or C-299 tubes are used, a storage battery is unnecessary. Ordinary No. 6 dry-cells, like those made for operating doorbells, are used for these types of tubes. The 199 or 299 tube requires a battery voltage of 4½, and inasmuch as the voltage of a dry-cell is 1½, it is necessary to connect three such cells in series as shown in Figure 8. The estimated life of the

three cells is from two to three months when the receiver is used an average of two hours a day. If it is used more than this, the battery life will naturally be shorter, and longer, of course, if used for a shorter period daily.

When you use 1½-volt tubes like the WD-12 or C-12, you should use three dry-cells, which should be connected in parallel as shown in Figure 9. This battery hook-up will provide a total of only 1½ volts, but its capacity will be much greater than a single dry-cell of 1½ volts. The three cells last much more than three times as long as a single cell and are therefore more economical.

A battery charger or charging resistance is unnecessary when you use dry-cells.

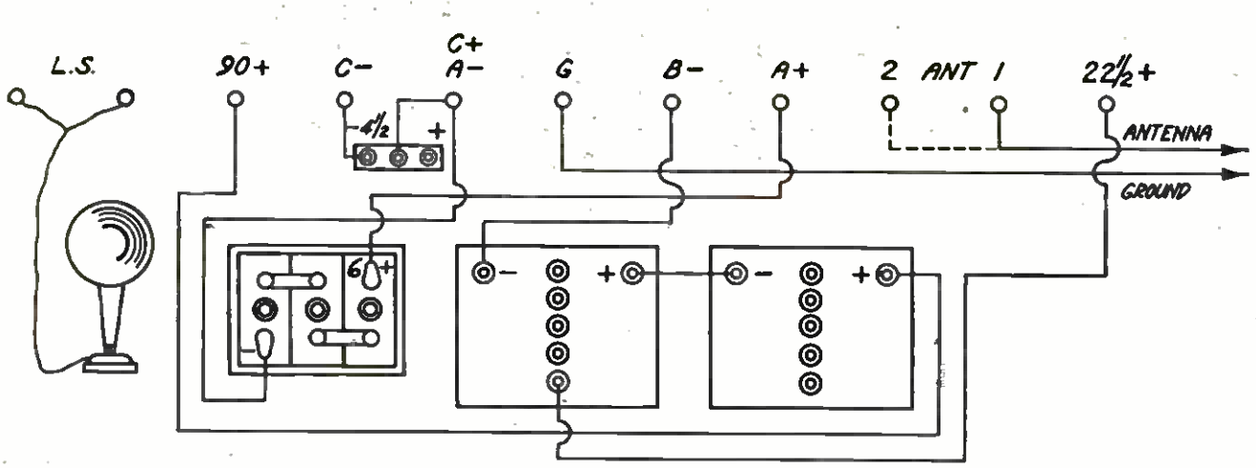
The "B" batteries used in this receiver are of the same type and voltage regardless of the type of tubes that are selected. Use two large size 45-volt batteries, connected in series to provide a total of 90 volts. Storage "B" batteries may be used with equally good results.

You may find that 67½ volts will give as good results as 90 volts, especially if you use WD-12 or C-12 tubes. With these tubes it is better to use only 67½ volts, for the smaller the voltage, the longer will be the life of the "B" batteries.

The life of the "B" batteries is approximately the same whether dry-cell or storage-battery tubes are used. The life of the batteries is governed by the amount of voltage in the tube circuit and by the average number of hours a day that the receiver is in use. The table on page 346 will show the approximate comparative life of "B" batteries under various conditions. These figures apply to such batteries as the Eveready No. 767 or the Burgess No. 2,306.

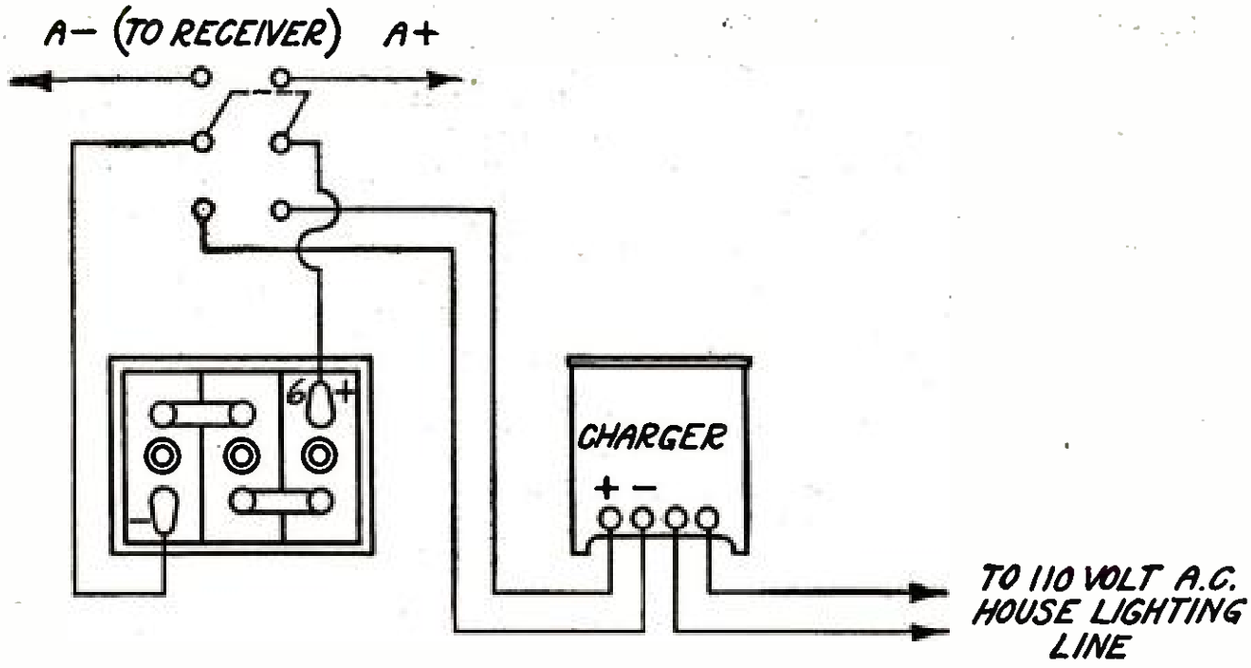
A "C" battery is not absolutely essential, but as a rule the tone quality and often the volume of a receiver can be much improved with this kind of battery. Besides, putting a "C" battery in the tube circuit materially lengthens the life of the "B" batteries as shown in the table above. If you decide to use a "C" battery, cut the small wire loop that sticks up just behind the binding post panel between the C and A (minus) binding posts, and separate the ends of these wires so that they cannot touch. Then connect the "C" battery as shown in Figure 6.

The small dry-cell type of "C" battery that is much like a "B" battery but which is smaller and has only three connections on the top, is the most suitable for the Trirdyn receiver. This "C" battery has a maximum voltage of 4½. The best voltage for this receiver may be determined by experiment. The posi-



HOW THE BATTERIES ARE CONNECTED TO THE RECEIVER

FIGURE 6: *The hook-up of the batteries and accessories is shown above. This diagram shows the connections when a storage battery is used for the "A" battery. If dry-cell tubes are used the storage battery must be replaced with dry-cells, connections for which are shown in Figures 8 and 9.*



THE WAY TO CONNECT THE BATTERY CHARGER

FIGURE 7: *When a storage battery is used, a charger becomes a great convenience. Here the connections for the battery and charger are shown with a convenient switching arrangement. To put the battery "on charge" the switch is thrown to the lower position and the charger input leads are plugged into the house lighting circuit. To connect the battery to the receiver the switch is thrown up.*

tive (plus) tap is connected to the A (minus) binding post of the receiver and the minus 4½-volt tap to the C binding post. While the receiver is in operation, shift the connection coming from the C binding post to the minus 3-volt tap. If the set works better on this post leave it there permanently, otherwise put it back on the 4½-volt tap.

The life of the "C" battery will be longer than that of either the "A" or "B" batteries. The "C" battery lasts approximately for a year.

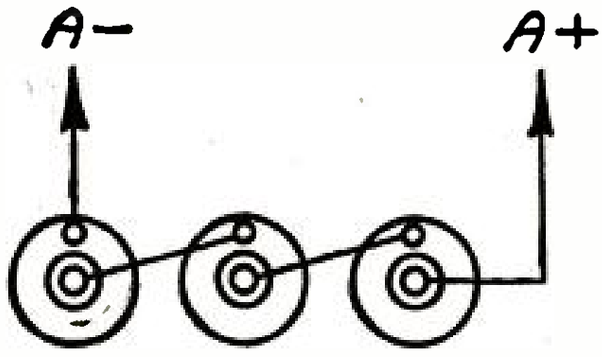
A simple way to test the condition of the "C" battery is to place the tongue across two of the taps. If current flows, as indicated by a salty taste, it is a sign that the battery still has life. When you get no "taste" at the battery terminals, you will know your battery is dead.

Your best results with a "C" battery will be most likely attained through the use of the 3-volt tap when you have 6-volt tubes, and the 4½-volt tap when you use dry-cell tubes.

First connect the batteries, antenna, ground and loudspeaker as shown in Figure 6. Before connecting the "C" battery, however, be sure to cut the small loop of wire that sticks out between the C and A (minus) binding posts. This wire is indicated in Figure 1 by the dotted line. The antenna should be connected to binding post 1 for the first trial.

You will notice that the small condenser C1 is equipped with two clips. These are for the grid-leak R3. A grid-leak does not come with the Trirdyn receiver and in some cases it is not needed. Frequently, however, much better results are obtained by making use of a 2 megohm leak for R3. Such a leak can be purchased at any radio store for 50 cents.

Before inserting the vacuum tubes in their sockets, make sure that the two rheostat knobs are turned as far as possible in an anti-clockwise direction. It is also advisable at this stage to disconnect the wires to the "B" battery which come from the B 22½ and the B 90 binding posts. Then insert the tubes, pull out



A SERIES HOOK-UP

FIGURE 8: *When UV-199 or C-299 tubes are used three dry-cells connected in series are employed for the "A" battery in place of the storage battery shown in Figure 6. These are the ordinary 1½-volt batteries and the proper connections for them are shown above.*

switch S and turn the rheostat knobs about halfway in a clockwise direction. If the tubes light up, it is an indication that the "A" battery connections are correct. The "B" battery can now be reconnected. If the tubes fail to light, however, it is a sign that the battery connections are wrong or possibly that there is a bent contact in the base of one of the tube sockets that prevents one of the tubes from lighting. Check up the battery connections and make sure that the tubes are making good contact with the four springs inside the sockets.

Assuming that all connections are properly made, pull out the battery switch-knob S and turn the rheostats on halfway. The receiver is now ready for operation. The coupling knob Y should be pulled out about halfway and the dial VC1 should be set at about 40. Then rotate dial VC2 slowly until a station or a whistle is heard. If the set whistles, readjust VC1 and VC2 until the whistle is at its lowest pitch. Then push the knob Y in until the whistle disappears. The signal that causes the whistle should then be heard clearly. Once a signal from a broadcasting station is heard readjust the rheostat knobs R1 and R2 until the volume of the loudspeaker is at its best. Then slightly readjust the dials VC1 and VC2 and the knob Y.

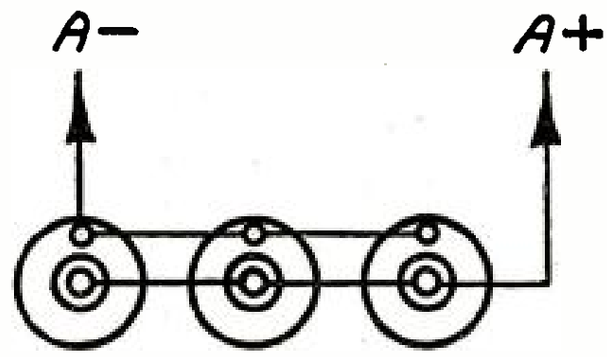
If nothing is heard as you adjust VC2 when VC1 is set at 40, move VC1 to 50 and repeat the adjustments. Continue to tune by trying dials VC2 and VC1 at different settings. If there are any broadcasting stations operating at the time within the range of the receiver, they will be heard when you reach some point on the dials. If you find that several stations are operating and more than one can be heard at a time, change the antenna connection from binding post 1 to binding post 2. This will allow for greater selectivity.

A little practice will soon give you the knack of tuning. After you become more familiar with the operation of the set, try varying the voltage of the "B" and "C" batteries as explained in this article under the heading "The Batteries That Are Required." Through these try-outs you will find the battery combination that gives the greatest volume with good tone quality.

Adjust the rheostats so that the filaments are lighted as dimly as possible and yet not so low that they prevent good volume.

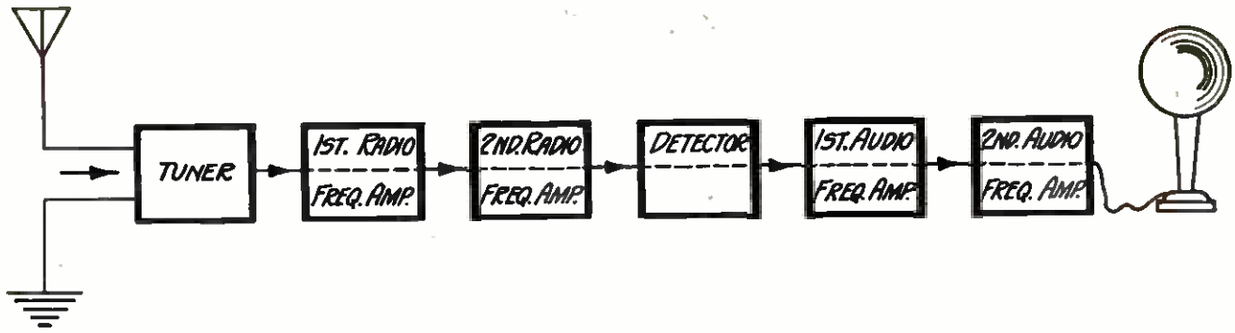
To turn the receiver off, push in the knob of switch S. This movement breaks the battery circuits automatically. The rheostats then remain unchanged and need not be readjusted the next time you use the set.

When you tune in a broadcasting station with the best volume, make a note of the settings of dials VC1 and VC2.



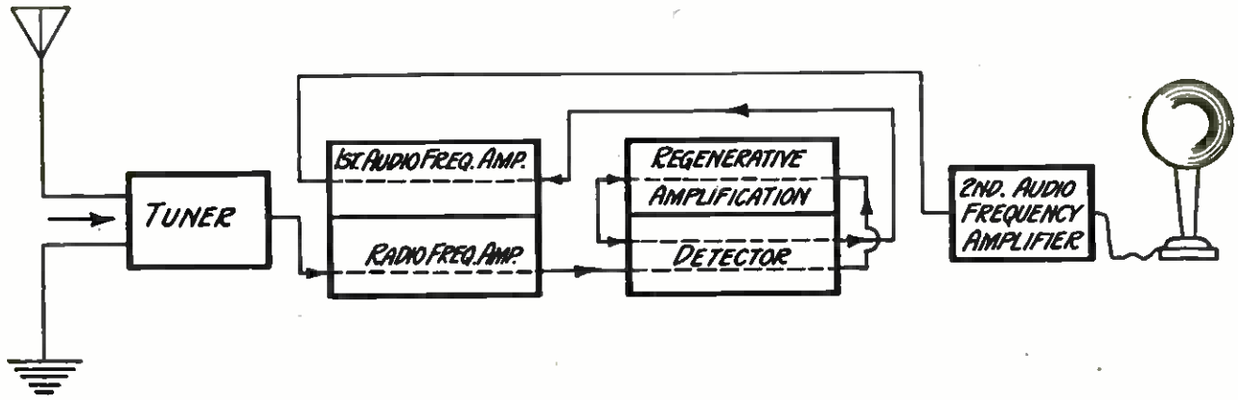
A PARALLEL HOOK-UP

FIGURE 9: *Here are the proper connections for the dry-cells that are used instead of the storage battery in Figure 6, when WD-12 tubes are employed.*



HOW THE ORDINARY RECEIVER WORKS

FIGURE 10: *The schematic arrangement of the units in an ordinary receiver using both radio and audio-frequency amplification is shown above. In this case each unit is distinct from the others.*



HOW THE REFLEX ARRANGEMENT OPERATES

FIGURE 11: *This diagram shows a receiver such as that in Figure 1, but in this hook-up two of the units do double duty. The first tube serves for both radio-frequency and audio-frequency amplification and the detector tube also serves as an amplifier.*

When you want to pick up this station again, all you need do is to set the dials at the positions indicated by your notations. But, you must use the same antenna connected to the same binding post as when the station was first tuned in. Different adjustments of the knob Y tend to change slightly the setting of dial VC2. In tuning in a station after it has once been "logged," you may find that the setting for dial VC2 has changed slightly, but this variation will not be enough to prove troublesome. By setting the dials according to the records you have taken for various stations these stations will be heard but a slight variation of VC2 may be required to compensate the variations of Y.

Different antennas and different antenna connections at the binding posts will affect the settings of dial VC1 but they will not effect the other dial. Therefore, it is well to note on the tuning chart or "log" the antenna connection that was used for each station you recorded.

The Next Simple "How-to-Build" Article

IN *the May issue of* POPULAR RADIO *Mr. Cockaday will tell how to construct a single-tube, four-circuit tuner that can be used in conjunction with the three-stage amplifier that was described in the March issue. This article will have a panel drilling plan besides the usual illustrations.*

WILL RADIO HELP OR

"It will help it," answers JOHN L. GOLDEN, the well-known producer, "for the following reasons—"

"WHAT is your idea of boosting radio when it's your biggest business rival?" my associates in the theatrical business keep asking me.

My answer is, "Radio is not my business rival. On the other hand, it is—or at least it can be made—a valuable and powerful ally in the business of popularizing legitimate drama."

And as evidence of the sincerity of my belief I began my experiment by broadcasting an entertainment that was staged by the members of the cast that is playing "Pigs." And that experiment has been eminently successful from the box-office standpoint—despite the fact that it was "viewed with alarm" by many of my fellow-producers.

Behind that experiment is a theory. The germ of it was planted in the summer of 1922, when the nightly outdoor concerts of the Philharmonic Orchestra were broadcast, by means of wire connections, from the Lewisohn Stadium in New York through station WJZ*. This experiment, which was the pioneer of its kind, was of special interest to me because it furnished the first evidence of the effects that the broadcasting of a public performance might have upon the paid attendance.

Up to the time that the performances were broadcast the paid attendance at the performances averaged something above 4,000. But as soon as the concerts were broadcast the paid attendance began to climb markedly. Within two weeks it reached the record of 15,000.

Never in his twenty years of experience as a Chicago theater manager, states "Steve" Trumbull, has any one feature helped patronage as the recent broadcasting of the play "Abie's Irish Rose." He

* This successful experiment, originated by POPULAR RADIO, was carried out by the engineers of the Westinghouse Company with the collaboration of the Western Union Telegraph Co.

HURT THE THEATER?

International

"It will hurt it," replies WILLIAM A. BRADY, the dean of the producers—for reasons stated on page 354

reports that by actual count at the box office, 2,876 persons mentioned they had heard "Abie" over the air. All of them had heard the play in the ether not more than forty-eight hours before appearing at the ticket window.

A short time ago the talking machine people arranged to have two of their operatic stars, John McCormack and Lucrezia Bori broadcast songs from one of the big stations. The sales of records were reported to have shown an immediate increase.

That made me think. Apparently radio was destined to have an effect upon the concert and dramatic stage. How can the stage profit from it?

I believe that there is a large part of the public which has never been especially interested in the theater. I believe that from that army it is possible to draw the patronage which will fill our houses. And I believe that radio is the ideal means of reaching these people and interesting them not only in the stage itself, but in the vital problems with which the stage deals.

The movies originally offered much more of a challenge to the spoken drama than does radio. Yet I do not consider that the movies have had a harmful effect upon the stage. They have brought a knowledge of acting to thousands who had none before. Certainly they have enormously increased attendance at theaters. In Chicago, where the theaters are open on Sunday nights, the audiences are composed largely of the overflow from the motion picture houses; many of them are people who never would have gone to the theater if they had not been educated to the drama by the pictures.

On my desk is a pile of some hundreds of letters received after my experiment with the "Pigs" company program. These contain overwhelming evidence that my

theory is right. Here is one, for example:

"I have just listened to your address over the radio from station WOR and thank you and your company for the pleasure it gave me. . . . Radio will never harm good drama; on the contrary it will be a fine medium for exploitation. Take my own case, for instance; tomorrow I am going to the Little Theater and get two tickets for 'Pigs.' It was tonight's radio talk that made me want to see it."

A White Plains merchant writes:

"Three out of the five customers who were in my store when your program came through became interested enough to go out and purchase tickets for the show."

These are only two out of scores of similar letters that have reached me. I regard them as concrete results that show which way the wind is blowing.

Radio is here to stay; all the theatrical producers in the world cannot knock it out. I do not believe that it would serve the interests of the stage to do so. I believe that radio can be developed as a tremendous agency for the promotion of the spoken drama.

As far as I am concerned—and I can speak only for myself—I welcome the radio as an important ally.

"Radio Will Affect the Theaters Just as the Films Did"

By WILLIAM A. BRADY

I AM for the radio. I am in the "fan" class, too. In my New York home I have the very latest in receiving apparatus, and no boy of twelve, picking up his first clear message through the medium of a home-made set, could get more of a kick out of it than I do.

But I am a theatrical producer also, and it is one thing to admire frankly the strides made by radio and another to sit by complacently while radio steadily undermines the foundations of a structure which has been a century in the rearing—the building up of legitimate theatrical enterprises in the United States.

I have been designated variously as "calamity howler" and "the alarm clock." Well and good. If, in those rôles I can make enough noise to wake the apathetic, short-sighted producers whose vision ends at the tips of their noses, the title will rest comfortably upon me. If I can arouse these people to the realization that there is such a thing as brotherhood in business and that without it they are headed for the slag heap, I shall feel that I have accomplished something worth while.

The coming of radio presents a problem somewhat similar to the coming of the motion picture.

Thirty years ago the motion picture business was struggling for a place in American commerce. At that time it would have been easy for the theatrical people to have absorbed it entirely or to have worked out a scheme of co-operation which would have given them at least an even break. But they only laughed at the idea of motion pictures having any serious effect upon an institution so firmly established as the drama.

Let's see what happened.

My introduction to the movies was in 1892 when I had Jim Corbett (who had just beaten John L. Sullivan) under contract. One day I received a telephone call from the Edison people in Orange asking me if I would permit Corbett to box six rounds before the "kinetoscope." The promoters offered $1,500 for Corbett's services. I agreed to the proposition but raised the price to $3,000. For that sum Corbett boxed six rounds with a fighter named Jim Courtenay. That was the beginning.

The first real battle to be pictured successfully by artificial light was between Jeffries and Sharkey and this was done by the old Biograph Company. The pictures aroused a good bit of interest and curiosity and were shown in connection with theatrical performances.

It was then that I began to talk to producers and warn them that the pictures

Foto Topics

BROADCASTING A MUSICAL COMEDY FROM THE WINGS

The microphone that picks up the sounds is usually installed "offstage," although sometimes it is located with the footlights or suspended overhead. Here is shown the operators who regulate the volume of production and who do the announcing.

were going to cut deeply into theatrical profits. But they (as now) sat back, smiled self-satisfied smiles, and laughed at my fears. Even when there came from Chicago the startling news that "Ben Hur," then a popular success on Broadway, had been filmed and the pictures were being circulated in the central and western states, they saw no menace. Soon afterward my own success, "Way Down East," was subjected to the same treatment. In this case, as well as that of "Ben Hur," when we questioned the right of the motion pictures people to thus steal our copyrighted ideas and material, we were told to go to the devil.

At the same time a bill was introduced in Congress permitting any picture producer to film any copyrighted play on the payment of a maximum price of $5,000 to the holder of the copyright. A party of us went to Washington and managed to get this measure killed. A sidelight on this question can be found in the fact that in 1921 D. W. Griffith paid me $175,000 in cash for the film rights to "Way Down East," which had been stolen fifteen years earlier and produced by one of the pioneer movie concerns.

As a justification for my fears, I would point out that there is today no first-class theater offering spoken drama in any of the following states: Wyoming, Texas, Arkansas, Kansas, Colorado, North Dakota, South Dakota, Montana and Idaho! And the production of spoken drama has fallen off 90 percent in Massachusetts, Connecticut, New Hampshire, Vermont, Kentucky, Tennessee, Mississippi and Alabama! In Maine the reduction has

been 95 percent. In the following cities there is not one first-class theater producing legitimate plays: Lynn, Lowell, Lawrence, Brockton, Taunton, Fall River, South Bend, Erie, Terre Haute, Evansville, Sioux City, Duluth and a lot of others of almost equal importance. In the old days we could take a Broadway success and clear hundreds of thousands of dollars in these very cities. Now they are *dead*—their first-class theaters given over exclusively to pictures!

That is my answer to those who criticized me for being an "alarm clock" on the movie question.

. . . . . .

Now the radio people are broadcasting the lines and music of plays—lines and music on which we hold copyrights and which we have made popular by expensive exploitation. For the privilege they pay nothing. Our copyrights are meaningless. Actors under contract blithely do their stuff for the radio while we advertise them and pay them ample salaries for their services.

The radio folks insist that their right to use our material lies in the fact that they are not broadcasting for profit—that there is no box office. Which is pure rot. If they cannot supply attractive programs they cannot sell their equipment. What is easier than picking up a play which has the advantage of having been tried and proved to be popular?

What would happen if various radio patents were appropriated by anyone who chose to do so and applied to a competitive business? I fancy there would be somewhat of a howl from the very people who are now appropriating the copyrighted property of theatrical producers. But I cannot see why the procedure would not be quite as fair.

Somewhere there is a solution to this problem. The radio people are having their troubles as the motion picture producers did at the start. The process of killing off the little fish will be much the same; it is under way now.

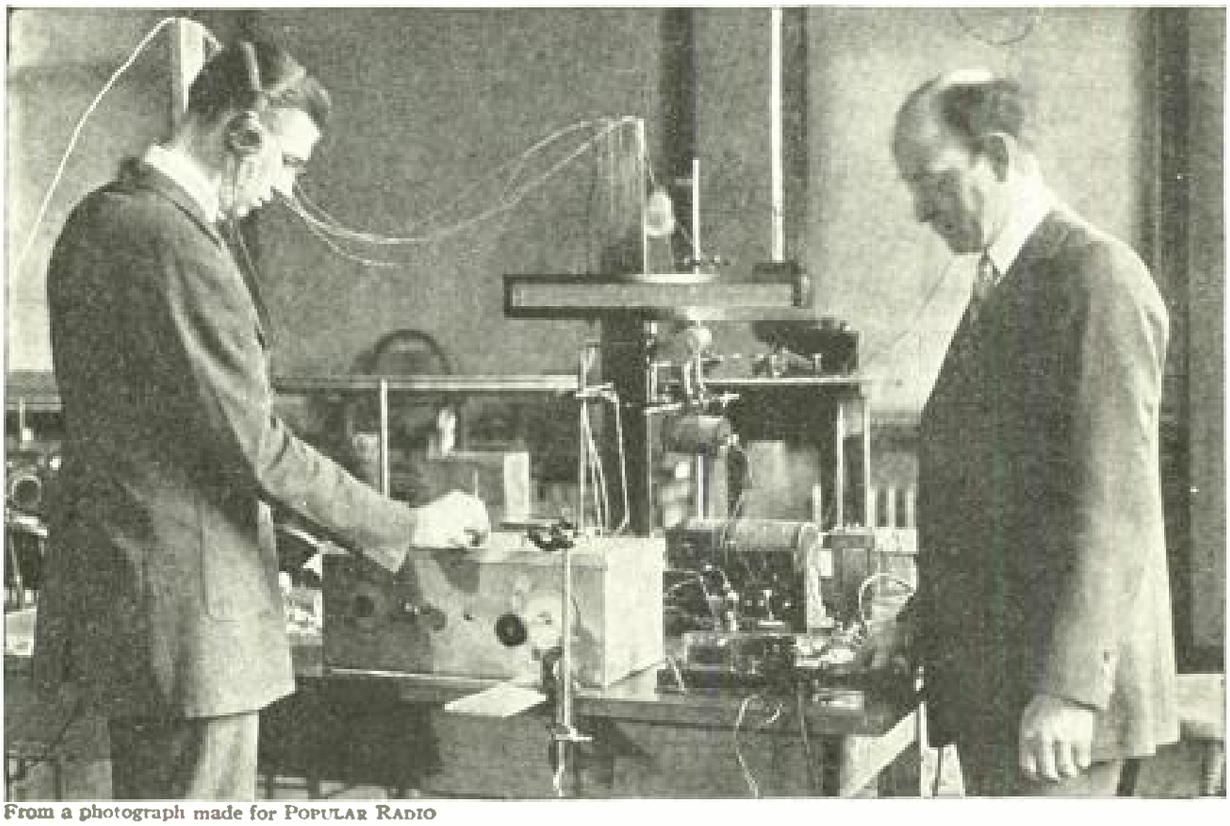
I want to see radio developed. Instead of fighting it, we should work out plans of mutually advantageous co-operation. The men who are making radio history are fair and decent and would welcome an equitable adjustment. They have their problems too. We theatrical producers are willing to meet them halfway, to give them certain things which they require, provided that we are justly compensated.

But until we do, radio is hurting the theater and will continue to hurt it.

From a photograph made for POPULAR RADIO

TRULY CELESTIAL PROGRAMS

An outpost of the American army stationed near Tientsin, China, has its own receiving outfit with which the doughboys pick up messages—and DX programs.



From a photograph made for POPULAR RADIO

THE APPARATUS FOR CHECKING WAVELENGTHS WITH THE QUARTZ STANDARD

Prof. W. F. Powers is shown at the left adjusting the quartz resonator that rests on the box that contains the tuning condensers. Dr. Cady (the author of this article) is at the right. They are employing the test method pictured in Figure 4.

The Quartz Crystal As a New Wavelength Standard

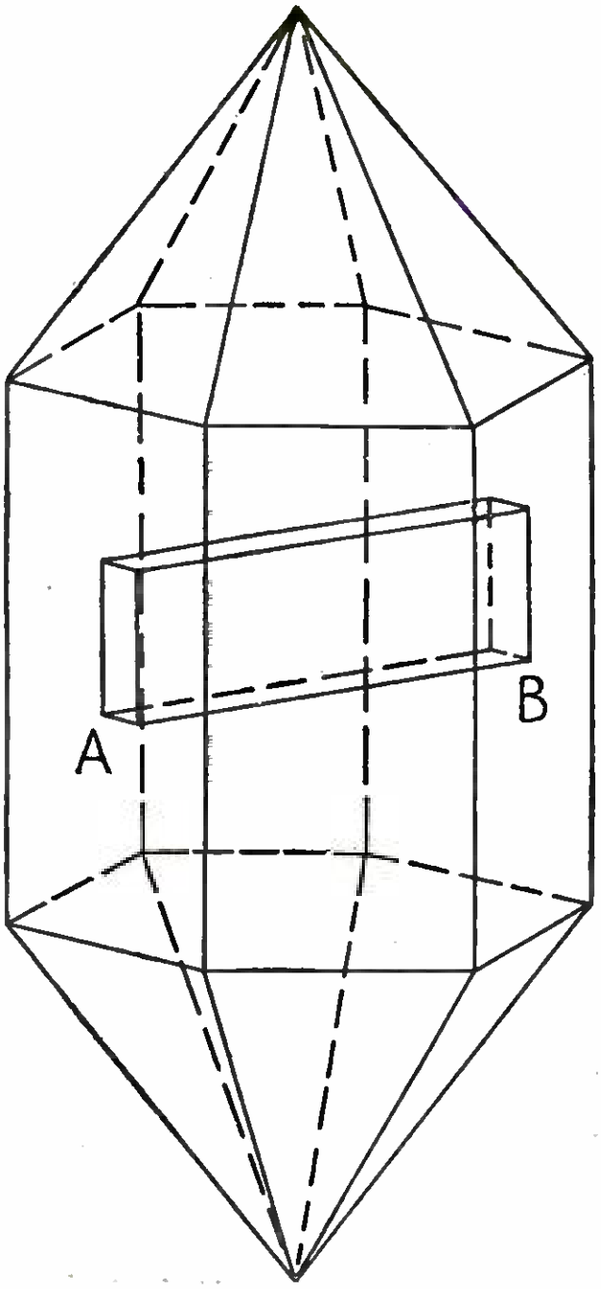
This article, written exclusively for POPULAR RADIO, describes the first international comparison of standard, government wavemeters ever made. The standard used was the new crystal resonator that puts to practical use the "piezo-electric" theory

By WALTER G. CADY, Ph.D.

Professor of Physics, Wesleyan University

SUPPOSE you had a tuning fork one thirty-second of an inch long. And suppose that it could be kept in constant vibration by an electric current at the rate of 3,000,000 vibrations a second. Could we hear the sound? Would it be of any use if we could?

When we consider that the ear is deaf to notes of frequencies above about 20,000 cycles, the prospect of hearing such a sound, or of making use of the high-frequency vibrations of such a tuning fork, does not seem particularly good. If, however, a regenerative vacuum-tube circuit be used to drive the fork and if the fork only vibrates when the circuit is exactly tuned to it, and if, when the fork begins to vibrate, an



HOW THE STANDARDS ARE OBTAINED

FIGURE 1: *The element for the wavelength standard is cut as indicated above by the rectangle AB of the enlarged drawing of a quartz crystal. These plates are always cut perpendicular to two opposite faces of a crystal.*

ammeter registers a "kick" or a telephone makes a "click," we will have what amounts to a new type of wavemeter.

For by having a number of "forks" of different sizes whose frequencies are accurately known, we can calibrate our circuit easily and quickly over the entire range, and with greater precision than with any ordinary wavemeter.

This is now an accomplished fact. It is the purpose of this article to show how it is done, and to give the results of a series of comparisons between standard government wavemeters in the United States, Italy, France, and England—the first international high-frequency comparison to be carried out by this method.

First of all it must be understood that the "tuning forks" here described are not really forks at all, but are small rods or plates cut from quartz crystals, carefully ground to a certain size and suitably mounted. They are commonly called "piezo-electric crystals."

Nearly half a century ago it was discovered by the famous brothers Curié in Paris, that a plate cut in a certain way from a quartz crystal has the curious property of becoming electrified when compressed. Soon after Lippmann, whose name is associated with one of the methods of color photography, found that these plates also expand or contract a very little when they are placed in an electric field, for example between the plates of a charged condenser.

Since then many other kinds of crystal have been found to possess these same peculiarities. Electricity produced in this way is called "piezo-electricity" (*pressure*-electricity), and such crystals are said to be "piezo-electric."

Some crystals, notably those of Rochelle Salt, are much more strongly piezo-electric than quartz, but none have been found that combine these electric properties with mechanical strength and constancy so well as quartz does. Fortunately, good crystals of quartz are also very abundant in nature.

For some years various attempts have been made to put piezo-electricity to practical application, in some cases with marked success. Ingenious telephone receivers and transmitters have been constructed from Rochelle Salt.*

* See the article by James H. Collins, "The Voice in a Lump of Salt," POPULAR RADIO for September, 1922.

tals of Rochelle Salt quartz, or of another mineral called tourmaline have also been used to record vibrations in the crust of the earth and to measure the pressure produced by explosives in guns or the pressure deep under the sea.

Figure 1 shows a somewhat simplified view of a quartz crystal. By means of a special saw the entire crystal can be cut into small slabs about a millimeter thick. AB in the figure is one such slab, extending entirely across the crystal in a direction perpendicular to two of the opposite faces.

If this thin slab of crystal quartz is placed between the plates of a small condenser and if the plates are charged, as is shown in Figure 2, the slab of quartz will expand or contract lengthwise, depending upon which plate of the condenser is positive. This change in length is much too small, of course, for the eye to see.

In what follows, we shall refer to such quartz slabs or rods, cut from natural crystals, as "resonators."

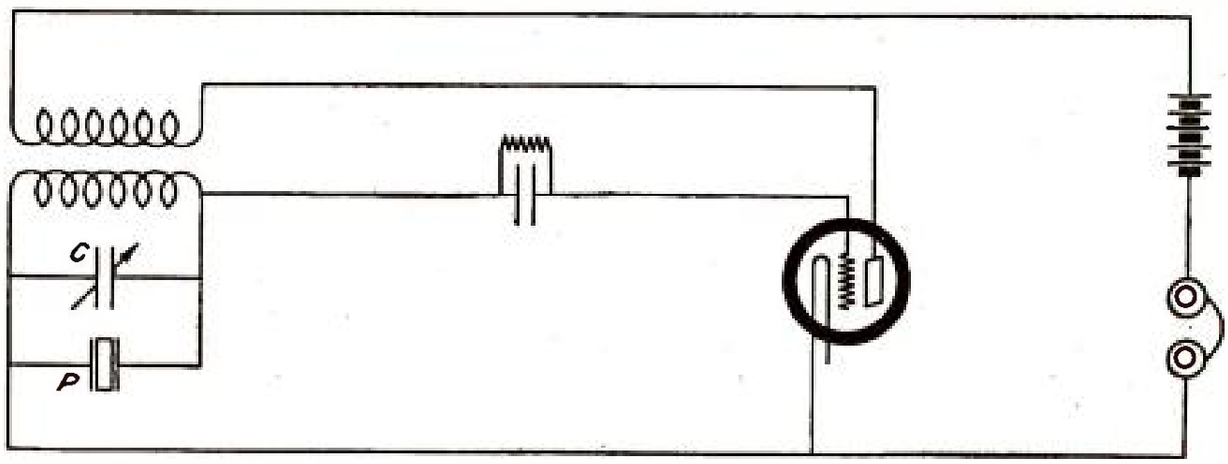
We can now see how such a resonator will behave in an electric circuit. For if the condenser plates of Figure 2 are connected in parallel with the tuning condenser C (or the variometer) of a regenerative circuit, as at P in Figure 3, there will be a high-frequency alternating electric field across the resonator and the latter will expand and contract at the same frequency.

HOW THE CRYSTAL WORKS IN THE INSTRUMENT

FIGURE 2: *The quartz plate clamped between two metal plates forms a condenser. When this condenser is charged, the plate lengthens to a slight degree as indicated by the dotted lines.*

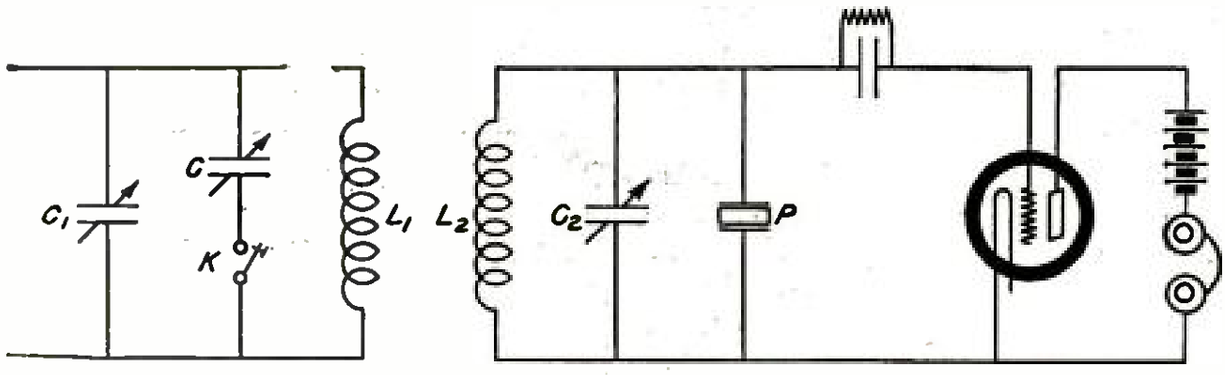
The quartz rod will be in a state of "longitudinal vibration," as when a long steel rod is struck a sharp blow on one end. The amount of this vibration is utterly insignificant at almost all frequencies. But, just as in the case of the steel rod, there is one particular frequency which is the *natural frequency of vibration of the resonator.* If the circuit is tuned so as to generate just this natural frequency, the electric force in the crystal will be reversed at just the right instants to build up strong vibrations.

When a child in a swing "pumps," he brings his muscular force to bear in the right direction at the right time in a very similar manner. We say that the swing moves "in resonance" with the pulls of the child. Similarly the crystal



THE RESONATOR IN A REGENERATIVE CIRCUIT

FIGURE 3: *In the hook-up shown above, P is the crystal resonator and C is a tuning condenser. In this circuit the crystal will expand and contract at the same frequency as that of the field across the resonator.*



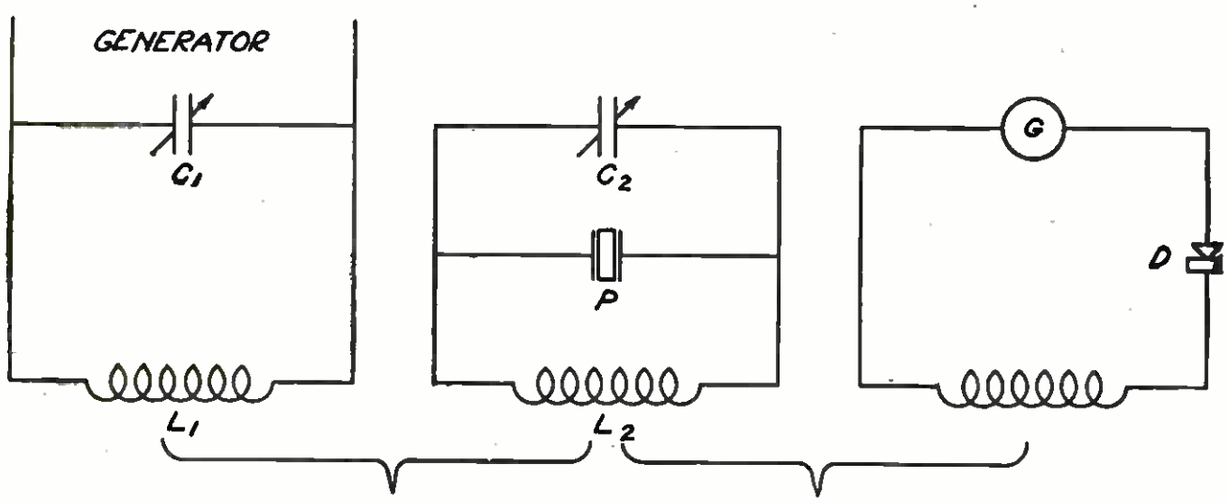
THE KEY-TAPPING MEASURING METHOD

FIGURE 4: *The resonator, P (shown above), is connected in a secondary circuit. Upon closing the key K a short beat note will be heard in the headphones in the right-hand circuit when the circuits under test are properly tuned by means of the condensers C_1 and C_2.*

is in resonance with the high-frequency current. The tuning of radio circuits illustrates this same principle of resonance, but in the case of the quartz crystal we have to do with *mechanical* vibrations set up in the crystal by the high-frequency currents in resonance with its natural frequency.

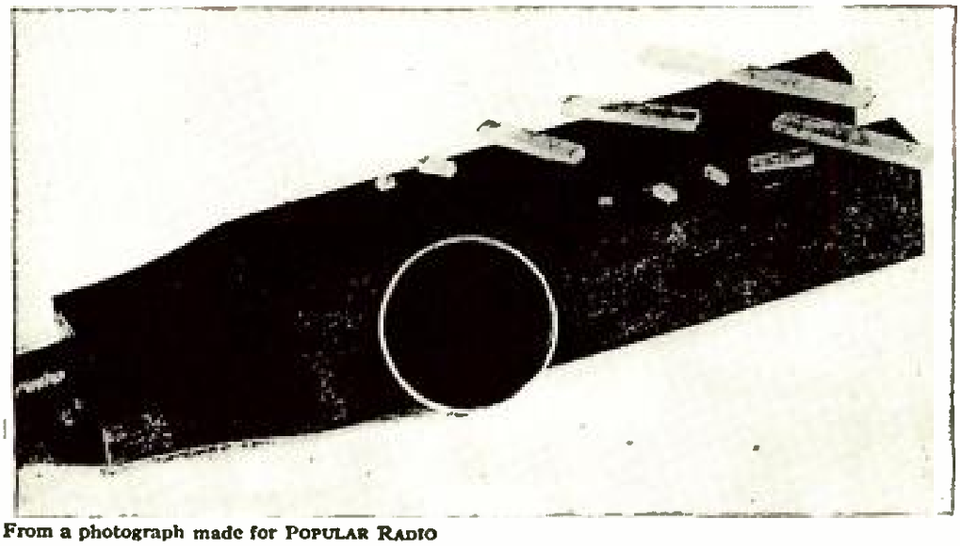
We thus see how a quartz resonator can be "driven" by an electric current so that it vibrates at one particular frequency, just as does a tuning fork. We have still to see how the resonator, when vibrating, causes an electric response in the circuit itself. This is something of which the ordinary tuning fork, even when electrically driven, is incapable. But in the case of the piezo-electric resonator, it is practically the only means to tell when the crystal vibrates.

The operation is easy to understand. We have seen that when a crystal is stretched it became electrified. It follows that when a quartz resonator is vibrating, *it must generate alternating electromotive forces of its own frequency*. For example, when a resonator is struck on one end it acts, so long as its vibrations continue, like a miniature high-frequency generator. It produces just such a damped train of waves in the electric circuit as would be caused by a single spark from a distant transmitting station, except that the damping of the crystal is much less than that of a spark.



THE "PICK-UP" CIRCUIT TEST METHOD

FIGURE 5: *When the generating circuit (marked "generator" in the diagram above) is in tune with the middle circuit, a sudden diminution of current takes place in the circuit containing the galvanometer, G. This gives the most accurate wavelength measurement of all the hook-ups.*



From a photograph made for POPULAR RADIO

WHAT THE RESONATOR ELEMENTS LOOK LIKE

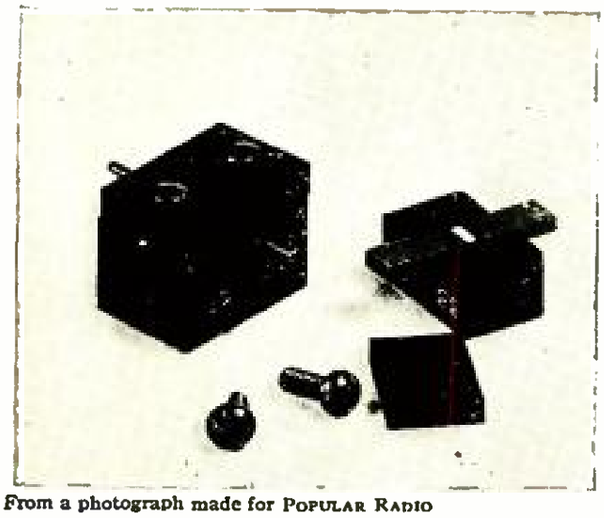
FIGURE 6: *The sizes of the crystals used in the resonators are indicated above by comparison with the disk (the size of a cent) and the tuning fork. These crystals vary from 150 to 3,000 meters wavelength.*

In Figure 3, let us suppose that the condenser C is set for a moment at just the right value to bring the resonator P to a state of strong vibration. If C is then suddenly changed by a small amount, a short beat note will be heard between two different frequencies; one due to the crystal, which continues to vibrate for a fraction of a second, and the other due to the regenerative circuit. As C is turned back and forth through the point at which the resonator vibrates, a sound will be heard each time the exact point is reached, at least to as high a degree of accuracy as is usually necessary. We have then "standardized" our circuit, as we have found how to set the condenser so as to generate a frequency practically the same as that of the standard quartz resonator.

If still higher precision is required, the resonator is not connected in the generating circuit itself, but in a secondary receiving circuit, as in Figure 4. Only the tuned portion L_1C_1 of the generator circuit is shown—any type of tube generating circuit may be used. Loosely coupled to L_1 is coil L_2 of the receiving circuit. P is the resonator. A crystal detector may be used in place of the vacuum tube in this circuit, if desired. C_2 is first set so as to tune the secondary circuit approximately to the resonator, then a small capacity, C, is connected in parallel with C_1 by closing the key K. If C_1 is at the right value before K is closed, then on closing K a short beat note is heard in the secondary circuit. C_1 is slowly varied until this beat note is of maximum loudness. The generator circuit is then in tune with the resonator to within a hundredth of a percent, and may be used to calibrate a wavemeter, or for any other purpose where an accurately known frequency is wanted. It is sometimes an advantage to produce the beat note by opening K instead of by closing it.

Still other methods may be employed to tune the generator set precisely to the resonator. In one such method, a milli-ammeter or a galvanometer is connected in place of the telephone in the secondary circuit and the setting of C_1 is determined by the sudden "kick" of the needle at resonance. C and K of Figure 4 are not used.

In still another method, the secondary circuit consists only of L_2, C_2, P, and a thermo-ammeter or thermo-element in series with L_2. When the generator is tuned to the resonator, a sudden reduction of current takes place in the thermo-ammeter or in the galvanometer con-



From a photograph made for POPULAR RADIO

HOW THE CRYSTALS ARE MOUNTED

FIGURE 7: *The white oblong at the right-hand part of the illustration is one of the quartz rods used in the tests described in this article. It is held between two brass rods and is housed in the small box at the left.*

nected to the thermo-element. An accuracy of one part in one hundred thousand is attainable in this way.

Finally, the secondary circuit containing L_2, C_2, and P may have coupled to it a pick-up circuit containing a coil L_3, a rectifying crystal detector D, and a galvanometer G, as in Figure 5. When the crystal resonator vibrates, it absorbs energy from the secondary circuit and thus causes a sudden diminution in the currents in both the secondary circuit and the pick-up one. The advantage of this arrangement is that the measuring instruments are in a separate circuit by themselves. The wavemeter can form, therefore, the secondary circuit.

Whenever practicable, one or other of these galvanometer methods was used in all the comparisons described in this article, owing to the very high precision which they make possible.

Let us now examine more closely the construction of the resonators for different frequencies.

In the first place, the shorter the rod or plate of quartz, the higher its frequency at resonance. For a radio wavelength of 3,000 meters we need a rod about three centimeters long, while for a 100-meter wave the resonator is only about one millimeter long, less than its own width! This is the sort of microscopic "tuning fork" described at the beginning of the article.

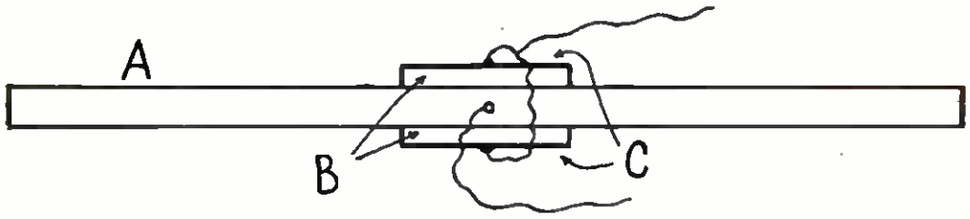
Figure 6 is a photograph of several unmounted quartz resonators for various wavelengths. From a quartz crystal such as that shown in Figure 1 a large number of rods or plates of different sizes may be cut. Any portion of the crystal may be used, as long as the direction of the cut is that shown in the figure.

The best method of mounting the quartz resonators is to let each rod stand on edge in a small pocket in which it is just free to vibrate. As shown in Figure 7, this "pocket" may be a depression in a small block of insulating material, formica having been found well suited to the purpose. The sides of this pocket are formed by small brass plates which also act as the terminals. In the best resonators only the middle of the rod rests on the bottom of the pocket, while the ends are free to vibrate without friction. However, the shape of the bottom makes little difference.

TABLE I

Exact dimensions of the six resonators, together with their values of wavelength and frequency.

Resonator	*Dimensions in Millimeters*			*Type*	*Wavelength Meters*	*Frequency Kilocycles*
	Length	*Breadth*	*Thickness*			
G1	1.76	1.13	0.63	Quartz	196.8	1523.8
G2	3.60	1.40	0.51	"	393.7	761.99
G3	12.02	2.16	1.08	"	1271.2	235.90
G4	30.3	2.64	1.23	"	3273	91.656
F23	90.5	9.75	3.16	Quartz-steel	10365	28.944
F24	180.0	9.23	3.14	"	20789	14.431



A RESONATOR FOR THE LONGER WAVELENGTHS

FIGURE 8: *The wavelength is proportional to the length of the flat steel rod, A, in the drawing above. The quartz plates, B, in this case are coated with tinfoil at C and are cemented to the steel rod A.*

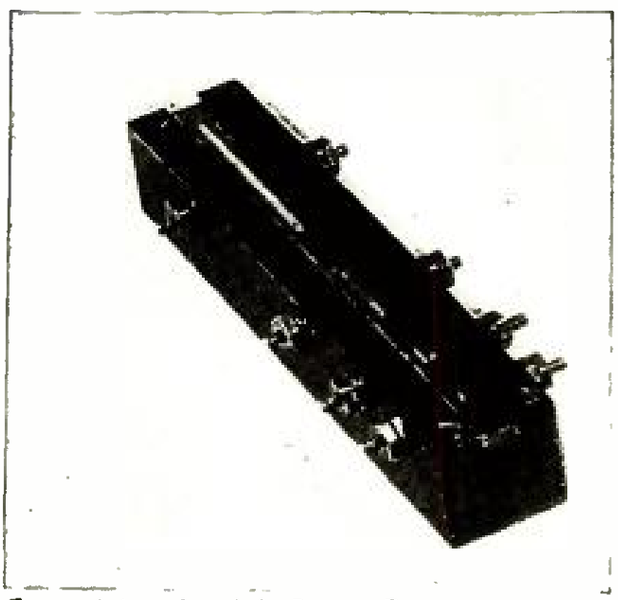
For a wavelength of 10,000 meters, a rod nearly ten centimeters long is needed. A quartz rod of this size gives a wonderful response when it vibrates, but is much too expensive for everyday use. So for wavelengths longer than about 5,000 meters, small quartz plates are cemented to the sides of steel rods, at the middle, as is shown in Figure 8. A is the steel rod, B the quartz plates, and C tinfoil coatings cemented to the quartz and connected electrically together and to one side of the circuit. The rod itself, suspended from a small hook at its center, serves as the other terminal.

When this device is connected to a generator of the right frequency the quartz plates expand and contract. In doing so they set the steel rod into longitudinal vibration. The resonant frequency is practically that of the steel rod alone, and not of the quartz. These quartz-steel standards give a precision about the same as that of the quartz resonators and as low a frequency as we wish can be reached by using sufficiently long steel rods. The rod may be even a yard long and in this case its frequency is so low that an audible note is heard when it vibrates.

Figure 9 shows four of the six resonators used in the tests abroad. They are mounted on a single block of hard rubber 9 centimeters long. Each "rod" stands on edge in a narrow pocket, with a brass plate on each side, leaving just enough room for the crystal to vibrate freely. A glass cover keeps the crystals in and the dust out. The device forms a sort of "vest pocket wavemeter," responding with high accuracy to four wavelengths between 200 and 3,000 meters.

In Figure 10 we have a photograph of the other two resonators, both of the quartz-steel type. When not in use, the steel rods may be unhooked from their suspensions and clamped firmly to the base. The quartz rods of Figure 9 are always ready for use.

Quartz crystal resonators can be made to respond to more than a single wavelength. This is made possible by a special form of mounting, which allows not only the fundamental frequency of the resonator to be excited, but various "overtones" of higher frequency as well. In other words, a crystal rod may be so mounted as to respond to any one



From a photograph made for POPULAR RADIO

A FOUR-ELEMENT RESONATOR

FIGURE 9: *The resonator in the picture above was used to measure wavelengths from 196.8 to 3,273 meters in the tests described in the accompanying article.*

of several different frequencies, somewhat as a bell when struck gives a number of high-pitched tones in addition to its fundamental note. The frequency or wavelength of every one of these overtones can be determined with the same accuracy as the fundamental itself, and thus the range of usefulness of the resonator can be greatly extended. In the comparisons which are described in this article, however, only the fundamental frequencies of the resonators, as recorded in Table I, were employed.

Let us now take a brief glance at the foreign laboratories where these high-frequency comparisons were carried out in the spring and summer of 1923. Tests were made at two places in Italy, at Rome and Leghorn. In Rome, the work was done in the new Military Radiotelegraphic Institute, through the courtesy of the Director, Dr. G. Vanni.

Leghorn is the Annapolis of Italy, for the Italian Naval Academy is here, and it was with a standard wavemeter at the Academy that the comparisons were made. Dr. G. Vallauri, who is in charge of the radio laboratory, is the designer of the new high power radio station at Coltano, a few miles from Leghorn.

Next, the Central Military Radiotelegraph Establishment in Paris was visited. Many of the well-known experiments of General Ferrié and of Messrs. Mesny and Jouaust have been performed in the laboratory of this Establishment.

Comparisons were made here between the piezo-electric resonators and the standard French wavemeter. On the day following, the wavemeter itself was checked against the "multivibrator," —a sort of super-wavemeter developed by Professor Abraham in Paris.

In England, the tests were made at the National Physical Laboratory in Teddington, not far from London. Although scientific work of the highest importance is done here, there is an air of peaceful antiquity about the old buildings and the flower-bordered walks. The room in which the wavelength comparisons were made, through the kindness of Mr. D. W. Dye, served formerly as Queen Anne's chapel! These experiments in Teddington were in some respects the most satisfactory of all, as comparisons were made directly with the standard multivibrator, and very high precision was attained.

A brief visit was paid also to the Royal Aircraft Establishment at Farnborough, at the request of the Air Ministry. There is an excellent radio laboratory here, with a wavemeter of high precision. Owing to lack of time, only one of the resonators was compared here.

All of the frequency values (converted from wavelengths into kilocycles), in the order in which they were obtained in the various laboratories, are assembled in Table II.

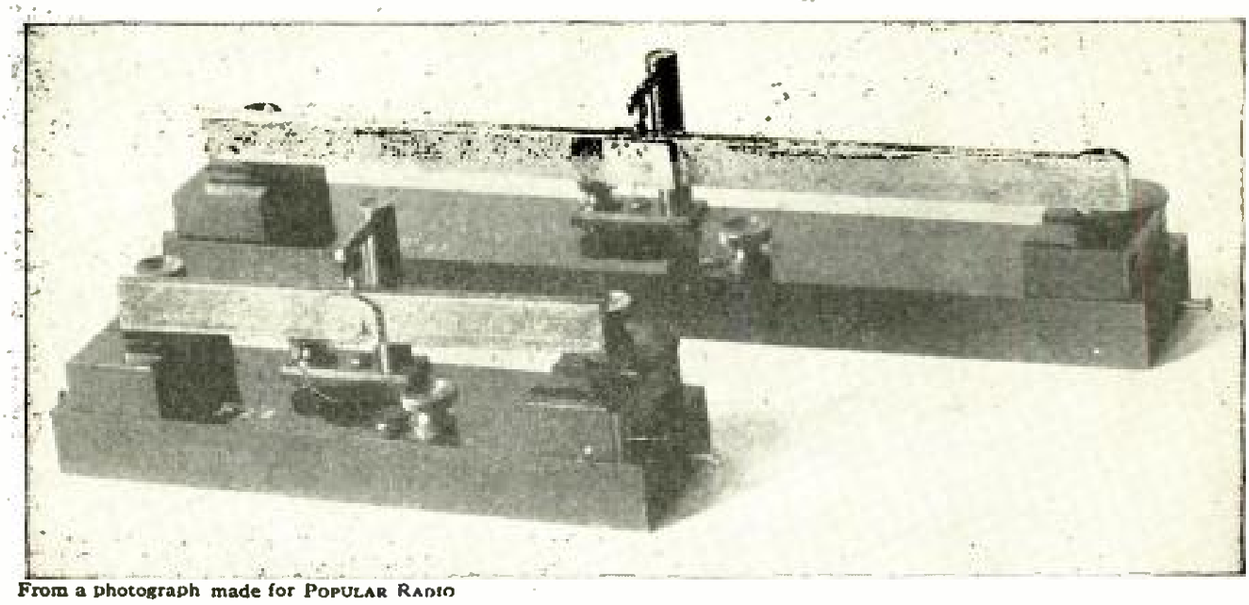
In the United States the resonators were compared, both before and after

TABLE II

Comparisons of National Wavelength Standards

Each number represents the frequency, in kilocycles, for each of the quartz resonators, as indicated on the wavemeter of the laboratory in question, corrected for all known errors.

Station	*G1*	*G2*	*G3*	*G4*	*F23*	*F24*
Rome	1532	758.2	234.9	92.14	.....	.....
Leghorn	.....	776.4	241.2	92.19	29.09	14.49
Paris	1521	761.4	235.8	91.91	28.972	14.451
Teddington	1524.1	761.82	235.90	91.480	28.960	14.421
Farnborough	.....	.....	.....	91.60	.....	.....
Bur. Stand.	1526	762.7	236.1	91.55	28.835	14.420
Cruft Lab.	1526	762.9	235.9	91.78	28.948	.....
Means	1523.8	761.99	235.90	91.656	28.944	14.431



From a photograph made for POPULAR RADIO

THE RESONATORS FOR LONG-WAVE TESTS

FIGURE 10: *The resonators in this picture are the quartz-steel type shown in the diagram in Figure 8. These were used in wavelength measurements from 10,365 up to 20,790 meters as explained in this article.*

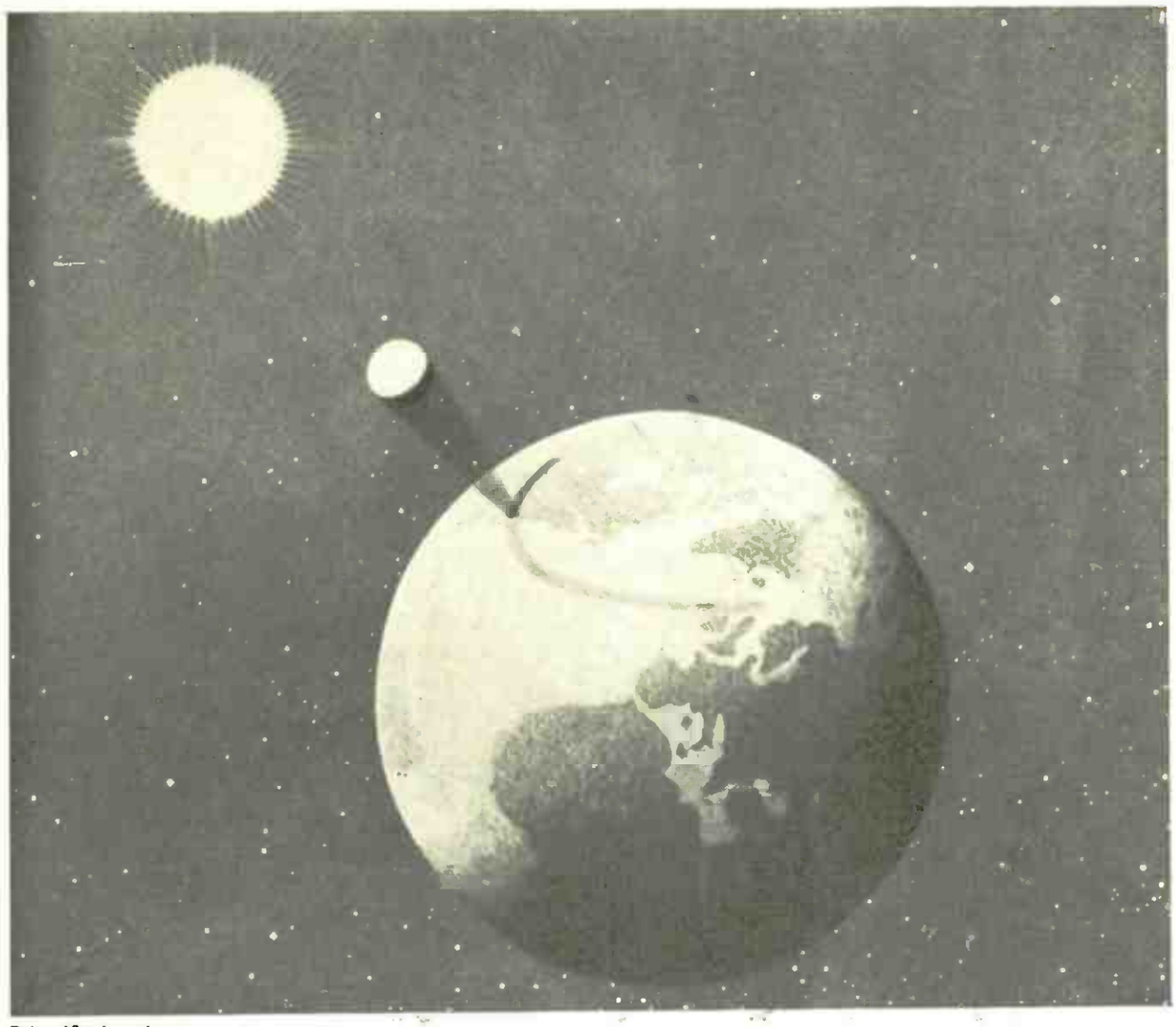
the trip abroad, with the standard wavemeter at the Bureau of Standards in Washington and also with Prof. G. W. Pierce's wavemeter at the Cruft Laboratory of Harvard University. The numbers given in Table II for these two laboratories are therefore averages. In no case did a single comparison, made before or after taking the resonators abroad, differ from the average by more than one-tenth of one percent.

The mean values at the foot of Table II have been figured with due regard to the probable precision at the different laboratories. These are the same as the values in the last colmun of Table I.

A study of Table II shows a fairly satisfactory agreement between the wavelength standards in the countries visited. The widest discrepancies are at Rome and Leghorn, but unfortunately the wavemeters in these laboratories were not the ultimate standards, as was the case in the other countries. In all cases, except when the resonators were compared directly with the multivibrator, the sharpness of resonance of the crystal was very much greater than that of the wavemeter. It is probable that most of the differences between the frequencies recorded at the different laboratories are due more to uncertainties in wavemeter settings and to errors in the wavemeters themselves than to any difficulty with the resonators.

Experiments extending over several years have shown that the piezo-electric resonators may be made useful in a variety of ways. When used with specially constructed circuits, as we have seen, they serve as wavelength standards of highest precision. To an accuracy of one-tenth of one percent, they may be used to calibrate any regenerative circuit, transmitting or receiving, with only the simplest sort of auxiliary apparatus-hot-wire meter, thermo-ammeter, or telephone receiver. By their use the operator can tell instantly whether his set is oscillating properly and the lengths of transmitted or received waves.

The resonators take up almost no room and their capacity is so small that they are practically without effect upon the adjustments of the circuit. Special clips for holding the resonators may be mounted permanently on any cabinet or switchboard. The resonators have also been found very useful as an aid in generating oscillations of accurately known wavelength for measuring inductances and capacities.



Scientific American

THE FOOTPRINTS OF THE ECLIPSE

The arcing path of the moon's shadow upon the earth is shown above. The movement of the earth on its axis and the combined motions of the moon and earth through space determine the form of the shadow's path.

What the Eclipse Did to Radio

By E. E. FREE

THE total eclipse of the sun, which occurred on the morning of January 24, 1925, not only gave the people of the northeastern states an opportunity to witness what is admittedly one of the most amazing of natural spectacles, but it made possible the carrying out of extensive radio investigations which promise to add a great deal to our knowledge of radio transmission, especially of the theory of the Heaviside layer.

The eclipse was visible as a total one in parts of the states of Minnesota, Wisconsin, Michigan, New York, Pennsylvania, New Jersey, Massachusetts, Connecticut and Rhode Island as well as in parts of Canada. Over most of the remainder of the United States, the sun was partially eclipsed. The chance of good weather was far from favorable. Both the time of the year and the comparatively early hour of the morning—a few minutes past nine—were against the astronomers. But the weather was unexpectedly fine.

The radio tests, however, were comprehensive. Radio fans interested in the eclipse had begun as long ago as last July to plan what was to be done. As the date of the eclipse approached more than 2,000 persons were enrolled as co-operating observers. The number of observations actually made was even larger, as many persons, who had heard of the tests at the last moment, "joined up" without advance registration.

The opportunity for radio tests presented by an eclipse arises from the fact that the spot of shadow produced by the moon may be considered as a short and local night. During the total part of an eclipse, in fact, it is nearly as dark as it is at night. All around is day—a slightly dim day, of course, for the sun appears as partially eclipsed for some distance from the actual shadow spot.

During the recent eclipse the shadow spot cast by the moon was about 100 miles wide from north to south. From east to west it was a little longer because of elongation that resulted from the fact that the sun was low in the sky so that the cone of shadow touched the earth's surface at a glancing angle. This spot was the local night mentioned above. It moved rapidly from west to east, because of the combined motions of the earth and moon relative to the sun.

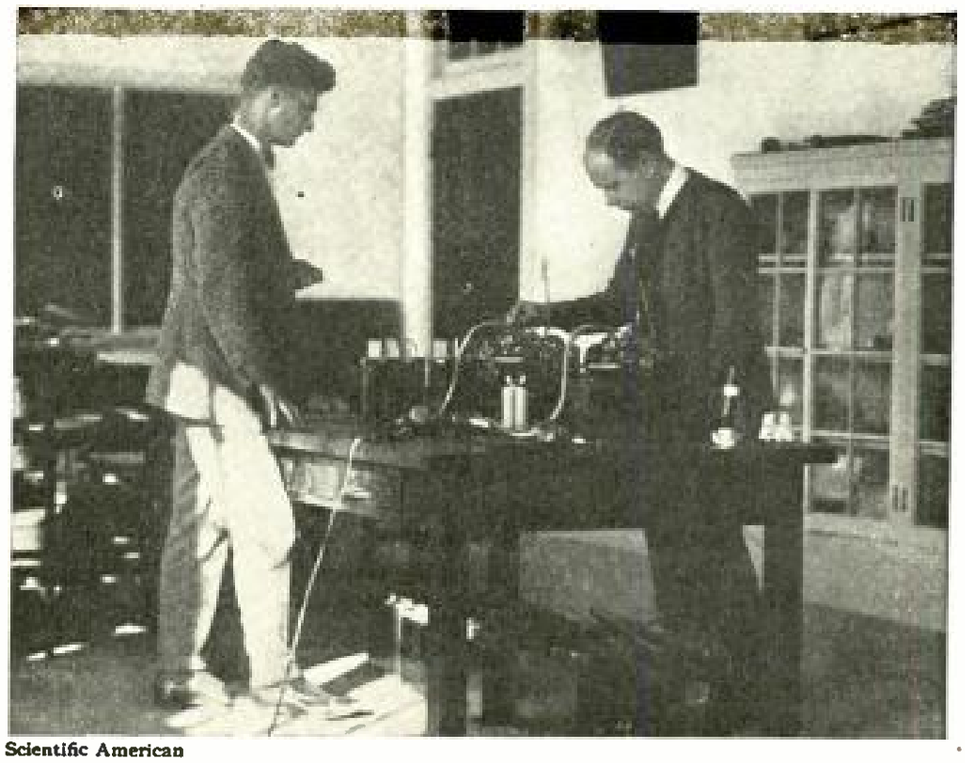
The effects of this moving spot of darkness on radio transmission were investigated by at least three sets of investigators. First, a group of radio engineers organized by Mr. Greenleaf W. Pickard set up recording apparatus at Ithaca, New York; Leominster, Massachusetts; New York City, and Middletown, Connecticut. Accurate measurements of field strength were made moment by moment on one or more of the broadcasting stations, WGR, WGY, WBZ and 2XI, the last being the short-wave experimental station of WGY at Schenectady. Mr. Pickard gave a brief preliminary description of these tests before the Institute of Radio Engineers on February 4, 1925.

In addition to these tests, the American Radio Relay League organized a network of transmitters and listeners, who used the amateur wavelengths and sent and received in code. Twenty transmitting stations were designated, all of which were within the path of the total shadow.

Finally, the *Scientific American* organized 2,000 radio listeners who registered for the tests, divided them into groups and requested them to listen on the morning of the eclipse to one of the four broadcasting stations: WGR, WGY, WBZ and WOR. All four of these stations co-operated by transmitting special programs from about 30 minutes ahead of the eclipse until about 30 minutes after the total part of it was over. All listeners were requested to keep a record of any fading or increases of intensity. Similar tests were made independently by three or four other broadcasters, notably by the Zenith Radio Corporation at Escanaba, Michigan.

The other broadcasting stations and amateur transmitters co-operated, for the most part, by keeping off the ether while the tests were in progress, as did the commercial stations as well. Thanks to this attitude of complete and willing co-operation on the part of everybody the tests have been, undoubtedly, a real success.

This article is written within a few days after the eclipse. It has been impossible to assemble, tabulate and study the thousands of listeners' reports. It is doubtful, indeed, whether this task can be completed for several months. Accordingly, a full report of the



Scientific American

LISTENING-IN ON THE ECLIPSE

At the Easthampton station the experimenters attached an Ediphone phonograph recorder to a radio receiver to get a record of the received signals from WGY. During the totality of the eclipse, the reception faded almost to zero.

meaning of the tests is impossible at present. It is possible to say, however, that there undoubtedly were marked effects and that they had a considerable complexity. It is probable that these effects were due to the action of the shadow on the upper levels of the earth's atmosphere.

Modern theories of radio transmission assume that there are two paths for a radio wave going out from a transmitting station. One path follows along the ground. The other follows along the upper levels of the air, sending down energy toward the ground as it goes. The energy received from any station not too far away consists of the upper and the ground wave. They combine in the receiver.

The eclipse appears to have interfered in some way with the upper wave. During totality this upper wave seems to have been cut off more or less completely, leaving only the ground wave to affect the receivers. For example, Alfred P. Lane and F. X. Walsh set up at Easthampton, Long Island, N. Y. an Ediphone phonographic recorder attached to a radio receiver. This was tuned to WGY. During totality reception at this station faded almost to zero, presumably because the upper part of the wave from WGY was no longer getting through.

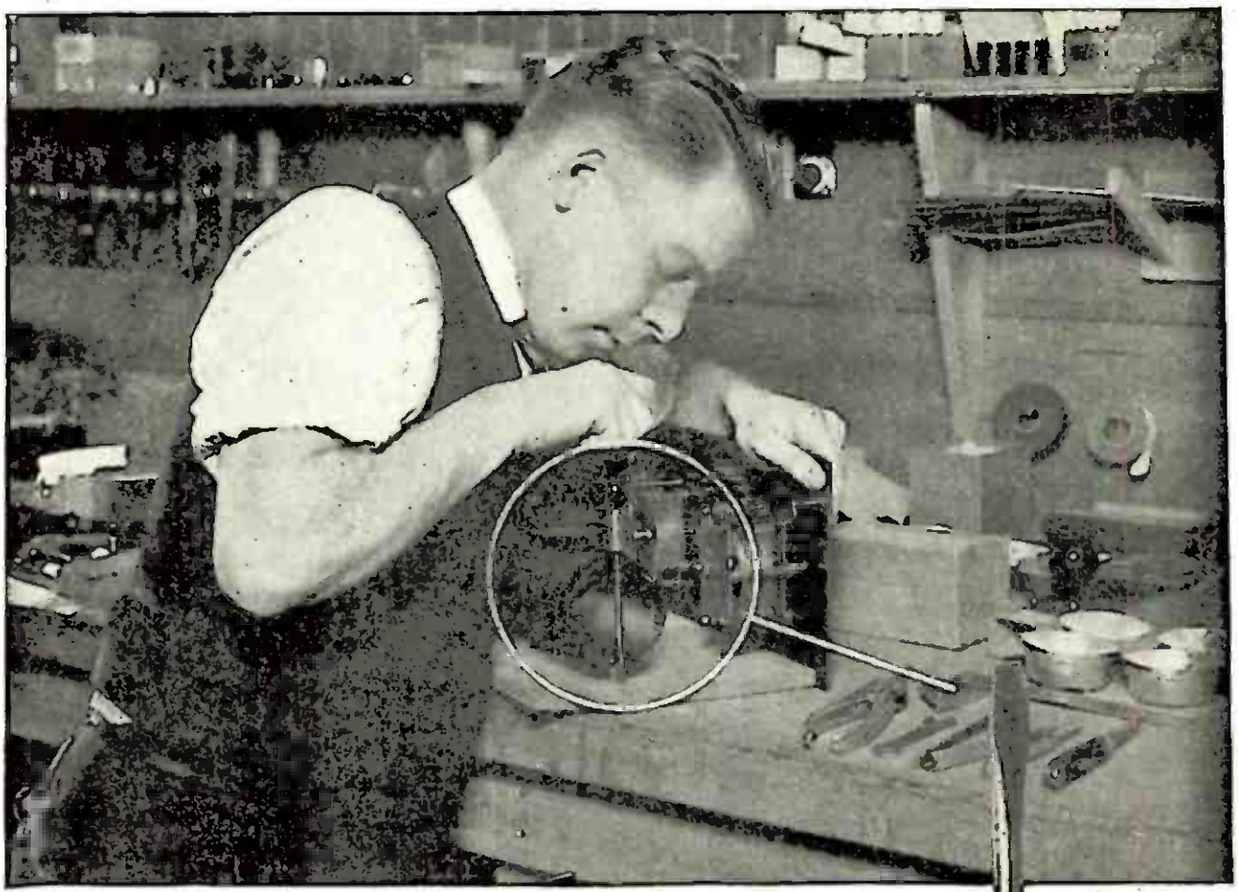
In other cases there were increases of intensity during totality. Still other stations, equipped with directional loops, observed variations in the direction of the arriving wave. But any detailed report of these and other results must wait until more time has been available for the study of the data.

Underwood & Underwood

AN AUTOMATIC RADIO RECEIVER THAT IS TURNED ON WHEN PROGRAMS START

The combination radio receiver, phonograph and clock (shown above) was devised by Joseph Pinto of Philadelphia who can have either radio concerts or phonograph music whenever he wants without starting the instrument himself. Mr. Pinto uses the phonograph as an alarm clock which starts a record at the hour he designates.

Handy Tools for Radio Fans: No. 2



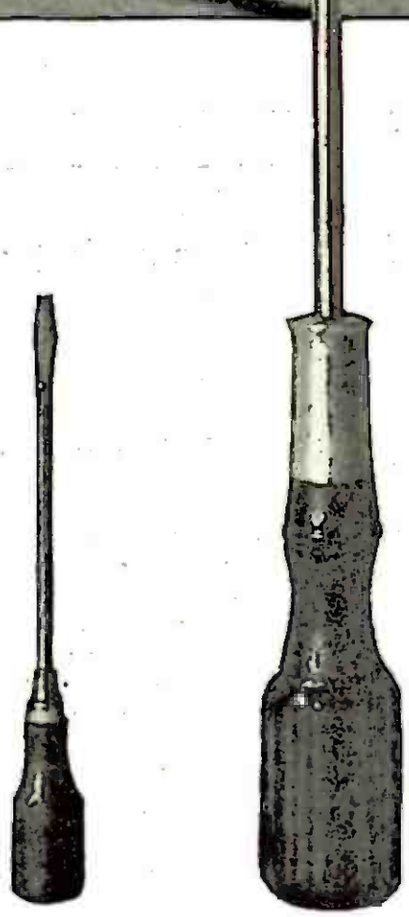
From a photograph made for POPULAR RADIO

SCREW-DRIVERS

A set of four of these tools is a necessity

EVERY set owner should have located somewhere near at hand, a number of tools for keeping his apparatus in repair. There are many things that he wants to do, such as to tighten up a loose screw or binding post or to put in a new battery wire which requires the use of pliers or of a screw-driver.

The second hint in this series—Screw-drivers—calls the attention of the fan to these tools which are so useful for work on the panel or on the baseboard in mounting instruments or tightening up loose screws anywhere throughout the receiving set. The set owner should keep on hand a set of four screw-drivers of sizes varying between the two shown at the right. The screw-drivers pictured here are exactly half-size, so that you will be able to judge just what sizes you will need.



The first suggestion of this series was SIDE-CUTTING PLIERS.

The Bray Productions

The BROADCAST LISTENER

Comments on radio programs, methods and technique
—from the point of view of the average fan

By RAYMOND FRANCIS YATES

What Radio Is Doing to the Phonograph

ALTHOUGH millions of horse power will be pumped into the luminiferous ether of space and many moons will come and go before broadcasting is purged of its trained-seal, paper-tearing and the "promising-song-writer-from-Walton, N. Y." acts, the evolution of the art seems to have taken on a little speed during the past few weeks.

Our great talking machine companies, who gathered their executives into conference four years ago that they might laughingly slap each other's knee in exchanging cute little witticisms about the ragged stranger at their door, recently filled their fountain pens with red ink and made significant changes in the contracts with their stars. John McCormack a satellite who, where broadcasting figured at least, could not be reached with the Yerkes Observatory, made his appearance at WEAF and sang into the same old microphone that was used the hour previous by J. Whosus Smith, tenor of the church choir of Short Hills, N. J. Frances Alda and Lucrezia Bori made their début with the same absence of glory.

The ragged stranger has come back at the conference door to kick it in.

While it would be a long way from the truth to claim that the talking machine industry has gone blooie or that the above-mentioned conferees have done anything more drastic than to stop their guffawing, it is safe to say that broadcasting has passed its grammar

school regents. Its victory has an economic value comparable with the victory of the moving picture industry when the Barrymores first capitulated to it. It means, kindly reader, that great things are going to happen within the next two years; that the J. Whosus Smiths from the choirs of Pearl River, N. Y. and Wright's Corners, N. D., and the Mary Joneses, deluded by thousands of local vocal teachers who must make a living, will return to their respective parlors still feeling that they lack the one thing that made Geraldine Farrar famous—a chance.

Yes, big things are going to happen in broadcasting.

* * *

Broadcasting "Human Interest"

It is funny what a little sentiment will do even when it is associated with very scientific things.

A short time ago one of the engineers of the Geological Survey decided that the old Swance River was not quite as large as scientists said that rivers should be and that it should therefore cease to exist as a river. To sum the matter up, it seems that Foster, unmindful of the scientific dimensions of a "he" river, wrote a beautiful bit of sentiment around a mere creek. When this very smart young fellow of the Survey found what a terrible error Foster had made, he immediately demoted the Swanee and made the necessary changes in his maps.

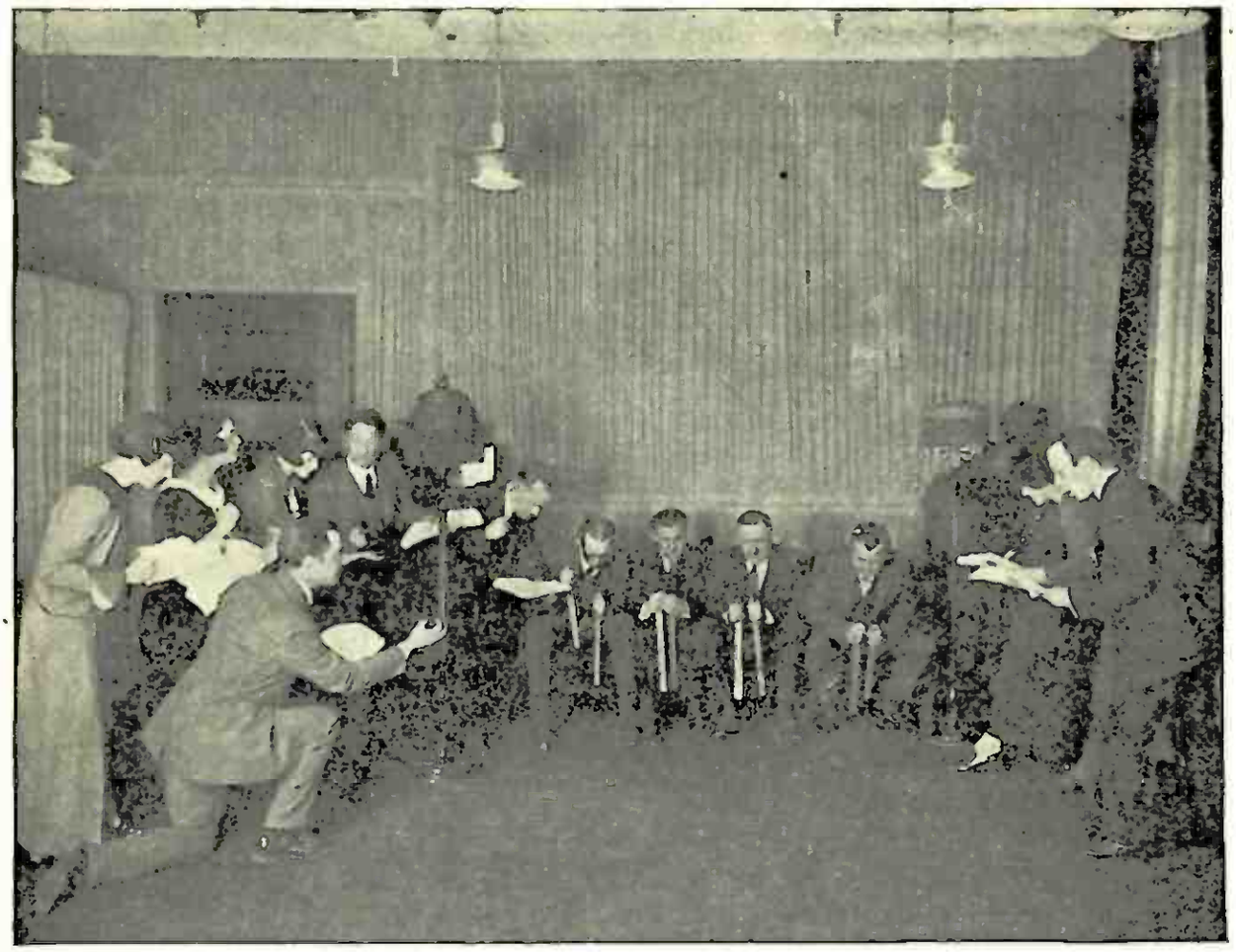
When a thing like this happens we invariably find a number of newspaper writers ready to jump on the platform to make an impassioned appeal for things that affect hearts and not cold scientific instruments of measurement. One writer in a New York paper made out quite a case for the poor old Swanee, maintaining that it did not rise in any part of Georgia but "in the highest mountains of the human soul and is fed by the deepest strings of the human heart."

What has this to with broadcasting? Well, simply this. A man, who is by far the greatest living entrepreneur of the radio decided that this bit of sentiment, given the proper dramatic treatment, would make a fine piece of broadcasting. He read it one Sunday night accompanied by the unobtrustive strains of Foster's old melody, "Way Down Upon the Swanee River." The thing was a perfect gem, and, old and hard as we are, we confess it reached

United

WHAT THE MANAGER OF A BROADCASTING STATION GETS

When station WEAF in New York recently featured some of the well-known grand opera stars on its program, it was literally swamped with applause cards and letters from fans. This snapshot was made of one of the morning mails!



Station WGY

HOW A HORSE-RACE LOOKS—IN THE BROADCASTING STUDIO

The four "jockeys" on the couch, who are playing parts in the broadcast production of "The County Fair," are using sticks to imitate the gallop of their mounts. The grandstand audience which surrounds them furnishes the shouts.

those innermost recesses, where, according to the calculations of the writer quoted, even misnamed creeks may have their sources. We do not know how many gallons we contributed to this struggling little stream, but we do know that many radio impresarios, instead of watching the programs of other stations too closely, would help the art a great deal by searching the printed columns for little ideas like this. There are a thousand and one mushy little things that may be dolled up and dramatized for broadcasting but it takes a genius and not an ex-certified public accountant to find them.

* * *

"Religion's Raid on Radio"

ALTHOUGH we recite the Nicene Creed a little less automatically than some with more sanctimonious poise, we could not help but admire Mr. Armstrong Perry's article (in January POPULAR RADIO), "Religion's Raid on Radio." It seems that one cannot turn to the radio on Sunday without being preached at in the usual quasi-dramatic tones or sung at in the usual mournful register. This is all very lovely and very stimulating when carried on in the atmosphere of art glass windows and Gothic arches done in Carara marble, but when this food for the soul is pushed through the mechanics of radio transmission and reaches the Sunday lounger in the easy-chair with his San Pedro Perfecto, it has lost much of its aesthetic value. Instead of being the stirring spiritual message that was designed in the original notes of its perpetrator, it falls into that unfortunate category of things that become painfully boresome a few minutes after the curtain rises.

A sermon or two on Sunday and a little—a very little—singing of the spiritual type might fill an ecclesiastical mission and it might even make the smoker of a San Pedro Perfecto feel a trifle elevated. But when every turn of the knob brings the wailing monotones of an impassioned repairman of spiritual mechanism or the dreary rhythm of No. 469, page 394, sung by a grade F troupe, one feels like taking the threatened bath, dressing up and marching right out to the nearest moving picture show to see Larry Semon in the same old stuff. After all, if Larry can make you laugh and the music makes you tap the floor with your foot, you'll probably never miss the spiritual food intended for you and you may feel a little better on Monday morning.

This is the beginning of the "League for the Alleviation and Control of Sunday Suffering on the Radio."

* * *

The Right Way to Broadcast the Drama

Two years ago there was a strange fascination to the adventure of radio; it held one under a pleasant spell. It brought to every idle pilot of the knob, the thrill that comes to the voyager or explorer seeing for the first time an enchanting vista in a strange land.

Broadcasting today is forlorn of thrill except for those who have been total or partial abstainers. The shell of the veteran listener grows harder and more impenetrable. Broadcasting appears unable to escape the similitude that threatens to lead it into a quagmire.

Something daring must be done to set it right. Simple expedients suggest themselves. Some of our local stations could well try the experiment of using programs that run two or possibly three nights. Of course, such a program would have to be assembled with care, and it would call for all of the genius available in the broadcasting art. Conventionalism would have to be routed, and there would have to be some sort of continuity and schematic arrangement of the programs. Let us, by way of argument, assume that KDKA has taken upon itself to broadcast for three nights a "Shakespeare Radio Revue" something aimed at the middle-brows.

Appropriate musical introductions are plentiful; excerpts from the operas, "Romeo and Juliet," or "The Merry Wives of Windsor," for instance. This might be followed with a brief controversial lecture, "Francis Bacon or William Shakespeare." More music and a eulogy to Edwin Booth (which would be gladly arranged by the Player's Club) would tend further to cement the thing. Then a bit from "Macbeth" or "Hamlet" by a capable amateur or a condescending and benevolent professional would bring the full spirit of Shakespeare into bloom. The more beautiful musical passages from "Othello" could be drawn upon to supply the inspirational material. A burlesque on the "Comedy of Errors" would not be entirely out of place nor would it be bad taste to treat other Shakesperian tragedies in a light, popular manner. More music and a grand finale by a man of Hackett's caliber would end an evening of genuine enjoyment.

* * *

How Often Does a Fan Listen In?

"How silly to think of broadcasting the same thing for three consecutive nights from the same station," the more thoughtless observer might argue. This suggestion is not nearly as rash as it might appear. There is certainly no visible object standing in the way of its success. Who, for instance, would be silly enough to believe that every listener is stationed at his receiver every night? It would be safe to wager that even a three nights' performance would not bring into the fold more than 80 percent of the listeners within the range of the station.

The idea suggests an endless chain of performances each with the power to create atmosphere. "A Night on the Montmartre" or "The Life of Schubert" are random suggestions along the same line of thought. All of the great tragedies of history and the lives of great men can be dramatized for radio in a most agreeable fashion. Of course, these things cannot be done by sitting in an office waiting for applicants to fill a date book.

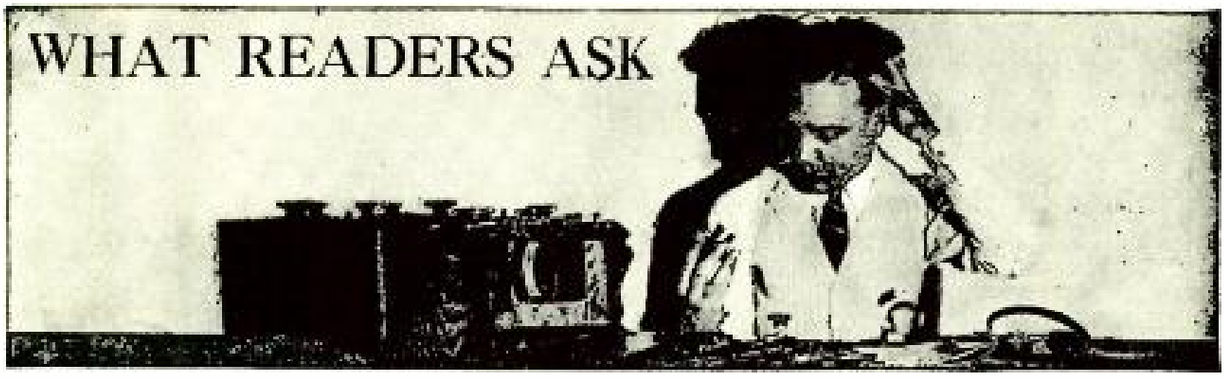
* * *

Will We Have Super-programs Too?

SUPER-POWER broadcasting is growing. Soon we shall have wave-mills grinding 10, 15 and even 25 kilowatts. That is all very wonderful and very marvelous, but where are the super-programs, dear Adolph?

The New Portable Receiver

The May issue will introduce a new and remarkably efficient portable receiver that was designed by Mr. S. Gordon Taylor of the POPULAR RADIO *laboratory. The receiver operates on loop and dry-cells and is mounted in small standard cabinet for use at home. With summer vacation time approaching many persons will ponder on a set they can take to "the great open spaces." This is that set. It may be slipped into a carrying case in which compartments for receiver, batteries, loop and loudspeaker may be provided. It is a single-control receiver, using six dry-cell tubes and it combines high efficiency with ease of operation and may be built at a cost for parts of about $60.00.*



CONDUCTED BY LAURENCE M. COCKADAY

IN justice to our regular subscribers a nominal fee of fifty cents per question is charged to non-subscribers to cover the cost of this service, and this sum must be inclosed with the letter of inquiry. Subscribers' inquiries should be limited to one question or one subject.

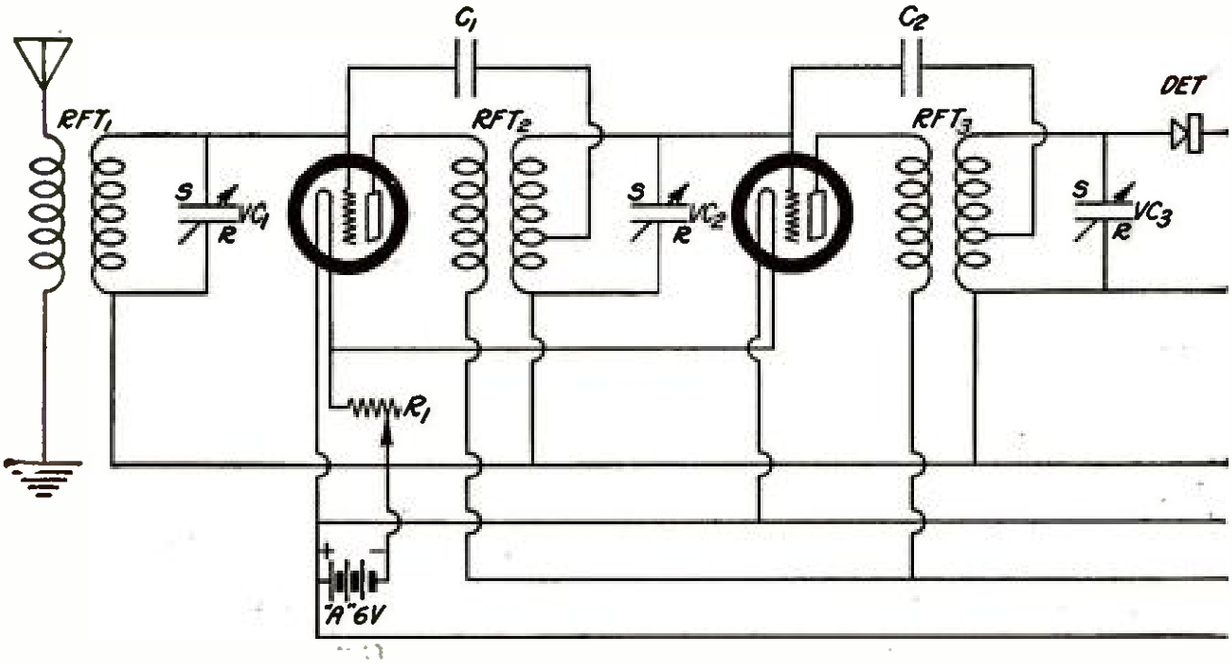
A Neutralized Radio-frequency With a Crystal Detector

QUESTION: Please show a circuit that embraces two stages of radio-frequency amplification of the tuned variety that is neutralized and has a crystal detector in place of the usual vacuum-tube detector. Also will you include two stages of transformer-coupled audio amplification with a "C" battery? If I use this receiver with ¼-ampere tubes, will it be semi-portable? I intend using a very small storage battery for the filament voltage and a crystal detector to allow for portability.

JOHN SCOTT

ANSWER: The circuit you ask for is shown in the diagram in Figure 3, which includes the various features you want to incorporate in a receiver. It will have a filament current consumption in operation of about 1 ampere. The parts that you will need to construct a set based on this circuit are the following:

*RFT1, RFT2 and RFT3—standard set of Neutrodyne couplers;
*VC1, VC2 and VC3—standard set of variable condensers for the Neutrodyne, .00035 mfd.;



A NEUTRALIZED CIRCUIT

FIGURE 1: *This wiring diagram shows how to hook up a crystal detector in a which makes portability more possible with this set,*

*C1 and C2—standard neutrodon condensers;
C3—mica, fixed condenser, .0005 mfd.;
DET—crystal detector;
AFT1 and AFT2—audio-frequency, amplifying transformers;
R1—filament rheostat, 20 ohms;
R2 and R3—filament rheostats, 30 ohms;
J1 and J2—double-circuit jacks;
J3—single-circuit jacks.

You may use four C-301-a tubes or four DV-3 tubes or four UV-201-a tubes in this circuit. A crystal detector of the fixed or semi-fixed variety is recommended for DET. The connections for the "A," "B" and "C" batteries are plainly indicated on the diagram in Figure 3.

An Antenna Coupler for the Superheterodyne Reflex

QUESTION: I am using one of your superheterodyne, reflex receivers with eight tubes. The loop I am using is so large that I do not have enough room to turn it in my small apartment. Would it be possible to do away with the loop and use instead an outdoor antenna or a short indoor wire? Would I have to use some form of coupler for tuning with such an aerial? If this scheme would be feasible, kindly tell me what are the mechanical and electrical specifications for such a coupler.

HAROLD V. SMITH

ANSWER: This scheme is entirely feasible and you will find a description of such a coupler together with pictures and other information if you will read our "Trouble Shooting" department this and next month. The use of this coupler enables the superheterodyne reflex to be used with any kind of outdoor or indoor antenna, and it replaces the loop inductance for tuning. No loop is needed with the coupler.

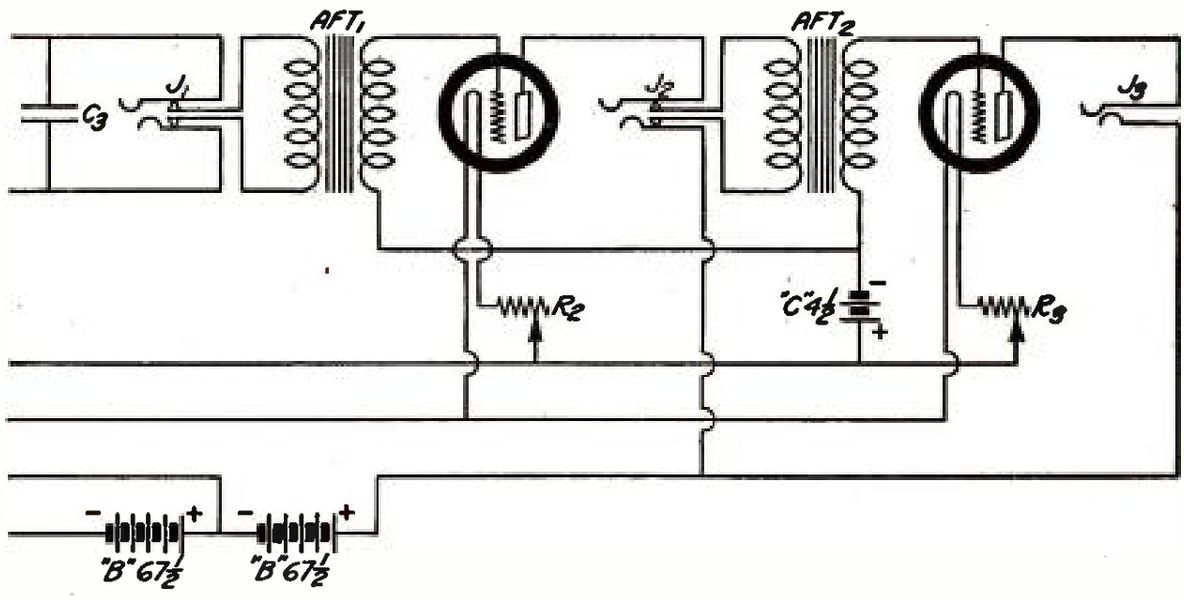
When "B" Batteries Should Be Replaced

QUESTION: At what voltage should my "B" batteries be discarded? After a few months they drop down rapidly. The ordinary 22½-volt battery becomes as low as 10 volts, after which it falls off rapidly to zero. However, during this rapid decline in voltage, I cannot get good quality from the receiver. At what critical voltage do you advise me to replace my "B" batteries?

FREDERICK LAUSSER

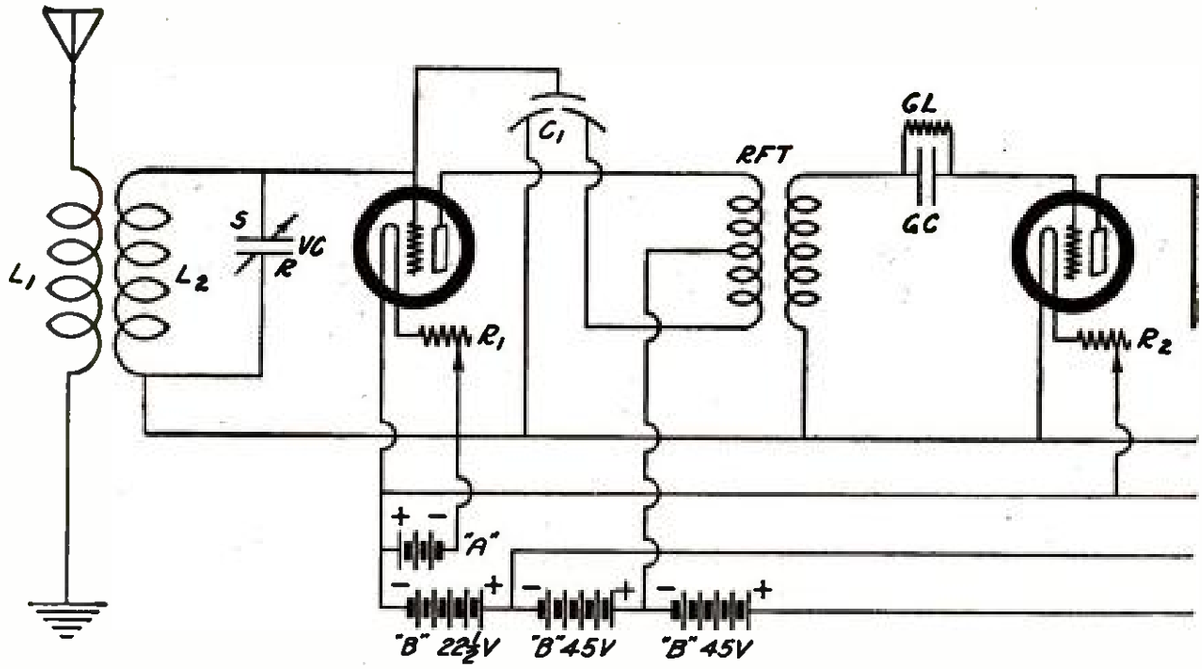
ANSWER: Never use an ordinary 22½-volt "B" battery after its voltage has dropped to 16 volts or less. Never use the ordinary 45-volt "B" battery after its voltage has dropped to 32 volts or less. Below 6 volts, the resistance of the batteries interferes greatly with audio-frequency amplification and distortion is sure to occur.

* These three items may be obtained in the form of a kit manufactured by any of the makers of Neutrodyne parts.



WITH A CRYSTAL DETECTOR

neutralized tuned-radio-frequency circuit. The connections for the crystal detector, are shown in the center at the left of the diagram.



Apparatus for One Stage of Tuned Radio-frequency Amplification and Two Stages of Audio-frequency Amplification

QUESTION: Please give me a hook-up for one stage of tuned radio-frequency, using the Telos vario-transformer and the Amsco compensator with two stages of transformer-coupled, audio-frequency amplification. I want to use a fixed coupler with a variable condenser in place of the ordinary Telos variometer for tuning the antenna circuit. Please give me this information together with information regarding the proper constants of the various instruments.

JOHN WILTON

ANSWER: You will find this circuit in Figure 2. The parts you require are the following:

L1 and L2—primary and secondary winding of the fixed coupler;
VC—variable condenser, .005 mfd.;
C1—Amsco compensating condenser;
GC—mica, fixed condenser, .00025 mfd.;
C2—mica, fixed condenser, .0005 mfd.;
GL—grid-leak, 2 megohms;
R1, R3 and R4—filament rheostats, 20 ohms;
R2—filament rheostat, 6 ohms;
RFT—Telos vario-transformer;
AFT1 and AFT2—audio-frequency, amplifying transformers;
J1 and J2—double-circuit jacks;
J3—single-circuit jack.

The tubes required for the first, third and fourth sockets are either UV-201-a, DV3 or C-301-a tubes. The detector tube for the second socket should be either a UV-200 or a C-300 tube. The two coils L1 and L2 may consist of L1, a honeycomb coil size L35 and L2 honeycomb coil size L50, or they may be made at home by winding over L1 ten turns of No. 18 DSC copper wire and for L2 fifty turns of the same size wire. These two coils should be wound on a bakelite or hard rubber tube with an outside diameter of 3½ inches. The two coils should be placed from each other a distance of ¼ inch.

Are British Broadcast Stations More Powerful than Ours?

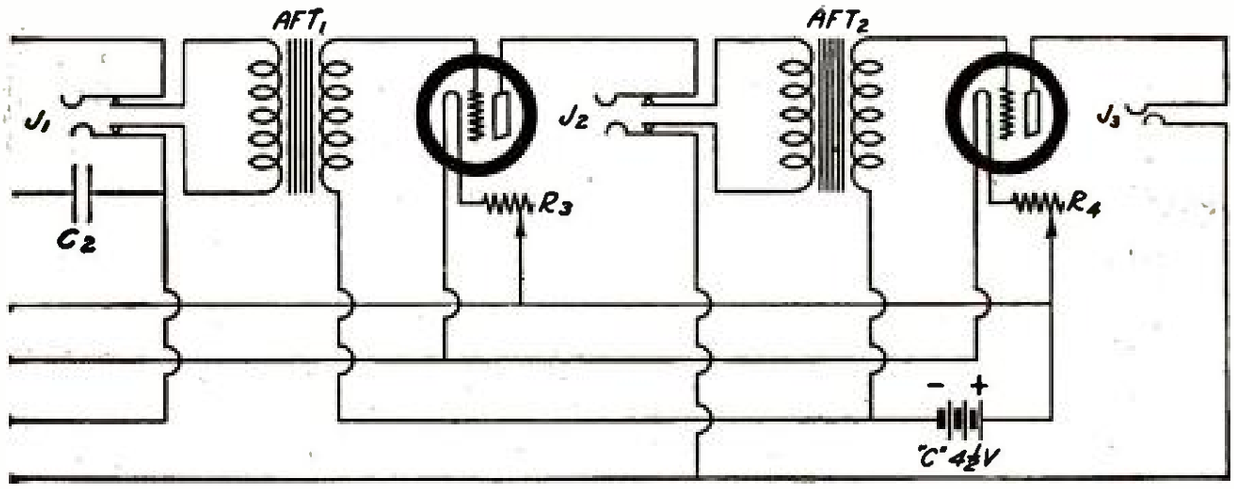
QUESTION: According to listings in various call books, the British stations often have as much as two to five times the power of American stations. Yet, the American stations seem to be heard in England much more clearly and more often than the British stations are heard in America. Is this accounted for by the higher efficiency of American stations or by a different power rating?

ARTHUR J. BEARD

ANSWER: American stations are rated for power by the energy that they are capable of transforming and supplying to the antenna circuit. In other words, an American broadcasting station with a power of 1,000 watts is capable of applying 1,000 watts of high-frequency energy to the antenna circuit. The British stations, however, are rated according to the input (in watts) in the plate circuit of the transmitting tubes. In a British station of

A RADIO-FREQUENCY CIRCUIT WITH A VARIOTRANSFORMER

FIGURE 2: *This circuit diagram indicates how to hook up one stage of tuned, radio-frequency amplification with two stages of audio-frequency amplification.*



1,000 watts, a supply of 1,000 watts (in plate energy) is applied to the tubes. However, this same British station, when rated according to our American rating, would probably be considered as delivering only from 350 to 500 watts to the antenna circuit.

Ready-made Receiver Articles

QUESTION: I have read your first two installments on "How to Operate Your Ready-made Receiver" and have found them extremely interesting. I have a Crosley Trirdyn set and am getting what I think are good results with it. However, if I could persuade you to include this in the series, I am sure that issue would be valuable to many.

HAROLD DAYTON

ANSWER: Our technical staff has prepared an article on the receiver you have mentioned, in response to a large number of similar requests. It appears in this issue on page 340.

Can No. 199 Tubes Be Used in the Eight-tube Superheterodyne Reflex?

QUESTION: I would like to build your new Eight-tube Superheterodyne Reflex Receiver, but first I want to know whether or not I can use No. 199 tubes in place of the No. 201-a tubes that are specified. If so, I will not have to buy a storage battery or a charger.

GEORGE D. WARD

ANSWER: The use of UV-199 or C-299 tubes in the receiver mentioned will greatly cut down its sensitivity and volume. However, they may be used, although they may cause you some trouble before all the kinks can be ironed out of the circuit. The set was designed especially for the use of the regular six-volt tubes; and we recommend that a builder use these in order to get the best results.

An Amplifier for the Single-tube Tuned-plate Receiver

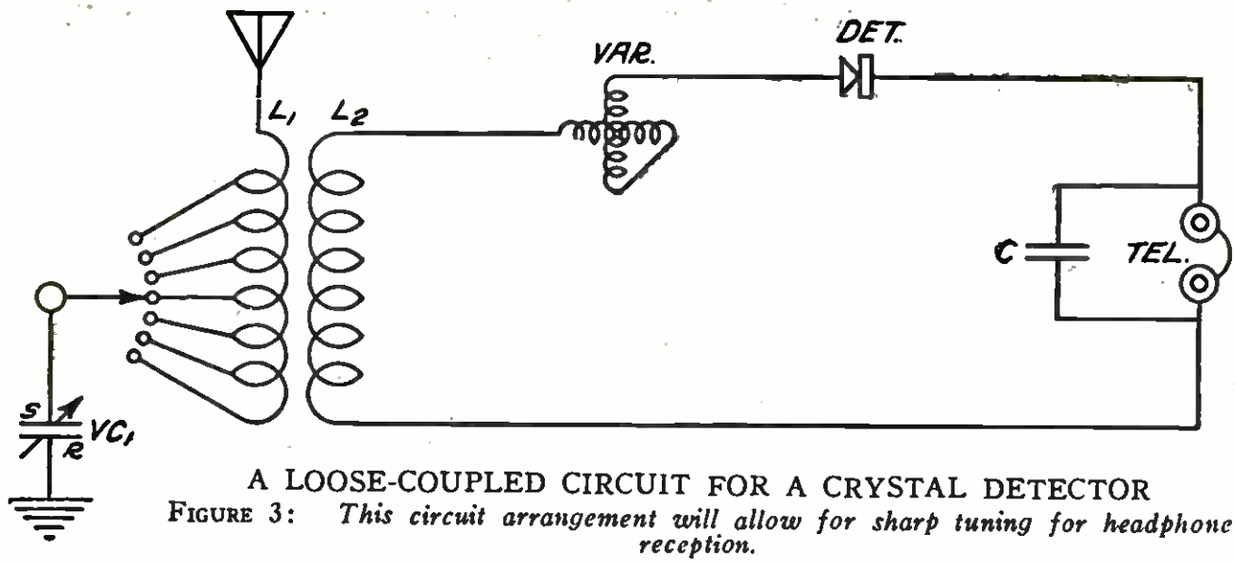
QUESTION: I have been following the simple "How-to-Build" articles and have built the No. 5 receiver, and am getting very fine results with it, on the headphones. Now, I would like to add an amplifier to it so that I may listen in with a loudspeaker. Where can I get the necessary information about it, with a picture wiring diagram?

DONALD STONE

ANSWER: In the March issue of POPULAR RADIO there is another simple "How-to-Build" article—No. 7 of the series. It tells you how to make an audio-frequency amplifier that can be added to any of the receivers previously described in this series. We recommend that you build it and attach it to the tuning unit you already have. This may easily be done by bridging it across the binding posts as specified in the article.

A Regenerative Receiver With Two Variometers

QUESTION: A neighbor has a set that I consider a wonder; he told me that he got it from POPULAR RADIO. He called it a two-variometer regenerative receiver. Will you publish it in your "What Readers



A LOOSE-COUPLED CIRCUIT FOR A CRYSTAL DETECTOR

FIGURE 3: *This circuit arrangement will allow for sharp tuning for headphone reception.*

Ask" Department for my benefit? Also please let me know what parts I will need for building such a circuit.

HOWARD V. THOMPSON

ANSWER: We are reprinting the circuit exactly as used by your neighbor; you will find it in Figure 4. If you use reliable instruments you should have good results with it. The list of parts is included below:

L1 and L2—primary and secondary coils of a tapped variocoupler;
VAR1 and VAR2—variometers;
VC1—variable condensers, .0005 mfd.;
GC—mica, fixed condenser, .00025 mfd.;
C1—mica, fixed condenser, .0005 mfd.;
GL—grid-leak, 2 megohms;
R1—filament rheostat, 6 ohms;
R2 and R3—filament rheostats, 20 ohms;
J1 and J2—double-circuit jacks;
J3—single-circuit jacks;
AFT1 and AFT2—audio-frequency, amplifying transformers.

Use a soft tube in the first tube socket which is the detector and two hard tubes in the two last sockets, which are amplifiers. The tuning is done by the variometer and the variable condensers; and the coupling between the antenna and the grid circuits is adjusted by rotating the secondary coil of the variocoupler.

A Sharp Tuning Crystal Set

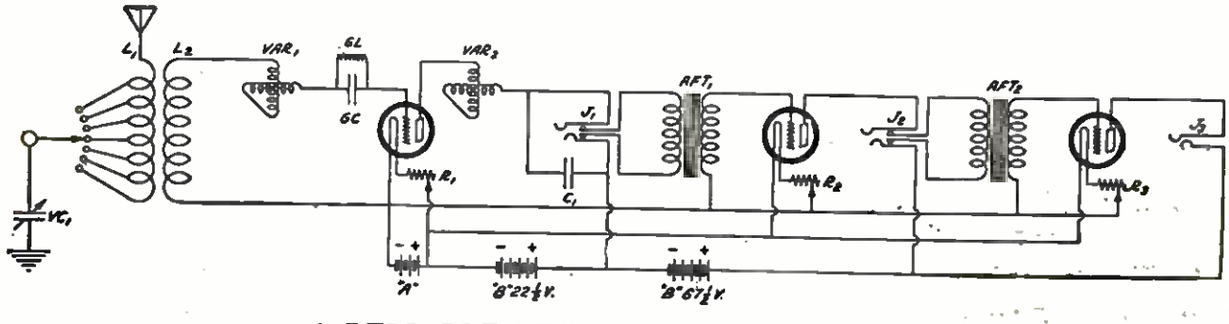
QUESTION: Please give me a simple tuning circuit for a crystal detector that employs a variometer and a variable condenser. I want to get a circuit that will tune reasonably sharp and that will give me good reception on headphones.

B. D. SMITH

ANSWER: You will find this circuit requested in Figure 3. Notice that we have added a variocoupler to the instruments you listed, so that you can make an inductively-coupled receiver. All the parts you need are given in the list below:

L1 and L2—primary and secondary coils of an ordinary, tapped variocoupler;
VAR—variometer;
VC1—variable condenser, .0005 mfd.;
VET—crystal detector;
C—mica, fixed condenser, .0005 mfd.;
TEL—telephones.

The antenna circuit is tuned by means of the variable condenser and the tapped switch. A secondary circuit is tuned by means of the variometer and the coupling or selectivity is controlled by rotation of the secondary of the variocoupler.



A RELIABLE REGENERATIVE HOOK-UP

FIGURE 4: *This circuit, that embraces two variometers, will give you good results for both local and distant reception.*

The Four-circuit Principle Added to the Colpitts Circuit

QUESTION: Will this be of value to your readers? Apply the Cockaday stabilizer to the ultra-audion or the Colpitts circuit by mounting a 50-turn honeycomb coil beside the regular honeycomb coil used in the circuit. These two coils should be mounted in a double-coil mounting with the stabilizer coil (the variable type). A .00025 or a .00035 mfd. variable condenser should be connected in shunt to this circuit.

R. FREDERICK

ANSWER: The principle of the stabilizer circuit may be applied to any regenerative receiver. As some of our novice readers may be interested in building an experimental set-up (it is simple and effective yet low in cost), we are presenting the circuit in full in Figure 5. The necessary parts are the following:

L1—honeycomb coil, size L50;
L2—honeycomb coil, size L35 or L50;
VC1—variable condenser, .00025 mfd. or .00035 mfd.;
VC2—mica, fixed condenser, .00025 mfd.;
GL—variable grid-leaks and filament rheostats, 6 ohms;
TEL—telephones.

The tube to be used with this circuit is the UV-200 or the C-300 tube. All tuning is done with the two condensers VC1 and VC2.

The Crystal as the Second Detector in the Superheterodyne Receiver

QUESTION: Would it be possible to use a crystal detector as the second detector in a superheterodyne receiver? I want to reduce the number of tubes in the superheterodyne because I am using it for a portable set. I do not care if the reception would be cut down somewhat in strength as long as I know it would give results.

HAROLD ANDERSON

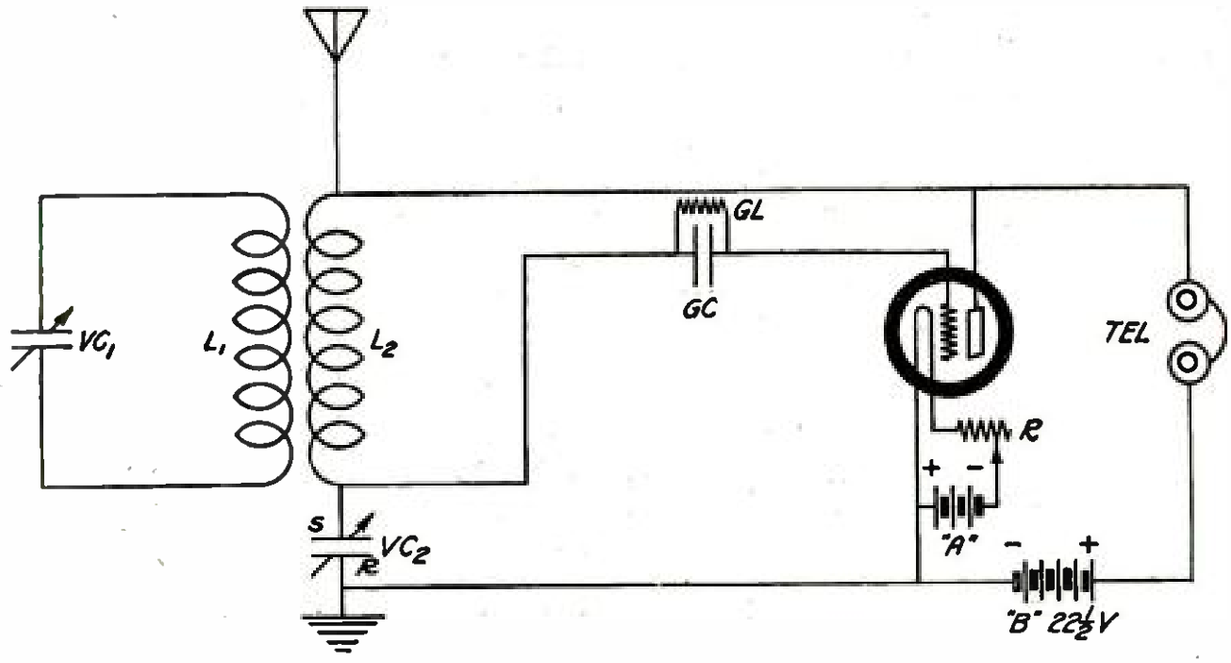
ANSWER: The "super" will give good results if used with a crystal detector for the second detector. However, it will need replacements from time to time.

The Proper Rheostat for the 199 Tube

QUESTION: What size resistance winding should I use in series with the filament of the UV-199 tube that operates on three 1½-volt dry cells connected in series?

J. B. D.

ANSWER: You should use a 30-ohm rheostat.



A MODIFIED COLPITTS CIRCUIT

FIGURE 5: *This hook-up shows the way in which the Four-circuit tuning principle can be adapted to the Colpitts circuit.*

CONDUCTED BY DR. E. E. FREE

Delusions of Radio Mind Control

THERE is always a certain percentage of the population afflicted with mild forms of insanity and the delusions possessed by these unfortunates fluctuate, like other popular ideas, in the waves of opinion which we call "fads." Just now there is a fad of "mental radio." Hundreds, possibly thousands, of people who are mildly crazy are imagining that their minds or bodies are being influenced in some fashion either by the radio waves used in broadcasting or by some mysterious variety of special waves sent out by this or that malevolent individual.

These delusions are not especially new. They were mentioned in these columns nearly two years ago. But the sufferers seem to be on the increase. The editors of this magazine have been consulted with increasing frequency during the past three months by persons who imagine themselves victims of some such persecution. That similar appeals have been made to the authorities of the United States Government is evidenced by a recent news dispatch from Washington.*

As a service to persons who begin to feel some such delusion, as well as in the interest of scientific truth, it is desirable for radio engineers everywhere to be publicly emphatic as to the utter impossibility of the mysterious "influences" alleged to be at work.

To speak of anything as utterly impossible is admittedly dangerous. Many so-called impossibilities have become realities during the past few years. Yet these delusions seem to be one case in which strong and dogmatic language is justifiable. Not only is it entirely contrary to everything that we know about radio for there to be any direct transfer of messages from a broadcasting station to a human brain, but there is still more cogent argument.

Although the use of radio is new, radio waves themselves are as old as the earth, probably older. Ever since there have been electric charges in space, similar, for example, to the charges that produce thunderstorms, there have been radio waves pulsing through the ether. Static did not originate all at once out of nothing on the day that Branly invented an apparatus to detect it. Static has been with us since millions of years before there were any such creatures as men. If the ether waves that carry radio had any oppressive or malevolent effects on the human mind that would have become, long since, one of the definite facts of life on earth, just as are the sunshine or the rain or the coldness of nights in the open air.

Nowadays, it is true, we have continuous waves with an intelligible modulation on them. From the physiological viewpoint this is a change of no importance whatsoever. It is unthinkable that our brains should be provided by nature with crystal detectors or with any other kind of electrical "gadget" capable of being effected by this purely arbitrary modulation while remaining unaffected by the fundamental ether impulse itself. If there is any effect of ether waves on the human body or the human mind that effect has been with us always. It is not due in the least to the use of radio and nobody is being persecuted or "influenced" by it.

Those who share these delusions of radio influence cannot bolster up their opinions by any reference to the alleged phenomena of telepathy. Telepathy may be defined, roughly, as the passage of ideas or of impressions from one mind to another without recourse to the usual channels of speech. gesture and the like. It is possible—although by no means proved—that something of this kind does occur, as has been several times mentioned in this department.

Recent telepathic experiments on the part of Mr. Gilbert Murray have attracted considerable attention in the newspapers. Mr. Murray is an eminent and distinguished Englishman. Conscious fraud on his part is unthinkable. It seems to be established that he (as well as a few other persons) possesses, at times, a remarkable and as yet inexplicable power of

* "Is Mental Radio a Possibility?" by Carl H. Butman. *Washington Radio News Service*, January 12. 1925.

guessing what is in the mind of other persons who are present. Dr. Walter Franklin Prince, Chief Investigator of the American Society for Psychical Research and the recognized American authority in this field has described some of Mr. Murray's accomplishments with interest and implied acceptance.*

Possibly this is all true. Science has not yet accepted telepathy as a proved fact but neither has science denied its possibility. In any event, this has nothing to do with mental persecutions by radio. If telepathy is a fact it is probably not related to any form of radio waves.† And a persecution by telepathy is unthinkable.

Why is it unthinkable? For a very simple reason. All experimenters with the supposed telepathic phenomena agree that a condition for success is a receptive condition of the mind. If Mr. Murray thinks about affairs of state or about the condition of his coal cellar he gets no telepathic messages.

Accordingly, if you begin to feel that some mysterious influence is attempting to "control" your mind, the remedy and preventative is in your own hands. Merely think about something else. Go to the movies, play a game of checkers, repair your radio set, sit down and read POPULAR RADIO. If you do this, any variant of telepathy is surely impossible. And any radio "mind control" is impossible anyway.

* "Experiences Which I Cannot Explain Away," by Walter Franklin Prince. *Scientific American* (New York), vol. 131, pages 384-386 (December, 1924).

† This is a reversal of an opinion expressed by the writer three years ago. Recent experiments on telepathy have made it almost impossible to ascribe these facts, if true at all, to any form of radio.

Radio Geology from Airships

THE possibility that radio waves can be used in one fashion or another to discover something about rock strata, ore deposits or water channels deeply buried in the earth without actually digging down to them, has already been discussed in POPULAR RADIO.* Mention has been made, also, of the proposals for the use of radio in discovering water in arid regions, which proposals were presented by Mr. Oskar Taussig, of Vienna, to the meeting of the World Power Conference in Wembley, England, last summer. Mr. Taussig's suggestions have now come to hand in more complete shape than was reported in the preliminary announcements of the conference.†

Mr. Taussig begins by referring to the suggestion made in 1910 by Dr. Heinrich Loewy of Vienna to the effect that when a radiating antenna is brought within a reasonable distance from a conducting body, the presence of that conducting body in the field of the antenna will affect the shape and nature of the field and may affect the nature of the radiation from the antenna.

Mr. Taussig suggests, to be concrete, a radio transmitter and antenna mounted on an airship. Possibly even a small aircraft of airplane type would be sufficient. This airship is to fly over the desert areas of the earth, while the radio transmitter is in operation.

* "Finding Mines by Radio," POPULAR RADIO for September, 1924, pages 238-245.

†"Electro-aviation Methods for Investigating the Interior of the Earth," by Oskar Taussig. In German. *Elektrotechnik und Maschinenbau* (Vienna), vol. 42, pages 666-668 (November 16, 1924).

Courtesy of Scientific American

A MIND CONTROL TEST

In one of the experiments conducted by Dr. Prince a blindfolded person attempts to "catch" the thought on which the persons who are seated around him have agreed to concentrate. A number of obsessed persons believe that they "catch" radio waves in a similar manner.

The surface soil of these desert areas, being dry, will not act as a conductor. Therefore the working of the transmitter will be unaffected.

But suppose that the airship crosses a place where there exists a considerable body of underground water. This water will form a conducting body. The reaction of this conductor on the transmitter will alter the natural wavelength of the antenna or, what is the same thing, it will alter the capacity between antenna and ground. This alteration can be detected. Thus, Mr. Taussig believes, it would be possible to locate those parts of any desert area where drilling would be most likely to develop supplies of water. It is said that tests made from a Zeppelin airship over Friedrichshafen, in 1922, showed the theory to be correct.

Mr. Taussig also suggests that similar underground detective work might be accomplished by transmitting waves downward into the ground and detecting the upward reflection of these same waves from underground conducting layers, either of water-saturated strata or of ore-bearing beds having a higher conductivity than normal for barren rock.

The suggestions are interesting. It is practically certain, we believe, that something of this sort will be accomplished some day. Nevertheless the plan is not so free from difficulties as this brief description might imply. Rock layers may differ among themselves in conductivity. The mere surface of the ground may act as an absorbing or a reflecting layer. Actual experiments are needed. Why would not this be a good co-operative project for the Geological Survey and the Navy, using the *Los Angeles* or the *Shenandoah* to carry the transmitter?

Gilliams Service

A MINE FINDER THAT WORKS LIKE A RADIO DETECTOR

With the apparatus shown above a German inventor named Pastor has succeeded in detecting the presence of metallic ores beneath the ground. When ores are situated under the tripod they affect the behavior of the detector, thereby disclosing their location.

Does Radium in the Rocks Affect Radio Reception?

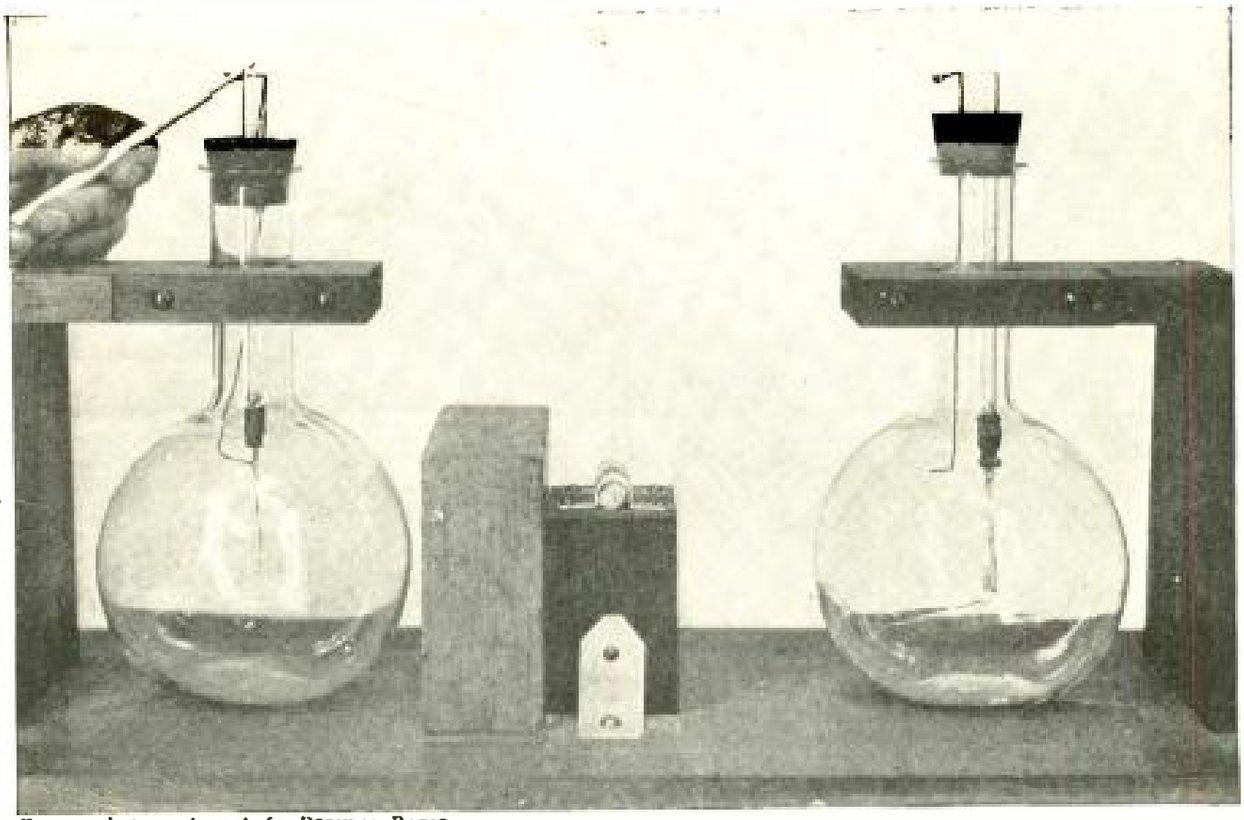
A MOST interesting possibility with regard to the cause of "dead spots" and other mysterious variations of radio transmission is suggested by a recent paper presented to the Academy of Sciences in Paris and dealing with the effect of radium in rocks and soils on the electrical condition of the air immediately above the earth materials in question.*

It is well-known, of course, that nearly all rocks, the majority of the waters from springs and wells and practically all soils contain very small amounts of radium. It is known, too, that the discharge of the so-called beta rays (really fast-moving electrons) and of the gamma rays (very short ether waves) from the minute amount of radium in the earthy materials is sufficient to produce a certain amount of ionization in the air immediately above. The rays from the radium hit against atoms of gas in the air, detach an electron from each of these atoms, and thus produce an "ion"; that is, a gas particle which carries an electric charge. The effect of this, as already explained many times in POPULAR RADIO, is to make the ionized air slightly conducting for electricity.

All this has been known for some time. What Dr. Stoklasa and his assistant have added is the information that the amount of radium in the surface materials of the earth, and accordingly the degree of electric conductivity imparted to the air, may vary greatly from one part of the world to another.

In the air over Paris, where the radium content of the soil is low—probably almost a minimum—the electric conductivity of the air was found to be $.4 \times 10^{-4}$ electrostatic unit. At the top of the Eiffel Tower, where the air

* "The Radio activity of Gases from Vesuvius and from Solfataras in the Campania," paper by J. Stoklasa and J. Penkava before the Academy of Sciences, Paris, on October 27, 1924. Reviewed in *Journal of the Franklin Institute* (Philadelphia, Pa.), vol. 199, page 136 (January, 1925), also in *Industrial and Engineering Chemistry, News Edition* (Easton, Pa.), vol. 3, number 2, page 8 (January 20, 1925).



From a photograph made for POPULAR RADIO

HOW RADIOACTIVITY AFFECTS THE AIR

This apparatus was devised by the Bureau of Standards to show how the rays from radium ionize the air and make it a conductor for electricity. In the flask at the left, the two gold leaves of the electroscope will stay apart when charged. In the vessel at the right, the rays from the tube of radium at the center ionize the air so that the electricity leaks off the gold leaves at once.

was mixed, doubtless, with other air coming in from outside areas, the conductivity was twice as great. Over Vesuvius, where volcanic emanations had been added by the volcano, the conductivity was twelve times that at Paris. Near the radium mines in Austria the air conductivity was six times that at Paris. Over the potash mines in Alsace the air conductivity was six and one-half times that at Paris, this being explained by the fact that the element potassium is slightly radioactive.

Dr. Stoklasa and Mr. Penkava did not attempt to apply these findings to radio. They were interested, instead, in whether these variations in radioactivity and in air conductivity might affect the growth of plants and, conceivably, the health or life of men and animals. There may be radio effects as well.

The conductivity of the air has an effect on the speed of radio waves that pass through it. It is such a change of conductivity at sunrise and sunset that is supposed to be responsible for the changes of radio transmission which are observed when the daylight-darkness line passes over the space between two communicating stations.

Now if the conductivity of the air is variable from place to place in response to differences in the radioactivity of the soil, there may be local retardations or accelerations of the speed of the waves. This will mean bendings of the wave direction, similar to the bendings that are supposed to occur at the sunrise line or at the under surface of the Heaviside layer. Interference effects and other transmission disturbances of considerable complexity are distinct resultant possibilities.

It is impossible to put out this suggestion except very tentatively. The differences obtained by Dr. Stoklasa are not really very great, all the conductivities being so small. Nevertheless it is obvious to all radio engineers that some unknown factors of considerable importance are affecting local radio transmission in many areas. Possibly this idea of local variations in the radioactivity of the ground deserves attention.

Filament Control Tuning

THE possibilities for some kind of fine filament control as a close tuning method is dealt with by R. J. Bann.*

"It is often remarkable how . . . careful filament control is successful in reducing distortion without having to 'detune' the set slightly," Mr. Bann points out. "On a single-valve, reflex circuit I have tuned in Birmingham, Aberdeen and London on the filament rheostat."

* "The Importance of Filament Control," by R. J. Bann. *The Wireless World* (London), vol. 15, pages 569-571 (January 28, 1925).

Sir Oliver Lodge Defends the Ether

Our readers can scarcely have forgotten the argument initiated in Popular Radio three years ago by Dr. Steinmetz's famous article, "There Are No Ether Waves." At that time Sir Oliver Lodge was to be found among the defenders of the real existence of the ether. In a recent address broadcast from 2LO, in London, he returns to the defense.*

Without the ether, he urged, the universe would be, not unity, but chaos. "You cannot imagine," he said, "empty space being thrown into vibration; there must be something in space which vibrates, and that 'something' extends to the furthest visible object, and constitutes a unifying and connecting mechanism, through which all our information is obtained. . . . To assert, requires knowledge; to deny, requires much knowledge. Let us be satisfied with positive knowledge so far as it has been vouchsafed to us, and leave negations to the self-sufficing and the omniscient."

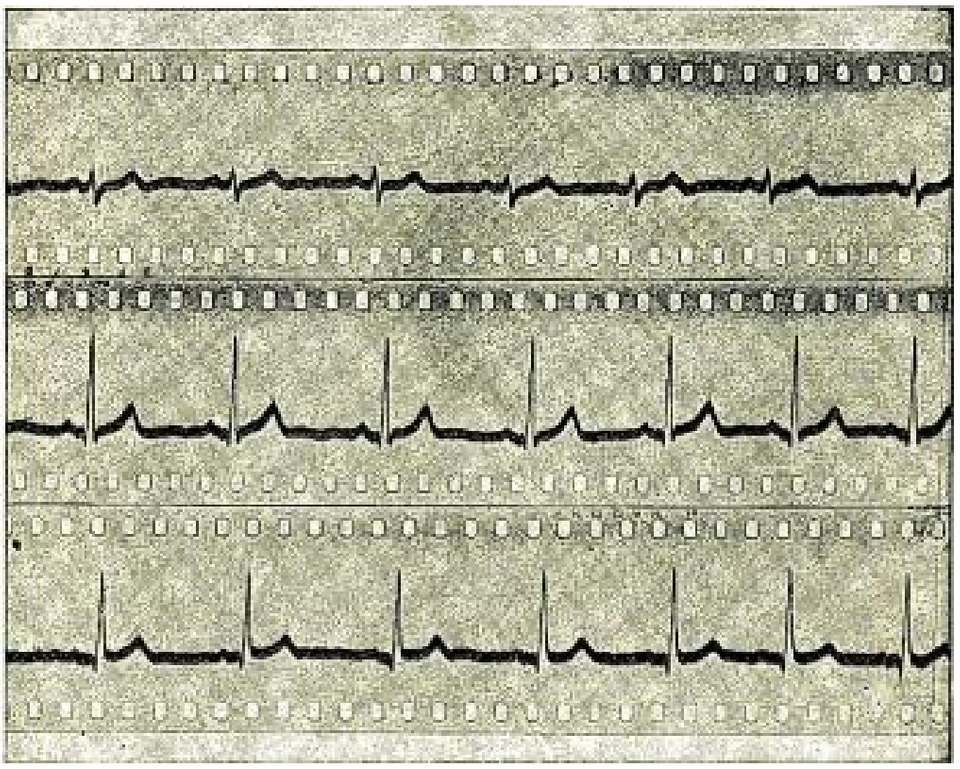
In a recent scientific article† Sir Oliver is still more explicit in his view of the ether as the only real and fundamental entity in the universe; the "world-stuff" out of which energy and matter, light waves and electrons are produced. "We find ourselves compelled," he writes, "to attribute to the ether of space the only substantial and fundamental existence in the material universe; and we must seek to resolve and explain everything else in terms of that. It is to be modified into electrons; these are known to build up the atoms; and thus the energy of their constitution can be part of the pristine energy of the ether. A great unification is proceeding before our eyes; it is by no means yet complete, it is only beginning; but the ideal is to resolve all material phenomena into manifestations of ether in various types of motion. That is what is looming before us, as a representation of the whole material universe, from stars and nebulæ, from atoms and electrons, down to the homely blocks of matter with which we daily deal, including our own bodies."

And that, for those that like it, is a sufficiently satisfactory picture. Dr. Steinmetz probably would not have liked it. He would have said that the ether, even as a unifying cement for the universe, is an unnecessary idea. One's decision must depend, we believe, on how one likes to think. To mathematicians no material cement is necessary to hold the stars together. Equations are enough. But for most of us, as for Sir Oliver, the idea of the ether is a convenient aid to thought.

But we must remember, as Sir Oliver so clearly does, that of actual knowledge about the reality of the ether we possess not one scrap.

* The address was broadcast on January 6, 1925, and is reported in *Nature* (London), vol. 115, page 59 (January 10, 1925). A series of seven talks was announced, at fortnightly intervals.

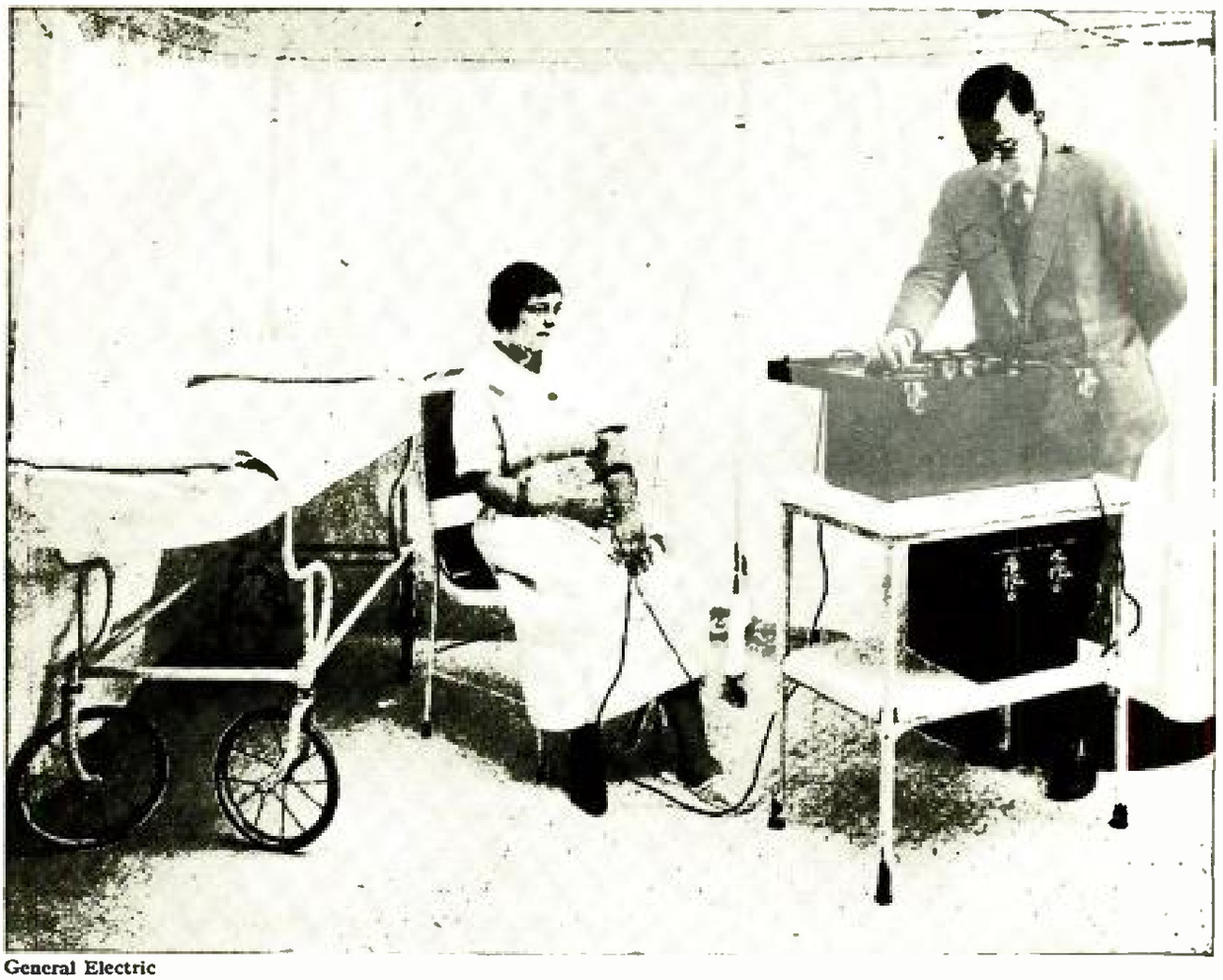
† "Matter and Energy," by Sir Oliver Lodge. *Scientia* (Bologna, Italy), vol. 37, pages 11-14 (January, 1925).



General Electric

HEART-BEAT RECORDS MADE BY RADIO APPARATUS

What the new electro-cardiograph record looks like. The sharp "nicks" that appear at regular intervals in the pictures indicate the heart beats.



General Electric

THE NEW RADIO DETECTOR FOR HEART BEATS

The feeble electric impulses that are produced by the beating of the woman's heart pass outward through the electrodes on her arm and leg and are amplified by radio apparatus so that they can be recorded on a photographic film.

Recording a Message from the Human Heart

AMONG the most ingenious of recent devices for the use of the physician is the new portable electro-cardiograph developed by Mr. L. T. Robinson and Mr. H. B. Marvin of the General Electric Company and demonstrated not long ago before the Schenectady County (New York) Medical Association. By means of this apparatus a physician can not only detect but record the feeble electric currents which are produced as the heart contracts and expands.

All muscular action, if not itself electrical, is accompanied by electrical changes of some kind. Whenever a muscle in your body contracts there is a corresponding electrical change, a change detectable by sufficiently delicate apparatus. This applies to the muscle of the heart as well as to other muscles.

Hence the principle of the electro-cardiograph. Electrodes are connected to the body, usually to an arm and a leg. These are connected, in turn, to a very delicate galvanometer. Every time the heart beats a feeble pulse of electricity goes out over the body, into the electrodes and through the operating mechanism of the galvanometer. In previous forms of electro-cardiograph the galvanometer and the rest of the apparatus were so complicated and so delicate that the instrument could not be moved. It was set up somewhere in a hospital. The patients were brought to it.

In the new form this has been changed. By making use of radio amplifiers to strengthen the very feeble currents from the beating heart Mr. Robinson and Mr. Marvin have been able to simplify the apparatus, making it far lighter and at the same time far less fragile. The new cardiograph, in its case, weighs only 37 pounds and the accompanying power unit weighs only 33 pounds in addition.

It will be possible, now, for a physician to carry an electro-cardiograph from hospital to hospital or to take it to the bedside of a patient whom it is unwise to move. Which is another benefit that medical science will owe to radio, for without the availability of the vacuum tube amplifier the new portable apparatus would never have been possible.*

* From a press statement by Mr. G. Bartlett, General Electric Company, Schenectady, New York.

CONDUCTED BY ALBERT G. CRAIG

Test "B" Batteries with 10 Watt Bulb

WHILE a high grade voltmeter is the best instrument with which to test the condition of dry cell "B" batteries, a handy substitute is an ordinary 10 watt, 110 volt electric light bulb. A 90 volt battery should light the lamp to nearly full brilliancy and a 22½ volt block will heat the filament to a dull red.

Keep Jack Contacts Clean

ALTHOUGH the contacts of all high grade phone jacks are made of silver which has a high degree of conductivity, dust or dirt may possibly get in between the metal surfaces. The result will be sizzling and frying noises in the headphones or loudspeaker. The simplest way to clean these jack contacts is to let them close on a piece of fine sandpaper and then pull the sandpaper out. Repeat this process with the sandpaper turned over and you will then be sure that both contacts are clean. Do not use emery paper because emery powder is conductive and may partially short circuit the jack.

Disconnect Wires at Batteries First

IF you have occasion to change the location of your receiver, be sure to disconnect the battery wires from the batteries before you loosen up the binding posts on the receiver.

Clean Your Antenna Insulators

RADIO fans, who erect antennas of enamelled wire and use insulators made of low-loss materials such as porcelain or glass, would do well to remember to take the antenna down and clean the insulators about once every six months. Soot and dust often collect on the surface of insulators and create a high resistance ground which will affect the signals. This is particularly true in cities where much soft coal is burned.

Mount Your Binding-post Panel Inside

WHEN there is sufficient space inside the receiver cabinet so that the binding post strip can be mounted on the baseboard without interfering with any of the instruments, such construction will save the work of cutting a large oblong hole in the back of the cabinet and the wires can be brought inside the cabinet through small holes spaced as are the binding posts.

Watch Out for Dials That Bind

OFTEN the dials on a home-made radio receiver will turn in anything but a smooth fashion simply because the hub of the dial is rubbing against the

edges of the shaft hole. In mounting dials of the ordinary type it is well to slip a piece of paper under the dial before you tighten up the set screw. Then you can remove the paper with the assurance that there is sufficient clearance between the hub of the dial and the surface of the panel. Some of the dials which can be mounted without a set screw have a tendency to move toward the panel when the clamping nut is tightened. With such dials it is desirable to use three thicknesses of paper.

Spaced Coils Are Easy to Wind

It is a simple matter to wind a coil with each turn of wire spaced a short distance from the next one. Start the coil with thread and wire at the same time applying considerably more tension to the wire than when no thread is used. After the coil is wound and the end of the wire fastened, the thread may be unwound. It is much easier if you can persuade a friend to hold a spool of wire in one hand and a spool of thread in the other while you use both hands to turn the coil form.

How to Improve a Loudspeaker

To take the tinny sound out of a loudspeaker with a metal horn, spatter it slowly with a mixture of hot paraffin and salt to which a little vinegar has been added to make it adhesive. When the coating cools, apply several coats of flat, black paint.

How to Get the Most Out of Your Tubes

By merely changing your tubes around in different sockets, the efficiency of your set may be increased as much as 50 percent. To do this correctly first tune in a station and then take two of your tubes and interchange them. Continue to do this in various combinations with the other tubes until the particular combination is found that gives the loudest reproduction.

Antenna Switching Arrangements

The radio experimenter who has several receiving sets hooked up on his bench usually finds it worth while to arrange switches so that he can change instantly from one set to another in order to compare their respective qualities on distant signals. As far as the battery supply to the various sets is concerned the problem is simple enough as there is nothing to interfere with connecting all of the sets to the same batteries provided, of course, that the minus "B" connection inside the several sets is always to the positive side of the filament circuit. If there is any doubt about this matter it is better to leave the minus "B" connection off all the receivers except one. The antenna lead-in can be run along the wall back of the bench and a number of single pole, single throw switches can be installed, so that by closing any switch, you will throw the antenna on to the set connected with the particular switch. All the receivers can be grounded and a change from one set to another simply means the opening of one switch and the closing of another.

Be Careful With Paper Templets

Most of the instruments now on the market for use in home-made radio sets which require mounting screws are supplied with paper templets so that the user has only to center punch the panel through the paper templet and then drill the holes. Unfortunately, however, some of these templets are printed from inaccurate plates and others are incorrect because of the shrinking or stretching of the paper that results from changing weather conditions. It is well to check up the actual dimensions for the spacing of the holes with the printed dimensions before using the templet. This is especially important when the holes are several inches apart.

CONDUCTED BY WILLIAM G. H. FINCH

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

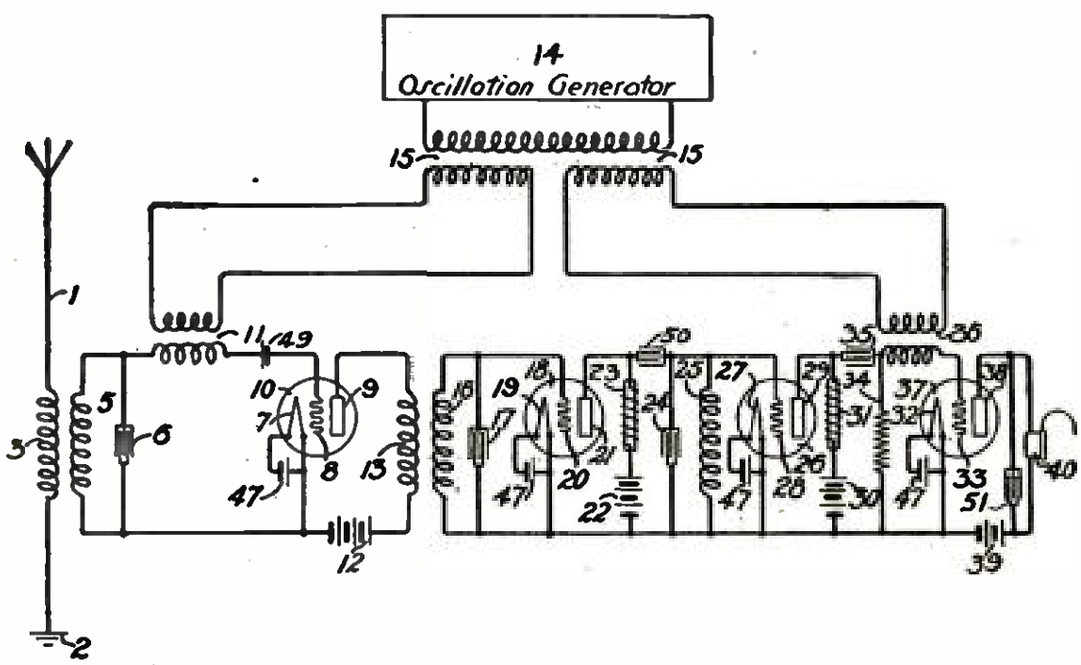
A Novel Receiver for Short-wave Reception

A NEW means for receiving high-frequency waves (short waves—150 meters or less), a system of multidetection, demodulation or frequency reduction method, by the use of which efficient reception and amplification on low wavelengths may be obtained, is proposed by Peter I. Wold of East Orange, N. J. *(Patent No. 1,514,752.)*

In radio systems that employ short waves, the frequency of the incoming waves is often too high to permit of efficient amplification.

In this patent use is made of a detecting circuit in which the high-frequency waves (short waves) are combined with those of other frequencies that are supplied by a local oscillator resulting in a beat note of a frequency above the limit of audibility but low enough to be amplified, and after amplification they are again reduced by further detection or rectification to some suitable audio-frequency. This system is shown in Figure 1 below.

Those interested in short-wave reception will be well rewarded by following some of the suggestions in Mr. Wold's patent.



WIRING DIAGRAM OF THE NEW SHORT-WAVE RECEIVER

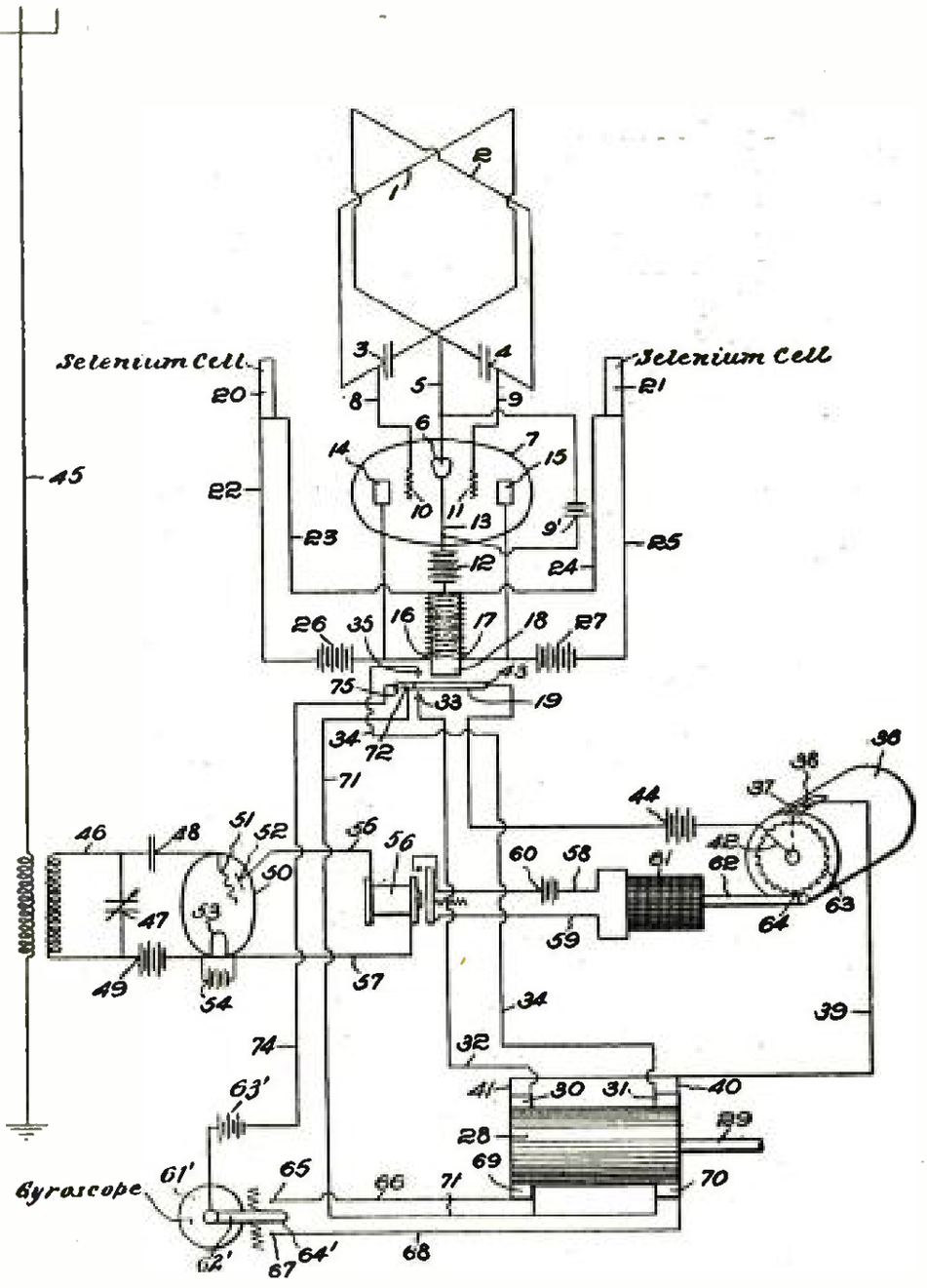
FIGURE 1: *This invention overcomes the difficulty that is ordinarily experienced in efficiently creating audibility through the amplification of waves of high frequency.*

A Radio Control System for Boats, Airplanes and Automobiles

THE experiments begun several years ago with the radio control of mechanisms have just been patented by John Hays Hammond, Jr., of Gloucester, Mass. Mr. Hammond's patent specification discloses a system for the control by radiant energy of moving bodies which may be either a vessel, aircraft or vehicle. *(Patent No. 1,513,108.)*

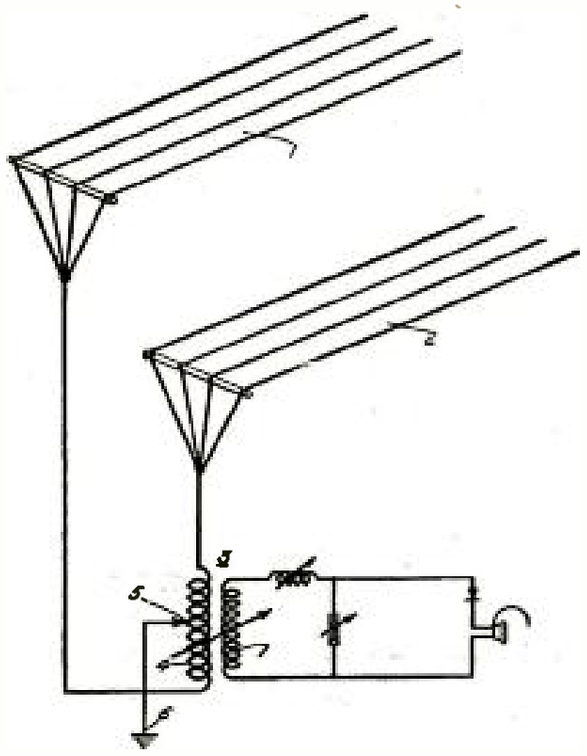
This is accomplished by a combination of selenium or other light-sensitive cells with a suitable vacuum-tube circuit. Some will recall the publicity given to Mr. Hammond's "electric dog" which he made to follow him by a flashlight held in his hand. A detailed drawing of the complete system is shown in Figure 2.

This invention also had a more serious aspect when it was used in experiments during the late war for the control by radio and light waves of torpedoes or airplanes. Scientists reasoned that should an enemy at night endeavor to pick up, with searchlights, a radio-controlled torpedo carrying high explosives, this very act would cause the light-sensitive



HOW HAMMOND'S ELECTRIC "DOG" WORKS

FIGURE 2: *This diagram shows how light rays or radio waves are used to operate this device which, through an electromagnetic arrangement, can turn wheels or a propeller or stop them in accord with transmitted waves.*



THE HOOK-UP OF THE STATIC REDUCING CIRCUIT

FIGURE 3: *The arrangement in the circuit of the two antennas, one of which is considerably higher than the other, is shown above.*

selenium cells, associated with suitably controlled circuits in the torpedoes, to attract the torpedoes to the searchlights and cause their destruction.

For Reducing Static

A MEANS for overcoming static interference to a marked degree and at the same time causing no diminution of received signals is presented by Frank Conrad of Pittsburgh, Pa. *(Patent No. 1,513,223.)*

The inventor finds that static changes and static induction in antennas of different heights are substantially the same, whereas the intensity of the impulses set up in antennas by incoming signals varies with the height. This phenomenon is pictured in Figure 3. The signals, as we know, are stronger at greater heights. On the basis of this phenomena, the inventor claims to eliminate the disturbing effects of static discharges through the use of two antennas for the interception of messages. These antennas are so associated with receiving apparatus that the equal static discharges in the two antennas cancel each other and become imperceptible. On the other hand, the unequal amounts of energy of transmitted signals picked up by the antennas, that result from their different heights, fail to cancel each other; whereby a residual effect remains that may be amplified to produce a readable signal.

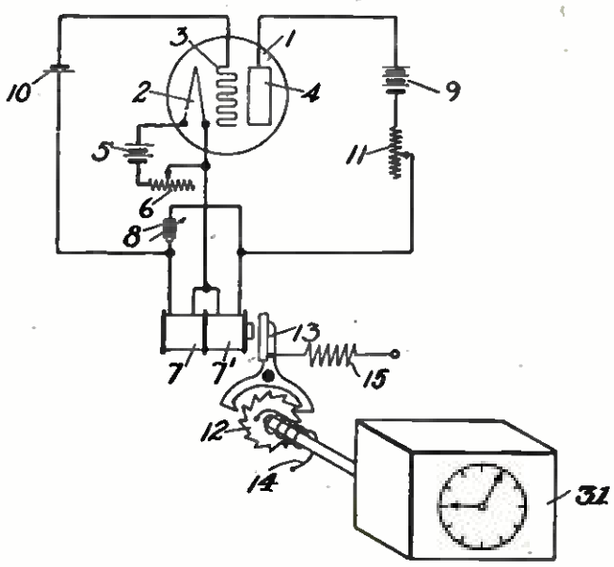
A Vacuum-tube Oscillator Chronometer

A VACUUM-TUBE oscillator chronometer and a method for increasing constancy of the operating characteristics of such device is provided for in a patent recently issued to Peter I. Wold of East Orange, N. J. *(Patent No. 1,514,751.)* It relates, also, to the provision of a chronometric system of exceptional constancy and accuracy by the expedient of using, as the actuating means for the time-controlling element, an oscillation generator in which the frequency is set by the constants of an oscillating circuit.

The type of generator proposed is familiar among radio engineers as a generator of high-frequency currents. The input and output circuits of an amplifying or repeating device are related in such a manner that energy, if fed back from the output to the input circuit, will develop a continuous series of oscillations if the physical and electrical constants of the amplifier or repeater and the electrical constants of the associated circuits are properly proportioned.

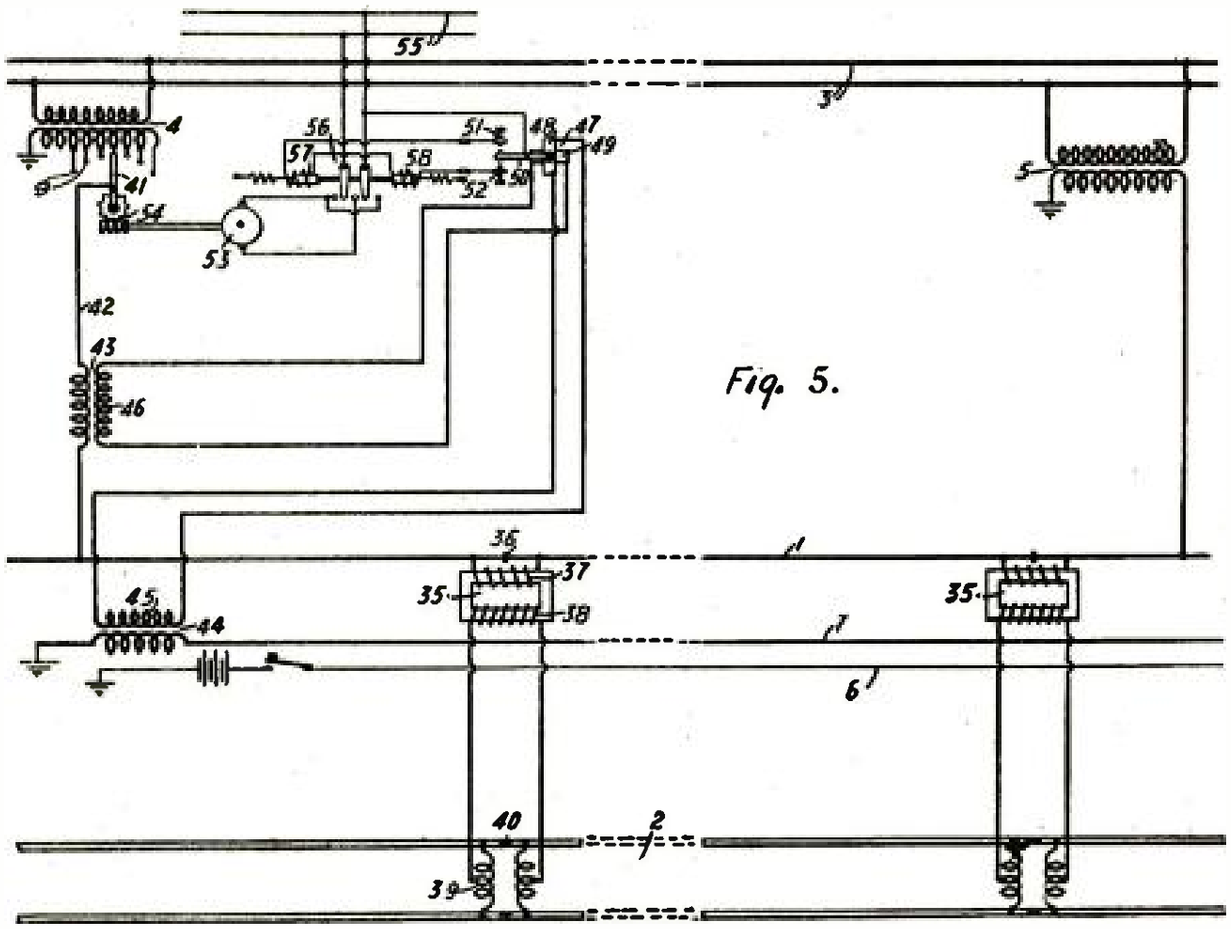
An inductive or electrostatic coupling is used for this purpose; or the same result may be effected through the internal capacity between the elements or electrodes of the tube itself. This tube circuit should include an oscillatory tuned circuit. The mechanical and electrical arrangement for this chronometer appears in Figure 4.

If the tuned circuit comprises the principal portion of the impedance elements in the tube circuits, it may be made to determine substantially the frequency of the oscillations generated. Therefore, it becomes possible to make the generated currents of the particular fre-



A NEW DEVICE FOR MEASURING FREQUENCIES

FIGURE 4: *This is the circuit in which beats of oscillating vacuum tubes are changed to mechanical impulses by an electromagnetic arrangement.*



A CIRCUIT THAT REDUCES INDUCTIVE EFFECTS

FIGURE 5: *The inductive effects in a power line are apposed with equal and oppositely directed electromotive forces, which reduce the disturbances, for instance, that occur when broadcasting stations are linked by telephone lines.*

quency desired by properly adjusting the constants of this circuit.

This invention should find wide application in the various radio laboratories or among those who are experimentally inclined, because it affords a method of accurately producing a frequency (as low as one cycle in ten seconds) that has a pure sine wave and as high as a hundred million cycles per second (radio frequencies).

Mr. Wold has provided a means for making a multitude of audio and radio-frequency measurements with one device; and, when used at audio-frequencies (up to 10,000 cycles) it provides the experimenter with a piece of apparatus that he can use to advantage to make impedance measurements of his audio-frequency transformers, and to determine the impedance of his tubes, he can readily match tubes and transformers thereby obtaining best results with his audio amplifier.

When used at radio-frequencies the same measurements may be made with radio-frequency transformers. There are numerous other measurements that can be made with such a "universal oscillator" and for those of our readers who desire further information we refer them to Bureau of Standards Circular No. 74, *Radio Instruments and Measurements*, which may be obtained for sixty cents from the Superintendent of Documents.

A New Way to Minimize Inductive Disturbances

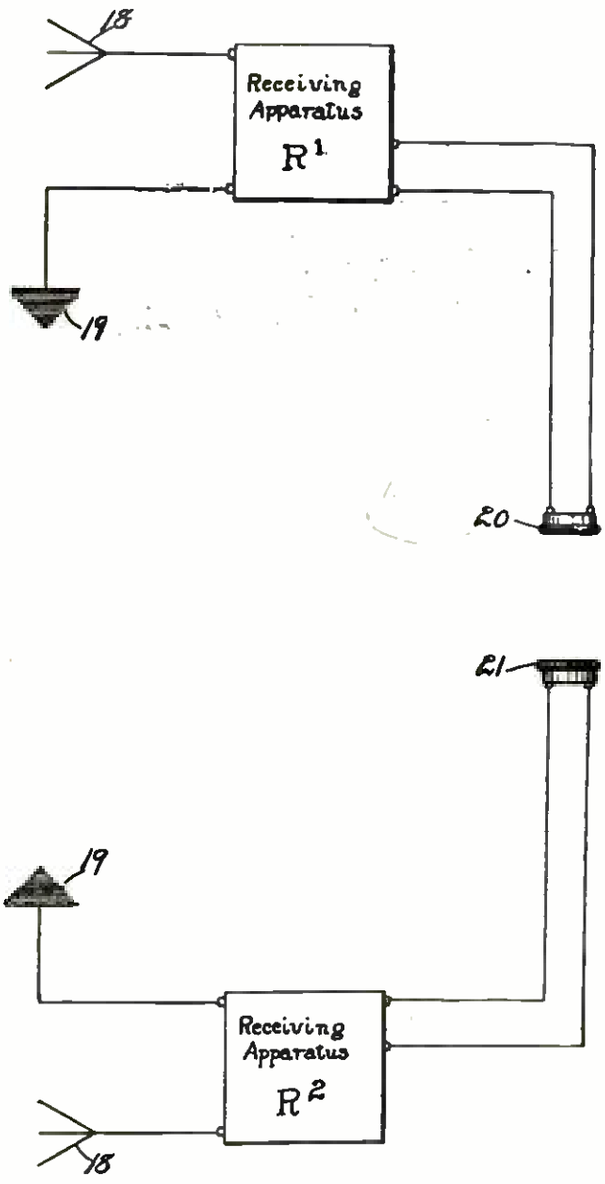
A MEANS for minimizing or neutralizing disturbances that may be impressed upon electrical circuits by electromagnetic induction from other circuits (such as parallel power lines in proximity to the former), has been proposed by Almon W. Copley of Wilkinsburg, Pa. *(Patent No. 1,513,224.)*.

This invention is particularly applicable to telephone circuits, and offers a means of improving radio broadcasting when relaying is employed for linking a series of broadcasting stations by wire for the simultaneous transmission of programs. The circuit arrangement for it is shown in Figure 5. Difficulty has always been experienced in broadcasting by pick-ups or transient currents that interfere with proper modulation. The inventor proposes to minimize or neutralize these disturbances by opposing them with equal and oppositely directed electromotive forces. The American Telephone & Telegraph Company

at present is utilizing equalizer and filter circuits to meet this problem and thus far has been fairly successful. However, the foregoing method affords another way to meet this problem.

Simulating the Listener's Presence in the Studio

A PATENT, which provides a method of producing the auditory illusion of being present in a broadcasting studio has been issued to Franklin M. Doolittle of New Haven, Conn. *(Patent No. 1,513,973.)* This inventor proposes to make use of different acoustical effects for each ear of a listener.



THE ARRANGEMENT OF THE RECEIVERS IN THE AUDITORY ILLUSION DEVICE

FIGURE 6: *This circuit "fools" the ears in somewhat the same manner as the stereoscope "fools" the eyes.*

He employs two separate channels of radio transmission (as shown in Figure 6), which may be obtained by the use of two wavelengths, or by employing a single wavelength and imposing two superaudible frequencies which are in turn modulated by the voice frequencies. He proposes the use of two microphonic devices, one of which is arranged to modulate the radiation of one channel and the second one to modulate the other channel, so that two versions of the sounds in a broadcasting studio that differ in phase relation will produce the consciousness of the presence of the artist when the listener's mind interprets these sounds.

Two receiving devices are required. A single telephone receiver is needed for each receiving set; and when these two telephone receivers are used as a headphone the right ear gets one sound interpretation of the concert and the left another.

While Mr. Doolittle has directed his attention to a timely problem we do not believe it will be universally adopted by the broadcasting stations for two reasons.

First, because at present the Department of Commerce is experiencing the greatest difficulty in allotting wavelengths to broadcasters with a sufficient frequency margin to insure the freedom from interference, especially in those receivers that employ circuits that cannot be tuned sharply.

Second, the other suggestion of the inventor that would overcome this difficulty in transmission, is to employ one frequency or wavelength, and superimpose upon it two superaudible frequencies, or frequencies above 10,000 cycles with sufficient margin to insure the success of using both channels simultaneously, so as to insure successful transmisssion.

There is still the obstacle to be overcome of employing two receivers so tuned as to be responsive to the superaudible frequencies. This would further require an investment in another receiving set, which fact alone would prevent the great majority of broadcast listeners from making such a scheme successful. The average broadcast listener who could afford to operate two receivers would not obtain success with such a method because of the minor difficulties that are attendant upon operating two receivers simultaneously to two frequencies that are relatively close, especially of the regeneration type.

A New Terminal Clip

MR. E. B. LEWIS of Waterbury, Conn., discloses a new clasp or clip with a combination of a terminal lug which should prove ideal for making quick connections. *(Patent No. 1,521,197.)*

A Balance Antenna System

ABRAHAM PRESS of Wilkinsburg, Pa., has received *Patent No. 1,522,745,* that shows a method for reducing disturbances from static.

THIS *department is conducted by* POPULAR RADIO LABORATORY *for the purpose of keeping the radio experimenter and the broadcast listener informed concerning the newest inventions and the approved developments in radio equipment. Only such apparatus as has been tested and endorsed by the Laboratory is noted in these columns.*

RECEIVING SETS

"Day-Fan" receivers; The Dayton Fan & Motor Co.
De Forest radiophones; De Forest Radio Co.
Dynergy radio set; Dynamotive Radio Corp.
Eaglet neutrodyne; Eagle Radio Co.
"Eagle" neutrodyne receiver; Eagle Radio Co.
"Eastern" Three Circuit Tuner; Eastern Coil Corp.
"Tesco" crystal sets; Eastern Specialty Co.
"Ecodyne" Duplex receivers; Economic Appliance Co.
"Eisemann" broadcast receiver; Eisemann Magneto Corp.
"Eisemann" 6-D receiver; Eisemann Magneto Corp.
"Erla" knockdown receivers; Electrical Research Labs.
Radjo low-loss Three Circuit Tuner; Electric City Novelty & Mfg. Co.
Model C-7 Superheterodyne receiver; Experimenters Information Service, Inc.

LOUDSPEAKERS

De Luxe Amplifier; Daven Radio Corp.
De Forest loudspeaker; De Forest Radio Co.
"Dictograph" loudspeaker; Dictograph Products Corp.
"Dictograud" loudspeaker; Dictograph Products Corp.
"Charmitone Loud Singers;" Dual Loudspeaker Co.

A GOOD MEDIUM-PRICED TRANSFORMER

Name of instrument: Audio-frequency, amplifying transformer.

Description: A transformer containing a core of the square D type with both the primary and secondary windings wound on one leg. Both these windings and the core are protected by a double metal case, which serves as a shield, as a protection for the windings and also as a means for fastening to a baseboard. The terminals are brought out to a combination binding post and soldering lug.

Usage: In any audio-frequency amplifier as an inter-stage coupling.

Outstanding features: Low in price. Low in ratio. Good amplification. Equipped with soldering lugs.

Maker: Rauland Mfg. Co.

AUDIO-FREQUENCY TRANSFORMERS

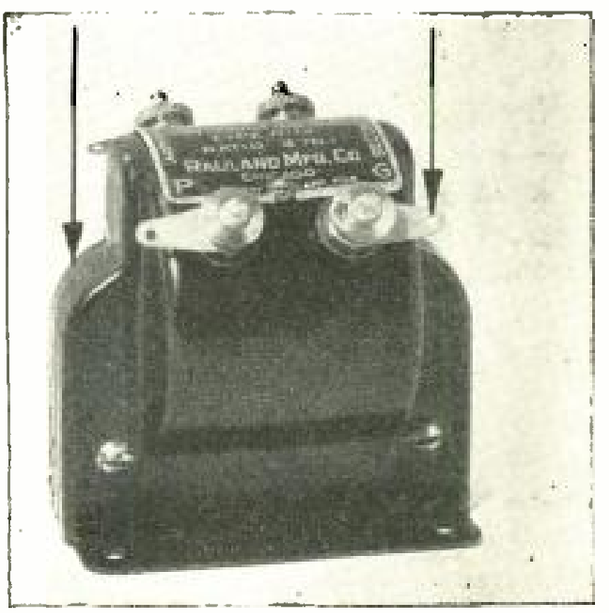
De Roy Phusiformer; De Roy Radio Corp.
"Dongan" transformer, Type C; Dongan Electric Mfg. Co.
Equi-flux audio transformer; James C. Doran & Sons
Dymac audio transformer, types A-1, E, G, H; Electrical Products Mfg. Co.
"Erla" audio transformers; Electrical Research Labs.
"Erla" push-pull transformers; Electrical Research Labs.
"Essex" audio transformers; Essex Mfg. Co.

MICA FIXED CONDENSERS

"Daven" Resistor-condenser; Daven Radio Corp.
"Dubilier" Micadons; Dubilier Condenser & Radio Corp.
"Erla" fixed condensers; Electrical Research Labs.

LOOPS

D. T. W. Collapsible loop (German); Tobe C. Deutschmann
"Erla" loop; Electrical Research Labs.



Equipped with a shield and with soldering lugs.

GRID-LEAKS AND RESISTANCES

Resistors and grid-leaks; Daven Radio Corp.
"Daven" resisto-coupler; Daven Radio Corp.
"Daven" precision resistors; Daven Radio Corp.
Filament ballast resistors; Daven Radio Corp.
"De Forest" grid-leaks; De Forest Radio Co.
Dubilier resistance unit; Dubilier Condenser & Radio Corp.
"Durham" variable grid-leak; Durham & Co.
"Durham" Metallized Filament grid-leaks; Durham & Co.
Fil-ko resistor; DX Instrument Co.
Fil-ko-leak; DX Instrument Co.
Lavite resistances; Eastern Coil Corp.
Glass grid-leak; Electrad, Inc.
Fixed grid-leaks; Electrad, Inc.
Carbon resistances; Electrad, Inc.

BATTERY CHARGERS AND RECTIFIERS

"Erla" fixed crystal rectifiers; Electrical Research Labs.

CRYSTAL DETECTORS

Universal Radio crystal detector; Electric City Novelty & Mfg. Co.

A MULTIPLE TRANSFORMER UNIT

Name of instrument: Multiple radio-frequency, coupling unit.

Description: In this piece of apparatus there are incorporated on a single base, three intermediate, coupling transformers and an initial transformer which can be used in a superheterodyne circuit. The units are placed side by side and are covered with a metal shield and are provided with insulated connection strips upon which are mounted the binding-post terminals. These terminals are marked with letters that designate the proper connections to the vacuum tubes and to the other parts of the circuit. This combination provides a simple unit, which can be fastened directly to a receiver baseboard by means of four wood screws.

Usage: In any radio-frequency circuit as an inter-stage coupling.

Outstanding features: Rigid construction. Neat in appearance. Takes up a minimum of space. Connections plainly indicated.

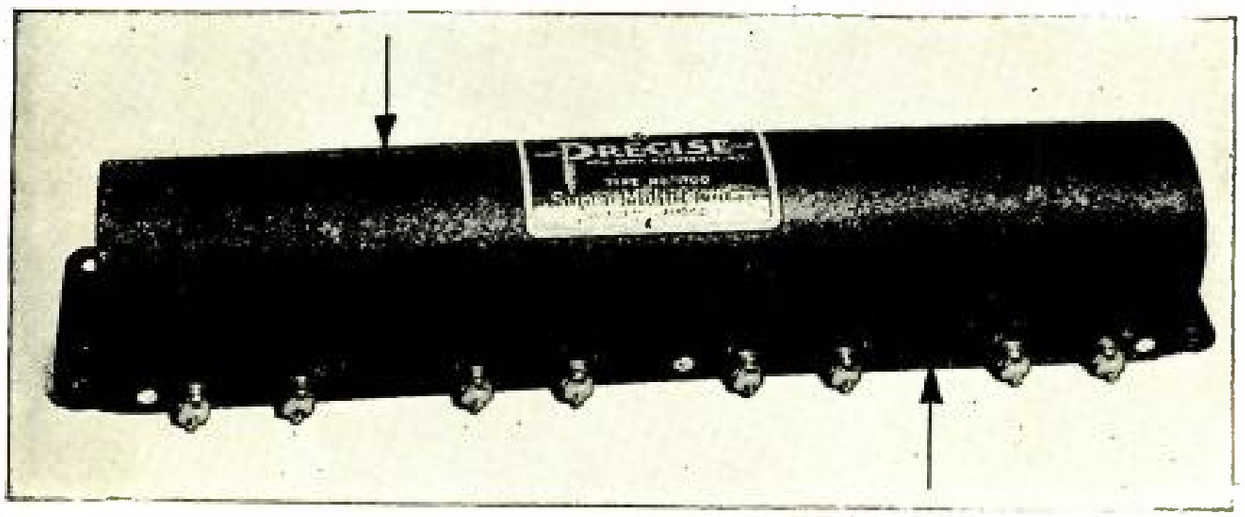
Maker: Precise Mfg. Co.

MISCELLANEOUS ACCESSORIES

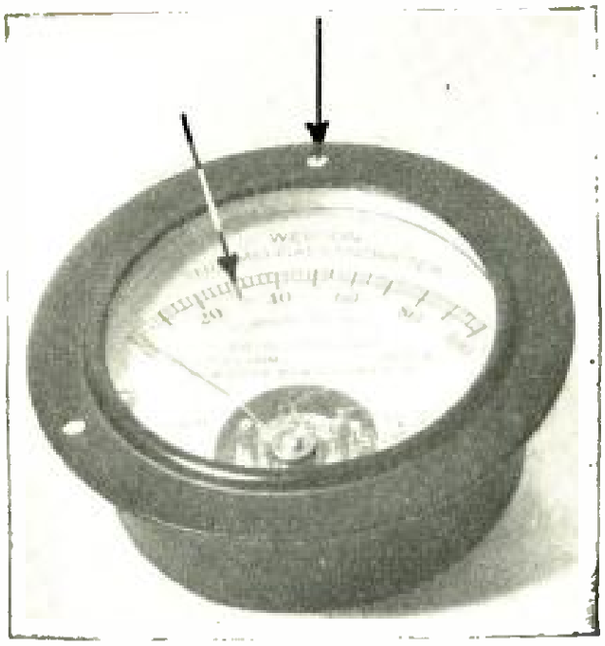
Resistor leak mounting; Daven Radio Corp.
Condenser mounting; Daven Radio Corp.
Combination grid-leak condenser mounting; Daven Radio Corp.
"De Forest" coil mountings; De Forest Radio Co.
"Dixie" engraved binding posts; Dixie Supply Co.
How to learn code; Dodge Radio Shortkut
"Dongan" high-resistance voltmeter; Dongan Electric Mfg. Co.
Dubilier Ducon (light socket aerial); Dubilier Condenser & Radio Corp.
"Nokorode" soldering kit; M. W. Dunton Co.
"Nokorode" soldering paste; M. W. Dunton Co.
Durad Base; Duraplate Co.
Durad Base Assembly Parts; Duraplate Co.
"Durham" bases; Durham & Co.
Fil-ko lightning arrester; DX Instrument Co.
Leather for radio sets and portables; Eagle-Ottawa Leather Co.
Easy seat cushion; Easy Seat Sales Agency.
"Eby" binding posts; H. H. Eby Mfg. Co.
Ekko album; Ekko Co.
Lead-in device; Electrad, Inc.
Indooraerials; Electrad, Inc.
Aerial outfits; Electrad, Inc.
Lightning arresters; Electrad, Inc.
Lamp socket antenna; Electrad, Inc.
Grid-leak mountings; Electrad, Inc.
Hydroground; Electrad, Inc.
"Erla" solderless connectors; Electrical Research Labs.
Bezels; Electrical Research Labs.
Lightning arresters; Electric Service Supplies Co.
Dynamotor; Electric Specialty Co.
Generators; Electric Specialty Co.
"Essex" antenna lightning arrester; Essex Mfg. Co.
"Essex" radio soldering fluid; Essex Mfg. Co.
Skware Flex Bus Wire #12; Essex Mfg. Co.
Binding post name plates; Etching Co. of America
Publishers of book "Modern Radio Reception;" Experimenters Information Service, Inc.

VARIABLE CONDENSERS

"De Forest" condensers; De Forest Radio Co.
Superadio variable condenser; De Witt-La France Co., Inc.
By-Pass condenser; Dubilier Condenser & Radio Corp.
"Duplex" condensers; Duplex Engine Governor Co., Inc.
DXL variable condenser; DXL Radio Corp.
Eagle Ball-Bearing die-cast condenser; Eagle Radio Co.
"Grin" variable condenser; Eastern Specialty Co.
"Erla" Miniloss condenser; Electrical Research Labs.
"Elraco" precision condenser; Elgin Radio Corp.
"Elraco" low-loss condenser; Elgin Radio Corp.



Equipped with a shielded case and insulated binding post strips.



Clear view scale. Equipped with three holes for panel mounting.

TUNING INDUCTANCE UNITS

"De Forest" variometers; De Forest Radio Co.
"De Forest" honeycomb coils; De Forest Radio Co.
"Eastern" coupler; Eastern Coil Corp.
"Cockaday" coils; Eastern Coil Corp.
"Eisemann" variometers; Eisemann Magneto Corp.
"Eisemann" varioconplers; Eisemann Magneto Corp.
Variohm; Electrad, Inc.
Verni-tuner; Electrad, Inc.
Duo-la-teral coils; Electrical Products Mfg. Co.
Selectoformer; Electrical Research Labs.
Radjo low-loss single or double tuner; Electric City Novelty & Mfg. Co.
"Pall Mall" varioconpler; Essex Mfg. Co.

SWITCHES

"De Forest" switches; De Forest Radio Co.
Eagle Multiple switch; Eagle Radio Co.
Radjo anti-capacity switch; Electric City Novelty & Mfg. Co.
"Arkay" cam switches; Essex Mfg. Co.

JACKS

Radjo anti-capacity jacks; Electric City Novelty & Mfg. Co.

AN EFFICIENT CONDENSER WITH A FULL-FLOATING AXLE

Name of instrument: Variable condenser.
Description: Well-made condenser, built along somewhat unique lines with a single bearing of large area that is insulated by two large bushings. The stationary plates are fitted with a removable dust cap to prevent dirt settling between the plates. It is simply mounted on the panel by means of two flathead screws, each threaded into the solid end plate.
Usage: In any radio-frequency circuit for tuning.
Outstanding features: New type of construction. High efficiency. Wide spacing of the plates. Smooth acting bearing. New method of insulating. Provided with dust cover.
Maker: Allen-Bradley Co.

A DEPENDABLE MILLIAMETER

Name of instrument: Thermo Galvanometer.
Description: A well-made instrument that operates from a thermo-couple and has a scale reading of 0 to 100 milliamperes. It can be fastened directly on a receiver panel or mounted as a laboratory instrument by means of a small bracket that can be obtained from the manufacturer. Equipped with three mounting holes for fastening directly to a panel. Also equipped with a small screw for making correct zero adjustment.
Usage: In any circuit where it is desired to measure the RMS value of the current flowing.
Outstanding features: Small in size. Suitably accurate for ordinary radio work. Neat in appearance. Portable.
Maker: Weston Electrical Instrument Co.

RHEOSTATS

De Jur 1-hole rheostat; De Jur Products Co.
Fil-ko-stat; DX Instrument Co.
Eagle Revolving resistor rheostat; Eagle Radio Co.
Precision rheostat; Electrical Research Labs.

HEADSETS

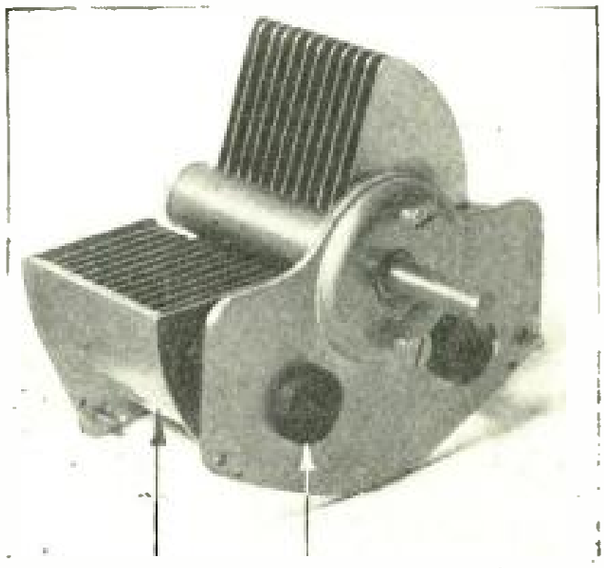
"Dictograph" headset; Dictograph Products Corp.
"Edson" phones; Edson Radio Sales Co.
"Eisemann" headsets; Eisemann Magneto Corp.

RADIO-FREQUENCY TRANSFORMERS

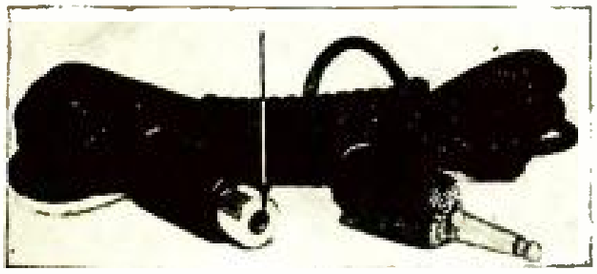
Telos vario-transformer; Danziger-Jones, Inc.
Duratran transformer; Dubilier Condenser & Radio Corp.
"Eisemann" R. F. transformer; Eisemann Magneto Corp.
"Erla" transformer; Electrical Research Labs.

SETS IN KIT FORM

Telos Kit; Danziger-Jones, Inc.
"Daven" Resistance-coupled Amplifier kits; Daven Radio Corp.
"Day-Fan" Unit Receivers; Dayton Fan & Motor Co.
"R-D-X" Reflex Receiver kit; Durrant Radio, Ltd.
Resistance-coupled Amplifier kit; Electrad, Inc.
"Erla" Superflex 3-tube Cir-kit; Electrical Research Labs.



Equipped with a dustproof case and insulated bushings.



Equipped with an extension plug.

A HANDY ACCESSORY FOR A LOUDSPEAKER

Name of instrument: Extension plug and cord.

Description: An extension jack which will accommodate the ordinary plug and cord, which is usually furnished with the loudspeaker. Attached to this extension plug is a cord about 25 feet long, at the other end of which is connected another plug, which can be inserted directly into the set.

Usage: As an extension for placing the loudspeaker at a distance from the receiving set.

Outstanding features: Neat in appearance. Provides a means for placing the loudspeaker in another room or for extending it out to a porch in summer. With this extension the loudspeaker may be placed in a room anywhere that will give the best results.

Maker: Four-Way Co.

A RESISTANCE-COUPLED AMPLIFIER UNIT FOR THREE STAGES

Name of instrument: Resistance-coupled amplifier.

Description: In this unit there have been combined three stages of resistance-coupled amplification primarily for use as an audio-frequency amplifier. The unit contains three sockets for vacuum tubes together with mountings for the grid and plate resistors. It is also equipped with fixed, coupling condensers that are located on the under side of the insulating block and it contains binding posts along the back edge for making connections. It is mounted on a bakelite base.

Usage: In any resistance-coupled, amplifying circuit.

Outstanding features: Neat in appearance. Capable of large variation of both resistance and capacity. Takes up very small space. Easy to install.

Maker: Daven Radio Corp.

BATTERIES

"Diamond" radio plate "B" batteries; Diamond Elect. Specialties Corp.
Edison" radio-primary battery; Thos. A. Edison, Inc.
Evide" "A" and "B" batteries; Electric Storage Battery Co.

RADIO CABINETS

Vulcanwood" (cabinet material); Diamond State Fibre Co.
Adapto radio cabinet; L. R. Donehue Lumber Co.
Eagle Console cabinet; Eagle Radio Co.

BATTERY CHARGERS AND RECTIFIERS

"Erla" fixed crystal rectifiers; Electrical Research Labs.

DIALS

"Erla" Dials; Electrical Research Labs.
"E-Z-Toon" dials; E-Z-Toon Radio Co.

PANELS

"Celeron" panels; Diamond State Fibre Co.

AMPLIFIERS

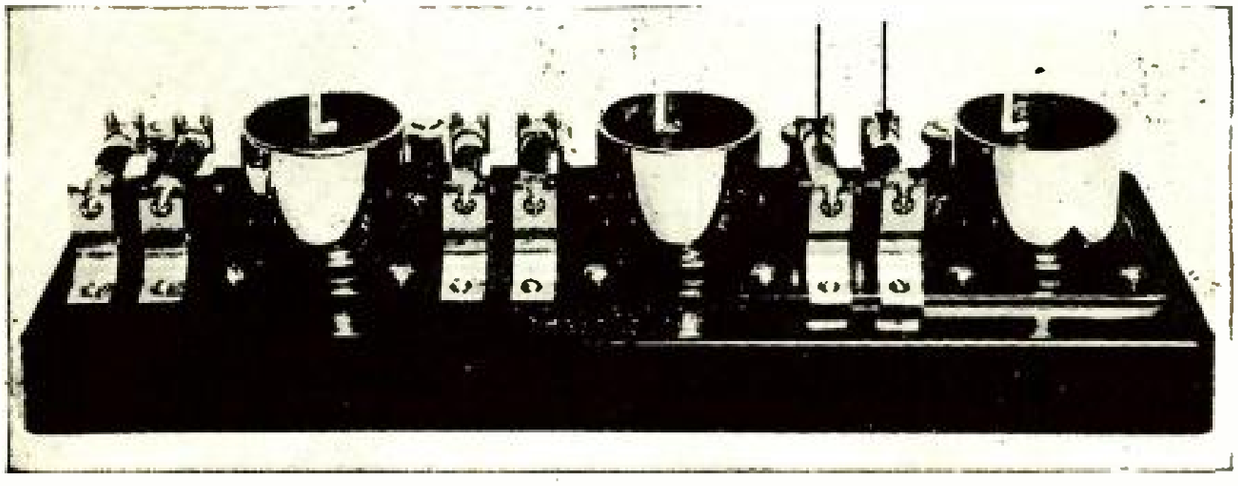
"Daven" Super-amplifier Unit; Daven Radio Corp.
Superadio Audio Amplifier Unit; De Witt-La France Co., Inc.
Superadio Radio-frequency amplifier unit; De Witt La-France Co., Inc.

POTENTIOMETERS

"De Forest" potentiometers; De Forest Radio Co.
"Eisemann" potentiometers; Eisemann Magneto Corp.
Potentiometers; Electrical Research Labs.

TUBES

"De Forest" audions (vacuum tubes); De Forest Radio Co.
Protect-O-Tube; The Don-Mac Co.
"Diode" detector tube (for dry cells); Electrad, Inc.



Equipped with six brackets for supporting and connecting the resistance elements.

SOCKETS AND ADAPTERS

"De Forest" tube sockets; De Forest Radio Co.
"Erla" sockets; Electrical Research Labs.
"Essex" bakelite socket; Essex Mfg. Co.

PHONE PLUGS

2-Way Phone Plug; Electrical Research Labs.

¶ This list of apparatus approved by the POPULAR RADIO LABORATORY will be continued as a part of the WHAT'S NEW IN RADIO APPARATUS department until all instruments, parts and complete sets have been included. The listing is alphabetical by manufacturers' names and the installment in this issue goes through the letters D and E.

Underwood & Underwood

GOLFERS FIND A USE FOR RADIO THAT KILLS THE GOLFER'S GROUCH

A new use for radio on the golf course suggests the possibility of reporting golf championship matches of the future with a portable radio transmitter that may be moved from hole to hole. In the picture above the golfers are lined up at the first tee of a golf course at Augusta, Georgia, listening to broadcast programs from the radio receiving set on the table while they wait contentedly for their turn to tee off.

CONDUCTED BY S. GORDON TAYLOR

EVERY radio receiver requires a careful balancing of all of its parts if the best results are to be obtained. Two receivers made from exactly the same design may give widely different results, owing to variations in the parts used, the skill of the experimenters and the locations of the receiver. This department is conducted for the special benefit of readers who have built the radio receivers described in POPULAR RADIO *and who want to profit from the experience of others in operating them—to learn the little kinks that get the maximum results.*

Loops Used With Superheterodyne Receivers

SOME readers have the impression that a loop antenna used with the superheterodyne receivers described in the December and January issues of POPULAR RADIO, results in limited wavelength range.

Inquiries that come to our laboratory indicate the common impression that the number of feet of wire on a loop determines its characteristics. A builder of one of the superheterodynes, for instance, asked if 110 feet of stranded wire would be enough to wind on a loop which he was constructing. Another reader said that he had used 100 feet of wire and had found the receiver incapable of covering the higher broadcasting wavelengths, while a third correspondent wrote that with 100 feet of wire on his loop, he could get nothing much below 300 meters.

The fact is that *the amount of wire used on a loop antenna is only incidental.* The size of the frame and the spacing between the turns of wire are the important factors that govern the wavelengths that can be covered by a particular amount of wire. One hundred feet of wire, therefore, may be too much or too little, according to the manner in which the loop is built.

It is difficult to give exact specifications for the number of turns to wind on a loop frame of a given size, or for the spacing of wires because the kind of wire used is a factor of considerable importance. The four best suggestions that we have made, on the basis of some extensive experiments in the laboratory, for building your loop are:

1. Make the frame as large as possible as the flat type of loop is usually the most convenient.
2. Space the turns ⅜ of an inch apart unless the loop is to be less than 2 feet square. In that case use ¼-inch spacing.
3. Use a good grade of stranded, loop wire with double silk insulation. "Litz" wire has no particular advantages. The ordinary loop wire usually is made up of from 30 to 60 strands of No. 38 bare copper wire, with a double silk, or one cotton and one silk covering or insulation.
4. Wind on the loop more wire than can possibly be needed—say, 120 feet.

When you have made your loop according to these suggestions, connect it to your receiver and tune in a high wavelength station. If the dial setting of the loop tuning condenser is somewhere near the dial setting given for that station on curve K1 (page 50 of the January, 1925 issue of POPULAR RADIO), then the loop, as wound, is about right. However, if the dial setting is more than 5 degrees lower than the chart indicates it should be, you will know that the loop has too many turns. Cut down the loop a half turn at a time until the tuning reading for the station, which is used to test on, agrees with that on the chart. If, however, the dial setting is higher than that on the chart, you have not used enough wire. Wire should then be added. But, if the loop was built

with 120 feet of wire and if you followed the four instructions above, you should not have to add more wire; and in any case you are not likely to need to take off more than 25 feet of wire.

When you want to build a tapped loop, you need only bare the wire at its center point, the middle of the winding, halfway between the two ends. Or, you may tap it at two or three equally spaced points that will provide greater variation.

The Effect of Local Conditions on Loop Reception

A loop antenna will work under almost any conditions. Plaster, wood or brick walls of houses have no apparent retarding effect on radio waves. Difficulty is frequently encountered in the case of stucco houses, however, because of wire screen reinforcement that is used in their construction. In such houses the walls act as a shield that prevents the entire power of radio waves from reaching the loop. All stucco houses are not built in this manner, however.

For stucco houses it is usually better to use outdoor antennas which, of course, are not hindered by walls.

Perhaps the best arrangement is to use the antenna in conjunction with the loop as explained in the "Trouble Shooting" department in the March issue. Good results can also be obtained by connecting the antenna lead direct to the ground in such a way that the antenna lead passes close to the loop and parallel with the plane of the loop.

An Antenna Coupler Coil

Where it is desired to use the outdoor antenna without the loop, the coupler (shown in Figure 1) may be used. This is made of 45 turns of No. 18 DSC wire wound on a composition tube that should be from 3 to 3½ inches in diameter, by 6 inches long. This winding serves as the secondary of the coupler. The primary is wound on the same tube and consists of 10 turns of the same kind of wire. The primary winding should be spaced 1½ inches from the secondary winding. To connect the coupler into the circuit, the primary winding is attached to the antenna and ground in the usual manner and the ends of the secondary winding are connected to the receiver binding posts which are provided for a loop antenna.

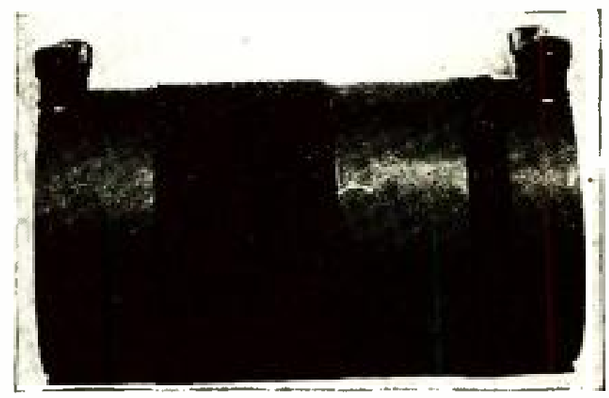
On a receiver with three binding posts, the middle of which goes to a tap on the loop as in the 7-tube superheterodyne receiver that was described in the December, 1924 issue, the tap-binding post should be connected with a tap from the thirtieth turn of the secondary of the coupler described above.

After you have hooked the coupler in the circuit and the receiver is in operation, you may find that tuning is comparatively broad on nearby broadcasting stations. If so, you can sharpen reception by removing one or more turns from the outside end of the primary winding. This gives looser coupling between primary and secondary.

Broad Tuning of Loop

A loop receiver should never be operated in the same room with another receiver to which an antenna and ground are connected, if selectivity in the tuning of the loop receiver is to be expected. The energy that passes through the antenna lead to the ground, by way of the primary coil in the other receiver, is picked up by the loop antenna with the result that tuning of the loop will be decidedly broad. In the laboratory a wire was connected from ground to antenna and in spite of the fact that this wire was 12 feet from the loop, the tuning of the loop was broadened to such an extent that a nearby broadcasting station could be heard anywhere on the loop tuning dial, providing the oscillator dial was left at the proper setting for that station. Immediately upon disconnecting the antenna from the ground, the loop tuning sharpened to normal.

The tuning of both dials of the superheterodyne described in the December and January issues should be very sharp for distant reception. On local stations, however, the tuning of the first condenser is not so sharp. This fact, however, in no way alters the selectivity of the receiver as a whole, inasmuch as the oscillator dial still retains its sharpness. On loud local reception, therefore, the oscillator may be considered in the light of the selectivity control with the loop tuning dial acting as a volume control. On distant stations, of course, this will not hold good as the tuning of the loop dial then becomes much too sharp.



THE ANTENNA COUPLER COIL FOR USE WITH THE 8-TUBE SUPERHETERODYNE

FIGURE 1: *This is how the coupler appears which is used in the antenna circuit of the superheterodyne receiver when the loop antenna is dispensed with for an outdoor aerial. The binding posts on the left are attached to the receiver where the loop antenna is ordinarily connected.*

"Shall I Build the Four-circuit or the Super?"

We hear from many readers who are undecided whether to build the Cockaday Eight-tube Superheterodyne, which was described in the January, 1925 issue, or the Four-circuit Receiver with Resistance-coupled Amplifier that was described in the October, 1924 issue.

To assist a fan in a quandary like this, one must know the requirements and circumstances in each individual case.

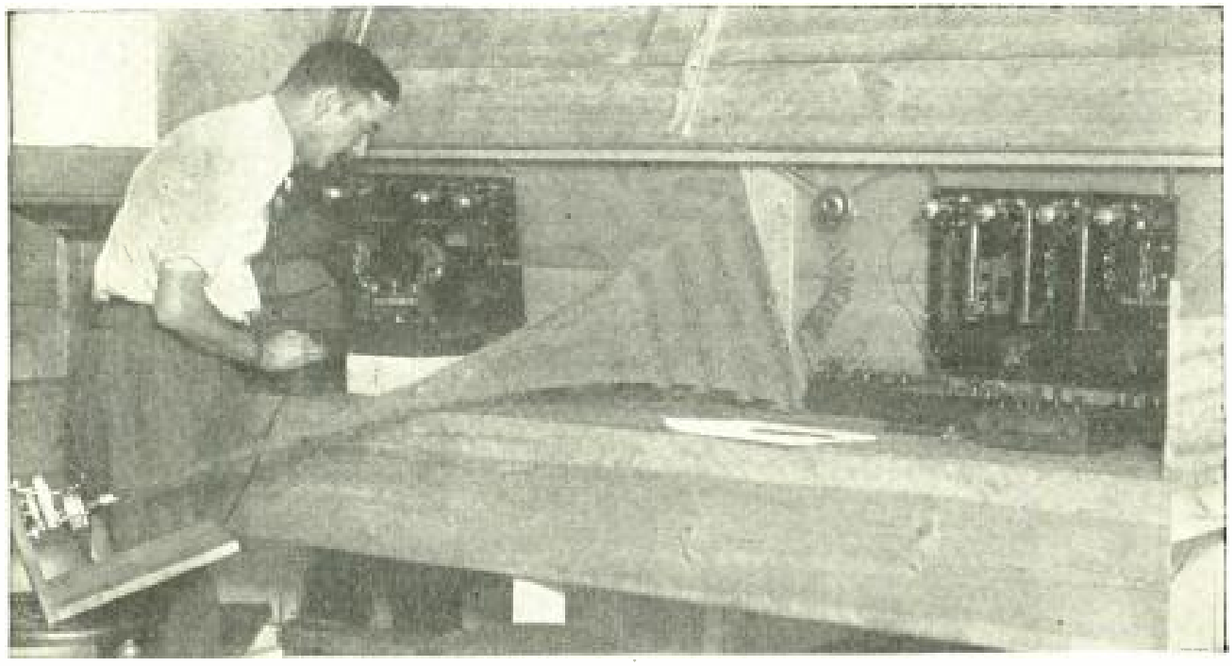
For an all-around receiver of excellence the Four-circuit Tuner is a logical choice, providing conditions will permit the erection of a good outdoor antenna. In this receiver the tone quality, volume, selectivity and ease of tuning are all that one could wish for. The cost of the complete outfit is lower than that of the superheterodyne and its upkeep cost is lower on account of the use of five tubes instead of eight in the superheterodyne.

On the other hand, the superheterodyne ranks high in the first four qualities mentioned above. The "super" has two advantages over the other in that it is used with an indoor loop antenna and provides more volume on very distant stations. In some cases, especially in crowded city districts, the erection of a long outdoor antenna is not practical and the use of a loop antenna then becomes necessary. In such cases the superheterodyne is the more suitable.

In spite of the use of such a small antenna with the superheterodyne, it will bring in the more distant stations with greater volume than any of the other types of receiver, including the Four-circuit Tuner. Therefore, for one who is mainly interested in DX reception, the superheterodyne offers an advantage.

As against these advantages, there is the consideration of original and upkeep cost of the "super." While the cost to construct this receiver is not much greater than that of the Four-circuit Receiver, its equipment is more expensive mainly in that three more tubes are required. The upkeep cost that consists of recharging the storage "A" battery and replacement of "B" batteries, if they be of the dry-cell type, is bound to be comparatively high on a receiver using eight tubes. Of course, the cost of charging the storage "A" battery is a negligible item so this expense alone is not important. However, the replacement of dry-cell "B" batteries is of the greatest importance because of their comparatively high cost. This latter expense can be largely eliminated by making use of storage "B" batteries and while their first cost is comparatively high, the cost of recharging them is low. To sum up then:

1. The Four-circuit Receiver is the best for local and distance reception up to about 1,000 miles. It will give loudspeaker volume for a considerably greater distance than this but never as great as will the superheterodyne receiver.
2. The Four-circuit Receiver is less expensive to construct and operate.
3. The superheterodyne receiver does not require the use of an outdoor antenna.
4. The "super" is selective in locations that are within a few blocks of powerful broadcasting stations.



Underwood & Underwood

TESTING A LOUDSPEAKER

Practically all "speakers" have a natural frequency at which volume is greater than at others. Borden Washington (shown above) is measuring the voices of loudspeakers to discover the places where they "shout."

CONDUCTED BY DAVID LAY

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

Seek Arctic Explorers by Radio

FOLLOWING their regular programs recently, three broadcasting stations, one at East Pittsburgh, Pa., another at Springfield, Mass., and a third at Chicago sent out messages into the northland asking for news of the ill-fated Nutting expedition that was headed for the eastern coast of Baffinland. The lost expedition that started from Norway was organized by William Nutting in an attempt to follow the course taken by the vikings in their daring voyages to the North American continent about 1000 B.C.

* * *

All Wave Channels Are Now in Use

WHEN the Third National Radio Conference met in Washington last October, a plan for the reallocation of wavelengths in the whole field of radio transmission was proposed chiefly in an effort to reduce interference and to create more channels for the growing broadcasting service. At that time there were 519 broadcasting stations. Today every available wave channel is in use. During the past three months the radio experts of the Department of Commerce have tried out several other plans for increasing the number of channels in the band allotted to the class B stations, but to date they have arrived at no practical scheme which insures a satisfactory arrangement between the broadcasters and the fans.

* * *

Listening in on the Motherland

MANY governmental officials stationed in South America keep in touch with home affairs by listening in on their radio sets, according to A. S. Cook, aide to Secretary Davis of the Department of Labor. Mr. Cook says that American attaches listen in almost daily to ten or twelve American stations. This is especially true in Santiago and Valparaiso, Chile, and also in certain places in Peru. These Americans report that they get stations in Texas, New York, and even Seattle, Wash., frequently, and Pittsburgh every day. He says radio is spreading rapidly among the South American natives, and even in the mountainous districts great interest is reported.

* * *

Modern Jonah Seeks Identity by Radio

A MAN, who spoke an unrecognizable language, was cast ashore at Cape Charles, Va. in December and was turned over to the immigration authorities. Last January, in an effort to discover his nationality and thus to be able to return him to his native land through some foreign consul, the Government permitted the "mystery man" to speak his jargon into a microphone at a broadcasting station. A few listeners wrote in to say that the man came from Lapland.

* * *

Foreigners Demand American Radio Apparatus

EXPORTS of radio apparatus from the United States have increased almost $200,000 a month recently; if the December exports have increased in proportion, the total exports for 1924 will reach a value of over $6,000,000. In 1923 the exports totaled $3,448,112. So far, for the first eleven months of 1924, the total is $4,950,746, a million and a half more.

* * *

Licensing Alien Patents Reduces Chances of Radio Monopoly

THE possibility of a radio monopoly in the United States becomes more unlikely on account of the action of the Navy Department in issuing licenses to American manufacturers under the so-called German patents which were purchased by the Navy during the war. The licensing of the German patents has been a matter of concern to the radio industry for the last two years. The licenses cover about 80 radio patents held by the Navy. The most important are the Schloemilch and Von Bronk patents which are basic on all reflex and radio-frequency circuits, and which are perhaps the greatest recent developments in radio.

Curbing Sales of "Bootleg" Tubes

A SENTENCE of three months in the workhouse was imposed recently on a radio dealer in New York City for offering for sale under misrepresentation "bootleg" radio tubes. The tubes, it was charged, were in cartons marked "Radio Corporation of America." It was also alleged that the corporation's name was stamped on the brass base of the tubes and that circulars and pamphlets with the corporation's name had been placed inside the cartons.

* * *

"Radio Photologues"

A CHICAGO newspaper has introduced what are called "radio photologues." Travel pictures are published in this newspaper's rotogravure section every Saturday. These are the basis of a travel talk that is broadcast that night. By this plan the listener can see the scenes of which the travel lecturer talks in much the same way as a stereopticon lecture is watched.

* * *

Jailed for Using a Receiving Set

A RADIO fan in Czechoslovakia was recently sent to prison for six weeks because he built a receiving set and occasionally sold parts without a license. In order to obtain the license, which this amateur should have had for operating a set under the Czechoslovakian regulations, one must furnish a diagram of the set with a list of units employed in it, pay a tax and advise the authorities whether the receiver is home-built or obtained from a manufacturer of radio equipment. Besides, the applicant must be a citizen of the Czechoslovak Republic and a permanent resident of the country. Despite these requirements, there are reported to be approximately 1,000 receiving sets in the republic.

* * *

A Fan Helps a Railroad When Telegraphs Fail

WHEN wire communication was interrupted by a sleet storm that played havoc with the Pennsylvania Railroad's telegraph and telephone systems in the Middle West, Dr. Charles L. Klenk, a St. Louis amateur, got a radio communication through to Philadelphia to the general superintendent of the Pennsylvania's telegraph department. A few railroads, including the Delaware, Lackawanna & Western, have their own radio communication systems to meet emergencies, but none of them is much past the experimental stage.

* * *

600 Broadcasters Sign Off

OUT of 1,180 broadcasting stations which have been "on the air" since September, 1921, only 550 are active today. This means that 630 stations have ceased to broadcast and the ether has been clarified by that amount. Practically all of the original 28 stations which started late in 1921, remained on the air for a year, and some of them exist today. In 1922,

Underwood & Underwood

WIRELESS HELPS THE WIREMAN

An electric power company in Washington, D. C. is working out a radio-telephone service for directing the operation of its system and for communicating with repair trucks out on a job. Just how this system of communication works will be described in an early issue of POPULAR RADIO.

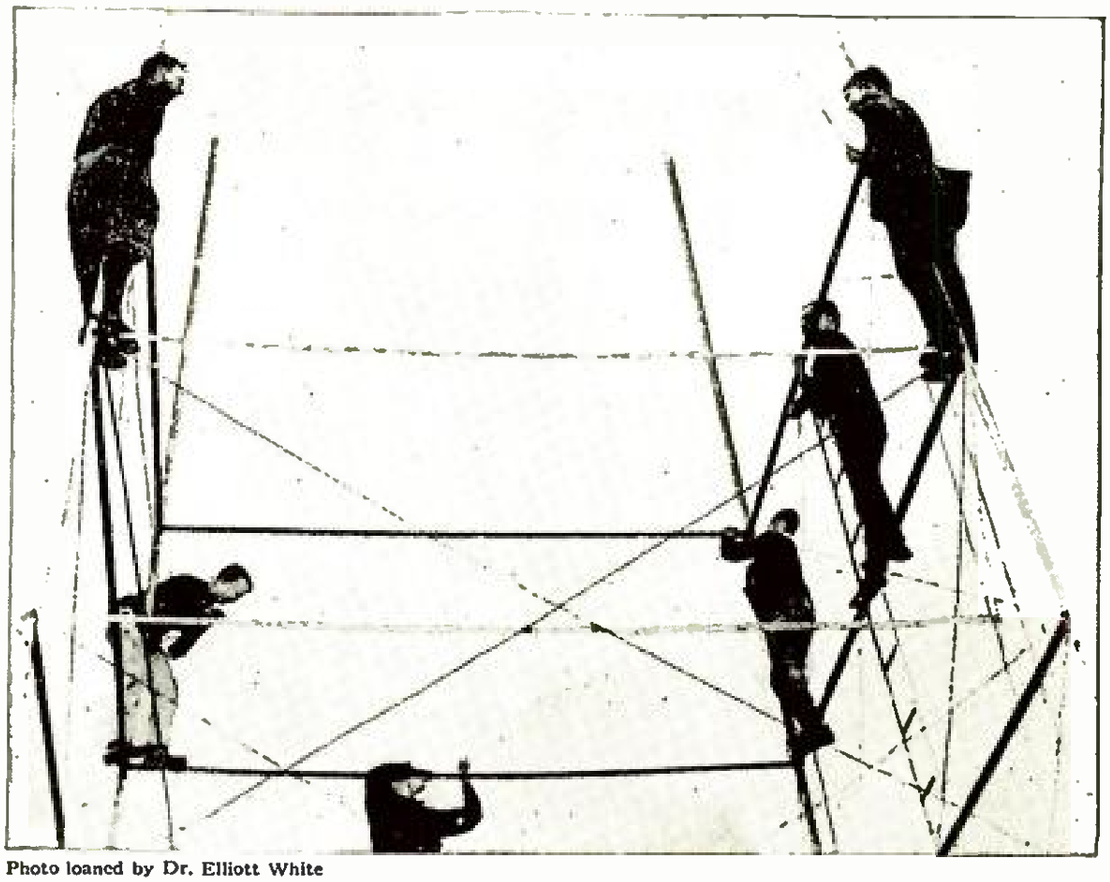


Photo loaned by Dr. Elliott White

DARTMOUTH STUDENTS "TAKE THE AIR"

Up among the granite hills of New Hampshire has arisen the antenna tower of station WFBK, owned and operated by the Dartmouth Radio Association. Occasional broadcasting is done on 256 meters, with 100 watts. Stations maintained at schools, colleges and universities are assuming significance with the development of "extension courses" conducted by radio for the benefit of the people resident in wide areas.

642 new stations opened and 94 quit operation; in 1923, 249 started up and 298 ceased transmitting, while last year, up to November 30, 249 more came on the air and 238 signed off.

* * *

World's Highest Radio Station

THE highest radio station in the world recently was opened on the Pic-du-Midi, in the Upper Pyrenees, near the Spanish border. It is located 9,439 feet above the level of the sea and will, it is expected, make possible the observation of several radio-telephonic phenomena which have thus far remained unexplained.

* * *

Radio Tells Fishermen the Price of Fish

FROM Boston comes a report of a novel use of radio by fishermen who put out from that port to ply their trade off the Massachusetts coast. The fishermen, instead of using radio for entertainment at sea, tune in on the market reports. When quotations on fish are "right," the trawls are pulled up and the schooners head for the market.

"Radio Bootleggers" in Bulgaria

A NEW type of "bootlegger" has arrived. This time his appearance is in Bulgaria where private radio receiving stations are prohibited by law. Fear of its enemies has stimulated the Bulgarian Government to pass this law, but the radio fan nevertheless finds that he can obtain a receiver through the aid of persons who make a business of smuggling sets into the country. Some time ago about seventy of these private sets were confiscated by the Bulgarian Government, but receiving apparatus is reported to be smuggled into the country in spite of the restrictions.

* * *

Transcontinental Air Mail Controlled by Radio

THE airplanes that carry the air mail on the new two-day schedule between New York and San Francisco are controlled and checked up by radio. Thirteen radio stations are located at flying fields along the route. As soon as an airplane leaves one of these fields *en route* for the next one, a radio message is passed along to the next field. The departure is also reported to Washington by radio.

Teaching by Radio in Germany

A "PEOPLE'S high school" was opened recently at Leipsic, Germany, to give instruction exclusively by radio. The pupils of the new school are the radio subscribers of the Leipsic circuit who, at regular evening hours, listen to lectures on scientific, literary, artistic and economic subjects. When diagrams and illustrations are necessary for clearer presentation of a subject, these are sent to subscribers beforehand for a small fee. The lecturer then refers to them by page numbers so that the listeners may follow the instructor as if they were in a lecture hall.

* * *

Laws Against Squealing Sets

THE first legislative bill aimed at the elimination of radiating receiving sets was introduced recently in the Connecticut Senate. The bill would prohibit emitting any noise or other disturbance that interferes with the reception of broadcast programs between the hours of 6 P.M. and 12 P.M.

* * *

Treats Patient Daily by Radio

THE ship's surgeon aboard the S.S. *Angers* "examined" a patient aboard the S.S. *Capitaine Faure* by radio recently while the vessels were plying the Indian Ocean. The physician prescribed for his invisible patient and thereafter for a week made regular "visits" over the ether. This is said to be the first case of prolonged treatment and consultation by radio.

Gilliams Service

RADIO PARTS ON PUSHCARTS

This peddler of radio parts saves his voice by letting German broadcasting stations do his hawking. With an antenna atop his pushcart and a receiver, he catches the radio fans.

* * *

Radio Defeats Wire Thieves

IN Persia, where Arab tribesmen look upon thieving as a pastime as well as an occupation, radio-telephone stations are particularly desirable means of communication. Telephone and telegraph lines often suffer from depredations of tribesmen who steal the overhead wires for the metal they can get from them. The Anglo-Persian Oil Company, which has installed a system of radio stations, no longer needs to depend on wire telephones or to be at the mercy of tribal robber bands.

* * *

Amnesia Victim "Finds" Herself by Radio

BY broadcasting an appeal from station WEBH at Chicago for assistance in discovering her identity, Charlotte McGuire of St. Louis was identified by a relative in her home town. The young woman left her home on November 19 to return to classes at her college. From that day until she found herself in a Chicago hospital, Miss McGuire remembers nothing. She did, however, have a faint recollection that her first name was Charlotte. The aunt who heard this name spoken over the air by the familiar voice of her niece was able to identify her.

* * *

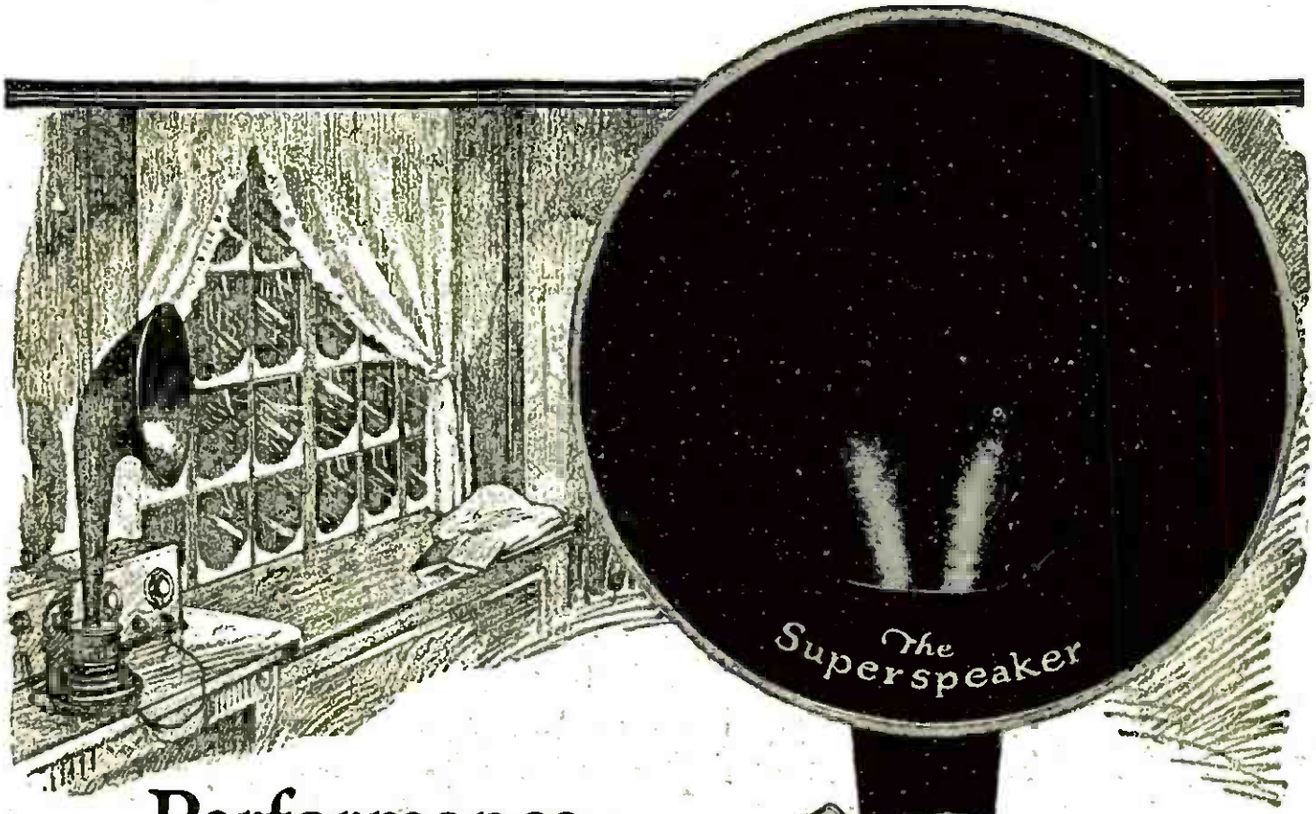
Amateurs Come to Newspaper's Rescue

THANKS to amateur radio operators, the *Decatur Herald* went to press a short time ago although the land lines that carried its news were put out of order by a heavy snowfall in Illinois. Mark Spies of Decatur, Ill., and W. C. Fowler of St. Louis worked nineteen-hour watches for two nights to get the news through to the Illinois newspaper.

* * *

The High Cost of Radio in Lithuania

IN Lithuania a radio fan must petition the postal authorities before he may erect or install a radio receiving station. His application must bear a twenty-five cent revenue stamp and be accompanied by $10 to cover the yearly tax. If the fan proposes to buy an assembled set, he is charged $2.50 extra in taxes; and, if this set has an amplifier, he must pay an additional dollar. Besides there is a $10 tax for every tube used. Sets not properly licensed are subject to seizure by government officials. Banks or commercial organizations must pay a $200 tax annually for permission to use a receiving set, whereas motion picture theaters and cafés pay only $100.



Performance

Through the calm, moon-lit silence of the mid-winter night, your Jewett Superspeaker will increase amazingly your ability to reach out and bring in messages you would hear otherwise only through your headset.

But stormy weather is Superspeaker weather too. January blizzards and the hot humidity of July will both find your Superspeaker reproducing faithfully, roundly and without distortion, the sound vibrations brought to it by your Radio Set.

This uniformity of performance is possible only because of the Superspeaker's exclusive, patented air-gap adjustment.

With this adjustment you can increase or lessen Superspeaker volume, and can balance accurately the result of any climatic change.

Ensure uniform, year-round Superspeaker performance by the one and only possible method—The Superspeaker itself.

Throat straight as an organ pipe—No crooks or turns to impart bugle effect—Size ample to reproduce band and orchestral music—A big, glossy, substantial, non-vibrating instrument, built complete by musical instrument people who know their business. Sold by leading, established merchants everywhere.

The JEWETT RADIO & PHONOGRAPH CO.
5672 DIXIE HIGHWAY PONTIAC, MICHIGAN

"THERE IS NO SUBSTITUTE FOR THE BEST"

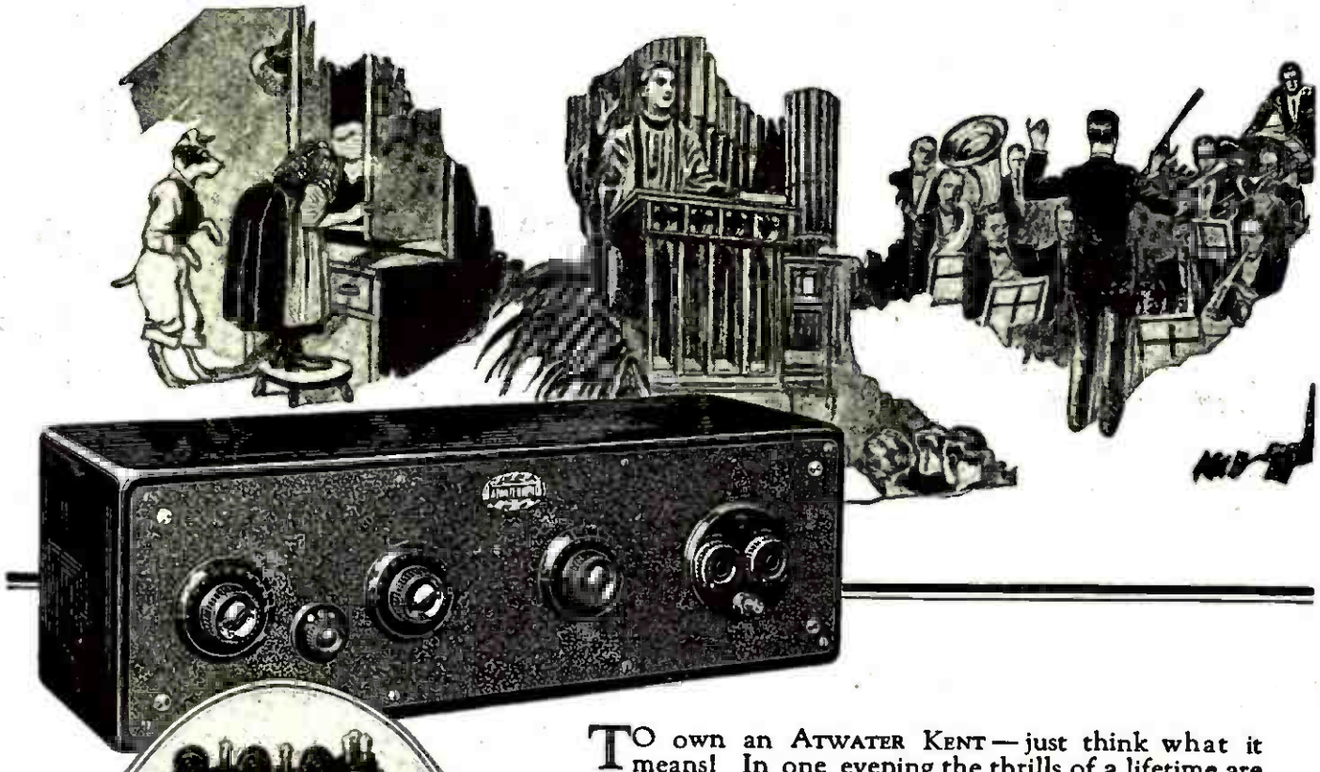
Superspeaker

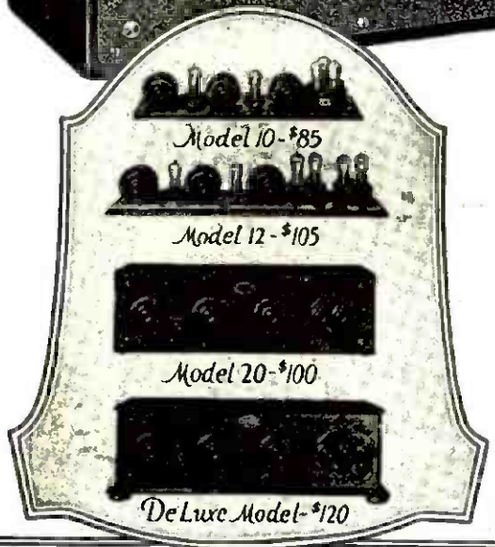
Trademark Registered

All apparatus advertised in this magazine has been tested and approved by POPULAR RADIO LABORATORY

ATWATER KENT

RECEIVING SETS





TO own an ATWATER KENT—just think what it means! In one evening the thrills of a lifetime are crowded into a few short hours.

Set its dials and the melodies of a famous orchestra flood your home; another touch and you hear a lecture from a thousand miles away—turn again and you have the news of the day or the sweet voice of a renowned singer generously broadcasting for your entertainment.

Choose whatever program you will, with an ATWATER KENT you are master of the air.

There is an ATWATER KENT well within your means: it combines every feature that assures radio satisfaction for years to come—Any ATWATER KENT dealer will help you in your selection.

Interesting literature on request

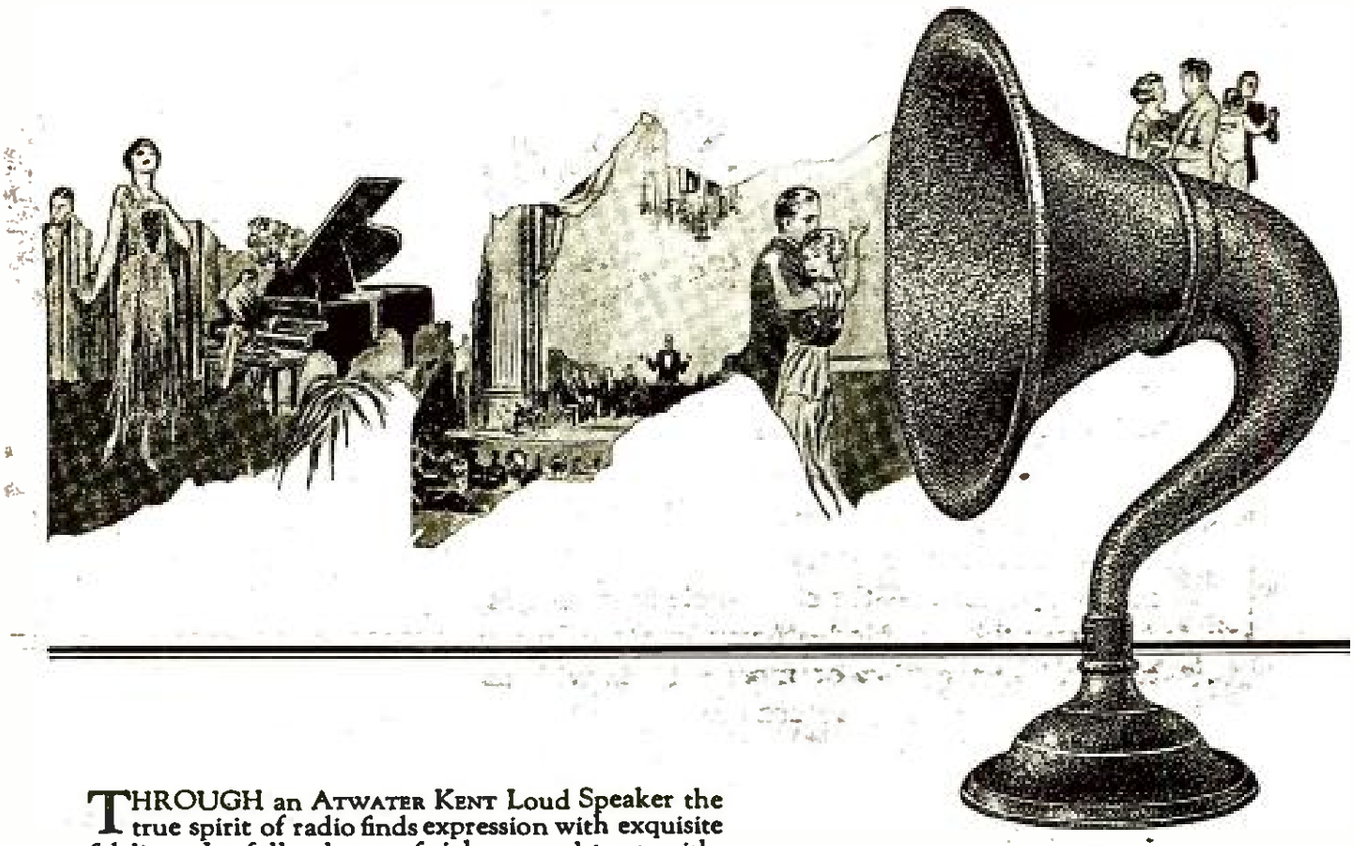
ATWATER KENT MANUFACTURING COMPANY
4712 Wissahickon Ave., Philadelphia, Pa.

Pacific Coast prices slightly higher

THINK WHAT IS BACK OF IT

ATWATER KENT

LOUD SPEAKERS



THROUGH an ATWATER KENT Loud Speaker the true spirit of radio finds expression with exquisite fidelity. Its full volume of rich, natural tone, without a trace of the mechanical or suggestion of the artificial, is at once a credit to your receiver and to the artist at the distant microphone.

The ATWATER KENT Loud Speaker brings out the best from any set:—it is the final touch that makes your radio a living thing.

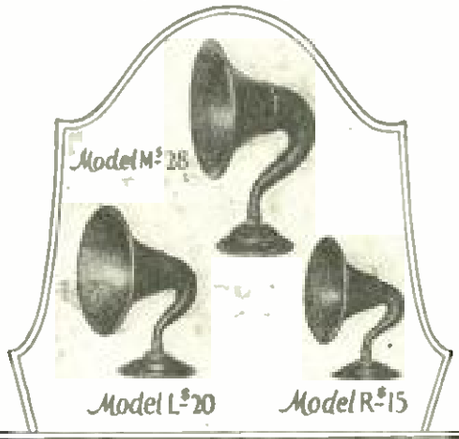
Decide today to buy one for your family. Let them all hear the wonderful things that are on the air.

Your dealer has three ATWATER KENT models for your selection.

Interesting literature on request

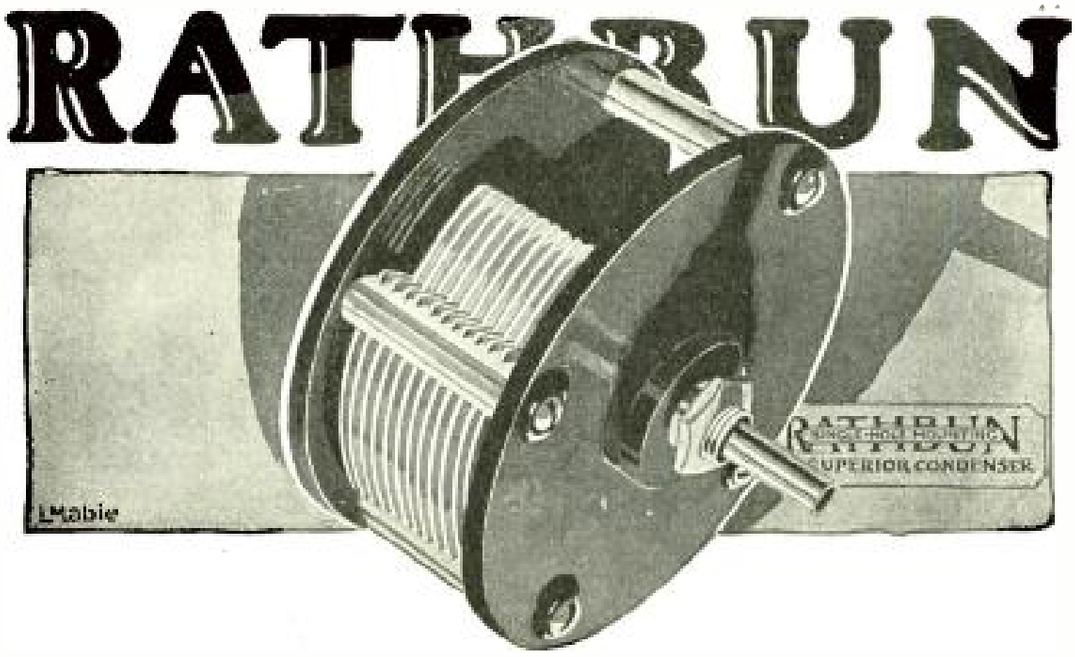
ATWATER KENT MANUFACTURING COMPANY
4712 Wissahickon Ave., Philadelphia, Pa.

Pacific Coast prices slightly higher



BRING OUT THE BEST FROM ANY SET

RATHBUN



Just A Real Good Condenser!

AMONG the extravagant and oftentimes misleading claims made for so-called "low-loss" condensers, the Rathbun stands out as just a real good job—at a fair price.

Rathbun Condensers are guaranteed electrically and mechanically perfect—they are as well made, as skill, the best materials and the honest desire to give full value can make them. In actual results you will find them the equal of any other condenser—at any price. There is no need to pay more.

Insist on Rathbuns—they are good condensers. Try them in the next set you build—the single-hole mounting is a real convenience. And bear this in mind—if you can get longer distance, sharper tuning, better quality or more volume with any other condenser on the market today, return ours, and your money will be immediately refunded.

Don't be fooled by "low-loss" bunk. Insist on end plates of genuine moulded Bakelite.

We have prepared a little booklet giving in detail the story of so called "low-loss" condensers, including a tabulation of the losses, accurately measured, in over fifty standard condensers. You will find it interesting and instructive and it's free for the asking.

An Entirely New System of Radio Reception

Rathbun Single Hole Mounting Superior Condensers have been specified for use in the *Hoyt System of Signal Augmentation*, by the inventor *Francis R. Hoyt*. We have a limited number of Blue Printed copies of Mr. Hoyt's original laboratory notes on this new system of radio reception, together with nine circuit sketches, which will be sent free to you upon receipt of this coupon and 4 cents for postage.

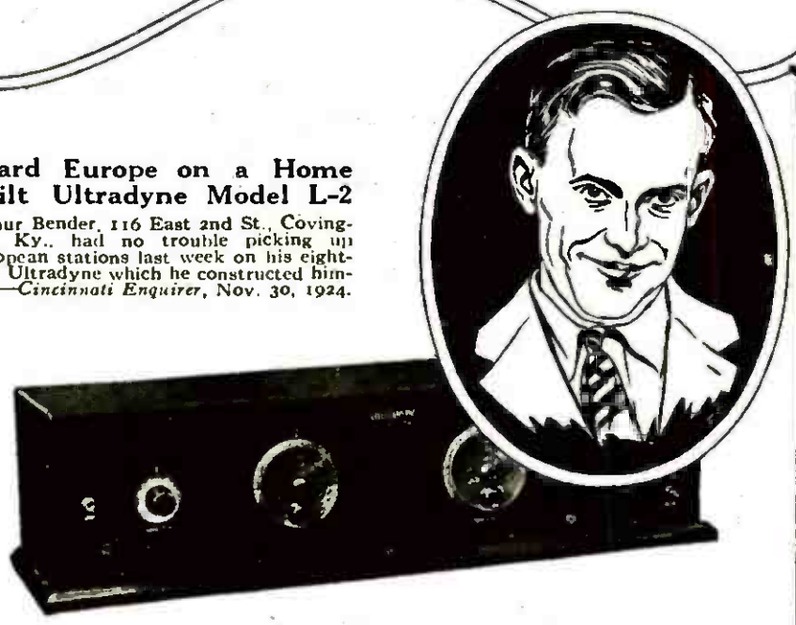
NAME_____

ADDRESS_____

_____

RATHBUN MANUFACTURING COMPANY, INC.
JAMESTOWN, NEW YORK

Honest CONDENSERS



Heard Europe on a Home Built Ultradyne Model L-2

Arthur Bender, 116 East 2nd St., Covington, Ky., had no trouble picking up European stations last week on his eight-tube Ultradyne which he constructed himself.—*Cincinnati Enquirer*, Nov. 30, 1924.

Thousands have built it!

LIKE Mr. Bender, thousands have successfully built the Model L-2 Ultradyne and claim it the most wonderful receiver they have ever known for great distance on the Loud Speaker.

In no other receiver is found the "Modulation System" of radio reception—an outstanding radio engineering development by R. E. Lacault, E.E., A.M.I.R.E., Chief Engineer of this Company and formerly Radio Research Engineer with the French Signal Corps Research Laboratories.

With the application of regeneration to the "Modulation System" the Ultradyne is capable of detecting the faintest broadcast signal, regenerating and making it audible on the loud speaker.

In addition, the Ultradyne is the most selective receiver known. Regardless of close similarity in wave length, it selects any station within range—brings in broadcasting clearly, distinctly, faithfully.

The Model L-2 Ultradyne will do everything better than any super-radio receiver operating under the same conditions.

Write for free descriptive folder.

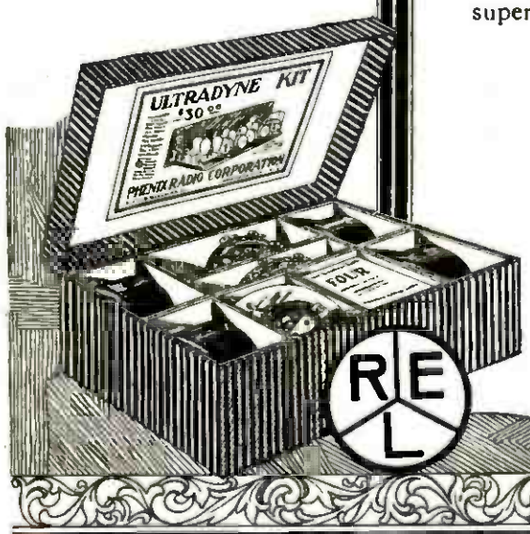
How to Build and Operate the ULTRADYNE

32-page illustrated book giving the latest authentic information on drilling, wiring, assembling and tuning the Model L-2 Ultradyne Receiver..... **50c**

THE ULTRADYNE KIT

Consists of 1 Low Loss Tuning Coil, 1 Special Low Loss Coupler, 1 Type "A" Ultraformer, 3 Type "B" Ultraformers, 4 Matched Fixed Condensers.

To protect the public, Mr. Lacault's personal monogram seal (R. E. L.) is placed on all genuine Ultraformers. All Ultraformers are guaranteed so long as this seal remains unbroken..... **$30.00**



ULTRADYNE •

MODEL L-2

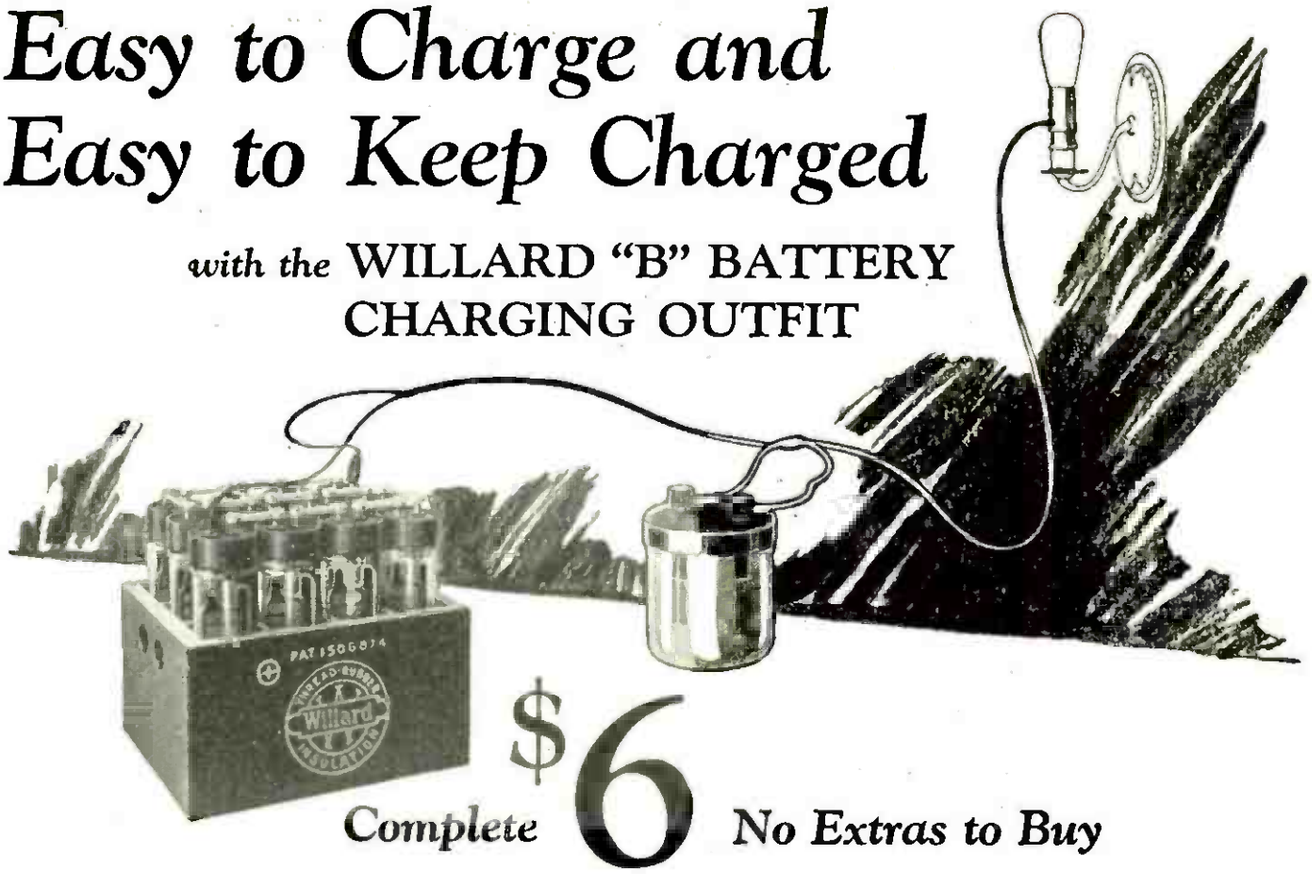
Phenix Radio Corporation

7-9 Beekman Street

New York

Easy to Charge and Easy to Keep Charged

with the WILLARD "B" BATTERY CHARGING OUTFIT



Complete $6 *No Extras to Buy*

It's as easy to recharge a Willard "B" Battery as it is to change a tube.

The new Willard "B" Battery Charging Outfit comes complete. No extras to buy. Simply screw the plug into your light socket, clip the charger terminals to the battery and charging starts immediately. Charges both 24 and 48-volt units. Cannot injure the battery.

WILLARD RADIO BATTERIES

FOR SALE AT ALL WILLARD SERVICE STATIONS AND RADIC DEALERS

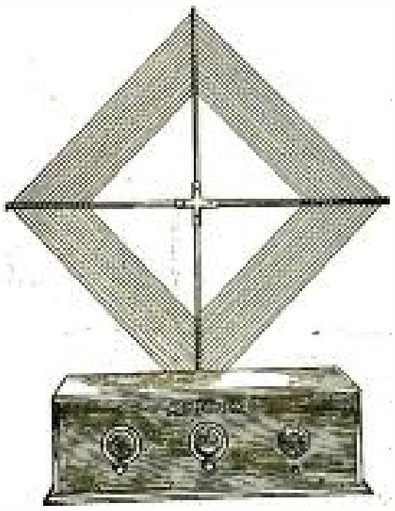
Current that is the same strength all the time is what you need for better radio reception.

Only a battery that is rechargeable can produce this type of current.

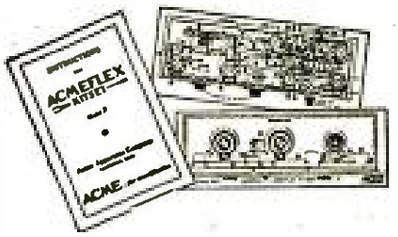
That is one reason why 185 broadcasting stations use Willards. Other reasons are freedom from noise, economy, and the better all 'round results they get with Willards.

Why buy "B" batteries more than once when Willards last for years, and can be recharged so easily.

FOR BETTER RADIO RECEPTION, USE STORAGE BATTERIES

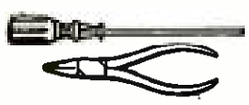


A set anyone can put together and enjoy all-the-year round radio



Directions given so simply that anyone can follow them

ABOVE are illustrated the circular of printed instructions and the life-size diagrams of the wiring, which are packed with each Model "S" Kitset. Step by step the making of the set is described in clear, simple language—just simple operations which anyone can easily follow.

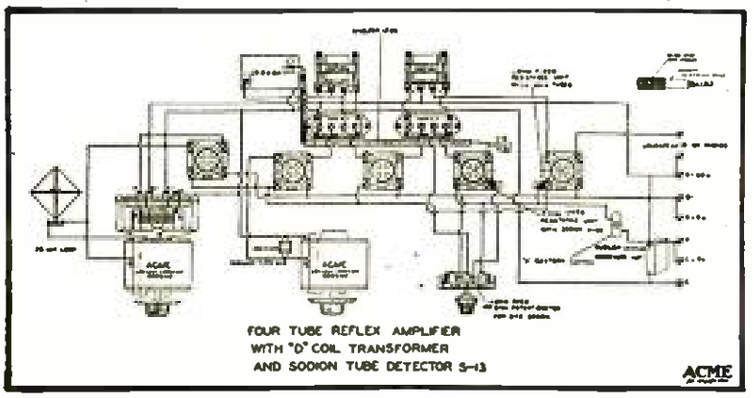


Only two tools required—a screw-driver and pliers—and they are included in the Kit.

Enthusiastic praise from Model "S" user from New York City:

"Well, I believe we had every jerk-water station in the U. S. Stations I never heard of before. At 11.45 P.M. I pulled in KFI (Los Angeles, Calif.) on the loudspeaker. At 12.15 A.M. KGO (Oakland, Calif.). I went back and picked up KFI three times. My home is located in what is considered one of the worst sections for radio. The skyline of New York is directly opposite me. I am on the harbor, a mile from the Navy Yard, and have three bridges with electric trains to bother me, but with it all I got the Coast. Forgot to mention that two locals were on—WHN and WJZ; some selectivity."

ACME
~ for amplification



This is the new model "S" Acmeflex Kitset

IN THE above wiring diagram special attention is called to the D-Coil radio frequency tuning unit and the vacuum tube detector, giving the famous Acme Reflex (trade-mark) still greater distance, greater selectivity and better reception.

We can save you about $60.00 on this $150.00 radio

IF YOU bought this set completely assembled it would cost you $150. But by putting it together yourself you can buy it for only $80, plus cabinet, saving about $60. We could make it for less but it wouldn't give results.

Acme Engineers have done all the engineering for you and have written clear, simple directions which show you, step by step, how to put the set together. Many have done it in three hours, and found it fascinating fun. Even if you know nothing about radio you can put it together. All the parts are in the kitset, even the loop. No antenna to erect. Even a screw-driver and pair of pliers, the only tools you need, are included. No soldering to do. The panel is all drilled for you. The only accessories to buy are tubes, batteries, loudspeaker and cabinet. If you don't want to put it together yourself, there are amateurs and dealers glad to do it for you.

And your finished set is the famous Acme Reflex (trade-mark), now wonderfully improved in distance, selectivity and reception. It will pull in more stations, louder and clearer, than most sets using the same number of tubes (five). Only one tuning dial—easy to tune. Send coupon today for complete information.

Note these features of Model "S" Acmeflex Kitset

Complete directions given for putting set together.
No antenna to erect.
No technical knowledge or workshop required.
Only two tools and they are in the Kit.
No soldering to do.
Only one tuning dial.
Excellent reproduction.
Greater distance, sensitivity and selectivity.
Non-radiating—won't bother your neighbor.
Saves you about $60.

ACME APPARATUS COMPANY, Dept. C3, Cambridge, Mass.

Pioneer Radio and Transformer Engineers and Manufacturers

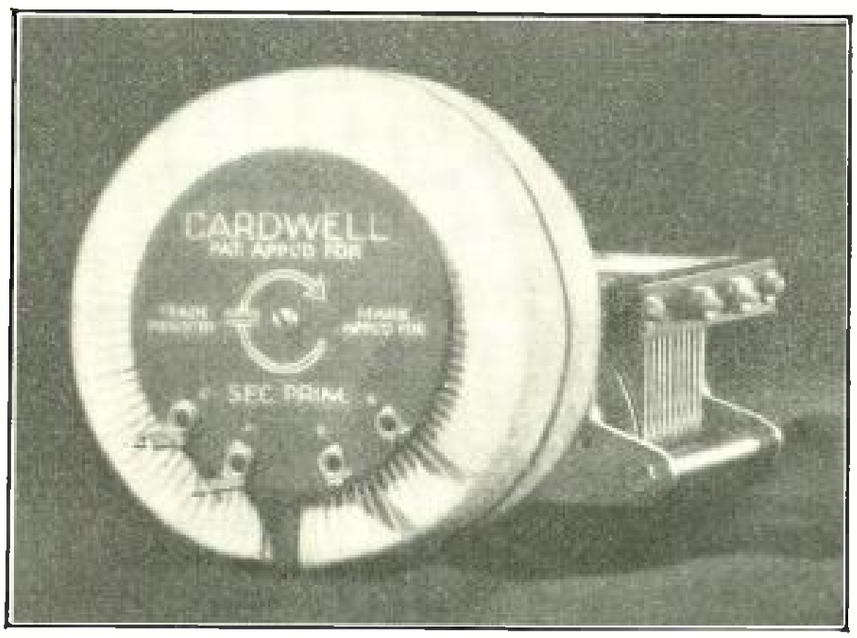
ACME APPARATUS CO., Dept. C3, Cambridge, Mass.

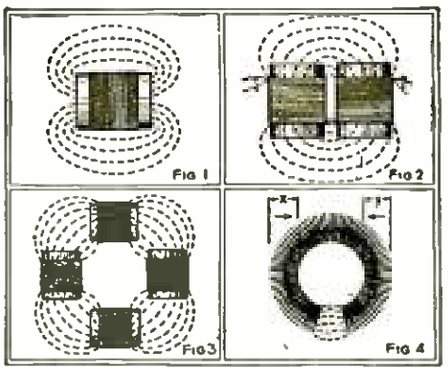
Send complete information about the new Model "S" Acmeflex Kitset to:

Name.....

Street.....

City..... State.....





General Theory of the Toro-Tran

Figure 1 shows how the field of the ordinary coil extends into space and increases losses due to stray field. Figure 2 shows a "double series" winding, which restricts the field somewhat. Figure 3 shows a "four series" winding and the field almost enclosed. In Figure 4 (the Toro-Tran) the field is entirely enclosed and the losses due to stray fields are eliminated.

Note that a stray signal passing through the coil at "X"—not introduced from the aerial or the tube—is balanced out at "Y" by the reversed polarity of the winding. This rejects undesirable signals, while the concentrated internal field builds up the tuned signal. Hence maximum distance and selectivity.

—and now the TORO-TRAN!

CARDWELL, whose pioneer "low-loss" condenser established new standards of radio efficiency, is now introducing the Toro-Tran*—the ideal *balanced* coupling inductance for all radio frequency work.

*TRADE MARK
Registry applied for

The Toro-Tran eliminates signal energy picked up by ordinary coils from nearby stations. It eliminates magnetic feed-back in multi-stage radio frequency circuits, thus removing the most active factor in causing howling and distortion, and thereby increasing selectivity and distance. It rejects almost entirely the interference effects caused by electrical power machinery, elevators, door-bells, arc stations, etc.

The Toro-Tran winding confines the field to the inside of the coil, a small area, and thus avoids one of the greatest causes of loss known to radio receivers—that of stray magnetic fields, which result in the absorption of signal energy and reduce the efficiency of the receiver tremendously.

Note these unusual advantages in assembly and operation

1. Compactness. The coils do not require spacing or angular mounting. They occupy less space than your condensers.

2. Permit exact nullification for tube and stray capacity without guesswork or tedious testing.

3. Closed magnetic field eliminates magnetic feed-back in tuned radio frequency amplifiers.

4. Low distributed capacity, due to air spacing of each winding and to low voltage-drop per turn of small diameter wire.

5. Maximum coupling and high ratio of voltage increase due to concentrated field with zero leakage.

6. Absence of all supporting insulation in the field of the coil. This is one of the greatest loss factors in the ordinary circuit and is not remedied by "skeleton" or so-called "low-loss" windings.

7. Ease of neutralizing oscillation due to tube capacity by means of rotating control, which anyone can "balance."

8. Low capacity between primary and secondary, affording maximum transfer of energy to succeeding grid circuit.

The Toro-Tran has a lower "circuit resistance" (i.e., effective resistance as assembled in a set and not as isolated in the laboratory for theoretical measurements) than any inter-stage tuned transformer made and has a correspondingly higher amplification factor, its ratio exceeding ten.

To appreciate the many remarkable advantages of the Toro-Tran, write for our two free booklets: "The Torodyne Circuit" and "The Most Interesting Radio Frequency Transformer Ever Invented."

Toro-Trans are ready to mount in any tuned radio frequency circuit. Replace your ordinary coils with Toro-Trans. You will be astonished with the results. Most .00035 mfd. variable condensers will tune them, but by using Cardwell Condensers you get maximum efficiency.

Order from your dealer or direct

CARDWELL TORO-TRAN WITH BALANCING POTENTIODON	$ 4.00
Cardwell .00035 Condenser for tuning	4.75
Cardwell .00035 Vernier Condenser	6.25
Cardwell .00035 Dual Condenser (two-in-one)	8.00
Cardwell .00035 Triple Condenser (three-in-one)	12.00
Cardwell Audio-Trans (compound audio transformers)	10.00

The Allen D. Cardwell Manufacturing Corp.
81 Prospect Street, Brooklyn, N. Y.

Balkite Battery Charger. Charges 6 volt "A" storage batteries.
Price $19.50
West of Rockies $20
In Canada $27.50

Balkite "B"—replaces "B" batteries and dry cells. Operates from light socket.
Price $55
In Canada $75

A uniform, constant power supply for both "A" and "B" circuits

Here at last is a convenient and unfailing power supply for your radio set. Balkite Radio Power Units furnish constant uniform voltage to both circuits, and will give your radio set greater clarity, power and range. The Balkite Battery Charger keeps your "A" storage battery charged. Balkite "B" replaces "B" batteries entirely and supplies plate current from the light socket.

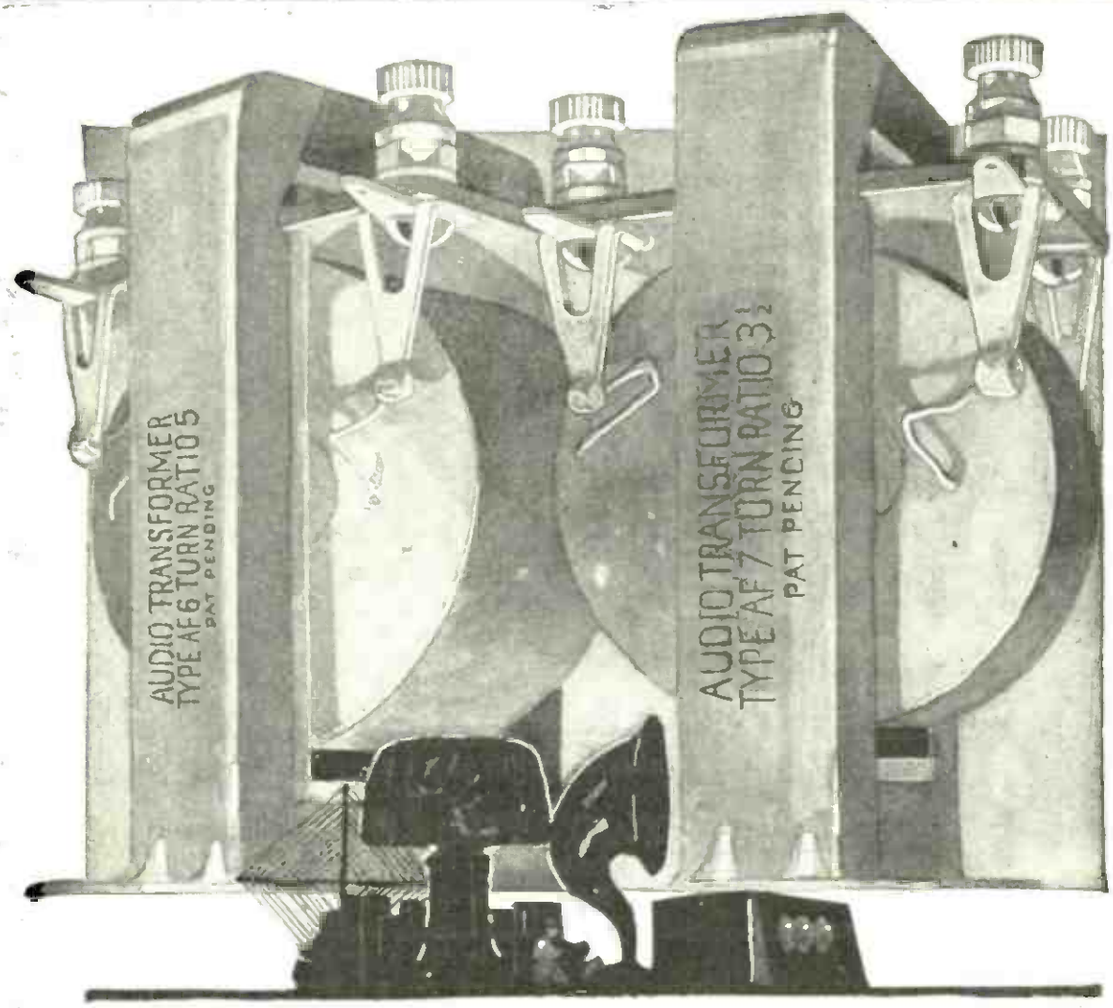
Based on the same principle, both the Balkite Battery Charger and Balkite "B" are entirely noiseless. They have no bulbs or moving parts, and nothing to break, adjust or get out of order. They have a very low current consumption, are simple and efficient in operation, and can be put in use at any time by merely connecting to a light socket. Both are guaranteed to give satisfaction.

Sold by leading radio dealers everywhere

FANSTEEL
Balkite *Radio Power Units*

BALKITE BATTERY CHARGER— BALKITE "B" PLATE CURRENT SUPPLY

Manufactured by FANSTEEL PRODUCTS COMPANY, Inc., *North Chicago, Illinois*



POWER

WHEN it comes to making a loudspeaker deliver the goods, there's nothing like a pair of AmerTrans.

Built to operate by the pair, they secure from two stages all you could possibly hope for in audio amplification.

Look for a pair of AmerTrans in the set you buy—use them in the sets you build. Learn just what the famous AmerTran "kick" means—and then get a loudspeaker to *take* it.

AmerTran is made in two types, one quality—
A F 6 — ratio 5: 1 and A F 7 — ratio 3½: 1.
Buy them by the pair!

AMERICAN TRANSFORMER COMPANY
175 EMMET STREET, NEWARK, N. J.
"Transformer builders for over twenty-four years"

Price either model $7.00
At your dealers.

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

A New System of Radio Reception—

Francis R. Hoyt, inventor of the Hoyt System of Signal Augmentation has specified AmerTran for use in this new system. We have a limited number of Blue Printed copies of Mr. Hoyt's original laboratory notes on this new system of radio reception, together with nine circuit sketches, which will be sent free to you upon receipt of this coupon and 4 cents for postage.

NAME .....

ADDRESS.....

.....

Another Famous TOWER

Tower's Scientific LOUD-SPEAKER

$8.50

It had to be the BEST

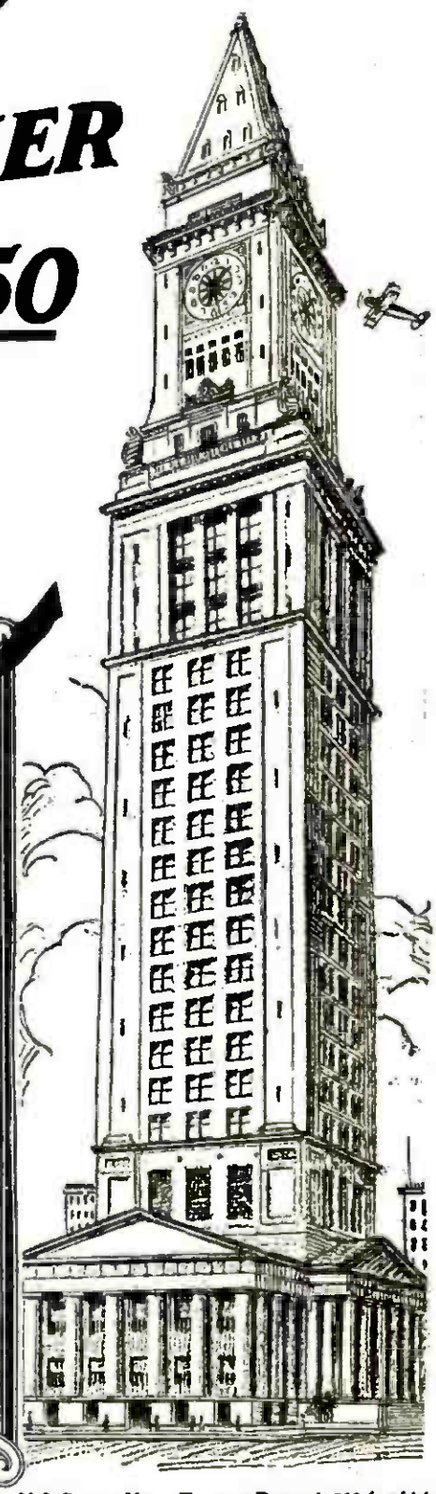
We could have manufactured a loud speaker two years ago, but we wouldn't! We have waited — studying, planning continually striving for perfection and now at last! WE HAVE IT—In the new TOWER'S LOUD SPEAKER.

The many features include, magnets that lift two lbs. 10 oz. diaphragm of specially constructed material, perfect non-vibrating horn, 10" bell.

TOWER'S phones are tested by Government Licensed Operators. On sale at all good dealers.

Tower's Scientific 2.95

THE TOWER MFG. CORPORATION
98 BROOKLINE AVE. Dept. J BOSTON, MASS.



The U. S. Custom House Tower at Boston is 500 feet high and is situated in the business district overlooking Boston Harbor. It is the tallest Government building in America.

Worlds Greatest Loud Speaker Value

Super-Power 6-Tube Pliodyne 6

The famous new Golden Leutz Model. Range 1,500 to 3,000 miles. Two stages radio frequency; detector and three stages audio frequency amplification. Solid mahogany cabinet. Finest materials throughout. Guaranteed mechanically and electrically perfect. Completely constructed, without accessories, $60

For any Circuit

Prompt shipment can be made on tested, standard apparatus of the following manufacture:

E. I. S., Inc.
General Radio
Ultradyne — *Willard*
Sangamo Electric
Benjamin Electric
Allen Cardwell
Dubilier — *Formica*
Weston — *Magnavox*
Jewell — *Amer Tram*
Western Electric
Radio Corporation
Music Master — *Acme*
Cutler Hammer — *Frost*
Federal — *Kellogg*

Super-Heterodyne C-7

Model C-7, the Long Distance Concert Receiver With a Telephone Range of 3,000 Miles

FEW of the so-called new "circuits" or modifications of standards approach the C-7 in efficiency—for long range, for high audibility, for selectivity. Experimenters' Information Service design. ***Seven tubes give the result of ten*** because this model allows signals to be regenerated and heterodyned through radio frequency amplifier.

E. I. S. Model . . . All material we furnish is endorsed and recommended by the designers.

Using the finest apparatus and building to Naval standards, Model C-7 has a telephone range of 3,000 miles.

Norden-Hauck Price List Saves You Money

Free Information—Write for descriptive matter and price list. Our service is as near as your mail box.

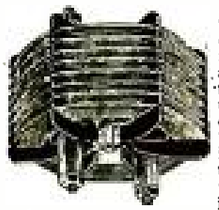
Full Stock on Hand—We carry complete stocks of laboratory tested apparatus for immediate shipment.

Engineers . Office and Laboratories

NORDEN, HAUCK, INC. 1617 Chestnut St., Philadelphia

The Andrews
Paddlewheel-Coil

Pats. Pend.



A new low-loss coil of ideal characteristics, which can be used in any circuit where a high grade R.F. transformer-inductance is required. Has an exceptionally high ratio of inductance to resistance, and also to distributed capacity—the real test of a coil.

The small amount and placing of the insulation reduces absorption losses to a minimum. No adhesives are used insuring a coil with negligible internal losses and one which is practically moisture proof. Your results will be greatly improved by using this superior inductance. Its exclusive construction assures *maximum amplification, minimum distortion* and much *greater selectivity*. Price, with bracket, $3.00.

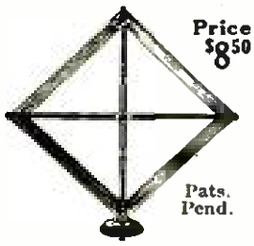
This coil is the type employed in the ANDREWS DERESNADYNE RECEIVER and is manufactured under license from the Andrews Radio Co.

Write for folder describing this wonderful new coil, its characteristics and its uses.

DUO-SPIRAL FOLDING LOOP

A special model for every circuit. Easily portable. Base has silvered dial graduated for calibration. Handle permits adjustment without body capacity effect. Neat in design and handsomely finished in silver and mahogany. Ideal for summer reception.

Write direct if your dealer cannot supply you.



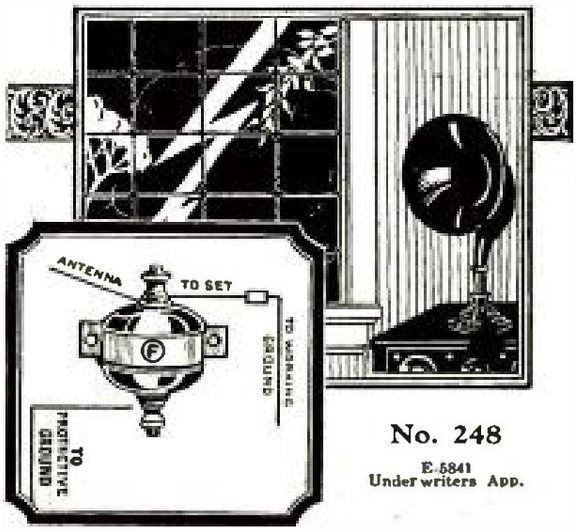
Price $8.50

Pats. Pend.

Radio Units Inc.

1301 First Avenue **Maywood, Ill.**

Perkins Electric, Ltd., Montreal



No. 248

E-5841 Underwriters App.

"Little Joe"

Lightning Arrester

Especially designed for Radio Work. Made of Porcelain, small, neat rugged and serviceable. Can be suspended on antenna or fastened to wall.

Ask Your Dealer

M'f'd by **CIRCLE F MFG. CO.**

Trenton, New Jersey

Radio—Through Your Phonograph!

In your own phonograph is hidden a horn of proved acoustical merit.

With a Jewett Vemco Unit, this horn can provide excellent Radio reproduction—reproduction so loud, so clear, and so accurate as to rival that of the best phonograph record you have ever heard.

But be sure that the Reproducer is a Vemco! That is the secret of accuracy, volume and tone.

No tools, no changes—Slips easily on or off the tone arm of a Victrola—We supply simple adapters for other phonographs. Volume control develops distant broadcasting to amazing strength. Above cuts show actual size. The same reproducer used in the famous Jewett Superspeaker. Price $12; West of the Rockies, $12.50. Adapter, when needed, slight addition. At your dealers or use the coupon.

"THERE IS NO SUBSTITUTE FOR THE BEST"

JEWETT RADIO & PHONOGRAPH CO.
5668 DIXIE HIGHWAY PONTIAC, MICHIGAN

SEND NO MONEY—
Just Fill In The Blanks!

Jewett Radio & Phonograph Co.
5668 Dixie Highway, Pontiac, Mich.

My dealer is not yet supplied so please send me, carrying charges prepaid, a Vemco Unit with adapter if needed. I will pay the postman. My Phonograph is a

_____
(*make*)

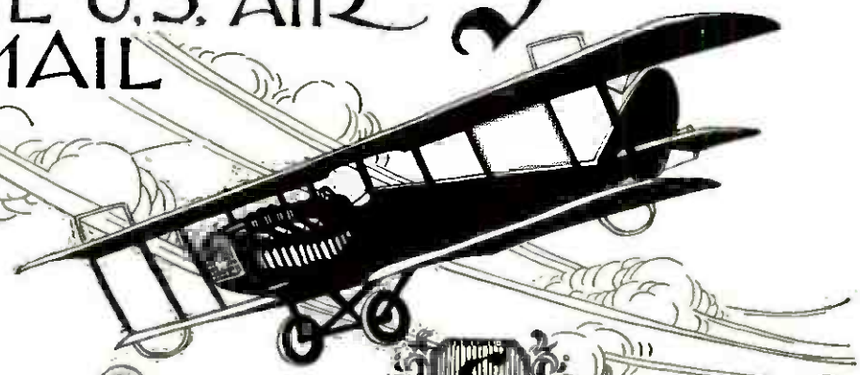
_____
(*Name*)

_____
(*Address*)

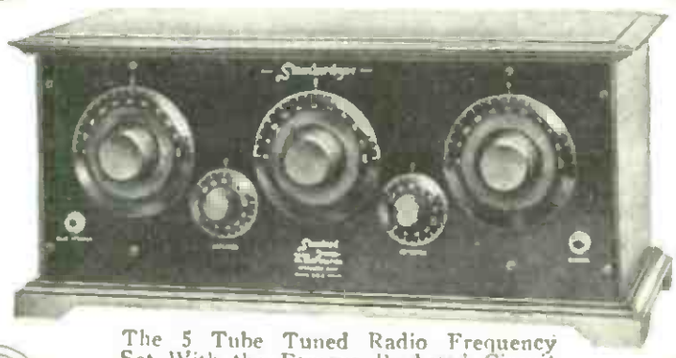
The Jewett Vemco Unit

Standardyne—

AND THE U.S. AIR MAIL



The WORLD'S GREATEST DISTANCE SMASHERS



The 5 Tube Tuned Radio Frequency Set With the Famous Re-Acted Circuit

DELIGHTED owners of **Standardyne** Radio Sets all over the country look forward every night to the pleasure of listening to Far Distant Stations.

And they are never disappointed.

Standardyne Distance Performance is always dependable.

That's why hundreds of **Standardyne** fans are added to the rapidly growing list of pleased owners each week.

These owners appreciate a set which couples with Dependable Distance Performance, rare beauty of cabinet design, complete lack of annoying distortion and noise, selectivity which eliminates the undesired station immediately, and volume clear and strong.

Buy your **Standardyne** *from your nearest local dealer. If he does not carry* **Standardyne** *ask him why.*

$60

WITHOUT ACCESSORIES

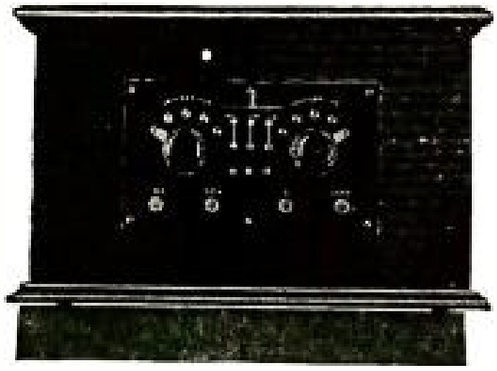
THEY BOTH MAKE THE SAME STOPS

NEW YORK
CHICAGO
PHILADELPHIA
DENVER
LOS ANGELES
PITTSBURG
CLEVELAND
MIAMI
OMAHA
FT. WORTH
NEW ORLEANS
DETROIT
ST. LOUIS
KANSAS CITY

Standy Say's—

COAST TO COAST IS NO IDLE BOAST WITH Standardyne

MANUFACTURED BY
The Standard Radio Corporation
WORCESTER, MASS.
—U.S.A.—



KIC-O—the permanent power plant for your radio

If you are tired of buying new batteries every little while—if the stations are not coming in as loudly and clearly as you think they should—if you want better reception at lower cost—if you want a real permanent power plant that will last for years—then buy a KIC-O.

These new KIC-O Nickel zinc alkaline storage "B" Batteries are the product of years of research. They are not harmed by standing idle or overcharging. They give a slow, even discharge over a long period of time and by using the KIC-O Double Potential Charger, which can be attached to any electric light socket, you have a permanent power plant.

Write for full description which will tell why KIC-O units are better than dry cells, "B" eliminators and acid "B" batteries.

PRICES

PZ indicates panel type with switches
CZ is plain type without switches

Voltage	M.A.H.	Type PZ	Type CZ
130	2500	$36.00	$33.00
100	2500	27.50	24.50
70	2500	21.50	18.50
45	2500	16.00	14.50
22½	2500	.....	7.50

MULTI-POWER UNITS
(No recharger required)

130 volts	$43.50
100 "	35.00

KIC-O CHARGERS

Type K-1 Single Unmounted	$1.50
Type K-2 Single Mounted	3.50
Type K-3 Multi-Polar Mounted	5.00
KIC-O Special Charger Chemicals (one cell)	.50

KIMLEY ELECTRIC CO., Inc., 2667 Main Street, Buffalo, N. Y.

DONGAN

AUDIO TRANSFORMERS

Choice of

35 Set Manufacturers

Receiver performance reaches its ultimate through Dongan Audio Transformers, designed and built in the big Dongan plant devoted exclusively to the manufacture of electrical devices for 15 years. Set manufacturers find Dongan the most practical of all Audio Transformers for their purposes.

Fits all Hook-ups. Ratio: 3½ to 1; 6 to 1

Ask our engineering department for facts.

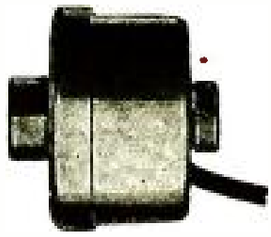
Individual Set builders see your dealer or write us direct for information.

Dongan Electric Manufacturing Co.
2983 Franklin St. Detroit, Mich.
Transformers of Merit for 15 Years

Morrison

Loud Speaker Unit

$5



Volume ***Tone***

The Best in Radio

Every set reaches its maximum performance when it reproduces through a Morrison Unit. Volume on long distance work and the marvelous Morrison tone quality are unmatched. Thousands of Morrison owners from coast to coast know this.

Of all the elements in radio receiving there is one you can be certain of—buy a Morrison and you've got the best reproducing unit you can buy. Use it indefinitely—it's built to stand long service.

Morrison is an adjustable unit.
Ask for our booklet on Loud Speaker Facts.
On sale at all good radio and phonograph dealers.
Mail orders shipped promptly from factory.

MORRISON LABORATORIES, Inc.
345 E. Jefferson Ave. Detroit, Michigan

"Shut off that piker set and come on over...

Sure, we've got something. What? Oh, a couple of Esquimaxes from Calcutta telling bedtime stories in Yiddish. Hurry up! This is real DX stuff."

When spark sets were the only ones used in radio, who spent most of the time rigging up aerials on the roof? The boy. When people talked about "wireless" as a black art known only to a few engineers like Marconi, who was in the advance guard of experimenters? The boy. Who listened in on those first crystal sets to local broadcasting? The boy—always the boy. Upon his imagination, pioneer radio worked best. To him—and there's a new crop every day—the far-seeing radio manufacturer will continue to tell his story with profit.

You cannot tell your story more effectively to boys than through the advertising columns of THE AMERICAN BOY. With its 500,000 loyal young readers, THE AMERICAN BOY provides a direct route to the boy market. And why? Its readers are, on the average, from 15½ to 16 years old, the high spot in radio enthusiasm. Boys are the greatest buyers of radio supplies in the market. They exert a powerful influence on the buying decisions of their parents and chums.

Put the prestige and companionship of twenty-five years behind your radio advertising. Tell your story to the boy in the magazine with which he chums month by month throughout the year. Get to the boy-market of today and the young-man-market of tomorrow by advertising in THE AMERICAN BOY. Copy received by May 10th will appear in July.

The American Boy
"The Biggest, Brightest, Best Magazine for Boys in All the World"
Detroit Michigan

MAR-CO RADIO PRODUCTS CONDENSERS

Here's the PROOF *that—*

"A better *condenser* makes *any* circuit better!"

I have had built an 8-tube Super-Heterodyne and of course bought with care the best parts the market offered. The result was, I tried several well-known condensers which were not satisfactory and by chance tried a pair of "Mar-co Condensers" and was greatly pleased with the performance of my set. So much so I hoped to pick up one of the foreign stations during test week.

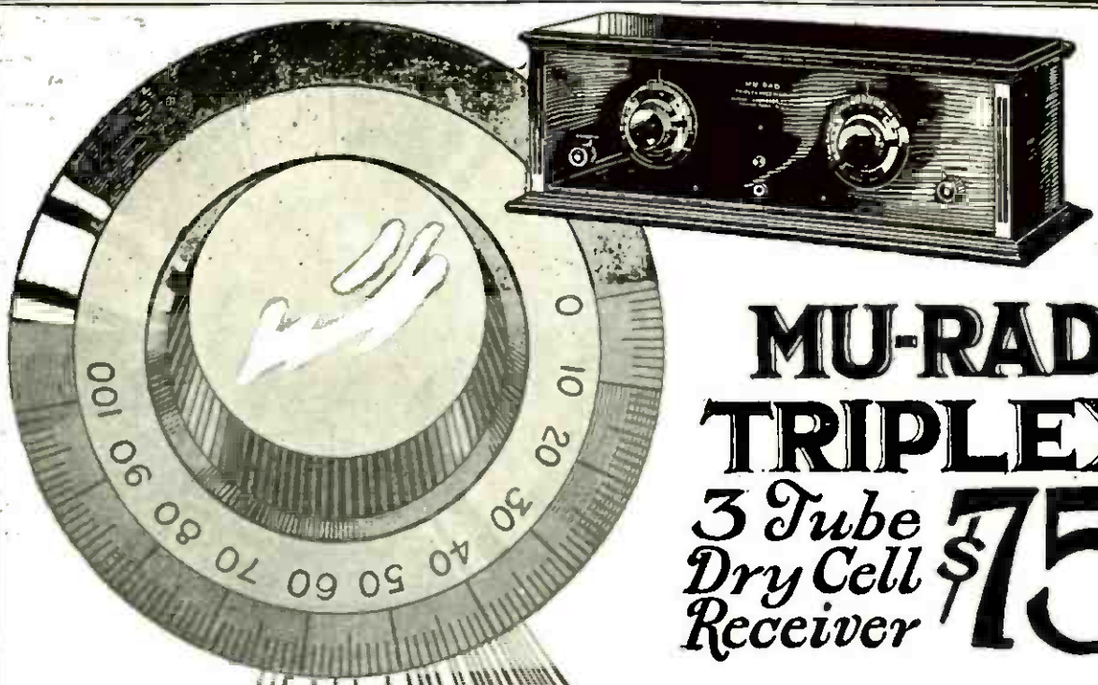
On tuning in on 470 meters, picked up "Lyons, France, Station PTT," which came in as loud and clear as a bell with orchestra music, and held them until they signed off at 12 midnight, Eastern Standard Time.

I am enclosing a confirmed telegram of my reception that you may know Mar-co Condensers proved 100% on a test with an amateur at the dials.

Yours very truly,

(Signed) H. W. DAHL

MARTIN-COPELAND COMPANY · Providence, R. I.



MU-RAD TRIPLEX

3 Tube Dry Cell Receiver $75

DIALS THE CONTINENT

Four-tube efficiency with only three tubes! Advantages that ordinarily cost you twice the price of the Mu-Rad TRIPLEX Receiver—*can be logged*, sections located at certain points on the dial ALWAYS; gives you a continent from which to "fish" for stations, *real distance*; and most conveniently *portable*, because the batteries are contained inside the handsome mahogany cabinet.

Why experiment with an unknown receiver, just because you only want to make a moderate investment? Here are the advantages you want at your price, and backed up solidly by an old, well established, respected radio name.

Write for literature and the name of the nearest Mu-Rad dealer.

MU-RAD LABORATORIES, INC.
809 FIFTH AVE ASBURY PARK, NEW JERSEY

CIR-KIT

More Power per Tube brings Greater Radio—Economically

Triple power is the basis of Erla Supereflex records. Tubes, as used in Supereflex, simultaneously amplify received radio frequency currents, reflexed radio and reflexed audio frequency currents. So 1-tube Supereflex rivals the power of conventional 3-tube circuits. And 3-tube Supereflex readily outclasses the ordinary five!

Only such power can give you the thrill of Supereflex distance and volume; always with Erla crystal-pure tone—and with uncanny selectivity that gets what you want when you want it.

This finer radio is brought within the reach of all by Erla Supereflex *CIR-KIT*, the factory-sealed carton of genuine Erla apparatus for building Supereflex yourself. Anyone can follow the *CIR-KIT* assembly plan to perfection, using only screwdriver and pliers, without the risk of drilling or soldering.

Pride of workmanship, extreme economy, priceless radio performance, are yours in Erla Supereflex *CIR-KIT*. Select your model at the Erla store. 1 to 5 tubes, antenna and loop types.

SEE ERLA RECEIVERS

Inherent Erla advantages in power, tone and selectivity are now available in beauteous complete Erla receivers. Retail prices range from $67.50 to $225. Both price and performance place Erla receivers among the sensations of radio history.

ELECTRICAL RESEARCH LABORATORIES
Department R, 2500 Cottage Grove Avenue, Chicago

ERLA

ULTRA HANDY CHARGER

Charges All Storage Batteries "A" or "B" 2 to 48 Volts

Radio fans! Here is a convenience that you cannot afford to be without. The Ultra Handy Charger is more than a convenience, *it* is a necessity. Keep your batteries fully charged. It will improve your reception and lengthen the life of your batteries.

Absolutely Fireproof

There is positively no danger of fire when using the Handy Charger. Even if allowed to run for several days no harm can be done. The taper charge makes it impossible to overcharge the battery—as the charge in the battery increases the current in the charger decreases. For all batteries, "A" and "B," both 24 and 48 volts. Charges quickly—5 to 7 amperes to a 6-volt battery—"B" batteries at recommended rate.

No bulbs nor liquid. **No auxiliaries necessary.**
No breakable glass. **No frequent adjustments.**
No fast wearing parts. **No sticking contacts.**

Simple to Connect

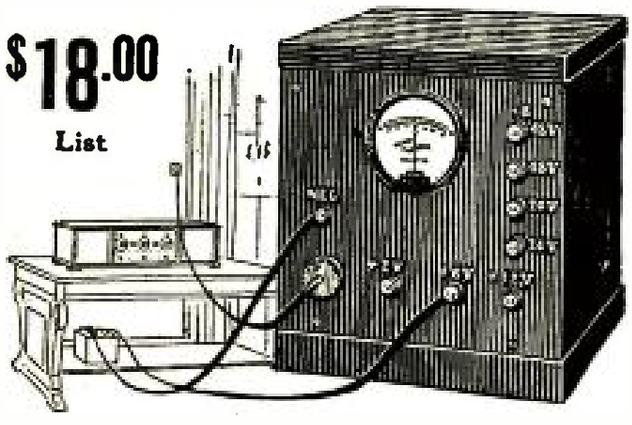
Very simple to connect and disconnect. Just connect the sturdy clips to battery and plug the cord into a light socket—then turn on current.

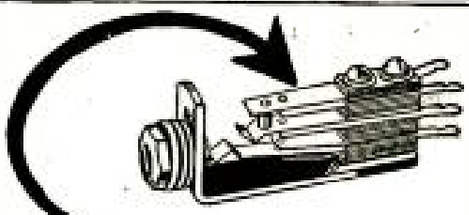
The Crystal Mahogany finish on the Cabinet makes the Ultra Handy Charger sufficiently attractive to stand beside the most beautiful Radio Set. It is not messy and will not dirty the home or harm the furniture. There are no acids to spill!

Ask your dealer to show you. If he cannot supply, write us.

INTERSTATE ELECTRIC CO.
4339 Duncan Ave., St. Louis, Mo.

$18.00
List





The spring's the thing!

Don't underestimate the importance of good jacks.

Don't buy jacks because they're cheap.

Over 25 leading set manufacturers use only Pacent Jacks. They have that most important essential—*fine springs* that keep the tension constant and the contact perfect.

Write for catalog of complete Pacent Line

PACENT ELECTRIC COMPANY, Inc.
91 Seventh Avenue, New York City

Washington
Minneapolis
Boston
San Francisco
Chicago
Birmingham

Pacent
RADIO ESSENTIALS

Philadelphia
St. Louis
Buffalo
Jacksonville
Detroit

Canadian Licensees: R. H. White Radio Co., Hamilton, Ont.

"DON'T IMPROVISE — PACENTIZE"

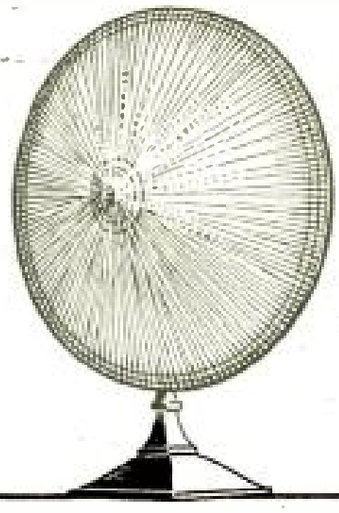
Super Kits

Save Half

Buy a RUBICON Kit containing ***only the parts needed*** to round out your present outfit. Coils, intermediate transformers and fixed condensers tested to match *are* important. RUBICON Kits supply these. Use your own parts for the rest—and save half.

♦♦♦

RUBICON COMPANY
29 N. Sixth Street
Philadelphia



Hear the Formica band every Wednesday evening from 9 to 10 Central Standard Time over WLW.

They have re-designed but they still use Formica!

THERE has been a great deal of activity in the engineering departments of the set makers since the first of the year—new models, new prices, newly simplified sets. Every conceivable substitute for Formica panels, tubes and insulating parts has been examined, tried and thoroughly tested.

But Formica is as prominent as ever in the sets that have been O.K.'d for production. For there is no substitute—nothing that combines the beauty and permanence of Formica, its strength, freedom from warping and distortion.

The makers know that Formica in their sets *never gives trouble!* And trouble is the most expensive thing the set maker can have. No small saving in material cost can make it worth while.

Last year 125 leading makers used Formica—this year the percentage will be just as high.

Dealers and jobbers prefer Formica because it is the best known and most easily sold line of panel materials.

Write for booklet, "What Formica Is."

THE FORMICA INSULATION COMPANY

4641 Spring Grove Avenue, Cincinnati, Ohio

SALES OFFICES

50 Church Street.....New York, N. Y.
9 South Clinton St.....Chicago, Ill.
516 Caxton Bldg.....Cleveland, Ohio
1142 Granite Bldg.....Rochester, N. Y.
422 First Avenue.....Pittsburg, Pa.
6 Beacon Street.....Boston, Mass.
55 Calle Obispo.....Habana, Cuba
289 Victoria St..Toronto, Ontario, Canada
1026 Second Avenue...Minneapolis, Minn.
725 Bulletin Bldg.....Philadelphia, Pa.
708 Title Building.....Baltimore, Md.
585 Mission Street.....San Francisco, Cal.
419 Ohio Building.....Toledo, Ohio
309 Plymouth Bldg.....New Haven, Conn.
Whitney Central Bldg....New Orleans, La.

Write for Booklet "What Formica Is"

1 Formica is used by 125 leading makers—and has for years been used by more makers than all other materials.

2 Formica will last forever.

3 Formica, in appearance, is the finest of all panel materials and always remains so.

4 Formica's electrical qualities of every kind far exceed any possible requirement.

5 Formica has high mechanical strength and will not break in use.

6 Formica will not sag from heat or cold flow under pressure. It retains its dimensions. Everything you fasten to it stays tight and precisely where you put it.

7 Formica panels are sold in neat craft paper envelopes which assure you that you are getting the genuine.

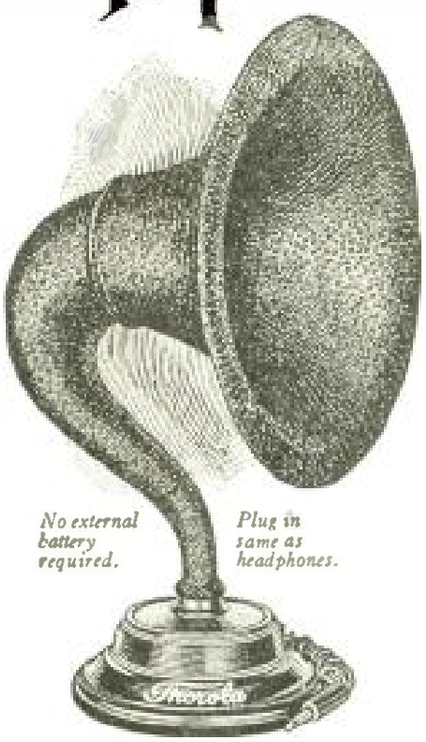
8 Formica is one of the most widely approved materials in radio.

FORMICA

Made from Anhydrous Bakelite Resins

SHEETS TUBES RODS

Pipe Organ of Loud Speakers



THOROLA 4 . . . . . $25

THOROPHONE . . . $45
Powerplus Speaker (Storage Battery)

THOROLA 6 . . . . . $15
Phonograph Attachment

THOROLA 9 . . . . . $40
Cabinet Loud Speaker

The Thorola 10-day Refund Warranty is a guarantee to every user that Thorola will fulfill every claim.

MEMBER R.M.A.

Without pure musical tone, how hollow is all else in radio! Distance and volume, yes. But only TONE can make them worth while.

Command *MUSIC* with your radio set. Equip it with Thorola loud speaker, and know the modern radio entertainment which needs no excuse before the most critical audience. Thorola elevated radio to the sphere of art, with betterments only Thorola brings.

The Thorola Controlled Mica Diaphragm, for tonal purity and volume, is to radio what the pipe organ is to instrumental music.

The exclusive Thorola Separix literally assorts sounds, preserving the shades and overtones which determine the timbre of song or instrument; the naturalness of voice.

The Thorola Synchronizer balances each Thorola with each individual circuit, as must be done for finest radio.

The whole Thorola reproducing unit, by its very size, suggests not only extreme volume, but utmost accuracy of reproduction due to precision design, which skimping does not permit.

Projecting the sound is the Thorola horn of Thorite, a *neutral* laboratory compound acoustically faithful beyond natural horn materials.

Thorola improvements are bound to better any radio receiver. Thorola volume permits tuning down for local stations, and brings in distant signals clear and strong. Thorola tone makes radio an *ART*. Hear it at your Thorodealer's.

REICHMANN COMPANY
1725-39 West 74th Street • CHICAGO

Thorola

THE SPEAKING LIKENESS

THE NEW MODEL C-7

"The Rolls-Royce of Reception"

MODEL C-7 SUPER-HETERODYNE
Wave-length Range, 200 to 575 meters. Dimensions, 40 in. x 8 in. x 8 in.
Tube Arrangement: Regenerative Detector, Oscillator, 2 Stages Radio, Detector, 2 Stages Audio

Important Today

THE EXPERIMENTERS INFORMATION SERVICE, Inc., has been recommending the Super-Heterodyne method of reception since the early part of 1922. In February, 1923, a Super-Heterodyne of our design was installed on the S.S. *Western World*, pier 1, Hoboken, N. J., in the cabin of Dr. Horatio Belt. On the voyage to Rio de Janeiro, Brazil, at a distance of 3,000 miles, southeast of New York, the entire Greb-Gardner fight was received from WJZ, with sufficient audibility for the entire cabin full of passengers to hear the bout, blow by blow, plainly. At 3,300 miles southeast of New York, an entire evening church service was received from Pittsburgh. At that time there was not another single firm advertising or advocating the Super-Heterodyne. Since then Mr. A. Ancieux, Engineer, Trarivia Elec de Arequipa, Arequipa, Peru, has reported consistent reception from KDKA, WDAP, WEAF, WGY and others, a distance of over 5,000 miles, using a Model "C" Super-Heterodyne. The Pratt & Brake Corp., of New York City, sent a Model C to Rio de Janeiro which received American broadcast station at a distance of over 7,000 miles.

Practically all concerns now featuring Super-Heterodyne have copied our original Model C design, and to prove again that we are far in advance of competition, we present this Improved Model C-7 Super-Heterodyne as the *Most Sensitive*, *Most Selective*, and finest reproducing Broadcast Receiver that can be built.

7 Tubes Give the Results of 10

The Reason:—When regeneration is added to a one tube non-regenerative receiver the increased amplification is about equal to adding two stages of tuned radio frequency amplification. Heretofore it has been impossible to add regeneration in the 1st Detector of a Super-Heterodyne and accordingly this has been a big loss.

The new Model C-7 Super-Heterodyne has a special 1st Detector circuit with a split antenna inductance so arranged that normally the detector would oscillate continually. However, in addition, a neutralizing condenser is inserted in the circuit which gives absolute control of the oscillations to such an extent that the circuit can be adjusted to just below the oscillating point, as this adjustment gives the maximum regenerative amplification. The new circuit has a bias potential on the 1st Detector grid, in place of the usual grid leak and condenser, and this allows infinitely weak signals to be regenerated and heterodyned through the radio frequency amplifier, which an ordinary grid leak and condenser would block. On a weak signal the difference in sensitivity is very noticeable. Using a 22-foot indoor antenna in the suburbs of New York loud speaker reception has been obtained from KGO, Oakland, California. A normal range of 2,000 miles is easily obtained on an average small antenna at night under average conditions.

Blueprints giving all construction data $1.00

EXPERIMENTERS INFORMATION SERVICE. Inc.

Designers of the Highest Class Radio Apparatus in the World

476 Broadway, New York, N. Y.

C. R. LEUTZ'S NEW BOOK, "MODERN RADIO RECEPTION"
325 Pages **200 Illustrations** **$3.00 Postpaid**

Everyone Interested in RADIO Should Write for this FREE Radio Book

BE SURE

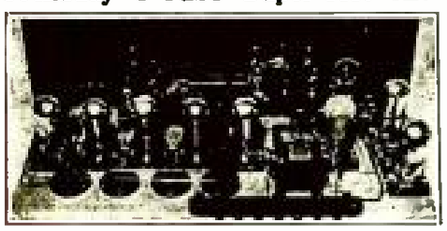
To consult our FREE 80-page catalog BEFORE making your purchase. You will be amazed how much you can save on KNOCK-DOWN KITS and standard quality parts. Remember W. R. S. Sells DIRECT TO YOU at WHOLESALE PRICES.

W. R. S. kits contain every authorized part for building the circuit you wish to build. You can start in to build the second you get the kit—when you finish—RESULTS are there. No more hours of trouble shooting—no more hunting for this or that missing part—everything is there! Down to the last screw—nut—wire—packed in sealed cartons that eliminate all difficulty and doubt in the purchase and assembly of proper materials.

Hundreds of Popular Radio readers have already bought from this institution. Never a complaint lodged with us. We live up to our advertising statements.

Complete Parts Exactly as Specified and Approved by Mr. Cockaday

Cockaday 8-Tube Super-Het Kit



1 General Instrument .0005 mfd. NO LOSS with Insolantite Insulation
1 General Instrument .001 mfd. NO LOSS with Insolantite Insulation
1 Haynes Griffin Input Transformer (new type)
3 Haynes Griffin Intermediate Transformers (new type)
1 Precision Autodyne Coupler
1 Karas Harmonik Audio Frequency Transformer
1 Amplex Grid-denser
1 Benjamin Cleartone Socket
7 Federal Sockets No. 16
1 Pacent Double Circuit Jack
1 Pacent Single Circuit Jack
2 SEALED 4 inch Dial
1 Amsco Rheostat 2 ohm
1 Amsco Rheostat 400 ohm
2 Daven Resista-Coupler Mounts
1 Daven Grid Leak Mounting
2 Daven Resisters 5 megohm (500,000 ohm)
1 Daven Resistor .5 megohm
1 DavenResistor .005 megohm 5,000 ohm)
2 Daven Resistors .25 megohm (250,000 ohm)
2 New York Mica Condensers .0001 mfd.
4 New York Mica Condensers .006 mfd.
1 New York Mica Condenser .00025 mfd. with grid leak mounts
1 Duratran Radio Frequency Transformer.
1 Walbert "A" Battery Switch
7 Eby Marked Binding Posts
1 7 x 24 drilled and engraved Bakelite mirror-finished panel
1 Mahogany Baseboard
1 Drilled binding post panel
1 Box assorted screws, nuts, washers, lugs, etc.
40 feet of extra heavy No. 12 tinned buss bar wire
1 Set of angle brackets for mounting post panel
1 Special Cockaday bracket for mounting Amplex gridenser
1 Set of three Popular Radio blueprints covering complete constructional details for building this receiver

For full description of this Kit refer to Page 37 of our catalog

ON APPROVAL

You take no risk whatever in sending us your orders. If you so instruct us we will ship you any article by express subject to examination; so you may examine it before acceptance or payment.

QUICK SHIPMENTS

We pay transportation—our records prove every order shipped the same day as received.

SEND NO MONEY IN ADVANCE

Send no money in advance unless you prefer to send with order. We ask no deposit. You run no risk. We take all the risk of pleasing you.

Cockaday Super-Het Built in Cabinet

Our Cockaday 8-tube Super-Het. built by expert engineers of the exact same parts as listed; in a beautiful piano-hinged cabinet, constructed of the best materials, *and the most exacting workmanship*, with such an extraordinary low price, is considered to be the best super-heterodyne on the market today.

Each receiver is tested for long distance, as well as local reception, and is thoroughly inspected, and must meet the most exacting demands before being shipped.

Cockaday 8-tube set, without tubes or batteries $99.50
This Super-Het with 1 Korach Tuned Loop and 8 C 301 A's or U. V. 201 A tubes $132.00

The Cockaday Improved DX Receiver

1 New York DX coil
1 Rathbun .0005 Condenser
1 Kurz-Kash Dial
1 Dubilier .00025 Type 640
1 Dubilier .00025 Type 640
1 Dubilier .005 Type 640
1 Dubilier .02 Type 640
1 General Radio Type 285 Amplifying Transformer
2 Bradleyohms No. 25
1 Cico Double Jack
1 Cico Single Jack
1 Cico Filament Battery Switch
1 7 x 24 Drilled and Engraved Panel
1 Baseboard 22¾ x 9 ⅜
1 Amperite No. 1A
1 General Instrument 6 Ohm Rheo.
1 General Instrument 20 Ohm Rheo.
1 Fil-Ko-Leak
1 Benjamin Cle-ra-tone Socket
3 Walbert Sockets
2 Daven Mounts No. 50
1 Durham .5 Meg. Metallized Leak
1 Durham .25 Meg. Metallized Leak
30 feet of extra heavy tinned buss bar
1 Drilled Post Panel
8 Eby Binding Posts
4 Special Angle Brackets
1 Box of Dixie screws, nuts, lugs, washers, etc.
1 Set of 3 Popular Radio Blueprints, covering complete constructional details for building this receiver.

For description of this Knockdown Kit write for Our Free Catalog

This Receiver built in a mahogany piano-hinged cabinet and guaranteed to be wired in accordance with Mr. Cockaday's specifications. Ready to operate $65.00

CRAIG 4-TUBE REFLEX RECEIVER

Write for our Catalog for complete description of this 4-tube marvel.

CAPT. PAUL EDWARDS' SUPER-HETERODYNE

Complete parts for this receiver in stock; at "WRS" money-saving prices.

Write for your FREE copy of POPULAR RADIO reprints of Cockaday's description of the 8-Tube Reflex Super-Heterodyne

WHOLESALE RADIO SERVICE CO.

Mail Order Dept. P. R.
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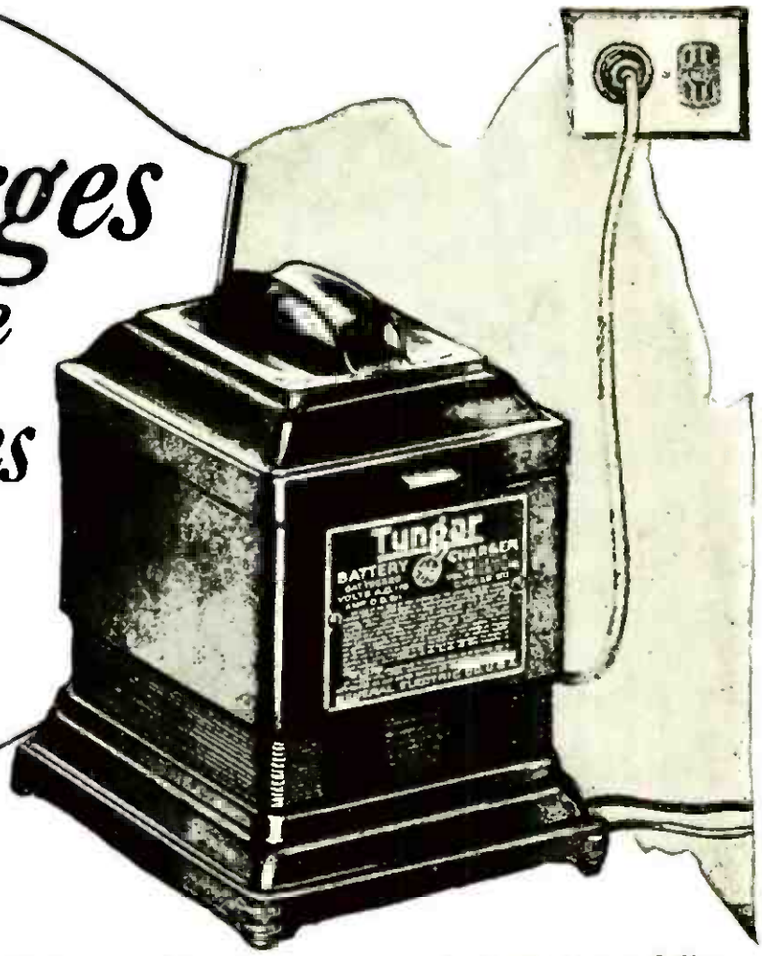
Retail Store
218 Fulton St.

It Charges —any size —all makes



The new Tungar will keep your storage batteries up—fully charged all the time. It charges radio "A" batteries of 2, 4, or 6 volts. Radio "B" batteries of 24 to 96 volts. And auto batteries, too.

It makes no disturbing noise—is simple—charges while you sleep. Just clip the Tungar to the battery, plug it in on the house current and leave it overnight to charge. A Tungar at home means clearer tone—full volume—your set at its very best all the time for all that's on the air.

The Tungar is a G-E product, developed in the great Research Laboratories of General Electric.

The New Model Tungar charges Radio A and B batteries, and auto batteries. Two ampere size (East of the Rockies) $18.00

The Tungar is also available in five ampere size, design unchanged (East of the Rockies) . $28.00

60 cycles—110 volts

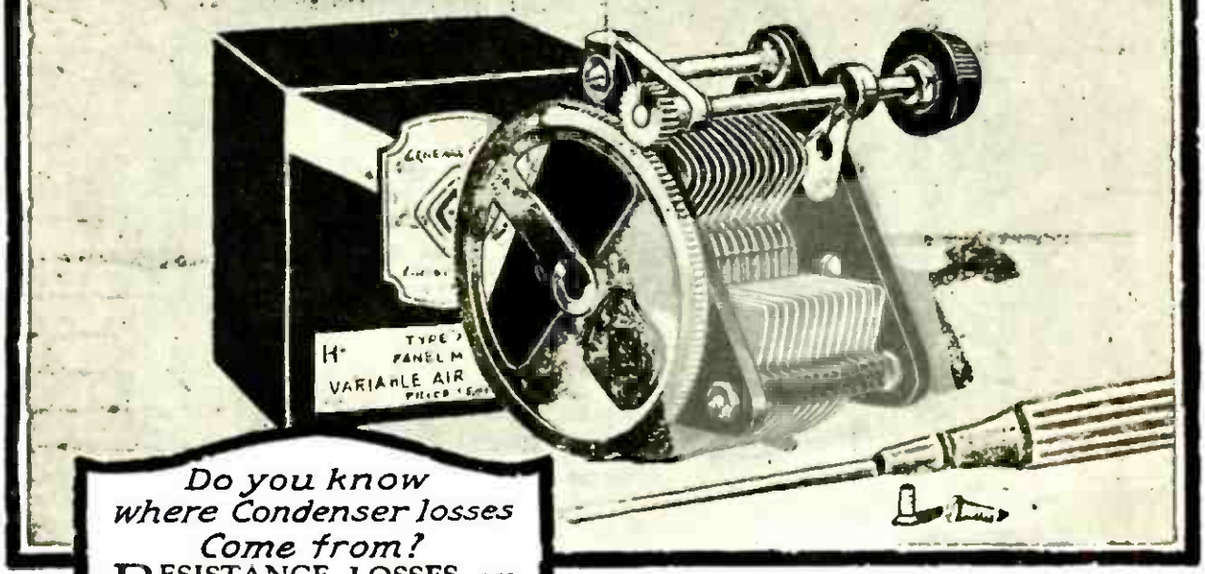
Tungar
REG. U.S. PAT. OFF.
BATTERY CHARGER

Tungar—a registered trademark—is found only on the genuine. Look for it on the name plate.

Merchandise Department
General Electric Company, Bridgeport, Connecticut

GENERAL ELECTRIC

Facts! not Fancies!



Do you know where Condenser losses Come from?

RESISTANCE LOSSES are the losses which most seriously affect the efficiency of a condenser when at working radio frequencies. They arise from poor contacts between plates and from poor bearing contacts. Soldered plates and positive contact spring bearings reduce these losses to a minimum.

Eddy current losses occur in metal end plates and the condenser plates themselves. While not so serious as resistance losses, they increase with the frequency, and therefore should be kept as low as possible.

Dielectric losses are due to absorption of energy by the insulating material. Inasmuch as they vary inversely as the frequency, they have less effect upon the efficiency of a condenser at radio frequencies than any other set of losses. The use of metal end plates in short-wave reception to eliminate dielectric losses is never justified, because they introduce greater losses than well-designed end plates of good dielectric.

The design of General Radio Condensers is based on scientific facts and principles, not on style and fancies.

Specially shaped plates always in perfect alignment give the uniform wave-length variation which permits extremely sharp tuning.

Rotor plates are counterbalanced to make possible accurate dial settings.

In 1915 the General Radio Company introduced to this country the first Low Loss Condenser, and ever since has been the leader in condenser design.

Lower Losses and Lower Prices make General Radio Condensers the outstanding values of condenser design.

Licensed for multiple tuning under Hogan Patent No. 1,014,002

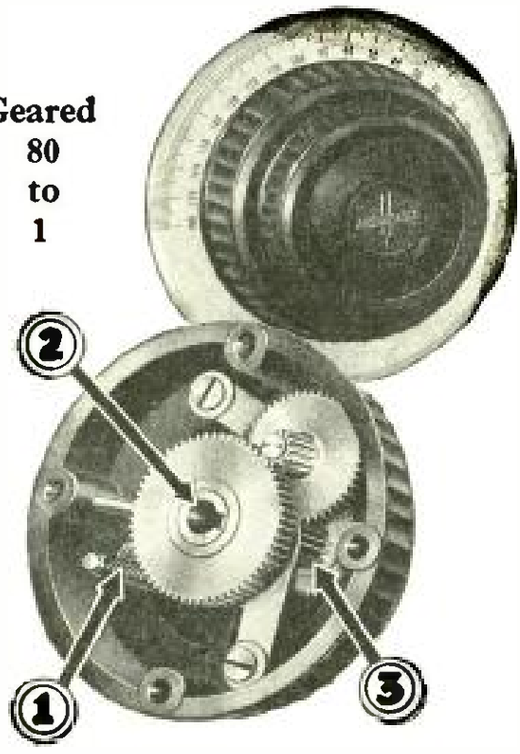
Type 247-H, with geared Vernier Capacity, 500 MMF. *Price* **$5.00**

Type 247-F, without Vernier Capacity, 500 MMF. *Price* **$3.25**

GENERAL RADIO CO.
CAMBRIDGE, MASS.

GENERAL RADIO
Quality Parts

Absolutely Essential for Sensitive Sets



ACCURATUNE FEATURES

1. No back lash. A new principle takes up all lost motion and back lash and produces a very smooth operating instrument.

2. Long center bushing eliminates all dial wabble and takes all standard condenser shafts. Permits dial mounting flush with panel. No cutting of condenser shafts.

3. Gear Mesh and alignment perfected to the same degree of accuracy as the mechanism of a watch. Ratio 80-1.

You can change from ordinary dials to Accuratune Micrometer Controls in an instant, no set alterations necessary. More efficient than built-in verniers—a revelation in fine tuning.

At your dealers. Otherwise send purchase price ($3.50) and you will be supplied postpaid.

Write for descriptive circular.

MYDAR RADIO COMPANY
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Canadian Representative: Radio, Ltd., Montreal
English Representative: G. E. Marbaix
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ACCURATUNE
REGISTERED U.S. PAT. OFF.
MICROMETER CONTROLS

Solid Rubber Case

You Save 50%

World 6-Volt Storage Batteries are famous for their guaranteed quality and service. Backed by years of Successful Manufacture and Thousands of Satisfied Users. You save 50% and get a

2-Year Guarantee Bond In Writing

World Battery owners "tell their friends." That's our best proof of performance. Send your order in today.

RADIO BATTERIES	
6-Volt, 100-Amperes	$12.25
6-Volt, 120-Amperes	14.35
6-Volt, 140-Amperes	16.00
AUTO BATTERIES	
6-Volt, 11-Plate	$12.25
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SEND NO MONEY

Just state battery wanted and we will ship day order is received, by Express C. O. D., subject to your examination on arrival.

Extra Offer: 5% discount for cash in full with order. Buy now and get a guaranteed battery at 50% saving to you.

Approved and Listed as Standard by Leading Authorities

including Radio News Laboratories, Popular Science Institute of Standards, Popular Radio Laboratories, Radio Broadcast Laboratories and Lefax, Inc.

Solid Rubber Container

Now Standard equipment on *all* World Storage Batteries. No more leakage or breakage of jars or rotting of box.

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World

Globe LOW-LOSS TUNERS

Loses Nothing
Tunes every radio impulse the aerial receives

No Metal
No Eddy Current Losses

Little Insulation
Low Distributed Capacity

Large Wire
Self Supporting

Anti-Capacity Windings
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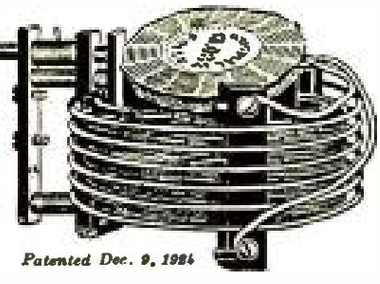


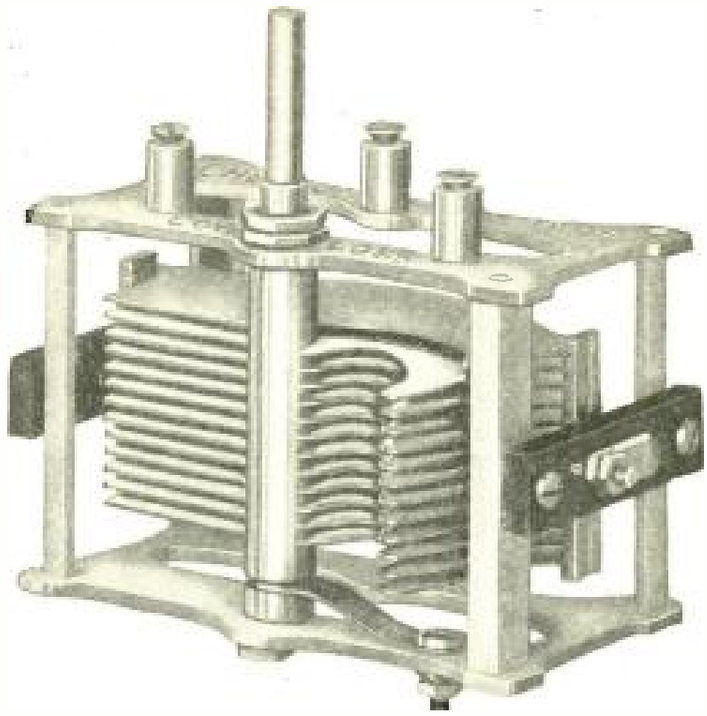
Patented Dec. 9, 1924

GET ORIGINAL GLOBE COILS

Standard Tuner (Broadcast Range)	$7.00
Short Wave (35-135 Meters)	$7.00
For Superdyne Circuit	$8.50
R. F. Transformer	$6.00

Circular on Request. Dealers and Jobbers Write.

Globe Radio Equipment Co.
217 WEST 125th ST., N. Y. C.



Note new plate shaping which assures open tuning of low wave lengths —a Chelten innovation.

Are You Having Trouble with Low Wave Lengths?

Here is the answer—the new Chelten Variable Condenser. The new, exclusive plate design remedies that common fault of old style condensers—crowding of stations at the lower ends of the dials. Put one in your set and note the vast improvement in tuning and in tone.

The New Chelten Midget Low Loss

A precision Vernier Condenser, built on exclusive minimum loss design, by the originators of this type unit. Specified by Radio Engineers everywhere. Interesting booklet for set builders and scientific experimenters gladly supplied on request.

CHELTEN VARIABLE CONDENSER

Duraluminum structure. Solid brass rotor shafts with milled slots for plates. Plates soldered in. Adjustable end bearings, consisting of steel ball in brass cup. Electrical contact spring separate from bearing, making lubrication possible without touching contacts. Large wiping area provides minimum contact resistance.

Cat. No.		Brass Plates	Aluminum Plates
913—13 plate	—0.000250 M. F.	$4.10	$3.25
919—19 "	—0.000350 M. F.	4.25	3.35
925—25 "	—0.000500 M. F.	4.50	3.50

At Your dealer's—or sent direct via Parcel Post

CHELTEN ELECTRIC CO.

Stenton Ave. and Rockland St.
PHILADELPHIA

COCKADAY WILL TELL YOU

If you have a problem that you have not been able to work out ASK COCKADAY

POPULAR RADIO maintains for the benefit of its readers a Technical Service Bureau and Laboratory, under the personal supervision of Laurence M. Cockaday which will, without charge, answer by personal letter any question, problem or request for information submitted by a subscriber. This service is, however, also available to readers, other than subscribers, at the very nominal rate of 50 cents the inquiry.

In writing please confine your questions to one general subject, writing on one side of the paper only, and enclose a self-addressed and stamped envelope.

It is possible that your individual problem has been covered in an issue of POPULAR RADIO, and so as an aid to you we endeavor to keep a supply of back numbers in stock. The condensed index below gives a few of the subjects that have appeared recently, look this list over and if the information you want is covered, we will be pleased to supply back numbers at 35c. a copy.

July, 1922
—Steinmetz on ether waves.
—How to learn the code.
—How to make a two-circuit Receiving Set.
—How high frequency currents are generated.
—Pointers for preventing interference.
—How to make a loose-coupler coil.

August, 1922
—How machines are controlled by Radio.
—How Radio circuits are coupled and tuned.
—What "call letters" mean.
—How to make a variable condenser.

September, 1922
—How to build the Armstrong Circuit Receiver.
—A resonance wave coil for reducing static.
—How to make a rotary plate condenser.
—The simplest receiving antenna.

October, 1922
—How to make a spider-web tuner.
—How to make your own grid condenser.
—Don'ts for Radio fans.
—How to use a Regenerative Set as a transmitter.
—How to restore worn-out crystals.

November, 1922
—Sir Oliver Lodge on ether waves.
—How to add a Vacuum Tube to your crystal set.
—The most popular transmitting aerial.
—How to make a novel variocoupler.

December, 1922 (Out of stock)

January, 1923 (Out of stock)
(A Reprint of Mr. Cockaday's article describing the DX Regenerative Receiver may be had for 25 cents.)

February, 1923 (Out of stock)

March, 1923 (Out of stock)

April, 1923 (Out of stock)

May, 1923 (Out of stock)
A reprint of Mr. Cockaday's original 4-Circuit Tuner will be found in POPULAR RADIO'S HANDBOOK. See page 92.

June, 1923
—How the Microphone Transmitter Works.
—How to Build a Good Single Tube Receiver.
—How to Make a Crystal Detector Stand.

July, 1923
—The ratio in size between your antenna and your coil.
—Useful facts about ear-phones.
—How to make a dry-cell tube Regenerative Set.
—How to keep up your storage battery.

August, 1923 (Out of stock)
A reprint of the Tuned Radio Frequency Receiver will be found in POPULAR RADIO'S HANDBOOK. See page 92.

September, 1923
—How to get a radio license.
—How weak signals are regenerated.
—How to make a battery charging rectifier.
—How to build the Haynes DX receiver.

October, 1923
—Practical hints for Coil Calculations.
—How to make a Two-stage Audio-frequency Amplifier.
—Ten good rules for Broadcast Listeners.
—How to make a simple Honeycomb Receiver.

November, 1923
—The 100 Best Hook-ups (Part 1).
—Receiving without Antennas.
—How to build the New Regenerative Super-heterodyne Receiver (Part 1).
—How to build a combination Short and Long-wave Receiver.

December, 1923
—How to Select your Radio Parts.
—The 100 Best Hook-Ups (Part 2).
—How to Read a Diagram (Part 1).
—How to build an efficient Crystal Receiver.
—How to Build the Super-heterodyne Receiver (Part 2).

January, 1924 (Out of Stock)
(A Reprint of Mr. Cockaday's article describing the DX Regenerative Receiver may be had for 25 cents.)

February, 1924
—How to add "Push and Pull" amplification to the 3 tube Cockaday 4-Circuit tuner.
—The original 4-Circuit Tuner as a Portable Set with Loop.
—The 100 Best Hook-ups (Part 4).
—How to build a 3-tube Reflex Receiver.

March, 1924
—Hoffman Transformer Measurement Chart.
—The 100 Best Hook-ups (Part 5).
—How to Build an Amateur Transmitter.
—A 3-tube Reflex Receiver (Part 2).

April, 1924
—How to Build a Simplified Neutrodyne Receiver.
—The 100 Best Hook-ups (Part 6a)
—How NOT to Tune the Single Circuit Receiver.
—A Novel Substitute for "B" Batteries.

May, 1924
—A Compact Radio Kit for a Spring Hike.
—How to Get the Maximum Radio-frequency Amplification.
—100 Best Hook-ups (Part 6b).
—Where Interference Comes In.
—How to Make an Audio-frequency Amplifier that Does Not Distort.

June, 1924
—How to Install a Receiver on your Boat.
—The 100 Best Hook-ups (Part 7).
—How to Build a Regenerative Receiver for Use with an Indoor Antenna.
—How to Make a Two-Slide Tuner.

July, 1924
—How to Avoid Local Interference.
—How "Resistance" Affects Radio Circuits.
—An Ideal Set for Summer-time Reception.
—100 Best Hook-ups (Part 8).
—How to Do Your Soldering Correctly.
—How to Build the POPULAR RADIO Portable.

August, 1924
—How to build a single dry-cell tube, four-circuit tuner.
—How to build a two tube reflex receiver.
—Helpful hints for the broadcast listener

September, 1924
—How to build a single dry-cell tube reflex receiver.
—How to build a multi-wave tuner.
—How to improve broadcast reception.

October, 1924
—How to Build the (Cockaday) Four Circuit Tuner with a Resistance-coupled Amplifier.
—How to Select a Ready-made Receiver.
—How to Build a Detector-amplifier.
—A Radio Set to Pack in Your Suitcase.
—Harnessing the Radio and the Movie.

November, 1924
—How to Locate Interference from Power Lines.
—Cockaday Article for Beginners.
—How to Build a Low-Loss Tuner for Short-wave Reception.
—The New Type of Superheterodyne.

December, 1924
—How to Build a Non-radiating 7-tube Superheterodyne Receiver.
—Cockaday Article for Beginners.
—How to Get the Most Out of Your Ready-made Receiver.

January, 1925
—How to Build the Cockaday 8-tube Super heterodyne Reflex Receiver.
—How to Improve Broadcast Reception.
—Cockaday Article for Beginners.

February, 1925
—How to Get on a Radio Program.
—A Loudspeaker for a Crystal Set.
—How to Build a 4-tube Reflex Receiver with the New Sodion Detector.
—Cockaday Article for Beginners.

March, 1925
—How to Build the Improved DX Regenerative Receiver.
—Factors that Govern the Capacity of Condensers.
—What "Induction" Means to Your Set.
—A Five Meter Vacuum-tube Transmitter and Receiver.

Popular Radio

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MULTIPLE CONDENSERS

(Licensed under Hogan Patent 1014002)

Insulated with PYREX
or ISOLANTITE

Of Extreme Precision

For Single Control Circuits

All Capacities

General Instrument Corporation

Manufacturers of Laboratory Equipment

423 Broome Street, New York, U. S. A.

VOLT-X
VARIABLE GRID LEAK

NEW!

A BALL-BEARING GRID LEAK THAT STAYS PUT

Screw adjustment, expansion contact and resistance unit that cannot wear or tear.

VOLT-X GRID LEAKS

are positive and smooth in action with an accurate range of from one-half to fifteen megohms. Balancing Resistances for Super-Heterodyne and other circuits 30,000—150,000 ohms.

They fit any standard leak mounting, and get the absolute maximum from your tubes. They do not wear out.

Grid Leak $1.00
Grid Leak Mounting .30

BURTON & ROGERS MFG. CO.

755 BOYLSTON ST., BOSTON, MASS.

"The Best Transformer Money Can Buy"

Karas Harmoniks bring out the vital harmonics and rich overtones of musical sounds by amplifying the very low and the very high frequencies equally with the middle tones.

Price $7.00

A pair of Karas Harmoniks in your set will give your reception a musical quality far beyond anything you ever heard from a radio set before. Try it!

KARAS ELECTRIC CO.

40-40 N. Rockwell St. Chicago

More Power — *Greater Volume*

CELERUNDUM "The Crystal With a Soul"

DE-TEX-IT

LOW LOSS—POSITIVE CONTACT

FIXED DETECTOR

Best for Reflex—Requires no adjustment—will not burn out

CELERUNDUM RADIO PRODUCTS CO.

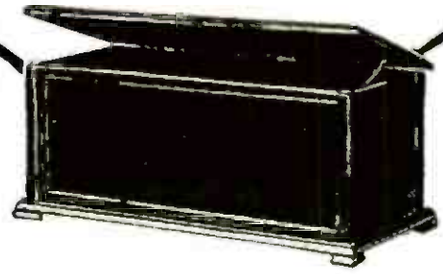
Wollaston (Boston) Mass.

Ten Reasons Why the King Quality Kit Makes an Unusually Good Receiver

1. By means of switchboard type of cable all wiring goes into the set as a unit.
2. Bus wires are cut to proper length and bent to shape.
3. Coils of liberal dimensions and wound with heavy wire, are attached to Cardwell Low Loss Condensers.
4. Tube sockets supported by scientifically designed metal brackets.
5. Neutrodon operated by micrometer screw so receiver can be properly neutralized.
6. Dials are one piece and made of Bakelite.
7. Bakelite panel is drilled, properly engraved and filled in with white.
8. Instructions are easy to follow, no technical knowledge needed.
9. All parts specially built for kit, same as used in factory built King Quality Neutrodyne Receiver.
10. It is designed by engineers who know radio.

WHEN the King Quality Kit is assembled, you not only have the joys of neutrodyne—the ability to bring in far off stations, the clear full tones, the absence of distortions—but there is also even greater joy from the thought that you built the receiver, yourself.

Ask any Radio dealer about the King Quality Neutrodyne Kit or write



KING QUALITY PRODUCTS CO., INC.

BUFFALO, N.Y. BRIDGEBURG, ONT.

KING QUALITY KQ BUFFALO

And when you have the kit assembled, you will want to put it in a cabinet worthy of its quality. We can supply that, too, in either mahogany or walnut, plain and fancy models.

Without Tubes and Batteries
$75.00

Enjoy Your

Echophone Portable *Now*— As Well As This Summer

The Echophone "3"

An exceptionally powerful 3-tube set. Uses dry batteries. Two dial tuning. Range 1800 to 2000 miles. Without tubes and batteries, **$50.00.**

The Echophone "4"

A combined radio and audio frequency 4-tube receiver of unusual selectivity. Non-radiating—clear toned, easy tuning. Without tubes and batteries, **$75.00.**

Here is a radio that gives you all the advantages of portability without the usual sacrifice in efficiency.

It uses the same receiving unit as in the Echophone cabinet type (either the "3" or the "4") and operates from a standard wire aerial which for carrying purposes winds on a spring reel fitted in the case. Convenient and ready to use wherever you are!

The Echophone Portable weighs, with batteries and built-in loud speaker, only 32 pounds. No larger than ordinary traveling bag—size 9"x 12" x 18". With the Echophone "3" receiving unit $75.00; with Echophone "4" $98.00.

Your dealer will gladly show you this set and explain its features in detail. See him today. Drop us a card now for descriptive folder.

ECHOPHONE RADIO, Inc.
1120 N. Ashland Ave., Chicago, Ill.
ECHOPHONE RADIO SHOP
Long Beach, Cal.
ECHOPHONE SALES CO.
156 2nd St., San Francisco, Cal.

ECHOPHONE

Storage Battery Results at Dry Cell Cost

The Superheterodyne Transformer

which contains a Condenser.
Adjusted and sealed at the factory.
Sold under a money back guarantee.
Descriptive literature on request.

Complete set of 4 blue prints $1.00

Victoreen Radio, Inc.
6532 Carnegie Ave. Cleveland, Ohio

BOSCH NOBATTRY

"B" Current from the electric light socket. The Bosch No-Battry is a device which enables anyone to obtain from an electric light socket perfect and ample plate voltage for radio vacuum tubes. It takes the place of all "B" batteries and is decidedly more efficient, reliable, convenient and economical.

Type BAN for AC current $49.50
Type BDN for DC current $30.00

American Bosch Magneto Corporation
Main Office and Works: **Springfield, Mass.**

RADIO TUBE EXCHANGE

We Repair All Standard Makes of Tubes, Including

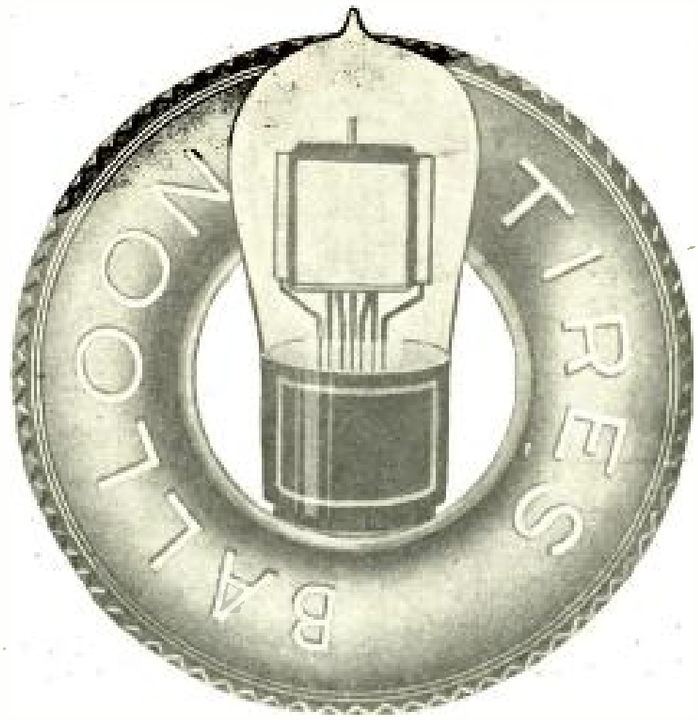
W.D. 11 or 12
U. V. 199 or C 299
U.V. 201A or C 301A
C. 11 or 12
D.V. 1 or D.V. 2
U.V. 200 or 201
C 300 or 301

$1.50

U.V. 202 Repaired, $3.00

ALL TUBES GUARANTEED TO DO THE WORK.

RADIO TUBE EXCHANGE
200 BROADWAY, NEW YORK
All Mail Orders Given Prompt Attention. Orders Sent Parcel Post C. O. D.



Balloon Tires for Your Tubes!

Delicately adjusted springs at the base of a Benjamin Cle-Ra-Tone Socket do the same for the radio tube that balloon tires do for the automobile—absorb jars and shocks.

Outside rumbling traffic, inside footsteps, mechanical and human activities amazingly vibrate floors of buildings—as finely adjusted scientific instruments have proved. This comparatively small shaking of the tube develops a very perceptible noise in the filament, and very often breaks this hair-like wire when it is cold.

Benjamin Cle-Ra-Tone Sockets "float" above their base and the tube filament escapes this ever present trembling. More sensitive experiments are thus possible, and distant, faint signals come in much clearer. Stiff bus wiring does not affect the flexibility of Cle-Ra-Tone Sockets. They are adaptable to every hook-up and especially desirable in portable sets. There are no rubber parts to deteriorate. Bakelite is used wherever possible to insure sturdiness, long life and high dielectric insulation. Contact points to tube terminals are perfect and permanent. Terminal lugs for soldering. Made in two sizes: standard base, and a base for tubes similar in terminals to the UV-199.

Spring Suspended — Shock Absorbing

Accepted by Leading Manufacturers and Radio Engineers

BENJAMIN

Benjamin Electric Mfg. Co.

247 W. 17th Street, New York
120-128 So. Sangamon St., Chicago
448 Bryant Street, San Francisco

They say~ (Continued from last month)

THEY SAY OF THE AUDIOLA "SUPER":

14 "Absolute elimination of distortion and foreign noises is attained. . . . One stage of straight audio coupled with a stage of push-pull audio gives the volume of three audio stages with the clearness and distinctness of headset reproduction."

Audiola amplifies with Thordarsons!

THEY SAY OF THE OZARKA:

15 "Ordinarily a three step amplifier is noisy but we can guarantee the OZARKA to give the greatest volume possible with a tone reproduction that is satisfactory to everyone."

Ozarka amplifies with Thordarsons!

THEY SAY OF THE MASTER:

16 "The parts used are the best. Shielded, distortionless transformers insure perfect reproduction, unusual volume and tone."

Master amplifies with Thordarsons!

THEY SAY OF THE HARTMAN:

17 "The range, selectivity, volume, clarity and freedom from noises is remarkable."

Hartman amplifies with Thordarsons!

Music Master Success

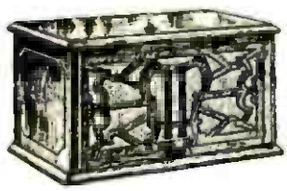
Music Master
Resonant Wood Insures Natural Tone Quality

Model VI, 14" wood bell $30

Model VII, 21" wood bell $35

Connect Music Master in place of headphones. No batteries. No adjustments.

Prices of all models slightly higher in Canada



Model VIII, Mahogany Cabinet with "full-floating" wood bell $35

Model V, Metal Cabinet, mahogany finish wood bell . . $18

—*Its True Significance*

THE advent of Music Master sounded the death knell of the mere "loud speaker", transformed the radio receiving set into a musical instrument and made possible the wonderful stellar program now the feature of nation-wide broadcasting.

Music Master does more than reproduce—it interprets, it re-creates. Imitated but never equaled, it remains the *supreme musical instrument of radio*—and there IS no substitute.

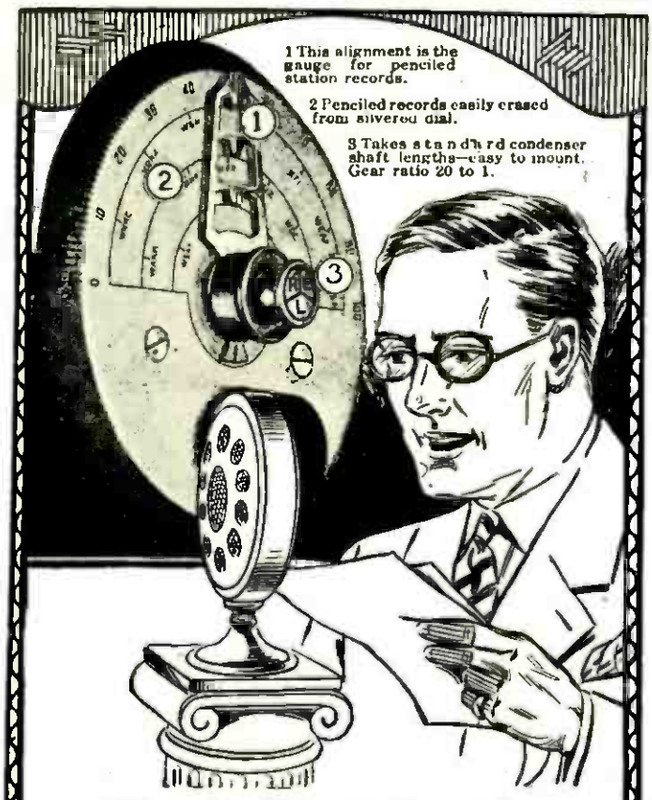
MUSIC MASTER—the Ultimate of Artistic Radio Re-Creation

Music Master's precision instrument is the acme of scientific perfection. Music Master's tone chamber of heavy cast aluminum is a marvelous mold of sound without distortion. Music Master's amplifying bell of resonant wood gives to every sound its full, vibrant qualities and natural characteristics.

Music Master's manufacturers pledge unreserved and unconditional protection to every purchaser. Back of your dealer stands the Music Master Corporation to guarantee its products *direct* to anyone, anywhere, at any time.

Music Master Corporation

Makers and Distributors of High-Grade Radio Apparatus
Tenth and Cherry Streets, Philadelphia
Chicago Pittsburgh
Canadian Factory: Kitchener, Ontario



Don't Wait for the Announcer!

Designed by R. E. Lacault, E. E., A.M.I.R.E., inventor of the famous Ultradyne circuit. This monogram seal (R. E. L.) is your assurance of Lacault design.

$2.50

Made by the Hammarlund Mfg. Co., your assurance of quality and dependability — produced solely for the Phenix Radio Corp. At your dealer; otherwise send purchase price and you will be supplied postpaid.

Once you have marked your favorite stations on the Ultra-Vernier silvered dial, all you need is your radio program.

Make your evening's selection. Forget wavelengths. Don't fumble nor guess. The Ultra-Vernier indicator points instantly to the preferred station and tunes it in with infinite precision.

Single control operates vernier for hair-splitting adjustment and governs station indicator. For unprecedented tuning ease, replace your old dials with Ultra-Verniers—today.

Write for descriptive folder.

ULTRA-VERNIER
TUNING CONTROL

PHENIX RADIO CORPORATION
7-9 BEEKMAN STREET
NEW YORK CITY

for super-fine tuning

MAJOR TUNER does the trick! Selectivity? Lots of it — so much in fact that a fraction of a point movement of the condenser dial is enough to tune out one station and bring in another.

MAJOR TUNER is the most advanced form of Low-Loss three circuit tuner. It is packed with complete picture wiring diagram and full instructions.

Your dealer will supply you! **$4**

BEL-TONE RADIO CO.
161 Jamaica Ave., Brooklyn, N. Y.

DURHAM
Grid Leaks

Used by Eagle, Howard, Thompson, Zenith and others. Fit all sets. Sold on guarantee.

50c *Metallized* Fixed Leaks 18 sizes; under ¼ meg., 75c; over ¼ meg., 50c.

Glass Sealed Variable Leaks 3 sizes fit all sets; 75c each for 1/10, 5 and 10 megs. **75c**

At dealers or postpaid

DURHAM & COMPANY, Inc.
1936 Market Street • Philadelphia, Pa.

Radio Dealers HEADQUARTERS

The House of a thousand values

Eight Big Warehouses

Write for Catalog C1003

WAKEM & McLAUGHLIN
225 E. ILLINOIS ST. — CHICAGO

All apparatus advertised in this magazine has been tested and approved by POPULAR RADIO LABORATORY

Here's a peculiar fact about radio insulation

MATERIAL that is satisfactory for general electrical use often gives poor results in radio-frequency service. Experience has shown that best results come with the use of material and apparatus designed especially for radio's peculiar demands. This is particularly true of insulating material.

Radion *is* a special material, developed to order by our engineers to meet the needs of radio. For radio-frequency insulation its characteristics are highest, as shown by authoritative laboratory tests.

The use of the most efficient insulation material is important not only for panels, but also for dials, sockets, knobs, binding post panels, rotors, stators, spaghetti tubes, etc. In all these there is a Radion product of the right type and size for your set. Radion is also used by leading set manufacturers who appreciate the superiority of "the supreme insulation."

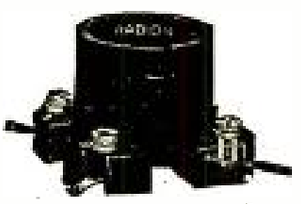
Radion Dials help to keep down losses

RADION DIALS match Radion Panels perfectly and make the ideal mounting for your set. In design, quality and high finish these Dials are exceptional. They are moulded with knob and dial plate in one piece with strong metal insert. Condensers and other radio instruments equipped with Radion dials show lower losses than those operated with dials of other materials. All standard sizes.

Surface leakage very low with Radion Panels

THE high polished, satin-like finish of Radion Panels prevents moisture from gathering to form leakage paths and cause leakage noise. Surface leakage and dielectric absorption are exceptionally low.

Radion Panels resist warping. They are easy to cut, drill and saw. They do not chip. No special tools needed. Eighteen stock sizes, two kinds, Black and Mahoganite.



Radion Sockets eliminate capacity effects

THE utmost protection against leaks and losses is provided by Sockets made of Radion—V-T Socket, Improved Type. Threaded metal bushings moulded in the socket insure positive contact between terminal points. The Radion collar with strong bayonet lock eliminates the capacity effects that occur when metal collars are used.

AMERICAN HARD RUBBER COMPANY, Dept. B-4, 11 Mercer St., New York City
Chicago Office: **Conway Building** ***Pacific Coast Agent:*** **Goodyear Rubber Co., San Francisco-Portland**

RADION

The Supreme Insulation

Made to Order for Radio Purposes Exclusively

Mail coupon for Booklet. "Building Your Own Set"

AMERICAN HARD RUBBER COMPANY
Dept. B-4, 11 Mercer St., New York City

Please send me your new booklet. "Building Your Own Set," giving wiring diagrams, front and rear views, showing a new set with slanting panel, sets with the new Radion built-in horn, lists of parts and directions for building the most popular circuits. I enclose 10 cents.

Name.....

Address.....

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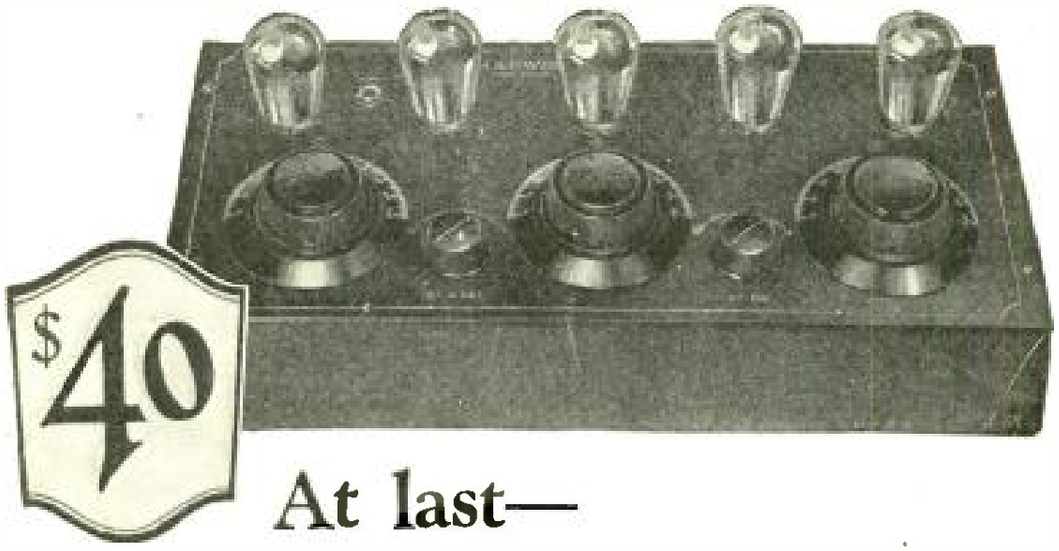
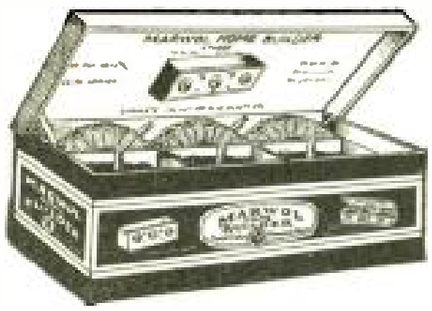
MARWOL

BABY GRAND

FIVE TUBE TUNED RADIO FREQUENCY



At last—
A guaranteed Set
Price beyond comparison



Marwol Home Builder
includes three condensers, three radio frequency coils, complete layout of front panel, sub-panels and wiring diagram.

$15.00

The remarkable success of the Marwol Circuit as incorporated in the Marwol Model A-1 is so great that it has made possible a Baby Grand Marwol. This identical famous circuit is now available in a different unique design—a great departure from the conventional model—at considerably lower cost!

The Marwol Baby Grand is a 5-Tube Tuned Radio Frequency Receiver which differs from the original Marwol only in design! Offers the same remarkable selectivity and range, with ease of operation, that makes the Marwol today's best radio buy for the money!

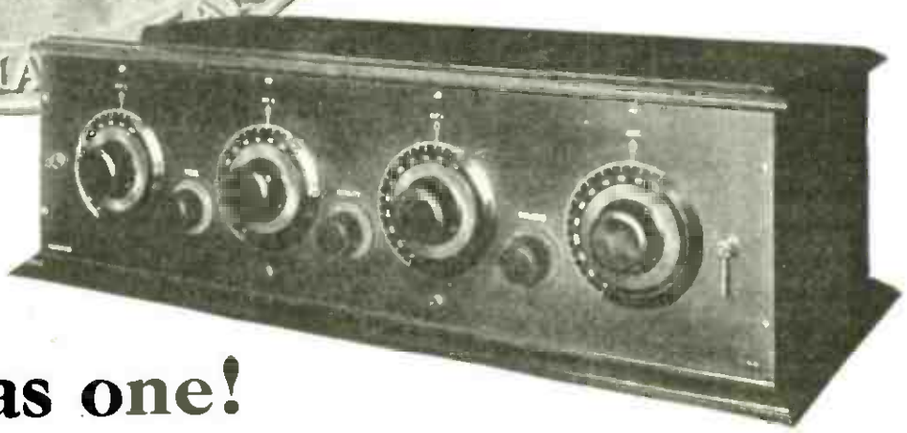
Write for descriptive folder. At your dealer's—otherwise send purchase price and you will be supplied postpaid. Price West of the Rocky Mts. $45.00.

MARWOL RADIO CORPORATION

85-E Mercer Street, New York City

DOLLAR FOR DOLLAR RADIO VALUE

Build a Telos— and hear the world!



Four Dials that Tune as one!

With the "Uni-control" lever *down*—all four dials tune together. Turn any one dial and the whole set responds.

Then, if you want ultra-fine tuning, turn the "Uni-control" lever *up*—and each dial tunes independently!

Telomonic III is the only set that combines single control simplicity of tuning, with multi-control opportunity for ultra-precise results on distance!

And Telomonic III is the only set in which three stages of tuned R. F. are made entirely practical. It is the only 6 or 7 tube set that runs entirely on dry cell tubes—with the plate current consumption of an ordinary 3 tube set.

You can't buy a Telomonic III—you must build it yourself—with the new Telos Kit. And the amazing variety this Kit offers, is fully explained in our handsomely illustrated booklet, "The KIT of a Thousand Possibilities." Use the coupon now for your copy.

DANZIGER-JONES, Inc.
25 Waverly Place **New York City**

Danziger-Jones, Inc.
25 Waverly Place, Dept. A
New York, N. Y.

Send me at once your profusely illustrated folder—"The Kit of a Thousand Possibilities"—free!

Name .....

Address .....

No. 23—Three-quarters actual size

High resistance means safety to batteries

Every radio fan knows that decreased "B" or "C" Battery voltage affects perfect reception. A reliable voltmeter is a necessary part of your equipment.

Nagel Voltmeters are built to a standard for resistance—60 ohms per volt. This means that you can test your batteries either by touch or continuous contact without fear of draining them.

Enjoy that sense of security by having a fine (but moderate priced) Nagel measuring instrument handy when you are in doubt about the strength of your batteries.

See your dealer or write

The W. G. Nagel Electric Company

Toledo, Ohio

(Makers of the well-known Nagel Automobile Ammeter.)

NAGEL

Manufacturers of

DRY CELL TESTERS · AMMETERS
HIGH-RESISTANCE VOLTMETERS
and VOLTAMMETERS · BAKELITE
HOT MOULDED INSULATIONS

PERSIL RADIO SERVICE

2114 Mapes Ave. **New York**

Cockaday's Latest!

8-Tube Superheterodyne Reflex

1	G. I. .0005 Condenser (Isolantite)	$5.50
1	G. I. .001 Condenser (Isolantite)	6.00
1	Set Haynes-Griffin Transformers	20.00
1	Precision Autodyne Coupler	3.50
1	Karas Harmonik A. F. Trans.	7.00
1	Amplex Grid-Denser .0005	1.25
1	Benjamin Cleartone Socket	1.00
7	Federal Sockets No. 16 ($1.20 each)	8.40
1	Pacent D. C. Jack; 1 Pacent S. C. Jack	1.10
2	Na-ald 4-inch Dials	1.50
1	Amsco Rheostat—2 Ohms	1.35
1	Amsco Potentiometer—400 Ohms	1.50
2	Daven Resisto-Coupler Mountings	2.50
1	Daven Grid Leak Mounting	.35
6	Daven Resistors—.5 Megohms, 5 Megohms, .005 Meg., .25 Meg.	3.50
7	N. Y. Mica Condensers: .0001 Mfd., .006 Mfd., .00025 with clips.	4.15
1	Duratran R. F. Transformer	4.00
1	Walbert "A" Battery Switch	.50
7	Eby Binding Posts	1.40
1	Sub-panel, bakelite 7" x 9", bus bar, brackets	.45

KIT OF ALL ABOVE PARTS. $74.95

(Blue Prints, Baseboard, Engraved Panel, $4.35 Extra)

5-Tube Cockaday, 4-Circuit Tuner

KIT Resistance Coupled: Parts exactly as Specified. Blue Prints. Bus Wire, etc. **$67.00**

WIRED In Genuine Mahogany Cabinet **$85.00**

In February's Popular Radio **Craig 4-Tube Reflex Kit**

PARTS as mentioned in magazine, including Blueprints, panel, bus bar, and baseboard only **$47.50**

WIRED In Genuine Walnut or Mahogany Cabinet **$74.50**

Delivered Free Anywhere. Canada, Add 5% to Order. One-third Must Accompany All Orders. Insured if you wish. Write for Illustrated Circular of Above Receivers.

The Traffic Cop of the Air

FERBEND Wave Trap

Add a **Ferbend** Wave Trap to your Radio Set and "Police" your reception. Regulate traffic. Guaranteed to tune out any interfering station. Widely imitated but never equalled. The *original* and only successful WAVE TRAP. Now in its third year. Sent Postpaid upon receipt of $8.50 or C. O. D. plus postage. *Send for Free Booklet.*

Always look for this Trade Mark. It is your protection against misleading imitations and those who infringe on the registered name "Wave Trap" and its reputation. "If it isn't a FERBEND, it isn't a WAVE TRAP."

FERBEND ELECTRIC CO.

21 E. So. Water St. **Chicago**

You will never know the thrills of radio until you own a

FRESHMAN MASTERPIECE

The Greatest Value ever Offered in a Radio Receiving Set

5 tube tuned radio frequency

embodying the 5 big features demanded in a perfect receiver.

$60

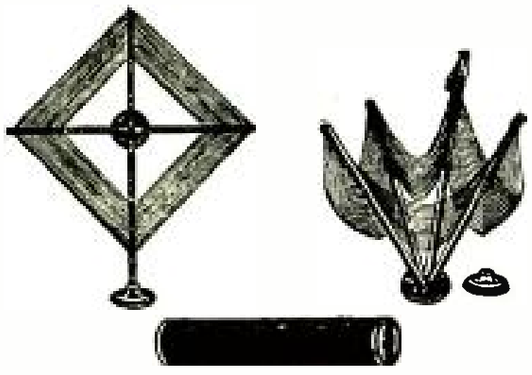
At all dealers

- ¶ Built of only the finest low loss material in a beautiful mahogany cabinet (or soft-toned leatherite);
- ¶ It brings in far distant stations,
- ¶ Night after night at the same points on the dials,
- ¶ With real loudspeaker volume,
- ¶ And full throated, true to life tone.

Be sure the serial number is riveted on the sub-panel. It is your protection and guarantee.

Chas. Freshman Co. Inc.
Radio Receivers and Parts
FRESHMAN BUILDING
240-248 WEST 40TH ST.-NEW YORK, N.Y.

SUPORTENA



PATENT APPLIED FOR

The ultimate in Folding Loop Development Inductance can now be varied at will, to suit the receiver.

An ingenious Slider on Upright Support equivalent to 16 different Taps!!

A Development especially adapted to Superheterodyne receivers.

Tunes below 100 and over 600 meters!!

Increases the efficiency of any loop set.

$9.00 **Construction Similar to the Popular PORTENA Loop, with Addition of The Slider Improvement.**

Manufactured by Radio's Master Loop Craftsmen.

J. NAZELEY CO.

571 HUDSON ST. **NEW YORK**

THIS FIVE-TUBE SET $39.50

FULLY BUILT AND WIRED COMPLETE IN DARK HEAVY MAHOGANY CABINET OF BEAUTIFUL DESIGN

Biggest 5 Tube Value on the Market

which will bring in all distant stations on the loud speaker in clear loud tones. A value of three times the price. Shipped on a guarantee of satisfaction or money back. A wonder set constructed on the new principle that requires no neutralizers and is self-balanced. Special features are low-loss coils, engraved bakelite panel, distortionless transformers and pure bakelite sockets. Wiring of the latest safety type. Perfect logging of stations. The set alone, shipped prepaid, is $39.50

This Set with All Accessories, Including American Bell Loud Speaker, with

adjustable unit, 5 R. C. A. UV201-A Tubes, 2 45-volt "B" batteries, 1 6-volt 90 amp. hour storage battery, complete antenna equipment, including approved lightning arrester, shipped prepaid, east of the Rocky Mountains $81.30

Send for Bargain Catalog of Everything in Radio

RANDOLPH RADIO CORP.

159 N. UNION AVE., Dept. 443, CHICAGO, Ill.

GILFILLAN NEUTRODYNE SETS — KITS — PARTS

Made in our three Radio factories with years of Radio experience behind them.

Send for Literature

GILFILLAN BROS. INC.

1815 W. 16th St., Los Angeles, Calif.

KANSAS CITY 2525 W. Penn Way

NEW YORK 225 W. 57th St.

NEUTRODYNE

SILVER SUPERS

COAST TO COAST

Reception with Speaker Volume on a loop.

SILVER SUPERS—the 7-Tube Wonder Sets surpass them all. One builder in New York worked KGO with an 18" Loop every night for two weeks—Chicago sets cut through the locals regularly to the West Coast on small loops. You can build a Silver Super that will get the same results. It's easy—you need only three tools.

ALL PARTS. $72.85

Send 50c for Blueprints and complete building instructions.

Silver-Marshall, Inc.

110 S. Wabash Ave.. Dept. A.. CHICAGO

DID you ever look the tube question square in the face? Ever stop to realize that the vacuum tube will make or break your receiving set as far as good results are concerned?

Give your set a fair chance to bring in the distant programs. Resolve now that a good set deserves good tubes and decide on MAGNATRONS. The results will pleasantly surprise you.

MAGNATRONS know no superiors. And yet the MAGNATRON DC-201A, the MAGNATRON DC-199 and the MAGNATRON DC-199 with the large base sell for only $3 each, at your dealer's.

CONNEWEY ELEC. LABS.

MANUFACTURERS New York City

MAGNATRONS

BLUEPRINTS FREE

Any set of famous Popular Radio Simplified Blueprints described on page 94 will be sent you absolutely free.

You know how helpful, interesting and practical POPULAR RADIO is. You fully appreciate that at $3.00 a year it is a real bargain. Consequently you should find it easy to convince one, two or more of your friends, who are not now subscribers, of the unusual value when any one of these six sets of Simplified Blueprints (described on page 94) is offered free with their twelve months' subscription for POPULAR RADIO at the regular price of $3.00.

In addition to the Blueprints given to your friends we will allow you one set free for each *new* subscription you send us with a $3.00 remittance. Five *new* subscriptions and remittance of $15.00 would entitle you to five sets free.

Only one set of Blueprints free with a renewal subscription whether your own or a friend's.

POPULAR RADIO, INC., Dept. 43,
627 West 43d Street, New York City

Enclosed is my remittance of $ covering annual subscriptions for POPULAR RADIO (names on sheet attached). Send me set(s) checked below.

- ☐ Set No. 2
- ☐ Set No. 3
- ☐ Set No. 4
- ☐ Set No. 6
- ☐ Set No. 7
- ☐ Set No. 8

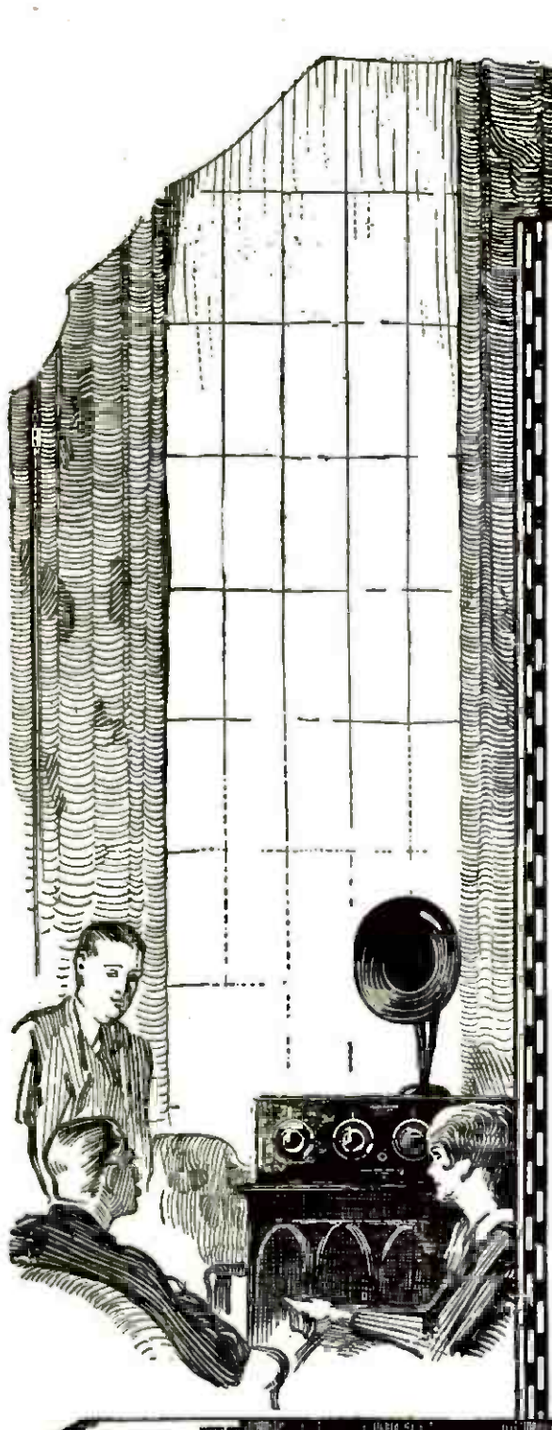
(See page 94 for description of Sets)

Name .....

Address .....

.....

Foreign postage 50c. extra. No extra for Canada.



Compare the Value!

COMPARE the MARV-O-DYNE point for point with any other receiving set. Consider the performance and the appearance and the units—consider those things and you'll wonder how such a set can be sold for only $98.

What other receiving sets costing $150 or more uses Haig and Haig Straitline condensers? MARV-O-DYNE does because they reduce losses and facilitate station finding. What other receiver incorporates a genuine Weston meter which has a special provision for measuring "B" battery voltage? MARV-O-DYNE has chosen this recognized standard as part of its Fil-a-meter.

And speaking of the Fil-a-meter—that in itself is an exclusive MARV-O-DYNE feature. The Fil-a-meter alone should make you choose the MARV-O-DYNE. What this device saves in tube and battery costs by keeping the tubes at the proper operating point is obvious.

MARV-O-DYNE has so many outstanding points of superiority that you owe it to yourself to go to the nearest dealer to inspect it.

$98

Write us for literature.

AMBER MANUFACTURING CORP.
115 W. Broadway, N. Y. City

The Amber MARV-O-DYNE

The set with the Fil-a-meter!

Don't take chances!

LOCK *your set!*

A BATTERY SWITCH *Plus!*

1. *Easily installed*—One hole mounting.
2. *Compact* — Requires less room behind panel than any other switch.
3. *Noiseless* — Positive wiping contact; can't wear out.
4. *Shockproof*—Shell mounting and key-handle insulated.
5. *Sturdy, simple*—Can't get out of order.

HERE'S a remarkable battery switch! Not only does it give sturdy, silent and efficient filament control—it *locks* your set, too!

There's no chance for anyone meddling with your set—*running down your batteries or burning out your tubes*—when the key to the Walbert LOCK-SWITCH is in your pocket. *Your set is locked and off!*

Play safe! Put a Walbert LOCK-SWITCH, (the *original* locking battery switch) on your set tonite. It costs no more than a plain battery switch! At your dealer or sent postpaid on receipt of purchase price.

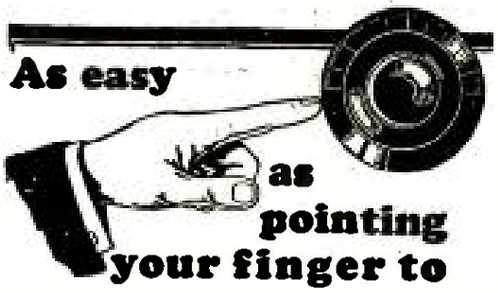
Walbert LOCK-SWITCH Silver plated	50c
Gold plated	65c
Extra key with key ring attachment	20c

Jobbers and Dealers: Write for discounts.

Walbert Manufacturing Co.
933 WRIGHTWOOD AVE.
CHICAGO, U. S. A.

WALBERT LOCK SWITCH

As easy



as pointing your finger to get the station you want on the

LIBERTY Sealed Five

Manufactured by

LIBERTY TRANSFORMER CO., INC.
555 N. Parkside Ave. CHICAGO, ILL.

JOS. W. JONES RADIO TRADE MARK

4 Tubes

Volume Distance **$65** **Two Dial Tuning**

Non-Oscillating Selectivity Purity of Tone

The J-65

The J-65 constructed entirely of Jos. W. Jones precision parts and built to last.

Write for literature descriptive of Jos. W. Jones receiving sets and precision parts.

Jos. W. Jones Radio Mfg. Co., Inc.
40-46 West 25th Street New York City
Branch Offices: Philadelphia—Boston—Chicago

KORACH

Tuned Loop

Tuning Feature
Directional
Can Be Logged
Collapsible

Patent Applied For

APPROVED!

Recommended and used on the famous COCKADAY 8-Tube SUPERHETERODYNE REFLEX

Laurence M. Cockaday, in the January issue of POPULAR RADIO, recommends the famous KORACH TUNED LOOP on his "Cockaday 8-Tube Superheterodyne Reflex." Mr. Cockaday and his associates are loud in their praises of this marvelous instrument. You too, will find it far superior to anything yet offered. Operates successfully on all sets designed for loop reception.

Brings in London, Paris, Madrid During Transcontinental Tests

The Editorial on page four of Feb. POPULAR RADIO tells how Cockaday, using the Korach Loop, logged the following Foreign Stations: 2BD, Aderdeen, Scotland; 5NO, Newcastle, Eng.; 2PY, Plymouth, Eng.; ESP, Paris, France; 2LO, London, Eng.; PTT, Madrid, Spain; WKA2, Porto Rico and CYC, Mexico City.

Positively the last word in loop construction. Exclusive features give you selectivity and distance unheard of before with loop aerials. If your dealer cannot supply you, order direct from us. Price $16.50. Send $2.00 as good faith deposit with your order, balance C.O.D. Parcel Post. Satisfaction guaranteed.

KORACH RADIO COMPANY
309 So. LaSalle St. Dept. 10 Chicago, Ill.
Full Particulars on Request
Dealers and *Jobbers*: Write at once for attractive discounts.

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each in any value from ¼ to 10

FRESHMAN SUPERIOR
You can depend upon them to remain accurate at all times

Made of high resistance material impregnated throughout (not coated paper). Unaffected by climatic conditions. Will not deteriorate. Clamped between solid knurled ferrules assuring rigid construction and firm contact at all times.
At your dealer's, otherwise send purchase price and you will be supplied postpaid.

Chas. Freshman Co., Inc., 240-248 W. 40 St., N. Y.

The Carborundum Crystal Detector

$1.50

From your dealer or post-paid direct

MONTHS of exhaustive research brings this remarkable Carborundum Crystal Detector Unit to the radio world. A specially made, carefully selected Carborundum Crystal, set in a protective cartridge.

Permanently fixed to retain its sensitivity indefinitely—it will not burn out.

Sharpens the tuning—increases the selectivity of any crystal or reflex set—and no booster battery is needed.

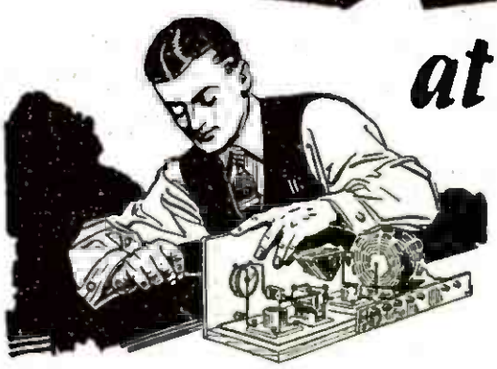
It gives results never before attained by any other crystal detector.

Every Carborundum Crystal Detector Unit is laboratory tested and is guaranteed for any properly designed circuit.

Manufactured only by
THE CARBORUNDUM COMPANY
NIAGARA FALLS, N.Y.

WANTED

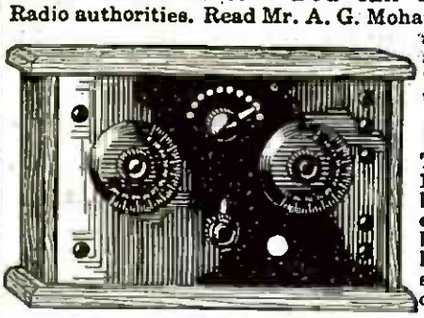
at $3,000 to $10,000 a year



Yes—$3,000 to $10,000 a year! These are the opportunities that exist everywhere today for big easy money in Radio. Radio is the fastest growing industry in the world. If you are in a routine job with poor pay and no future, here's the chance of a lifetime. Investigate! Look into the amazing money-making possibilities of Radio. In a few short months of training at home by mail, we can make you an expert representative of our Association. Learn to install, repair, build and sell high-grade radio sets. Become the Radio expert of your neighborhood. Find out how the Radio Association of America now makes all this easy for you. Radio offers not only big-salary jobs, but is a business you can easily get into for yourself.

Become a Radio Expert

Train at Home in Three Months Get your share of the big money being made in Radio. Mail the coupon for free information. Find out how in your spare time at home, without giving up your present position or losing a dollar of pay, you can become a Radio Expert in a few short months. No previous experience is necessary. For the man who prefers a salary, big-pay jobs are waiting with the U. S. Government, Steamships, Railroads, and thousands of corporations and business houses. For the man who wants to get into business for himself and be independent, Radio offers unlimited possibilities—either on a spare or full time basis. In no other line can ambitious men find the opportunities that Radio now offers. You can train under one of America's leading Radio authorities. Read Mr. A. G. Mohaupt's offer to train you personally in everything about Radio—construction, installation, repairing and selling. By enrolling with us now you get the benefit of the direct personal guidance of this well-known expert.



A. G. MOHAUPT, B. A., M. S.

Head of the Radio Association of America, Graduate Electrical Engineer, University of Wisconsin. Former Radio Instructor for U. S. Government. Author of "Practice and Theory of Modern Radio."

"I give my personal attention to every student taking my course. Your individual problems and questions are answered by myself. I work with you at every stage of the course, guiding you, directing you to your goal to be a Radio Engineer in the big-pay class. My course prepares you to successfully pass Gov't examination for Operator's License."

FREE—1000 MILE RADIO OUTFIT

This set when completed has a range of over 1000 miles. Right now we give it free to each member taking our course of training. Mr. Mohaupt's clear, simple instructions will show you how to build similar sets to sell at a big profit. When you have finished the course, you can sell this free set at a price that will practically pay the cost of your training.

Get The Facts—Mail Coupon

Radio knowledge is not only interesting and the means to the greatest form of entertainment the world has ever known, but is the most cashable knowledge a man can possess. Let us prove to you that there is nothing difficult about Radio—that any intelligent person can easily learn it right at home by mail under our simplified and approved methods. Mail the coupon now for all the facts. Let us prove that Radio is easier to learn and offers bigger money than any other business or profession you can get into. Don't wait—act while our Free Offer of a 1000 mile radio outfit is still in effect.

A. G. MOHAUPT, Radio Engineer
RADIO ASSOCIATION OF AMERICA
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Dept. 54 Chicago, Ill.

Please send me details regarding your Expert Home Training Plan and offer to representatives, also your offer of a 1000 mile Radio Set FREE.

Name.....

Address.....

City.....State.....

HERE'S A CHANCE FOR THE BOY TO BUILD A SET

FREE PARTS *for* COCKADAY RECEIVERS

Introduce POPULAR RADIO To Some Radio Friends and You Can Have the Parts You Want

IF you want to build your own set, here is your opportunity to secure FREE all the parts you need for any one of these three popular Cockaday Receivers. Call on all your radio friends, and on anyone who has a set and tell them of the many special features of POPULAR RADIO.

These liberal offers will make it possible for you to secure an order from every one you call upon. For each subscription with remittance you send us you will receive credits as per the following scale:

POPULAR RADIO

4 Months	for	$1.00	counts	16	credits
6 "	"	1.50	"	25	"
8 "	"	2.00	"	33	"
12 "	"	3.00	"	50	"
24 "	"	5.00	"	75	"

Send us the full amount collected with names and addresses of subscribers and tell us the parts your credits entitle you to and we will send them to you. If the subscriptions you secure do not give you enough credits for the parts you want, we will allow you to purchase credits at the rate of .03 cents each. *Example:* With (5) five 1-year subscriptions (250 credits) and 60 cents additional in cash you may have a set of Approved Cockaday Coils and a .0005 mfd. Amplex Grid-denser for which you need 270 credits.

If the parts you want are not listed on this page, we are prepared to supply them. Let us know what you want and we will tell you how many credits you will need.

On page 94 are described POPULAR RADIO'S Simplified Blueprints. You can have any set of prints you want for only 44 credits. You may also secure a copy of "How to Build Your Radio Receiver" described on page 88 for 60 credits.

Start today to earn your own set.

CREDITS Needed for Parts Required for the Cockaday 8-Tube Superheterodyne Reflex

(Described and illustrated in POPULAR RADIO for January, 1925)

Quantity	Item	Credits
1	"General Instrument" lowloss condenser (Isolantite insulation .0005 mfd)	220
1	"General Instrument" lowloss condenser (Isolantite insulation .001 mfd.)	240
1	"Haynes-Griffin" input transformer (new type)	
3	"Haynes-Griffin" intermediate transformers (new type)	800
1	"Precision" autodyne coupler	140
1	"Karas Harmonik" audio-frequency transformer	280
1	"Amplex" grid-denser .0005 mfd.	50
1	"Benjamin" Cle-ra-tone socket	40
7	"Federal" sockets No. 16 @ 48	336
1	"Pacent" double-circuit jack	24
1	"Pacent" single-circuit jack	20
2	"Na-ald" 4-inch dials No. 3043 @ 30	60
1	"Amsco" rheostat, 2 ohms	54
1	"Amsco" rheostat 400 ohms	60
2	"Daven" resisto-coupler mountings @ 50	100
1	"Daven" grid-leak mounting	14
2	"Daven" resistors .5 megohms @ 20	40
1	"Daven" resistor .5 megohms	20
1	"Daven" resistor .005 megohms	40
2	"Daven" resistors .25 megohms @20	40
2	"New York" mica fixed condensers .0001 mfd. @ 14	28
4	"New York" mica fixed condensers .006 mfd. @ 30	120
1	"New York" mica fixed condenser .00025 mfd., with grid leak mounting	18
1	"Duratran" radio-frequency transformer	160
1	"Walbert" "A" Battery switch	20
7	"Eby" binding posts @ 8	56
1	Composition panel 7 x 24 ins.	120
1	"Korach" tuned loop	660
	Total	3,760

CREDITS Needed for Parts Required for the Cockaday Improved DX Receiver

(Described and illustrated in POPULAR RADIO for March, 1925)

Quantity	Item	Credits
1	Primary, Secondary and tickler coils of the New York Coil Co. (DX Coupler)	200
2	Kurz-Kasch 4-inch dials @ 40	80
1	Rathbun variable condenser .0005 mfd.	180
2	Dubilier mica fixed condensers Type No. 640, .00025 mfd. @ 18	36
1	Dubilier mica fixed condenser Type No. 640, .005 mfd.	28
2	Dubilier mica fixed condensers Type No. 640, .02 mfd. @ 80	160
1	General radio type 285 amplifying transformer	280
2	Bradleyohms No. 25 @ 80	160
1	Cico double-circuit jack	16
1	Cico single-circuit jack	15
1	Cico filament battery switch	26
1	Composition panel 7 by 24 inches	120
1	Amperite No. 1A automatic filament current adjuster	44
1	General instrument filament rheostat (6 ohms) equipped with knob and dial	90
1	General instrument, filament rheostat (20 ohms) equipped with knob and dial	90
1	Fil-Ko-Leak	80
1	Benjamin Cle-ra-tone socket	40
3	Walbert sockets @ 20	60
2	Daven mountings No. 50 @ 14	28
1	Durham metallized filament grid-leak .5 meg.	20
1	Durham metallized filament grid-leak .25 meg.	20
	Total	1,773

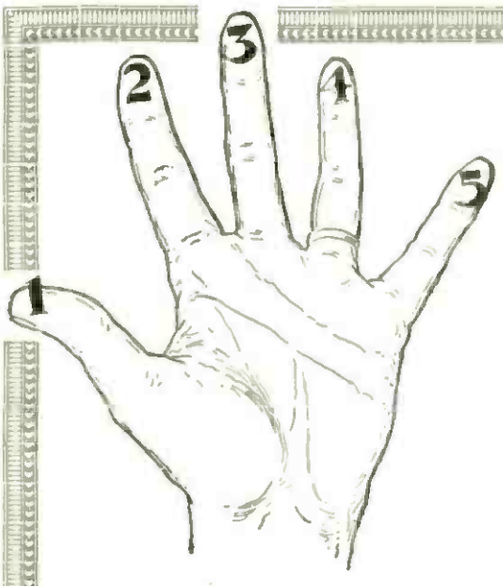
CREDITS Needed for Parts Required for the NEW Cockaday 4-Circuit Tuner with Resistance-Coupled Amplifier

(Described and illustrated in POPULAR RADIO for October, 1924)

Quantity	Item	Credits
1 set	"Precision" Cockaday Coils	220
1	"Cardwell" variable condenser (.0005 mfd.)	200
1	"Cardwell" variable condenser (.00035 mfd.)	190
2	"Accuratune" micrometer control dials @140	280
1	"New York" mica fixed condenser (.00025 mfd.)	14
9	"New York" mica fixed condensers (.005 mfd.) @ 24	216
1	"Amplex" grid-denser	50
1	"Bradleyleak"	74
3	"Bradleyohms" No. 25	240
5	"Benjamin" Cle-ra-tone sockets for UV201A tubes	200
1	"Amsco Dubl-Wundr" combination potentiometer-rheostat	80
1	"Amsco" switch lever	12
4	"Amperites" No. 1-A, with mountings	176
3	"Improved" double-circuit jacks	120
1	"Improved" single-circuit jack	28
1	"Improved" filament battery switch	40
1	"Precise" audio-frequency transformer No. 285-A	200
3	"Electrad" Certified grid leaks, ½ megohm @20	60
3	"Electrad" Certified grid leak mountings @14	42
7	Switch points @1	6
2	Stops @1	2
1	Composition panel 7" x 24" x 3/16"	120
8	"Rajah" snap terminals @8	64
		2,684

Popular Radio
Department 41
627 West 43rd Street New York City

All apparatus advertised in this magazine has been tested and approved by POPULAR RADIO LABORATORY



FIVE POINTS OF RADIO QUALITY

All Developed to the Utmost Degree

in Air-Way

Receiving Sets

TONE, SELECTIVITY, DISTANCE, VOLUME and APPEARANCE

are the five fundamental requirements of radio receiving sets to meet the demands of the buying public, and render satisfactory profits to the dealer.

AIR-WAY receiving sets are designed to and do meet these requirements to the satisfaction of the most discriminating buyer.

Their appearance attracts the buyer's attention and their performance meets his approval. Consequently they are satisfactory and profitable to the dealer, because they sell easily and stay sold, without the necessity of continuous service to keep them in satisfactory operation.

Model 51

PRICE $125.00

Model 51 is a five-tube tuned radio frequency set embodying the latest developments in this type of receiver, and includes such strictly up-to-date elements as Spider-web coils, Low-loss condensers, etc.

It is the ideal set for the D-X fan who wants to pick up stations all over North America, but still demands reception with pleasant audibility and clarity of tone.

Mounted in a five-ply walnut cabinet of attractive design and handsome finish. **PRICE, $125.00.**

AIR-WAY Model 41

A four-tube set with one stage of tuned radio frequency, detector and two stages of audio frequency amplification that meets all the requirements of the buyer of modest means.

We offer this set for the consideration of the dealer and buyer as absolutely the best radio value now on the market; in which is combined coast-to-coast reception, perfect tone qualities, and the utmost simplicity of tuning in connection with the required degree of selectivity.

Price $65.00

We invite correspondence from every established radio dealer, regardless of the lines he may now be handling, and have a most attractive proposition to offer. Write for it today.

AIR-WAY ELECTRIC APPLIANCE CORPORATION

TOLEDO **OHIO**

Worth $1,000 to Us!

It's worth that much to us—a name for a new Auxiliary Unit recently perfected by our engineers.

$1000 for a Name

26 Prizes for the 26 Best Names Suggested

You can win one of these prizes. Just tell us what you would call this new Auxiliary Unit—a simple, yet forceful name.

Prizes Are as Follows:

For the best name: $100 in cash and one $35.00 Auxiliary Unit.

For the 25 next best names: One $35.00 Auxiliary Unit for each name suggested.

Should two or more persons submit the name selected as best, second best, etc., each will be awarded the prize for which they are tied.

Rules of Contest

Contest is open to everybody. You do not have to own a radio set or buy an Auxiliary Unit. Send in as many names as you choose. Each name may win a prize.

Contest opens March 20, 1925, and closes promptly at midnight April 30, 1925. Announcement of prize awards will be made immediately thereafter.

Send all names to contest department, WALBERT MANUFACTURING COMPANY, 933 Wrightwood Avenue, Chicago.

WALBERT made it first!

FIRST, read carefully these facts. They state briefly and accurately what this auxiliary unit has done—what we *positively* guarantee the auxiliary unit *will* do when hooked-up with your set or any set:—

1. Increase the selectivity of your set as *you* would have it.
2. Give you absolute control over local interference.
3. Give your set the clarity and tonal qualities of a *perfect* musical instrument.
4. Give you amazing power—power to pierce greater distances with more volume.
5. Positively eliminates all radiation.
6. Will make your set better, no matter how good it now is.
7. Anybody can connect this unit in a few minutes. Furthermore this auxiliary unit:—
8. Will *not* alter the dial readings of your set.
9. Will *not* make your set unstable no matter how many stages of AF or RF amplification it already has.

These are facts. We unreservedly guarantee their accuracy. More than that, we will gladly demonstrate them to you *at our expense*. With your permission we will send this unit to you for a 7 days' test with your set. It must convince you by performance. It must do *all* we have said. It must fulfill your expectations or you may return the unit, and we will promptly refund your money.

Now—with Spring coming—is the time to make this test. This auxiliary unit works perfectly summer or winter. Send in the test application blank today.

WALBERT

MANUFACTURING CO.

933 Wrightwood Avenue
CHICAGO, ILL.

TEST APPLICATION

WALBERT MANUFACTURING COMPANY
933 Wrightwood Ave., Chicago, Ill.

GENTLEMEN: Enclosed please find check for $35.00. Send me the auxiliary unit for a 7 days' performance test. Should the auxiliary unit fail to meet with my expectations I will return it to you at *your* expense and you will immediately refund my money. *If I am a prize winner, you will refund my money.*

Name.....

Address.....

City.....State.....

Selectivity?

—Use Allen-Bradley Parts

The experienced radio fan has learned the value of guaranteed parts in his set. He knows that Allen-Bradley Radio Devices, such as the Bradleystat, Bradleyleak, Bradleyohm, Bradleydenser, etc., provide noiseless control. He incorporates them into his set for maximum selectivity, and he is not disappointed. The stepless, noiseless adjustment eliminates the harsh noises prduced by inferior devices. Any Allen-Bradley dealer will gladly show you why Allen-Bradley Radio Devices increase selectivity. Stop in, today.

An Exceptional Condenser

Like all Allen-Bradley Radio Devices, the Bradleydenser offers high efficiency and sharp tuning. Brass plates, soldered at all joints, and a new type of bearing insure low resistance and low losses. It is pronounced "a fine job" by radio engineers. If you want to see "an exceptional condenser," ask the Allen-Bradley dealer.

Allen-Bradley Co.
Electric Controlling Apparatus
276 GREENFIELD AVE. MILWAUKEE, WIS.

The Bradleystat, Bradleyleak, Bradleyswitch, Bradleyohm, and Bradleyometer are sold by all leading radio dealers and jobbers. They are known the world over for compactness, "one hole" mounting, and marvelous control. The superior finish will delight you.

MAIL THE COUPON

ALLEN-BRADLEY CO.,
276 Greenfield Ave., Milwaukee, Wis.
Please send me your descriptive literature on the Allen-Bradley line.
Name .....
Address .....
.....

THE NEW CROSLEY 51-SPECIAL

$23.50

Of Course the Famous Crosley 51 Regular at **$18.50** *Will be Continued*

Here is the popular Crosley 51 dressed up in new clothes. It is known as the Crosley 51-Special. This two-tube, genuine Armstrong regenerative receiver is exactly the same as the nationally known Crosley 51, except it is installed in a larger cabinet in which there is room for dry cell batteries. Also there is a slanting panel, a feature that adds to the appearance of the set and makes operation more comfortable. This radio is as artistic as it is efficient, appealing to the housewife who demands beautiful appearance and elimination of visible batteries. All Crosley radios are licensed under Armstrong Regenerative U. S. Pat. 1,113,149. Other models priced from one-tube 50, at $14.50 to the Trirdyn Special with sloping panel, at $65. For sale by good dealers everywhere. Write for catalog. Prices quoted are without accessories.

Prices West of Rockies—add 10%

THE CROSLEY RADIO CORPORATION

Powel Crosley, Jr., President

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Crosley Owns and Operates Broadcasting Station WLW

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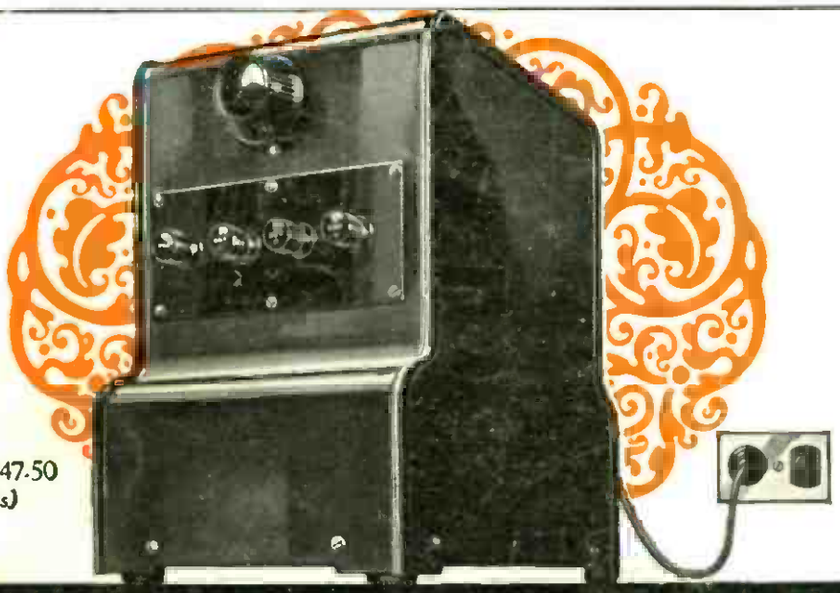

A. C. Type 800—$47.50
(60 cycles—110 volts)

Super-Ducon

For better reception *everywhere-and always!*

Right in your electric light wires lies all the current you need to keep your radio set at the peak of efficiency.

A Super-Ducon, plugged in, delivers a steady current of just the right voltage—always constant—always silent.

It takes the place of "B" batteries. Less trouble—lower upkeep—and better radio reception *always*—with a Dubilier Super-Ducon.

Tested and listed by the National Board of Fire Underwriters

Dubilier

CONDENSER AND RADIO CORPORATION