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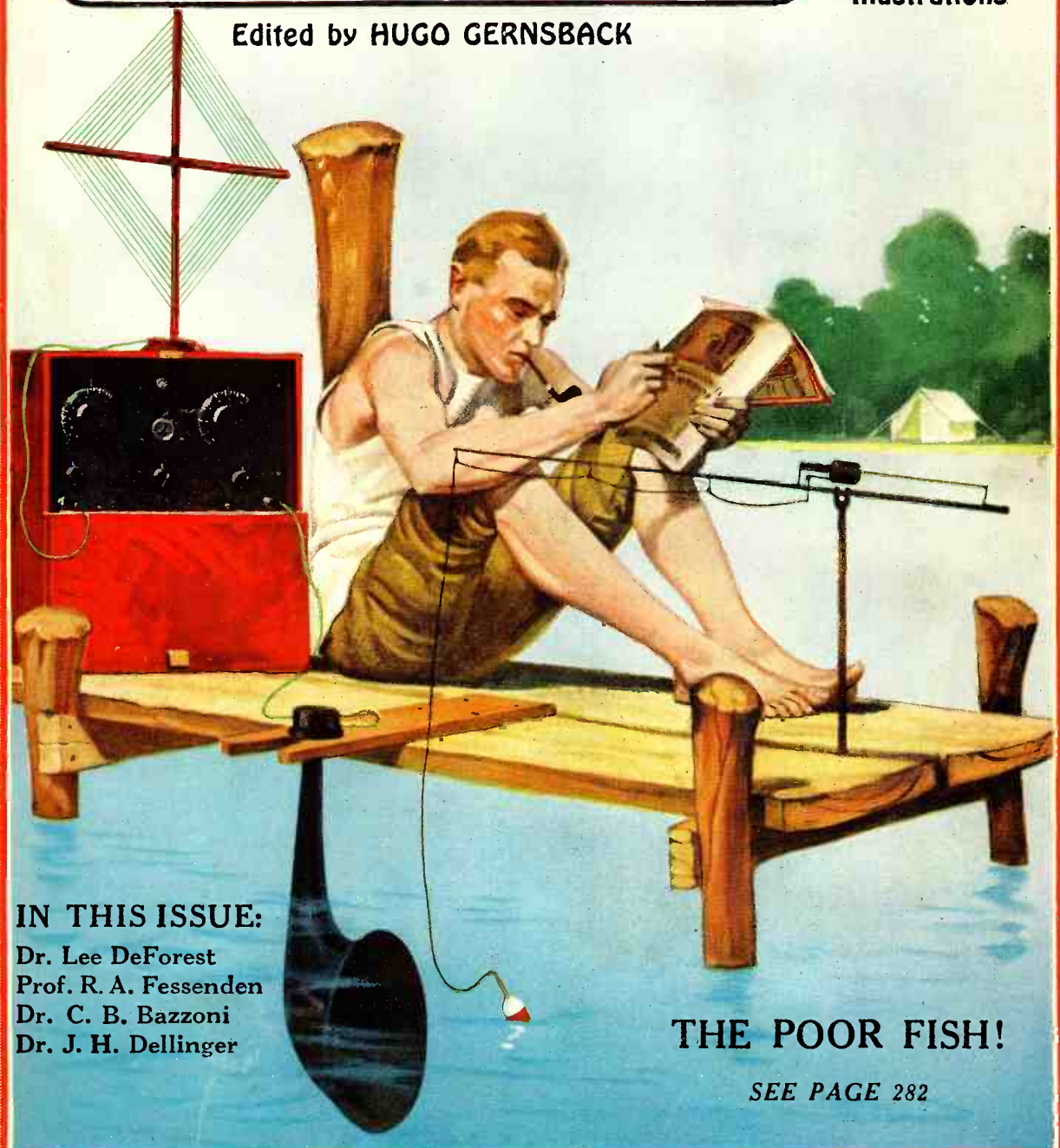
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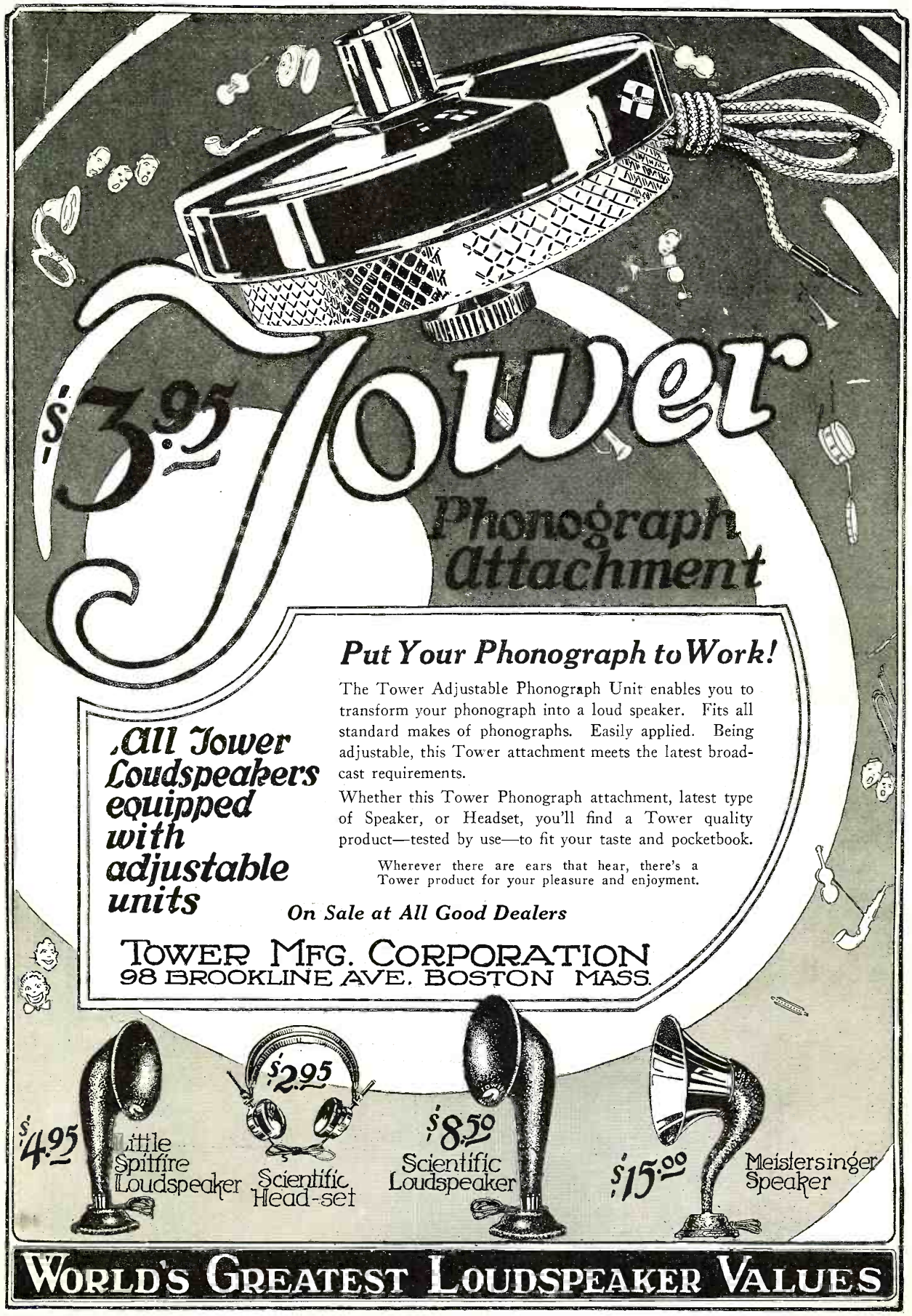
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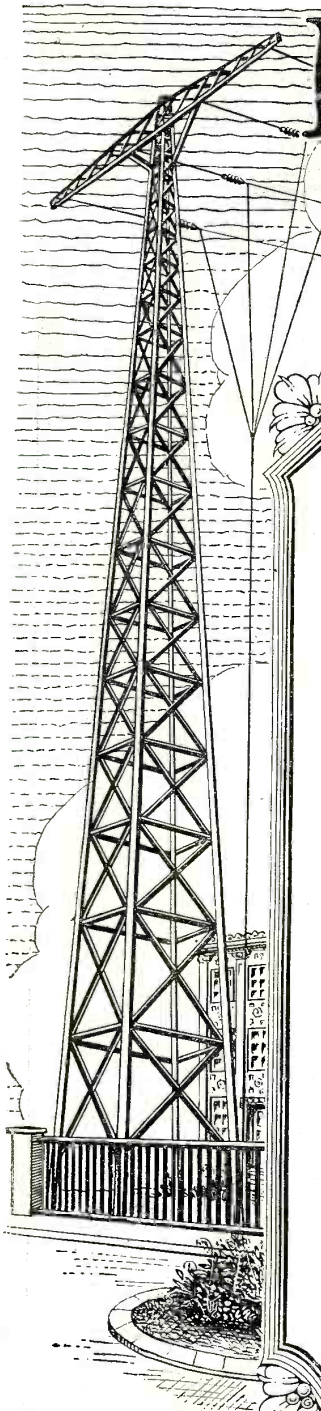
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VOLUME 7 NUMBER 3

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* * *

A discussion of the applications of the photo-electric cell by General Ferrie, Chief of the Communications Division of the French Army.

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Complete details on the construction of a double-range radio frequency amplifier, by the Director of RADIO NEWS LABORATORIES.

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Description of a 30-microfarad condenser, for use in filter circuits, which can be made at home for less than fifty cents and which can be easily held in the hand.

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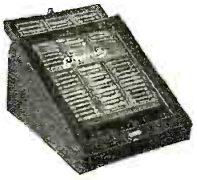
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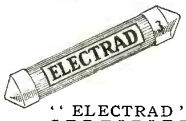
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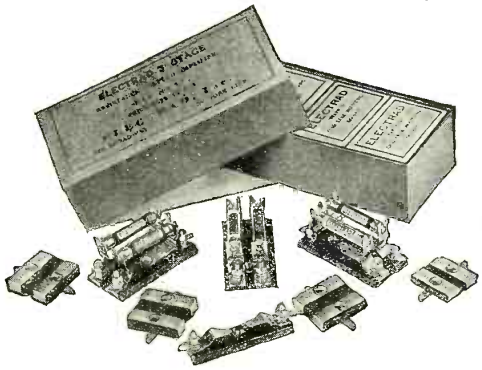
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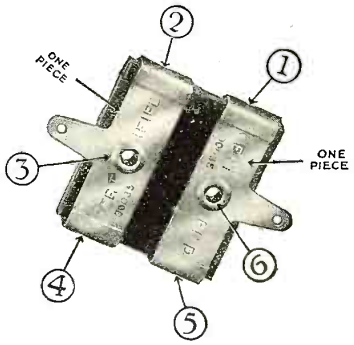


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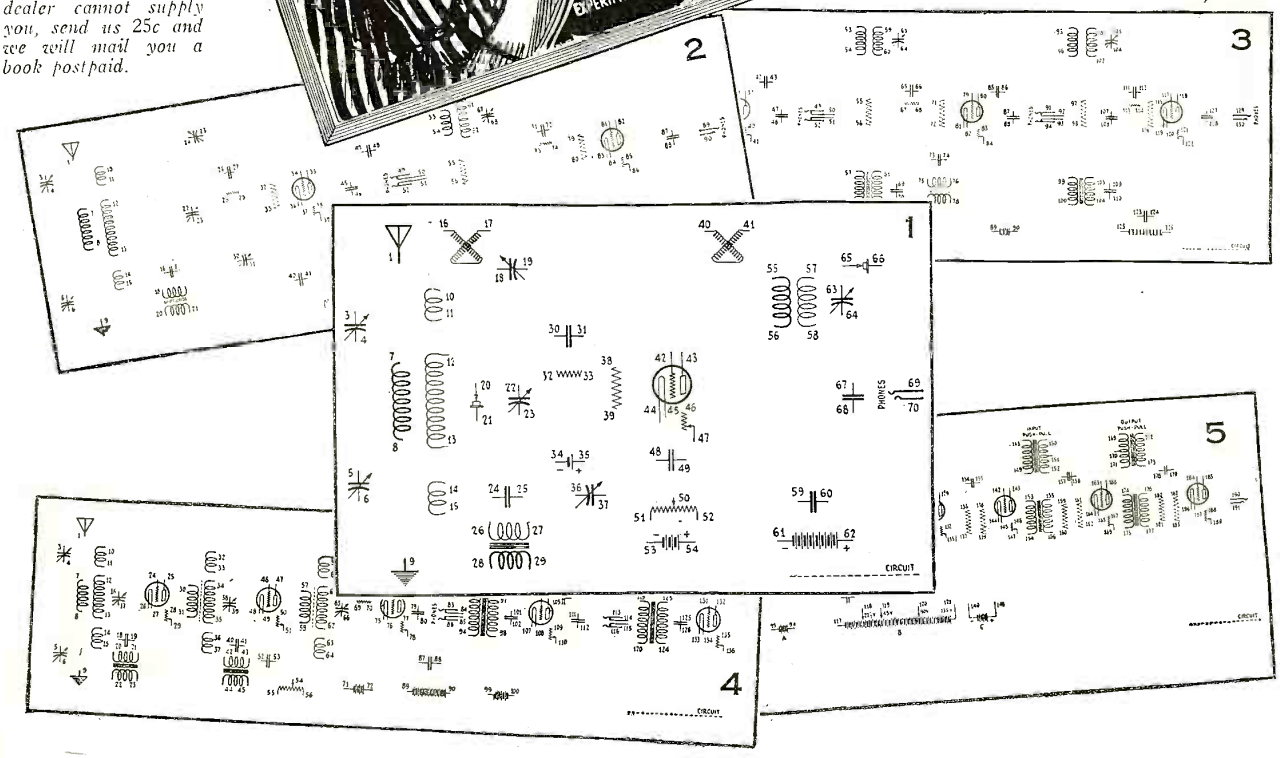
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Radio, with all its romance, knows no more magic name than Crosley.

From the time that Powel Crosley, Jr., first enabled millions to build their own sets by offering parts at a fraction of existing prices—down to the present day, radio's progress and Crosley achievements have gone hand in hand. Now Crosley announces not only vital improvements in radio performance—but in the Crosley "PUP" offers this finer performance at the lowest price in radio history.

This compact, efficient, receiver is an improvement of the famous Crosley one tube set, with which Leonard Weeks, of Minot, N. D., heard the MacMillan Polar expedition while the rest of America listened in vain.

The employment of the double circuit not only reduces radiation to a minimum, but radically improves selectivity. It can be tuned through local stations more readily. Under average conditions, its radius, with head phones, is 1500 miles or more.

You can use the "PUP" to check the performance of your larger set; to entertain that youngster whose curious fingers cannot resist the lure of dials and switches; to install in the maid's room, or even your office—for the air is full each day. You can take it on canoe trips, picnics, outings, and on your business journeys—for it's only half the size of a shoe box.

Engineered and built to the strictest standards of Crosley quality, this genuine long distance set can be offered at the phenomenal price of $9.75 only because of its simplicity and Crosley's tremendous manufacturing facilities.

It is not offered as superior to the higher priced sets. There *is* a difference in volume of sound—but *no* difference in receptivity, selectivity, tonal qualities—or the enjoyment it offers.

Make a point of seeing this newest achievement of Powel Crosley, Jr., at the nearest Crosley dealer's store.

ADD 10% TO ALL PRICES WEST OF ROCKY MOUNTAINS

Crosley manufactures receiving sets which are licensed under Armstrong U. S. patent No. 1,113,149 and priced from $9.75 to $60 without accessories.

CROSLEY

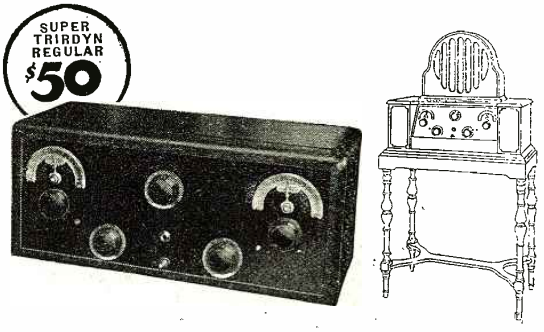
THE CROSLEY RADIO CORPORATION
CINCINNATI

new developments of Powel Crosley Jr.

3 Tubes Do the Work of 6 in These New SUPER-TRIRDYNS!

You have not heard the perfection of radio reception until you have listened to these two new Super-Trirdyns. In them the need for more than three tubes is eliminated by the famous Trirdyn hook-up—which combines tuned radio frequency, Armstrong regeneration and reflex amplification. There is no radiation. Distant stations come in clear and sharp on the loud speaker and can be accurately logged. Offered in solid mahogany cabinets of exquisite beauty and design, these new models are the aristocrats of radio reception at democratic prices.

SUPER TRIRDYN REGULAR $50



De Luxe Combination

At the extreme right sketched in outline is the new Super-Trirdyn Special DeLuxe Combination designed by Crosley and built by Crosley cabinet workers. It consists of a handsome solid mahogany table, the Super-Trirdyn Special (batteries self contained) and the Musicone DeLuxe. Sold separately if desired. Table $25. Musicone $27.50. Combination $112.50.

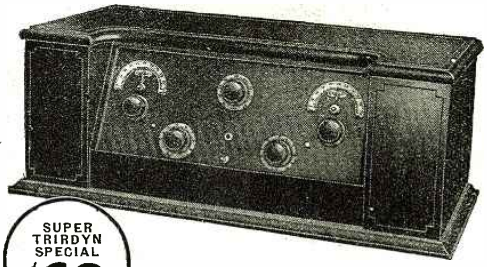
Other CROSLEY RADIOS for Every Pocketbook

One Tube Sets—the tremendous popularity of Crosley Models 50 and 50 Portable is proof of the efficiency of the Crosley Armstrong regenerative hook-up. One tube does the work of three, making possible the enjoyment of real long distance reception with dry batteries. Model 50, price without accessories, $14.50. Model 50 P, price without accessories $16.00.

Two-Tube Sets—more than 150,000 Crosley 51's have been made and SOLD in less than two years—a tribute to the efficiency of Armstrong regenerative reception combined with one stage of audio amplification. Local and nearby stations on loud speaker always and distance up to 1500 miles under average conditions. Much greater range with head phones. Model 51, price without accessories $18.50. Model 51 portable, price without accessories $23.50.

Three Tube Sets—these embody Armstrong regenerative circuit and two stages of audio frequency amplification. Distant stations come in on the Musicone with exceptional clearness and volume. Model 52, price without accessories, $27.50. Model 52, portable, price without accessories, $32.50.

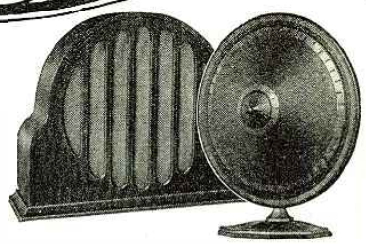
Crosley Amplifiers add amplification to the Models 50 and 51. Model 51A, single stage, matches the 51 in appearance. Price $14. Model 50 A, two stages, is a companion to the 50, price $18.



SUPER TRIRDYN SPECIAL $60

RADICAL IMPROVEMENTS IN PERFORMANCE—BEAUTY—VALUE!

Of interest to the millions who know Crosley's past achievements in the direction of better and less expensive radio are two new cabinet receivers—the 51 Special De Luxe and 52 Special De Luxe. These low priced models represent radical improvements in selectivity, performance, appearance and value. More selective control and improved receptivity have been achieved by the use of the new worm type tickler, the new Crosley vernier plate condenser and the double circuit. Radiation is thus reduced to a minimum. Both cabinets are attractive in design, with sloping panels, handsomely proportioned, and mahogany finished. Both are genuine Armstrong regenerative circuits, the 51 with one stage of audio frequency amplification; the 52 with two. Both are true long range receivers—easy to tune, easy to enjoy, and easy to pay for.



The MUSICONES

Rapidly Replacing Other Types of Loud Speakers

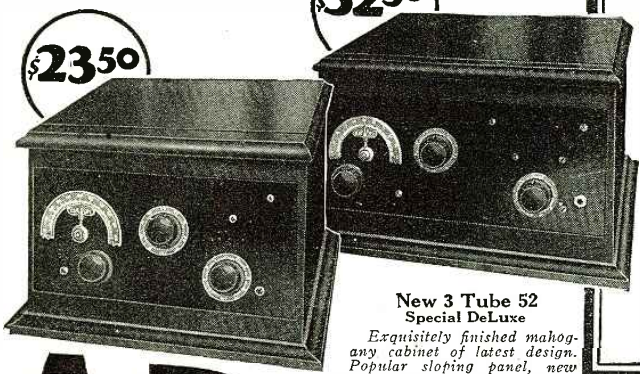
It is expected that no less than 500,000 present day "loud speakers" will be replaced by the Musicone in this, its first year. The Musicone reproduces the full tonal range of the human voice and music without distortion, over tones, resonance or chattering. It requires no adjustments nor additional batteries. The patented actuating unit is the secret of its faithful reproduction of all tones. Not the mere cone. Beware of imitation cone speakers. Listen to the Musicone *once*—and you will never be satisfied with the best loud speaker you have ever heard. Covered by basic patents. Price $17.50

The Musicone DeLuxe

The Musicone has been artistically combined with a clock case of beautiful mahogany with a grilled screen. The effect is charming and offers a real finishing touch to the Super Trirdyn or any other set. Price of Musicone DeLuxe.....$27.50

$32.50

$23.50



New 2 Tube 51
Special DeLuxe

Beautifully finished mahogany cabinet — sloping panel, new style controls — engraved metal dials —cabinet will hold necessary dry cell batteries.

New 3 Tube 52
Special DeLuxe

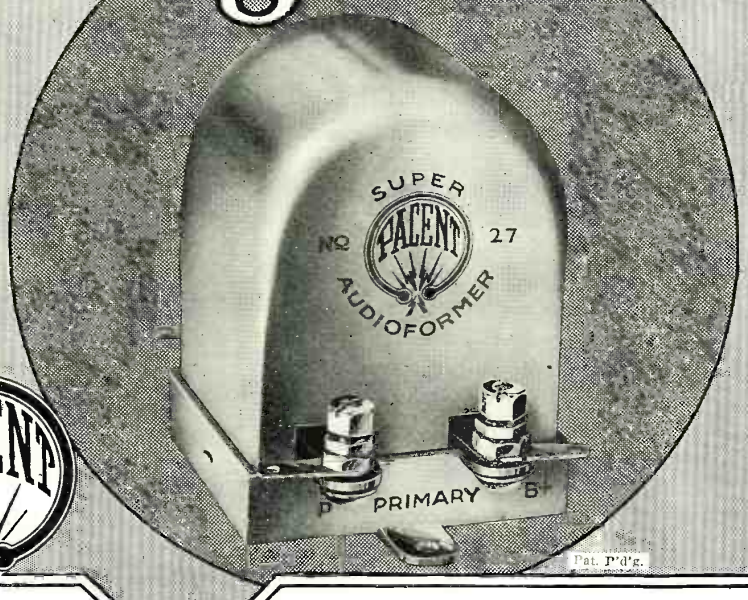
Exquisitely finished mahogany cabinet of latest design. Popular sloping panel, new style controls and art metal dials. Cabinet holds all necessary dry cell batteries.

RADIO

See the Crosley line at your dealers or write for full descriptive catalog.

THE CROSLEY RADIO CORPORATION
CINCINNATI

Pacent Engineering



PACENT

Super-Audioformer Advanced Features

1. Amplifies uniformly from 100 to 8000 cycles.
2. Can be used in any stage without distortion.
3. Proper ratio—3 to 1.
4. Right quantity of a specially manufactured iron used.
5. Air gaps minimized.
6. High primary impedance.
7. Low secondary capacity.
8. Especially designed for power amplification.
9. Will stand plate potentials up to 500 volts.
10. Eliminates audible vibration or "singing."
11. Rugged construction minimizes breakage.
12. Neat and attractive in appearance.

The Last Word In Transformers

The PACENT SUPER-AUDIOFORMER

Change your squeals to harmony. Make your radio set a musical instrument.

We announce the "giant brother" of our No. 26 audioformer—the Pacent No. 27 Super-Audioformer. A man-size transformer for a man-size job. It is the result of our several years of experience and engineering research.

By using just the right quantity of a specially manufactured iron; by minimizing air gaps; by making the secondary winding in two sections and giving proper attention to the spacing between coils and laminations, we have produced the *ideal* transformer. The ratio of 3 to 1 has been selected as proper—being high enough for energy amplification of 500 to 1 per audio step (using 201-A tube or equivalent) and yet low enough so that higher frequencies are not distorted.

In performance the Pacent Super-Audioformer stands alone. Its uniform amplification down to 100 cycles and up to 8000 cycles makes it a true amplifying unit for musical values without distortion.

If you are looking for mechanical and electrical faithfulness, you must select the SUPER-AUDIOFORMER. It is a particular product for particular people.

For power amplification, too, the SUPER-AUDIOFORMER is without a peer, for it has been especially designed with power amplification requirements in mind, with insulation to stand plate potentials up to 500 volts.

Characteristic Pacent solidity, ruggedness of construction, and neatness of appearance.

Supplied in all standard types.

MANUFACTURERS OF BETTER SETS—
We have the right transformer for you.
Manufacturers, Jobbers and Dealers
WIRE OR WRITE FOR PARTICULARS

Do you know about the PACENT TRUE STRAIGHT LINE FREQUENCY CONDENSER?

PACENT ELECTRIC CO., Inc., 91 Seventh Ave., New York City

OFFICES: CHICAGO—MINNEAPOLIS—BUFFALO—BOSTON—PHILA.—WASH., D. C.—SAN FRANCISCO—ST. LOUIS—PITTSBURGH

"DON'T IMPROVISE — PACENTIZE"

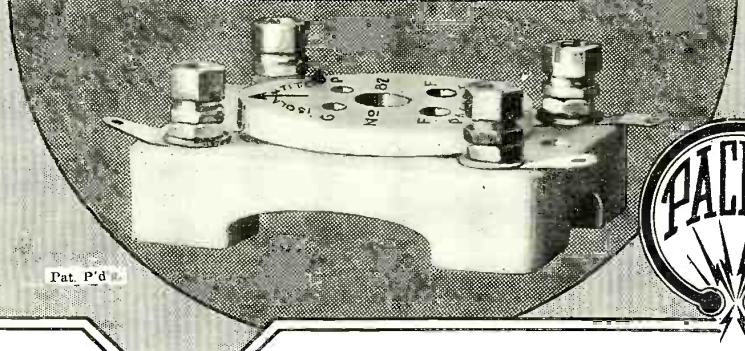
Achievements

THESE TYPE TUBES WILL FIT THIS SOCKET

UV 200	UX 112	UX 200
UV 201	UX 120	UX 210
UV 201-A	UX 199	UX 216-B
WD 12	UX 201-A	

UV 199 (with Pacent No. 20 Adapter)
C 199 (with Pacent No. 20 Adapter)

Also new types to come.



Pat. P'd

PACENT

Socket Advanced Features

1. Universal and interchangeable.
2. Isolantite base.
3. Negligible dielectric losses.
4. Negligible capacity effect between plate and grid.
5. Contact members of spring temper phosphor bronze.
6. One piece direct electrical connection between tubes and wiring.
7. Perforated lugs for easy soldering.
8. Pacent self cleaning, side wiping contacts require no attention.
9. Binding posts with convenient slotted hex nuts.
10. No high resistance joints.
11. Compact—for space economy.
12. Neat in design and appearance.

The Last Word In Sockets

The PACENT UNIVERSAL SOCKET

No need to worry about the change in radio tube bases. Realizing that the proposed changes decided upon by tube manufacturers would necessitate radical changes in the present type of tube sockets and perhaps the eventual "junking" of most of the sockets on the market—we immediately set to work on the problem.

Pacent progressiveness and forethought have resulted in the development of this UNIVERSAL SOCKET to give you an interchangeable tube holder. It will take the new X type tubes as well as the old standard UV and C types. (Excepting old 199 types which require Pacent No. 20 Adapter).

Standardize your set. Make it accommodate present type tubes, and be prepared for new ones to come by using the Pacent UNIVERSAL SOCKET.

The same careful forethought and progressiveness has resulted in the selection of the material used. After much experimenting and research, *Isolantite*—the perfect insulating material, with its mechanical strength of metal—was selected, and an arrangement made with the Isolantite Company of America to make this an exclusively Pacent feature. The socket being, with the exception of its metal parts, entirely of Isolantite, negligible dielectric losses and negligible capacity effect between plate and grid naturally follow.

The one piece soldering lug and contact construction supplies a direct and unbroken electrical connection between the tubes and the wiring. The contact members are of spring temper phosphor bronze, with the exclusive Pacent self cleaning, side wiping contact for each tube prong which requires no attention. The soldering lug ends are perforated for easy soldering, and binding posts are provided with convenient slotted hex nuts.

Perfected in every electrical and mechanical detail by real engineers, the PACENT UNIVERSAL SOCKET takes its place with the famous family of PACENT RADIO ESSENTIALS.

Supplied in popular mounting type and also for mounting on sub-panels.

MANUFACTURERS OF BETTER SETS—
We have the right socket for you.

Manufacturers, Jobbers and Dealers
WIRE OR WRITE FOR PARTICULARS

Do you know about the PACENT MICROVERN?

PACENT ELECTRIC CO., Inc., 91 Seventh Ave., New York City

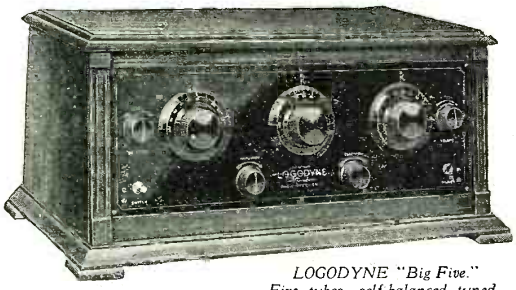
OFFICES: JACKSONVILLE—DETROIT—CANADIAN LICENSEE—WHITE RADIO LTD., HAMILTON, ONTARIO.

"DON'T IMPROVISE — PACENTIZE"

KODEL

The Emblem of

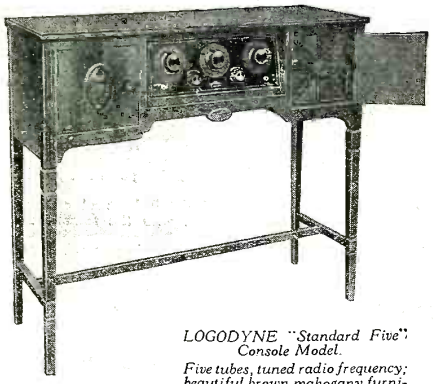
A New Standard



LOGODYNE "Big Five."
Five tubes, self-balanced tuned radio frequency; sloping panel, gold engraved; beautiful massive Adam brown mahogany cabinet; stations already logged. **$90**



LOGODYNE "Standard Five."
Five tubes, tuned radio frequency; lithographed panel and sub-panel; brown mahogany cabinet; stations logged. **$70**



LOGODYNE "Standard Five" Console Model.
Five tubes, tuned radio frequency; beautiful brown mahogany furniture design; built-in loud speaker and compartment for batteries and charger. **$165**

KODEL RADIO has set a new standard in radio manufacture.

To own a KODEL RADIO this year is to have the best that radio offers—or will offer in years to come. KODEL RADIO this year represents the highest development in radio engineering—the most beautiful in cabinet art—the most simplified of circuits consistent with utmost efficiency — KODEL RADIO offers the widest selection and choice of receivers and accessories ever designed by any single manufacturer.

In buying KODEL RADIO one buys with utmost confidence. For each model, regard-

Free *Write for new edition of our instructive booklet on radio operation "The Secret of Distance and Volume in Radio."*



LOGODYNE "Big Five" Console Model.
Five tubes, self-balanced tuned radio frequency; a masterpiece in furniture design; Adam brown mahogany; built-in loud speaker and battery and charger compartment; desk-like front panel can be closed when not in use.
$275

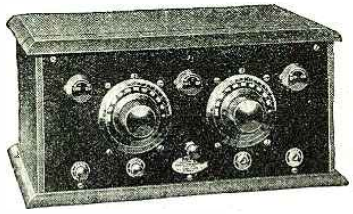
RADIO

Worth in Radio

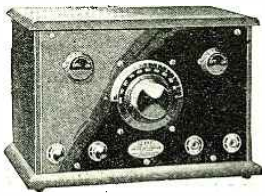
Of Radio Value

less of price is unqualifiedly guaranteed to represent the utmost in quality, in performance, in artistry, and workmanship — conscientiously made and expertly tested.

The choice of a radio receiver or accessory, so long as it bears the name KODEL RADIO, is largely a matter of personal opinion and price—all measure up to the same high standards set for KODEL RADIO this year—the best that radio offers.



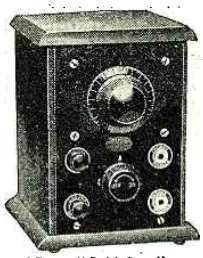
KODEL "Gold Star."
Three tubes; Kodel new circuit; low-loss plate condensers; brown mahogany cabinet; radio's greatest set value. **$30**



KODEL "Gold Star."
Two tubes; single dial tuning; plate condensers; mahogany cabinet. **$20**



KODEL "Crystal Set."
Sensitive, selective, black leatherette cabinet. **$6**



KODEL "Gold Star."
One tube; single dial tuning; mahogany cabinet.
$12

WKRC

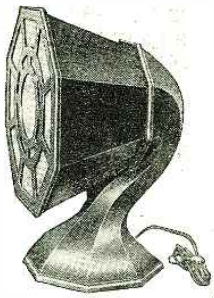
Owners of Kodel Broadcasting Station WKRC on the Alms Hotel. Send for program.



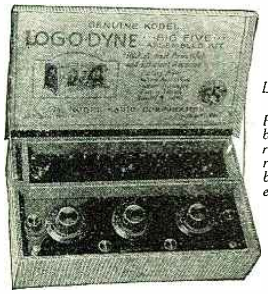
LOGODYNE UNITROLA.
Five tubes; tuned radio frequency; fits any standard upright or console phonograph; all operating parts enclosed; easy to install. **$87.50**



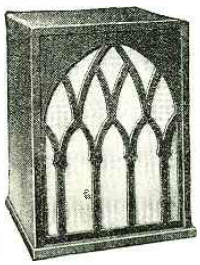
KODEL Microphone Loud Speaker the sensation of the season; exact replica of broadcasting microphones; has unique snail-shell horn constriction — amazingly clear and loud. **$20**



KODEL "DeLuxe" Amplifier.
Combines volume and tone of horn type speakers with dignity of cabinet type; artistic grill over golden cloth screen; beautiful, practical. **$25**



LOGODYNE Panel-Assembled Kits.
Front and sub-panels, beautifully engraved, already assembled; furnished with mounting brackets, wiring, solder etc., BIG FIVE Model
$65
STANDARD FIVE
$50



KODEL Cabinet Type Amplifier.
Solid mahogany cabinet beautiful old gothic lattice work over golden screen; built-in tone chamber.
$27.50

THE KODEL RADIO CORPORATION
501 East Pearl Street Cincinnati, Ohio



You may escape the collection ~ but not the need of OZARKA SERVICE

THE satisfaction you receive from your radio depends not on what it does once in a while—but night after night and month after month. Whether you grin or cuss depends on the service behind your radio.

Ozarka radio instruments are *only* sold by trained factory representatives, men who not only specialize in radio but sell and service Ozarkas only. 3,100 of these men, trained directly under Ozarka engineers constitute a service force, unequalled elsewhere in radio today.

When you buy a radio you'll compare appearance, tone, volume and selectivity by having various instruments set up in your own home but—that isn't enough—compare the service behind each one.

Any Ozarka factory representative will set up an Ozarka in your home—he will not even operate it himself, but depend for his sale on what you yourself do. If you, by your own operating, do not bring in the distance, the volume and tone, you expect a radio to give, then do not buy the Ozarka. If you do buy it, you can rest assured, no matter what happens, a competent service man is at your call at all times. No Ozarka representative can sell Ozarka Instruments without giving Ozarka service. You are entitled to such service—demand it!

The Ozarka Representative knows every part, every wire of the Ozarka. In fact he completely assembles his own instruments. His training on installations, aerials, ground connections, operation and service comes directly under our own engineers who designed and perfected the Ozarka circuit.

That is why our book, "Ozarka Instruments No. 100," describing all models of Ozarka should be of particular interest to you. This book and the name of the Ozarka representative near you, will be sent immediately at your request. Please give the name of your county.

We Have Openings for a Few More Ozarka Factory Representatives

OZARKA Incorporated, is now entering its 4th year. From a beginning with one engineer, one stenographer, one salesman — our present president, the Ozarka organization has grown to over 3100 people. There must be some good reason for this growth.

Ozarka instruments have made good — they have more than met competition. Ozarka representatives have made good not only because Ozarka instruments were right, but because they have been willing to learn what Ozarka engineers were willing and capable to teach them—Ozarka unusual salesmanship and Ozarka service.

There are still openings for the right men in this organization—men who believe in the future of radio—men who are tired of working for some one else—men who want a business of their own. Prove yourself by sales and willingness to learn and exclusive territory will be given you. The man we want has lived in his community for some time. He has the respect of his fellow men because he has never "put anything over" just to make money. He may not have much money, but he is not broke and is, at least, able to purchase one demonstrating instrument.

Check Coupon for FREE Selling Book

Radio offers a wonderful opportunity to men who are willing to start at the bottom and build. You need not know salesmanship, but will you learn what we will gladly teach you? You may not know radio, but we can and will teach you if you will do your part. With such knowledge and willingness to work, it doesn't seem possible that you cannot make good. Sign the coupon below, don't fail to give the name of your county. Better still write a letter, tell us about yourself and attach the coupon. If interested in our salesman's plan ask for "Ozarka Plan No. 100."



OZARKA

122 Austin and La Salle Streets
Chicago, Illinois



INCORPORATED

122 Austin and La Salle Streets
Chicago, Illinois

Gentlemen: Without obligation send book "Ozarka Instruments No. 100" and name of Ozarka representative.

Name ----------

Address---------- City----------

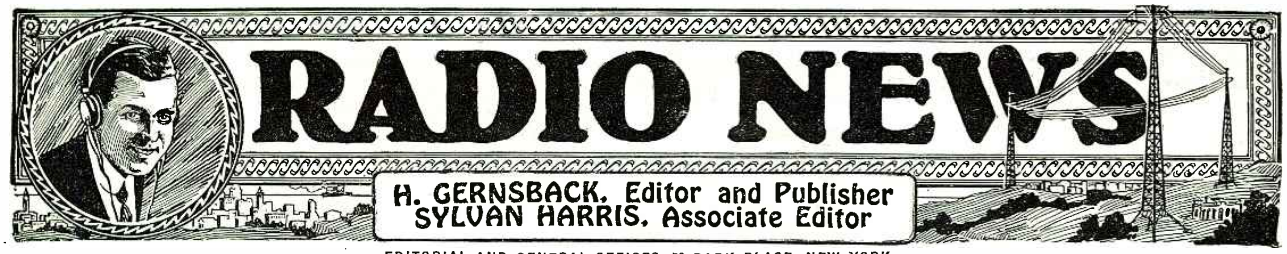
County---------- State----------

Gentlemen: I am greatly interested in the FREE book "The Ozarka Plan" whereby I can sell your radio instruments.

Name ----------

Address---------- City----------

County---------- State----------



EDITORIAL AND GENERAL OFFICES, 53 PARK PLACE, NEW YORK

Vol. 7 SEPTEMBER, 1925 No. 3

WHAT THE BROADCAST LISTENER SHOULD KNOW

By HUGO GERNSBACK

THE following is addressed to those who already own sets and who are always looking for additional radio information.

As the number of stations continues to increase rapidly, and as most of the stations are working on wave-lengths below 300 meters, many sets today do not tune down far enough. As a matter of fact, very many sets have distinct difficulty in tuning below 250 meters. There are plenty of excellent programs coming from the short-wave stations that many people would like to get and *cannot* get with the present sets.

Many letters come in to the writer asking for a remedy for this condition. Some relief may be obtained by connecting a variable condenser of about 23 plates in series with the aerial of your set. This sometimes helps, particularly if your aerial is long. A much better plan would be to shorten your aerial, if this can be done easily. An aerial of which the total length is not more than 50 or 60 feet will be found very much better for shorter waves.

Another remedy is to use one or more of the new straight-line frequency condensers. These condensers are to replace the ones now in your set. Much easier tuning will result, as the stations are not so badly crowded at the lower end of the dial. Replacing your present condensers with this new type will not be very expensive and will result in better service from your present set.

Very often it is found that signals coming from certain stations, even from the local stations, will fade rather badly. It may be said that bad fading from a local station is rarely the fault of the station, but rather the fault of your aerial. This is particularly the case when listening in to the low-wave stations. It can usually be traced to swinging of your aerial in the wind. This changes the capacity of the aerial and causes fading. The remedy is to tighten the aerial, taking up all the slack. This should be done once every three months, anyway. A good stunt is to put stiff brass or steel springs between the insulators and the wall or other support. This spring will keep an even tension on the aerial and allow for its expansion and contraction. In the wintertime the average aerial is taut, while in the summer it sags badly. This is due to differences of temperature. For the long waves, the swinging of aerials does not give much trouble, but the shorter we go on the wave band, the worse this effect becomes.

Many people are puzzled as to why stations come in on different dial settings during different times of the month. The radio fans should know that the tuning of regenerative receivers is affected by several factors. First, the voltage of the "A" battery and the voltage of the "B" battery. If your "A" and "B" batteries get weaker, the dial readings change. As soon as the "A" battery is charged and a new "B" battery replaces the old worn ones, you will find that the dial settings are exactly the same as they were originally, when the batteries were new. The intelligent observer will always know by the change of the dial settings that the batteries need attention.

Another factor that changes the dial settings is the condition of the tubes. You will notice that, in practically all existing sets, when the tubes are changed, the dial settings vary as well. Therefore, dial readings should be recorded only after the set is working correctly and finally adjusted. The tubes should not be changed around after they have once been put in place, unless you wish to change your dial readings every time you do so. And this is apt to become a nuisance, particularly for DX (distant) stations.

As everyone knows, DX is not easy to get, at best, and switching tubes around sometimes makes it a very difficult task to bring back such stations, because, with the tubes changed, they are on different dial settings.

Should you at any time either lengthen or shorten your aerial, or change your ground wire, you will immediately notice that the dial readings are changed. For that reason, the aerial and lead wires, as well as ground wires, of your set should not be changed any more than necessary, because it means a lot of arduous work to relog stations afterwards.

When considerable interference exists between stations the wave-lengths of which are close together, particularly in the lower part of the wave band, and the tuning is not very sharp, the following trick may sometimes be resorted to: Simply disconnect the ground wire and operate the set with the aerial wire alone. You will probably find that the intensity of the signals is cut down somewhat, but that as a whole you will be able to receive the wanted station clearly, because the interference can be much more easily tuned out.

If this does not give sufficient relief, it will next be in order to try one of the attachments that are on the market, which can be screwed into any 110-volt lighting circuit. This does away entirely with aerial and ground and in many cases gives excellent results. It means that the lighting mains become your aerial and ground. A number of combinations can be made, some of which may prove surprisingly good. The one trouble with this arrangement is that it does not work in all localities. It is apt to work better in isolated dwellings than in large apartment houses.

As a general rule, the outdoor aerial is the best for reception, particularly if you want to get the distant stations. If, however, you are satisfied with the locals, and you have a fairly good set, from three tubes upwards, there is really no sense in having an outdoor aerial. An indoor aerial, which is nothing but an insulated wire running around the moulding of the room, will do just as well and, as a matter of fact, it will be better, particularly if there is much interference from other stations. The indoor aerial is also much more desirable when there is undue interference from other nearby stations. This is particularly so in the big cities where there are many broadcast stations and where an outdoor aerial is apt to give too much interference.

Then we should not forget to mention the good old-fashioned bed-spring aerial, which is not half as poor as many people think. The metallic part of the bed-spring is attached to the aerial binding post, while the usual ground is used. Some surprising results have been obtained by the writer with such an arrangement, even to bringing in some distant stations.

Then we have a sort of condenser aerial, which is really an excellent one for many purposes, and some surprising results have been obtained by means of it. The writer uses the following arrangement with very good results: He secured a pound of tin foil and tacked this in long strips on one of the house doors, covering the two sides of the door. From each side of the door, connected to the tin foil, a wire was run to the ground and aerial binding posts of the set respectively. Stations came in very nicely. By setting the door at various angles some stations would come in while others would fade out In other words, such an aerial has directional qualities and can be successfully used to cut out interfering stations. The writer had very good results with such an arrangement, although he is located in a steel building. No doubt better results could be obtained with such an arrangement in a stone or wooden building. It will be noticed when using such an "aerial" that static is not so much in evidence as when using other kinds of aerials.

Perhaps you did not know it, but your wire net window screens, particularly in the summer, can act as a fair substitute for your aerial. If you have two windows in your room you can connect them by means of the usual connecting clips used so much in radio, and use the two screens as one aerial. The writer did this and obtained good results for a makeshift aerial. This may be remembered when away on your vacation with a portable set, when no other aerial may be available.

When you are using a super-heterodyne set, it is a good trick to ground the filament circuit; that is, the connections that go to the filament of your tube. This means that the storage battery leads either the positive or the negative pole, should be connected to the nearest ground available, such as cold water pipe or radiator pipe. Much better selectivity is obtained. The volume will increase somewhat and distant stations will be brought in much more clearly.

Mr. Hugo Gernsback speaks every Monday at 8 P. M. (E. S. T.) from Station WRNY on various radio and scientific subjects.

Concerning the Nature of Fading

By J. H. DELLINGER
Chief of the Radio Division of the Bureau of Standards



The radio reception equipment at the Bureau of Standards for studying the effects of fading.

RADIO is very much concerned just now with what is called fading. The term is probably an inaccurate one; it simply refers to the fluctuations of intensity of signals received from distant stations. It is not so likely to trouble you if the station is within 50 miles, but from that distance up to about 200 miles it is a genuine obstacle to satisfactory signal reception.

The spotlight of radio progress is indeed revealing fading as its chief enemy. For many years fading played a minor rôle, but it has now assumed the part of heavy villain and has all the other characters in the great drama of radio backed off the boards. This waxing prominence of fading is a relative matter. It is not that fading is any worse than it ever was, but that other enemies to perfection of radio reception have been yielding to the onslaught of scientific and experimental progress. We have been finding out what to do about interference of various kinds, that caused by other transmitting stations, electric power lines, radiating receiving sets and even atmospheric disturbances, but we have not yet found how to prevent or to substantially mitigate the irregular variations in the intensity of radio signals known as fading. There is a ray of hope. We are rapidly finding out many things about fading and its causes, and such knowledge is the usual preliminary to finding a remedy.

BROADCAST CROWDING

It is interesting that radio broadcasting has been established just in the border-line territory between the low frequencies (or long waves), which show little fading, and the high frequencies (or short waves), which fade badly. Very probably you have noticed that the shorter wave broadcast stations generally fade more than those on greater wave-lengths. This is important when you consider the problem, a perennial and serious one for the Government, of finding frequencies to assign new broadcast stations, finding places to put the increasing tribe of would-be broadcasters. They cannot go to lower frequencies, because below the broadcast range the ether channels are few and they are not available; they are pretty well taken by ship and other radio telegraphic use. Broadcasting might go to higher frequencies, on the other hand, as the number of ether channels there is unlimited, if it were not for the unreliability introduced into radio reception by fading. For the immediate future, therefore, broadcasting is in a straight-jacket in the band of frequencies which now confine it. It is difficult to see how more broadcast stations can be crowded into this limited band without destroying one another. Perhaps the solution to that problem is general acceptance of the view of those who maintain that there are too many stations already and that the multiplication of stations is economically unstable. I have strayed from my main subject, only to point out that a happy and complete solution of some of our most practical radio broadcast problems will be attained when we conquer the fading which troubles the upper broadcast and still higher frequencies.

I said that the causes of fading are becoming known, and a most fascinating thing it is to study what happens to a radio wave in traveling from the transmitting station to the listener. What happens depends on the frequency, or wave-length. With low-frequency waves there is little or no fading. Radio was not formerly troubled with fading, simply because radio work was done on waves of lower frequency than those which are now used for broadcasting. The amateurs were the only exception to this. They operated on frequencies above 1,500 kilocycles (or wave-lengths below 200 meters), and it became increasingly recognized among them that their received signals were subject to peculiar and inexplicable fluctuations. The mystery was why their signals should vary in this unaccountable manner while other radio signals did not.

TESTS ON FADING

In order to determine the facts about these fluctuations the Bureau of Standards organized a systematic series of tests, extending over a year, by a large group of amateurs. It was demonstrated that on these frequencies fading occurs at night and not in the daytime, that the average received signal strength is much greater at night, that fading is worse the higher the frequency, that weather conditions do not markedly affect fading, and that the amount and nature of fading are not characteristic of either the locality of the transmitting station or of the receiving station. From these facts (and others—see publications: "A Study of Radio Signal Fading," Bureau of Standards Scientific Paper No. 476, and "Radio Signal Fading Phenomena," Journal Washington Academy of Sciences, vol. II, p. 245, June 4, 1921) it was possible to derive the following explanation of fading:

In the daytime the radio waves go out from the transmitting station attached to, and sliding along, the ground, just as the electric current comes into our homes sliding along the wires. The waves do not penetrate very far up into the air because of the presence of a sort of electrical screen or barrier produced by the action of sunlight on the atmosphere. At night, however, this electrical screen disappears and the radio waves can penetrate into the very rarefied upper parts of the atmosphere which are permanently in an electrically conducting condition. The radio waves then slide along this upper conducting part of the atmosphere in just the same way that they slide along the earth's surface in the daytime, with this difference:

In sliding along the earth's surface in the daytime the waves are rapidly absorbed by the trees, buildings and other obstacles they meet, while in sliding along the upper atmospheric conducting surface at night they are free from this, and go much greater distances. So the short waves, which should go farther theoretically, because they are of higher frequency, really do go farther at night. But this upper atmospheric conducting surface is not smooth; it is rough and turbulent like a wave-tossed sea, and these variations give rise to the fluctuations of received signal intensity which we call fading.

SOME CURIOUS PHENOMENA

All of this, the investigation and the conception of the explanation I have described, was in 1920. Since then, broadcasting and the use of the very short waves have developed. Knowledge has accumulated, and it has verified and extended this explanation. We now know that there is a zone, somewhere between 50 and 150 miles around a transmitting station, in which fading is greater, and average signal intensity is less than at either greater or less distances. This is the main explanation of so-called *dead spots*. In this same zone fluctuations of the direction from which the waves reach the receiving station occur. Some of these direction shifts give a direct demonstration of the fact that the waves travel in the upper atmosphere. Some of the most remarkable changes in signal intensity, fading and wave direction occur daily during sunrise and sunset. As the earth's daily rotation makes the surface of separation between daylight and darkness swing over a given locality, the radio waves traveling in the upper atmosphere are actually tilted down and rapid and peculiar fading and direction changes occur. For certain very short waves it appears that there is an electrical conducting surface in the atmosphere which facilitates their transmission over great distances in the daytime, just as happens to other waves at night.

I don't want to give the impression that

(*Continued on page* 390)

An Invalid Experimenter

By THOMAS J. HOWELLS, Jr.

HERE is an intensely interesting human document, such as we rarely come across. Mr. Howells has been confined to his bed a number of years and it would be thought that in such a condition it would be impossible for any one to engage in extensive radio experimenting.

If other unfortunate individuals happen to read this story, it cannot help but put new life into them.

The romance of radio is a godsend to all shut-ins. Mr. Howells sets an illuminating example to all of his unfortunate brethren.—EDITOR.

EXPERIMENTING with radio is a mighty interesting way to pass the time—especially if you have more of it on your hands than you know what to do with.

Near the 1st of December, 1921, I joined the "retired," or "gentlemen of leisure" class, you might say. For several months I wasn't interested in radio or anything else much, but gradually, as the worst wore off, I became interested in other things again and needed something to keep my mind busy.

Reading offered the handiest and easiest means, so I read anything and everything I could lay my hands on, but this constant reading proved too much of a strain on my eyes. Looking around for something to take its place, I decided upon radio.

Radio had always fascinated me, even before the present broadcasting era, when it was still called "wireless," so it is natural that I should think of it first. I had followed its development by reading radio magazines and had puzzled out many hook-ups and diagrams, so when I started to tinker with my first set the usual hook-ups didn't give me much trouble.

Before attempting to build a set however, I read over all the "dope" I could find to see what kind of a set I should need to get good results. That's where I hooked my first snag. There appeared to be a startling difference of opinion as to what the range of a one-tube set is. The various radio editors insisted that fifty miles was all that could be expected, while the set manufacturers persistently plastered their advertisements with testimonials of set users who reported hearing stations one thousand to fifteen hundred miles *loud* and *clear*. (It was always *loud* and *clear*.) That didn't sound reasonable at all. It looked suspiciously as if one or both of them belonged in the Ananias Club. I was inclined to favor the editors, for it seemed that they had less cause to be partial. For that reason I was doubtful whether or not I could build a one-tube set that would pick up the nearest station, which was seventy miles away.

I felt certain that a crystal set wouldn't do, for crystal sets were classed as ten to twenty-five mile receivers. (Since then I have covered distances up to nine hundred miles on a simple crystal set under favorable conditions.) A regenerative detector was universally conceded to be the most efficient one-tube set, so, of course, nothing else would do. Incidentally, the "squeal-back" circuits will hold their own with any of them yet.

For several weeks I studied radio catalogues until I practically memorized them, before ordering the parts needed for a one-tube set. I expected to receive the parts from the various companies in a week or two and start building the set. Expected was all, however. Little did I know of radio companies. In about a month or two some of them condescended to let me know that they had received my order and then proceeded to fill and ship it at their own sweet leisure. It took more than two months to get all the parts necessary. (Service is much better now from most mail order companies.)

I didn't buy any tools at first, just used those that we happened to have. These consisted mainly of a breast-drill, a pair of pliers, a screw-driver or two and an old home-made electric soldering iron that had been resurrected. It was a bulky-looking specimen, but it worked well for several months before it short-circuited and gave up the ghost. Later these tools were supplemented with a hand-drill, blow-torch with large soldering iron, files and round-nosed pliers.

I was puzzled as to just how to proceed with building the set. As I am not allowed to sit up, the work had to be done lying down—which complicates matters considerably. However, it's easy when you get the hang of it. I found that the easiest method for me was lying on my elbows with a pillow rammed down beneath and behind them. At first my arms tired easily and my elbows got sore, but I got used to it after a while until now I can tinker all day and half the night when I take a notion.

I abandoned the bed in favor of a cot, because I can reach the floor readily from the latter, and this enables me to do much of my tinkering without assistance, as I keep much of my "junk" in boxes on the floor. These are pushed back under the cot when not in use.

At first I did all the drilling and other work myself, but the large breast-drill is awkward for me to handle, so now I have my brother do most of that work and the other work that cannot be done in bed, such as stringing up aerials and building cabinets.

Finally the parts for my first set were corraled, a hook-up selected, the panel marked and placed on the floor and drilled by holding the top of the breast-drill with one hand and cranking it with the other. Everything went beautifully until I tried to mount the parts on the panel. I then discovered the mournful fact that mounting-screw holes have an aggravating habit of parking themselves just a trifle out of line. This was remedied by reaming the holes.

The set was finally assembled, wired, tested and ready to work. The soldering job wasn't a work of art; it takes much practice to do a neat job of soldering, especially while lying on the elbows.

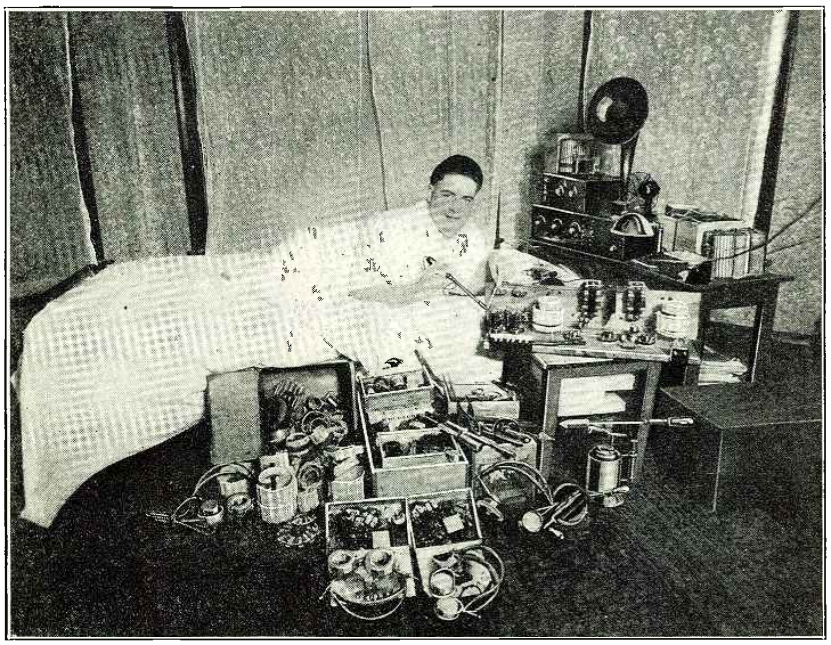
The aerial, ground and batteries were connected, the phones coupled up, the tube placed in the socket, and all was ready for the great moment. I put on the phones, turned on the rheostat and nervously commenced turning the dials slowly. A few minutes of this and then a squeal.

"Ah hah! A carrier wave!" I mentally rejoiced, and began fiddling with the controls to tune it in. Suddenly a voice broke through with startling clearness. I was thrilled through and through, with the thrill that comes but once in a radio bug's lifetime.

At that moment I would have felt amply repaid had the set cost a thousand dollars. After listening in a few minutes in awe, half - expecting the voice to vanish, I summoned everyone within range of my voice to come and listen. The phones were passed from one to the other until all had heard it, meanwhile waiting impatiently for the announcement. Finally it came: "KDKA, East Pittsburgh, Pennsylvania." Words cannot describe my elation. Right then and there radio editors in general suffered a sudden drop in my estimation. Fifty miles, bunk! Here was KDKA more than *five hundred* miles away, the first crack out of the box.

Then began a grand DX spree. I tuned and tuned and tuned, until one or two A. M., when all the stations within range had

(*Continued on page* 346)



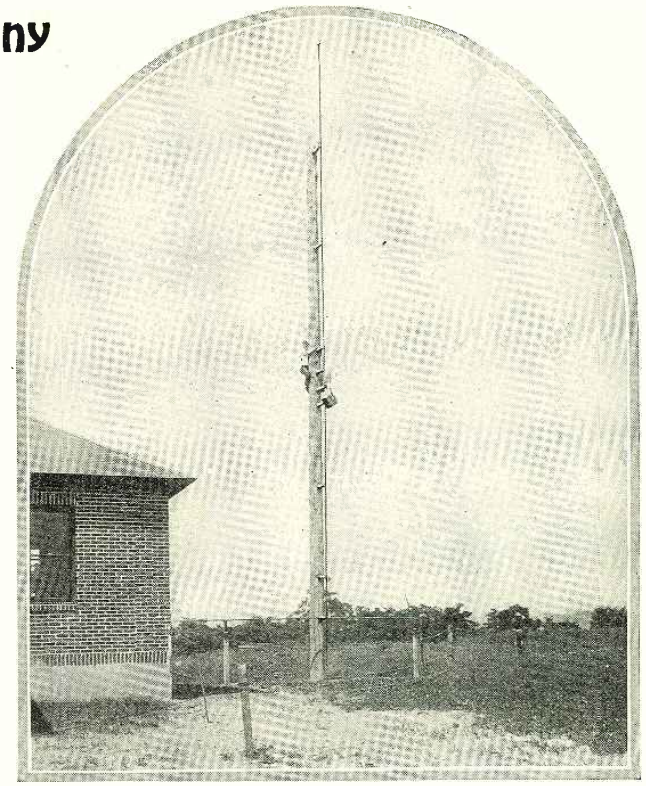
Mr. Howells is an inspiring example to those who are equally unfortunate. Even though he is unable to move about, he has managed to make enough sets to make any radio fan's heart glad.

KDKA Rebroadcast in Germany On a Single Tube

By S. McCLATCHIE

This article tells how a greeting in German was sent from America to German radio fans.

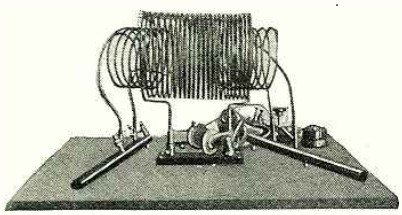
RADIO enthusiasts who build big multi-tube sets to "pull in the Coast," and possibly London or Madrid some day when the luck is good, may be surprised to hear that in Europe one may listen to American broadcasting 4,000 miles away any night on a single tube. In fact, with a one-tube set the strength of the signals may be brought up to such a point that the music is clearly audible with the phones at arm's length. By the addition of two audio stages, the old loud speaker can be made fairly to shout. At the risk of being slated for the Ananias Club, I will state that I have even listened to American broadcasting in Germany with a single tube and no aerial or ground connection whatever, and without a loop; in other words, the set was sensitive enough to render audible the minute energy picked up by the tuning coils and battery leads alone. For the benefit of those who are inclined to ascribe some of these statements to a vivid imagination, I am going to describe the set which produced the results and leave it to my readers to try it out and see for themselves.



The short-wave antenna used at KDKA. It consists of a rod mounted rigidly on the pole.

SHORT WAVES FOR DISTANCE

In the first place, it must be explained that the broadcasting I refer to is that sent out by KDKA on a wave-length of 63 meters. I have often picked up American stations in the broadcast band on a single tube in Germany, but for consistency and strength these are hardly even comparable to the short-wave reception. Indeed, it often happens that the fifth or sixth harmonic of a station 4,000 miles away gets through far better than the main wave, where this is in the broadcast band. I have heard WBZ on 55.5 meters and WGY on 76 meters, when not a trace of the main waves could be found. This is pretty strong evidence of the extraordinary carrying power of the short waves. With a good short wave receiver anyone in California, or South America, or Europe, or even Australia can listen to KDKA every night. The high-power 63-meter transmitting of KDKA at East Pittsburgh, Pa., may be heard regularly in almost any part of the world as long as static or daylight do not too much interfere. It was my privilege to cause programs from KDKA to be rebroadcast through the station at Stuttgart, Germany, for the benefit of German radio listeners. Many thanks are due to Mr. C. W. Horn, Superintendent of Radio Operations of the Westinghouse Electric & Mfg. Co. for his warm co-operation in carrying out the tests and relays herein described.



The receiving set used in Germany for the reception of KDKA's signals. The "flapping" type of condenser may be seen under the coils.

The set which I found most effective, after months of midnight experimenting, is shown in one of the accompanying illustrations. The hook-up used is the standard Armstrong regenerative circuit. The coils are wound with about No. 13 hard-drawn copper wire, in the form of a spiral spring. The secondary coil may be wound to a diameter of from 3 to 3½ inches, and should have about 30 turns, well spaced. The turns may be held in place and kept from sagging in the middle by being lashed to a small glass tube passing through the upper inside of the coil. The ends of the coil are fitted with plugs adapted to be inserted into the two brass uprights, which may be clearly seen in the illustration. In this way, coils may be quickly changed and various sorts tried out. Of course, the coil may be wound on bakelite tubing, if desired, but the spiral spring method shown is simple and inexpensive, and eliminates concern as to dielectric and surface leakage losses. The left-hand coil is the primary winding. This may have about 5 turns, but the best number should be found by experiment. This primary is untuned. In some locations it may be found that a ground connection is unnecessary, or even detrimental.

At the right in the picture is the tickler coil. This should have from 15 to 20 turns, depending upon how easily the tube oscillates. A tube with a strong tendency to oscillate is usually best. The primary and tickler coils are also removably fitted in brass uprights or bushings. They are mounted on hard rubber or bakelite rods, pivoted at the far ends so as to swing freely in a horizontal plane. These rods are made rather long, so as to form handles by means of which the coils may be swung in and out of the secondary. This arrangement is primitive, but it is very convenient and effective. The problem of a "low-loss" condenser is solved in a novel manner. Rigidly attached to one of the uprights supporting the secondary coil is a brass disc. Another disc is pivoted to the other upright and provided with a long insulating handle, by means of which it may be swung around. The capacity is changed by adjusting the distance between the two discs. Of course, this arrangement calls for very careful mounting.

ELIMINATING LOSSES

My primary purpose in developing this set was to eliminate, as far as possible, all sources of losses, theoretical and otherwise. To this end I went so far as to remove the base from the tube. The tube appears toward the rear of the set, in an inclined position. A grid condenser, grid leak, telephone bridging condenser and rheostat complete the receiver. The uprights of the secondary coil are mounted on a strip of bakelite, which in turn is affixed to the board that serves as a base for the whole equipment. This open, "bread-board" type of mounting has the merit of ready accessibility. It is not the thing for a parlor set, but it is ideal for the experimenter. To tune the set, the movable condenser disc is adjusted until the wave of the station is found. The signal is then cleared up by moving the primary coil back and forth. Adjustment of the primary coil has a very considerable tuning effect at the low wave-lengths. As both primary and tickler are provided with long handles near the base of the set, extremely fine tuning may be very easily accomplished. The best aerial to use with the set is a wire 50 or 60 feet long run up vertically, as far as possible. The signal strength drops as the aerial is increased in length beyond about 60 feet. Almost anything will do, however, as an aerial, even a connection to the water faucet or a bed-spring.

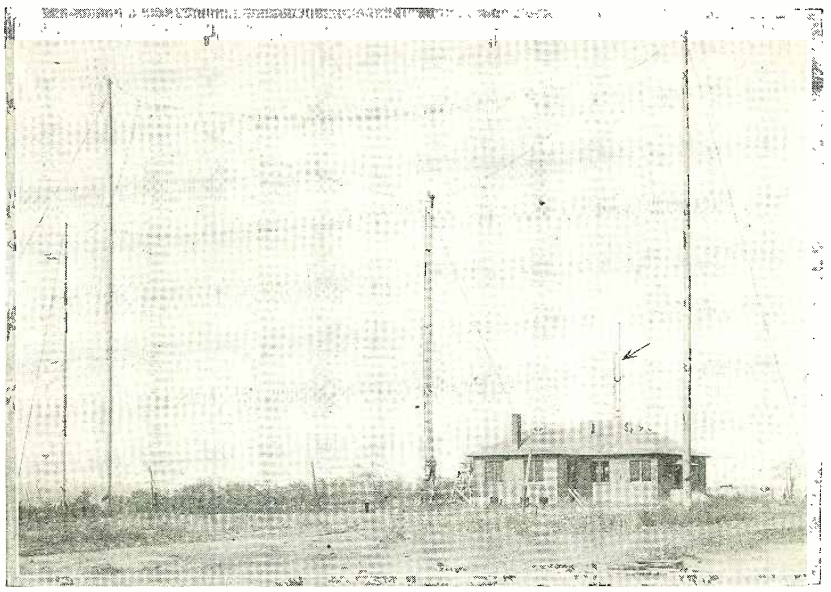
If you live at a great distance from KDKA, I am sure you will be very much astonished at the results from your first short-wave set, once it is working properly. Up to a distance of a few hundred miles there is no advantage from the short waves, but when you are a thousand miles or so away, you find that they "sure do travel." Of course, the set described may be used to pick up all sorts of short-wave transmissions. There are hundreds of stations to be heard in the band below 100 meters.

My success in picking up American broadcasting in Stuttgart attracted considerable notoriety. It was decided to rebroadcast KDKA through the local station from my set. With the hearty co-operation of the President of the South German Broadcasting Co., Consul-General Theodor Wanner, of the Director, Dr. Alfred Bofinger and of the technical staff, relay experiments were at once begun. At first, without any previous announcement, we tried relaying London. The listeners were unprepared for this, and their astonishment may be imagined when they suddenly began hearing the London Savoy Hotel Orchestra instead of the local program! But this was only the beginning of surprises for Stuttgart's radio audience, for within a few days we were able to bring them not merely London, but America, 4,000 miles away, so that even the owner of the crudest crystal set could hear the Westinghouse Band as though it were the local orchestra.

FIRST GERMAN RELAY OF KDKA

The first regular, publicly announced relay of KDKA was carried on the night of January 31. It was the first event of the kind to take place on the continent of Europe. The previous relays of America had all been carried out in England by the British Broadcasting Co., to whom all credit is due for the pioneer trans-Atlantic relaying. However, no Continental station had ever before brought America to its listeners. It was the beginning of a new bond of contact between the two great continents of the Western World. KDKA came through on this occasion with remarkable volume and clarity. All of the English stations, as well as Stuttgart, were relaying KDKA on this evening. I later received a letter from a listener in the neighborhood of Glasgow, Scotland, who was so kind as to say that KDKA came through more clearly from Stuttgart than from his local station. East Pittsburgh played a special selection of American melodies, closing with the "Star-Spangled Banner." It was a memorable occasion for all.

As this first attempt at relaying America was so successful, the Broadcasting Company decided to establish a special wire connection with my laboratory, located several miles from the station. After various delays, this special line was established and thoroughly tested out. The relay set-up, as finally worked out, was as follows: The receiving set as above described was connected to an audio amplifier consisting of one single-tube stage and of one push-pull stage. The push-pull output transformer was connected directly to the telephone line. This line was connected at the broadcast station to the transmitter in quite the same fashion as though the studio microphone had been at the other end, instead of my receiver. With normal reception conditions, this arrangement gave good, strong signals through the transmitter, although a good deal of skill was demanded of the broadcast operator to make the relay a success. In relaying, I kept my receiver in tune by listening to Stuttgart with a crystal set. During the relays we had to shift the wavelength of the Stuttgart station from its regular value of 443 meters to about 410 in order to prevent the seventh harmonic of the local station from interfering with the reception of the 63-meter wave.



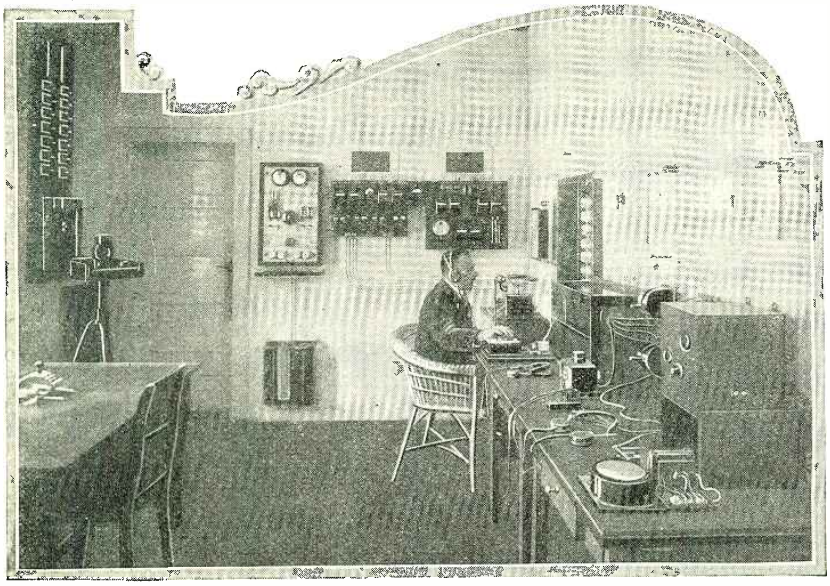
The antenna system at station KDKA, at Pittsburgh, Pa. The short-wave antenna is indicated by an arrow.

SECOND REBROADCASTING TEST

The second regular relay of KDKA was carried out on March 21 and was also very successful. I then arranged by cable with Superintendent Horn of the Westinghouse Company that KDKA should convey greetings from America to Germany. The date set was March 28. The event was announced all over Germany. In preparation I set up two receiving sets, each instantly available as an alternative to the other. Everything was most carefully tested and checked over. On the night of the event, we relayed Hanover and then Manchester, as a sort of preliminary heat; this went off very well. At midnight I began listening for KDKA. There are six hours of difference between Eastern Standard and Middle European Time, and it was then only 6 o'clock in America. At first, KDKA came through rather weakly; there was still daylight in East Pittsburgh, as spring was already with us. I tried the signals on the sender. The broadcast operator did his best, but was not able to bring anything very intelligible out on the air. We kept on trying for a full half-hour. I did what I could to improve reception, and the operator off at the station did all he was able to get the signals out through his sender. I was banking on the fact that the sun was fast racing westward and leaving Pittsburgh in total darkness. About 12:40 KDKA began coming through more normally. By 12:45 the Westinghouse Band was getting out through the Stuttgart sender in good shape. The trying period of tension was at an end. The greeting was to come at 1 A. M. At 1:01 the familiar speaker at KDKA began announcing. He introduced the editor, George Seibel, and said that he would deliver an address to Germany. Then very slowly, in German speech, was delivered the first greeting to be broadcast across the ocean from the American to the German people. It was in essence as follows:

"From Steuben, who helped in our fight for freedom, to Karl Schurz, one of the greatest American statesmen, have men of German blood worked together in building up our great American Republic. From this American Republic goes forth this greeting to the great German Republic, to all who are of German race, from Alsace to Danzig. Much have you given to the world through your great thinkers, through Kant and Lessing and Goethe and Schiller. Deeply are we indebted to you, and therefore we call upon you today to not yourselves forget the teachings which your great thinkers and poets have contributed to the world. Remain a united nation of brothers.

(*Continued on page* 350)



The interior of the German station at Stuttgart, which retransmitted America's first radio greetings to Germany in the native tongue.

The Dunoyer-Toulon Experiments

By PROF. C. B. BAZZONI, Ph.D.*



DR. CHAS. B. BAZZONI

THE long glass tube of the *mercury vapor lamp* is familiar to most people as the source of the weird green light that is used so extensively in photographic studios. This light is remarkably rich in the colors, blue and ultra-violet, which act best on the photographic plate: hence its use by the photographers. Many other people are also familiar with the use of this lamp in the *arc rectifiers*, which are employed sometimes to charge storage batteries from alternating current lines. The rectifying bulbs are different in shape from the tubular lamps, but they emit the same characteristic and somewhat ghastly green light. Within the last twelve months the French physicists, Dunoyer and Toulon, have published the results of a series of remarkable experiments on these mercury arc rectifiers, showing that they possess a number of properties readily applicable to important practical uses. Since most of these applications yet remain to be made in practical forms, the subject is at present one which will repay study by the amateur experimenters and hopeful inventor.

THE MERCURY VAPOR LAMP

In order to understand the Dunoyer-Toulon experiments it is necessary first to consider in a little detail the mode of operation of the ordinary tubular mercury vapor lamp. Although these lamps are made in many different patterns, the kind sketched in Fig. 1 is typical. The tube, which is made of glass, may be from 15 to 30 inches long and 1 inch or more in diameter. At the ends are enlarged pockets, A and B, into which metal terminals, T_1 and T_2, are sealed. These pockets are partly filled with mercury—two or three tablespoonsful in each. At P is a glass tip through which the tube was carefully exhausted of air after the mercury was put in and a suitable heat treatment given. Some of the mercury from the pockets will, of course, evaporate into the space AB, forming vapor of mercury, the density of which will be the greater the higher the temperature rises, just as is the case with water vapor over water. At ordinary room temperatures, however, the pressure of this mercury vapor is very small and we can say that at such times a first-class vacuum exists in AB. In order to get an electric discharge through the tube under these conditions, it is necessary to *ionize the mercury vapor;* that is, to break up some of the electrically neutral atoms of mercury, which form the vapor, into ions—each atom giving one positive and one negative ion.

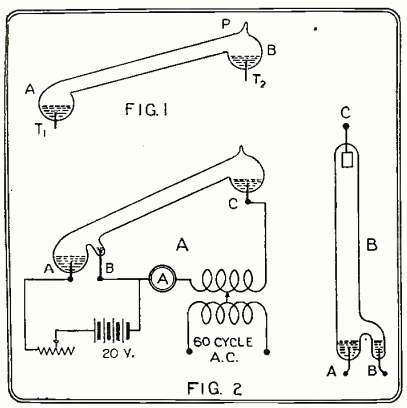


Fig. 1 shows the simple form of mercury vapor arc. Fig. 2 shows the form of arc which is operated by alternating current.

IN this article, the fourth of a series written for RADIO NEWS by Dr. Bazzoni, the well-known physicist, further applications of the phenomena of electric discharges in tubes are explained. There are few of us who realize that there are other tubes besides the three-electrode tubes which we use in our radio receivers, and that many surprising things can be done with the aid of these devices.

The experiments of Dunoyer and Toulon, described here by Dr. Bazzoni, showed that it was possible to obtain a current amplification in a special form of mercury vapor tube of nearly 100 million!

The voltage amplification obtainable was of the order of 100. Compare these figures with the ordinary tube used in radio receivers. Furthermore, the tube can handle great amounts of power, controlling, as explained in the text, as much as 48 amperes at 3,880 volts with no disturbance whatsoever.—EDITOR.

IONIZATION

Now the mercury atom is known to consist of an aggregation of electrical charges—200 elementary positive charges called *protons,* plus 200 elementary negative charges called *electrons.* All of the protons and 120 of the electrons are in the central part of the atom, but 80 of the electrons form an outer shell from which certain of them can be rather easily discharged. To ionize an atom it is only necessary to dislodge one electron from it. The dislodged electron is then the negative ion and the residue of the atom forms the positive ion. Once a few of these ions are formed in the vapor, things will begin to happen, provided a voltage is applied between T_1 and T_2. The negative electrons will rush toward the positive terminal at high speed, picking up enough energy to knock some more atoms apart as they collide with them; the plus ions, being enormously heavier—about 360,000 times as heavy as an electron—will drift more slowly toward the negative electrode. Not all of these ions will reach the terminals. Many pairs will recombine as they meet on the way and will, in the act of recombining, give out their energy in the form of light waves. In fact, all of the light emitted from the tube is developed in this way. The ions which do reach the electrodes will be stopped by the impact and will there develop heat. A very considerable amount of heat is thus produced. Unless care is taken, the nearby glass will be softened or melted. This heat will boil the mercury and increase the vapor density until, in some lamps, the hot pressure is above atmospheric. The glow of the arc, once started, is seen to be self-sustaining, since a few ions moving along the tube to begin with will produce more from the neutral atoms by collision. The initial ions necessary to start things can most easily be produced in a tube of the type of Fig. 1 by tilting the tube slightly with the potential on, so that a thread of mercury runs along from A to B. When this thread is broken by tilting the lamp back to its original angle, a short arc forms at the instant of separation, which is sufficient to furnish enough ions to start the main discharge.

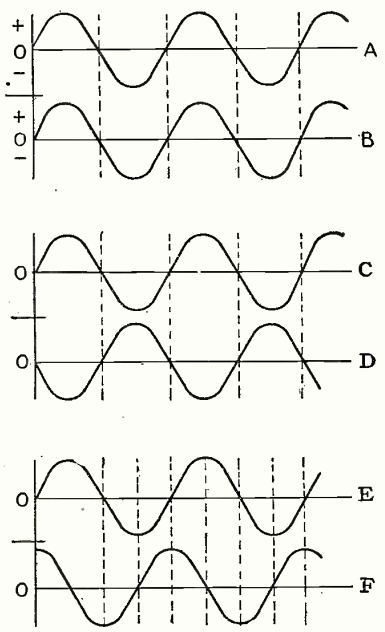


FIG. 6.

A and B show 2 alternating currents in phase; C and D show them 180° out of phase, or in opposition; E and F show a phase displacement of 45 degrees.

It will be noted that the passage of current through these tubes, as also the resulting production of light from them, involves the flow of the two streams of ions—the heavy, slow, positive ions drifting toward the negative terminal and the light, extremely rapid electrons shooting along to the positive terminal. It is, however, important to see that the continuation of the discharge is really due to the work of the negative electrons alone. These are so small that

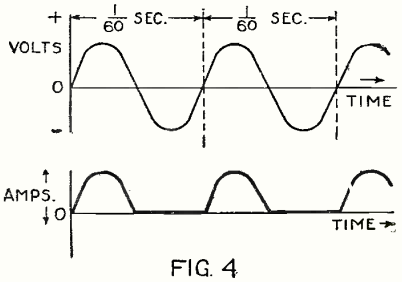


FIG. 4

A, the upper curve, is for the voltage impressed between the arc terminals. B, the lower curve, shows the rectified current passed by the arc.

*Professor of Experimental Physics, University of Pennsylvania.

they drive between the gas atoms far enough, before hitting one, to pick up enough energy to knock that atom apart which they do hit. The positive ions, on the other hand, are so large that they interfere with each other and with the atoms, before getting a chance to pick up much energy in falling down the tube.

MERCURY ARC RECTIFIERS

Since the two ends of the tube shown in Fig. 1 are identical, it is fairly evident that the discharge, once started, will pass in either direction—that is, whether T_1 is positive or negative with reference to T_2—and the lamp will burn either way round on direct current. Since, however, the ions in the vapor vanish practically instantaneously when the driving potential falls to zero, such a lamp will go out at the first alternation of an A.C. voltage and is, consequently, useless in alternating circuits. A simple modification will, however, enable us to make this lamp usable on A.C. and also give us a tube with a unilateral conductivity through which current can flow in one direction only. Such a tube will, of course, act as a rectifier for alternating currents. To accomplish this, a third mercury pocket and terminal is made

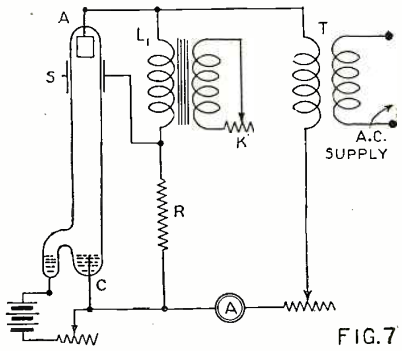


FIG. 7

The connections shown enable us to control the output of the arc very easily and accurately.

in the tube at B, close to A (Fig. 2). A low D.C. voltage, say 20 volts, will readily maintain an arc between A and B, once one is started by the tilting process described above. This auxiliary arc, having been formed, will continue to burn on its D.C. supply—probably passing through it 3 to 5 amperes—and will produce an atmosphere rich in ions in its end of the tube. If now C and B are connected to a 60-cycle A.C. line, C will become first positive and then negative to B 60 times a second. Each time C is positive, the electrons from the small arc will shoot along toward C and, in so doing, will produce collision ions, and thus enable the main arc to strike up between B and C. When, however, C is negative, the heavy, clumsy plus ions drawn slowly toward it will not be able to produce extra ions, no arc will strike and no current will flow. Thus, current will pass only while C is positive to B, giving a pulsating, direct current through the circuit BAC. The light given out by the tube will be intermittent, 60 flashes each second, but to the eye this will appear to be a steady glow.

The mercury pocket at C could as well be replaced in this lamp by an iron electrode, giving a more convenient form, as sketched at B (Fig. 2). The tubes used by Dunoyer and Toulon in their experiments were exactly of the two forms shown in Fig 2. The tube lengths were about 30 inches and the diameters about 2 inches. The material used was Pyrex glass and, in all the heavy current work, the entire device was immersed in oil to reduce the danger of failure through over-heating. Such a tube, oil-immersed, can be made to pass as much as 50 amperes under a pressure of 4,000 volts.

DUNOYER AND TOULON'S SHEATH

These tubes, as far as we have described them, are of types well known for years past. Now for a statement of what Dunoyer and Toulon did that was new. They merely provided the tube on the outside with a short, close-fitting, sliding metal sheath, as shown at S, Fig. 3. For producing the effects to be described the length of this sheath is of little importance—a tube 3 to 5 inches long will do. The best position for the sheath for producing clean results is near the anode, about as shown in Fig. 3. If the lamp, provided with the sheath, is operated on D.C., the sheath produces no effect on the discharge, no matter to what potential it may be charged or how it may be hooked into the circuit. On A.C. supply, however, the sheath has a marked influence.

Fig. 3 shows the arrangement of the sheath used by Dunoyer and Toulon for the purpose of controlling the arc easily.

Fig. 5 shows the connections from the power line to the arc by which the potential of the sheath is controlled.

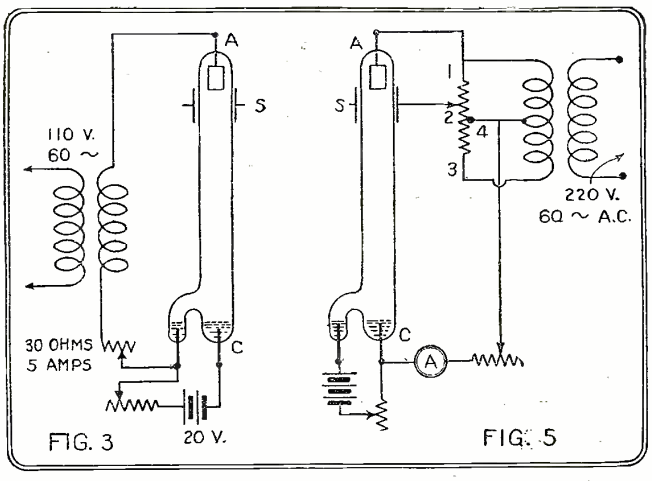


FIG. 3 FIG. 5

The potential variations on A when the lamp is fed from an A.C. transformer are as shown in Fig. 4A. Since the arc is lighted only while A is positive to C, the current flow through the tube (without the sheath) will be roughly as shown in Fig. 4B. The current flow and the glow in the tube start up as soon as A becomes positive and continue as long as A remains positive, that is, for one-half period of the feeding current. If now the sheath be put on the tube, *the potential of the sheath relative to A will determine entirely whether or not the arc will light.* Let us expand this statement somewhat and see exactly what it means. If the potential S to C is above a certain minimum value and is in the same direction as the potential A to C, *i. e.*, if S and A are both positive or both negative to C at the same time, then the presence of S causes the main arc to strike. If, on the other hand, the potential S to C is of opposite sign to that from A to C, and above a small critical value, the main arc is prevented from striking. These effects are due to the electrostatic influence of the charge on the sheath on the stream of ions passing up and down in the discharge. The experiments show that a variation of a few tens of volts in the potential of the sheath S is sufficient to bring about the lighting or extinction of the arc, even when the potential A to C runs into thousands of volts.

HIGH TENSION ARC RELAY

We see here at once an important application of the tube as a high-power, high-tension, cut-off switch, operable absolutely without sparking. Anyone familiar with the large, complicated, expensive and sometimes dangerous, oil-immersed circuit-breakers used in high-power, high-tension commercial circuits will realize the usefulness of this application. A tube of the dimensions described has been used to cut 5 amperes at 1,700 volts and 45 amperes at 3,880 volts with no disturbances of any sort. To open or close the main circuit it is merely necessary to close a telegraph key connecting S with a source of potential to make it positive or negative with reference to the anode.

Since this device operates only on alternating current, the potential of the anode is continually changing and the selection of a suitable source of potential for controlling S is not as simple a matter as it would be in ordinary D.C. work. The connections of

(*Continued on page* 375)

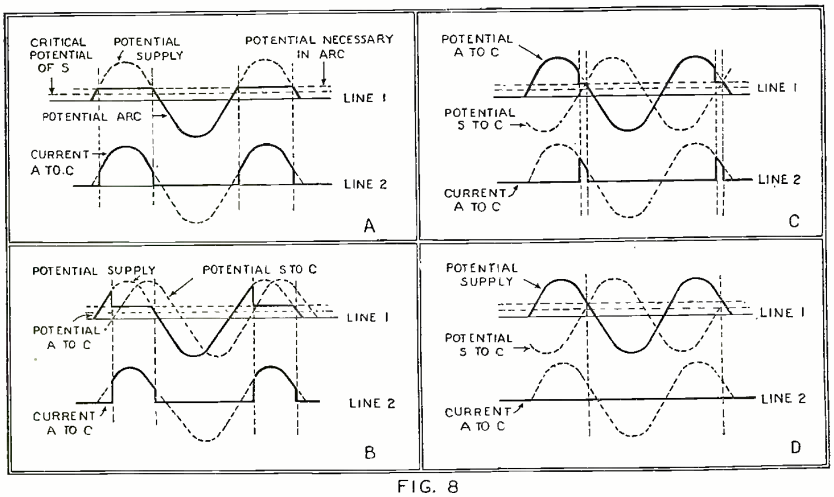


FIG. 8

The amount of current through the tube depends on the adjustment of the retardation apparatus. It can be controlled accurately, as shown by the curves, which are for four different values of phase angle.

The Inventions of Reginald A. Fessenden

PART IX

THE question has often been put to me, "Is Edison really a great inventor? Are not his inventions really due to his assistants?" Having worked with him for a number of years and having made a rather special study of the science of invention and of the history of inventions and of inventors, my own conclusion is that all of the inventions which go by his name were made by him personally, and that there is only one figure in history which stands in the same rank with him as an inventor, *i. e.,* Archimedes. The following partial list of Edison's principal inventions will support my position:

The phonograph.

The moving and talking pictures.

Incandescent lighting. Both carbon and metallic filament.

The system of electric distribution, including central station and underground conductors.

The carbon microphone transmitter, without which the telephone receiver (which was invented by Gray) would never have developed into the present telephone system.

The modern methods of manufacturing cement, which have made its use practical for modern construction work.

The Edison valve (the hot cathode tube, which is used as a receiver in wireless sets and is the basis of the DeForest's great invention, the audion).

The Edison storage battery.

The mimeograph.

The Edison duplex and multiplex telegraph systems, etc., etc.

EDISON AND HIS ASSISTANTS

From what has been said in the previous article it will be evident that he allows to those of his assistants who are capable and who have been "indoctrinated" in his methods a very considerable opportunity of developing their individuality in the working out of problems. But the inventions are always Edison's; the particular assistant who does the work is not material. If an assistant leaves or is transferred to another job, the work goes on just the same.

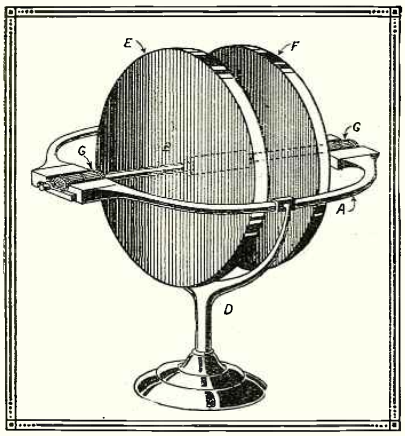


Fig. 1. Fessenden's electric gyrostat with three directions of freedom. Wheels E and F are driven by the motors G. The framework A rotates about two supports while the entire system rotates with the shaft D.

There is an old story of a famous organist who came down from London to a country village and played for the evening service. At its close the vicar's daughter said to the sexton, who had worked the bellows, "That was a beautiful anthem." Said the sexton, with entirely justifiable but disproportionate pride, "Yes. If I says it myself, I never pumped better." And of Edison himself the story is told that an assistant met once in Germany a glass-blower who had formerly been in Edison's employ, and who was posing as the real inventor of the electric lamp, and remonstrated with him, to receive as justification the reply, "Why, John, you know yourself that Edison never could blow glass."

It is of course true that without the organ-blower there would be no music, and without the glass-blower no electric lamp. But, as I have shown elsewhere, the responsibility for the music is measured by the ratio of the number of men who could play the anthem so well (perhaps four or five) to the number of men who could blow the organ (hundreds of thousands), and therefore the musician is substantially entirely responsible for the result. And so, with Edison's work. while much credit should be given to his assistants, the results are his. His knowledge of detail is such

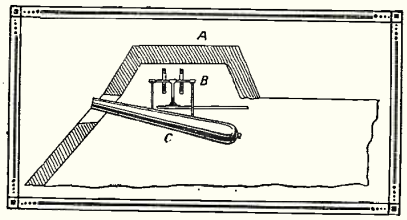


Fig. 2. The gyrostat is here shown mounted on the turret of the battleship. The gunner sights along the hollow rod rigidly attached to the gyrostat which automatically discharges the gun when pointing correctly.

that he does not need to follow out any one method of attack; he has many by which he can advance. On two or three occasions I noted his method, for he frequently had me accompany him on his morning rounds to save time when difficult problems needed survey, of dealing with new assistants who were evidencing more than a reasonable appreciation of the value of their contributions. He would listen quietly, not say much, but next morning he would, apparently casually, shift the development to an entirely new, and generally better, line. This would be effective.

In these morning rounds of inspection he was, as always, most considerate, and never found fault with the work, merely, when things were going wrong, explaining what should be done to make them go right. The nearest I ever heard him come to criticism was once when an assistant who had taken over a job on which a relative of the assistant's had worked for some time without result and was himself making no apparent progress, he turned to me and said, "I think, Fezzy, I shall have to make this job hereditary."

It will be evident then that the inventions, described in the previous article, in the development of which I took part, were Edison's and not mine, and would have been made, though perhaps in slightly different form, if he had employed other of his assistants for the work.

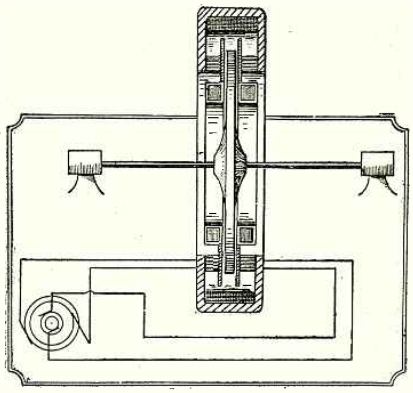


Fig. 3. Another form of Fessenden's high speed electric drive. In this case the disc forms the rotor of a high frequency alternating current motor.

GYRO GUN-SIGHT AND GYRO-DRIVE

But one invention I did make at this time, which can rightly be called my own. In the course of some mathematical work I had run across the fascinating gyrostat, and, puzzled as to the reason why it had not been used as a compass, had read up its history and had decided that the methods of driving it, *i. e.,* belts, steam, etc., had been the obstacle, and that it could be made to work by using an alternating current motor-drive. Also that there was an immediate commercial field for it as a sight for guns on shipboard. A very short article describing this use and also a letter referring to the possibilities of its use as a compass, was sent to the *Electrical World,* New York, and published May 18, 1899. The following are extracts from the article:

"One of the peculiar advantages of the electric motor is that it can supply power to a shaft which is itself in no fixed relation to a base—without interfering with its motion."

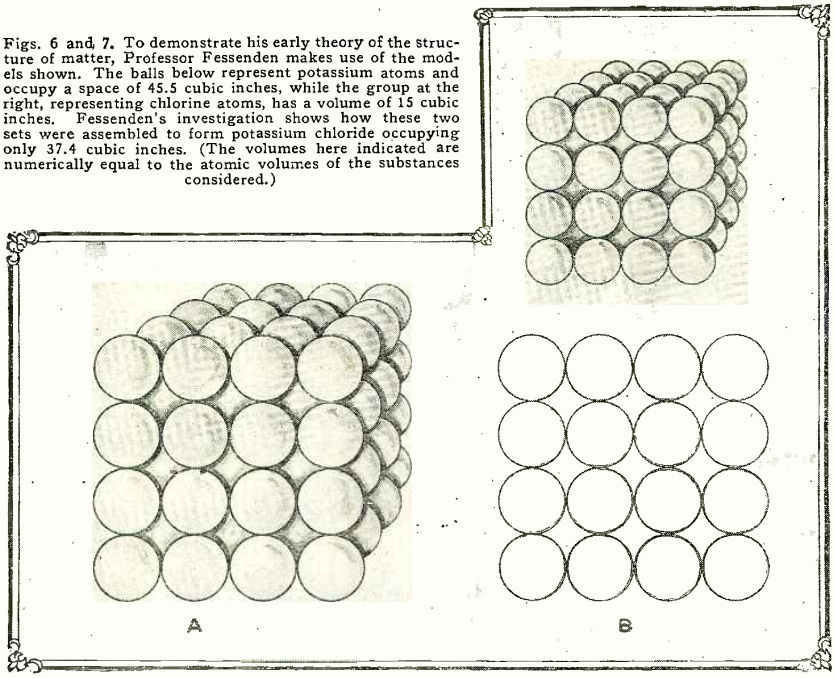
Then follows a description, accompanied by an illustration, of an electrically-driven gyrostat, and suggesting its use for taking lunar observations, where greater accuracy is needed than with solar, for photography of lunar eclipses at sea and for artificial horizons. The article then goes on,

"The gyrostat may also be used on torpedo boats or dynamite cruisers. The gyrostat is placed in the conning tower, Fig. 2, and the officer in charge sights the shaft, which may be hollow, attached to each end of which is a rod, so arranged that when the axis of the torpedo tube or gun is parallel to the shaft, they complete a circuit

Metal.	Atom. Vol.	Rigid. $\times 10^6$	Calc.	Young. M. $\times 10^6$	Calc.	Tens. str.	Ca
Iron.	7.1	750	550	2000	1560	65	74
Copper.	7.1	430	550	1220	1560	41	48
Platinum.	9.1					35	48
Zinc.	9.2	350	340	930	920	15.7	16
Silver.	10.2	280	270	740	750	29.6	29
Gold.	10.2	270	270	760	750	28.5	29
Aluminum.	10.4	250	260	680	690	18.	18
Cadmium.	13.		170	480	465		
Magnesium.	14.	150	143	390	395	10.4	9
Tin.	16.3	136	100	420	295	3.4	5
Lead.	18.1	84	83	190	235	2.36	4

Figs. 4 and 5. In attempting to develop a theory of cohesion, Professor Fessenden discovered some important relations in the quantities shown in this table. From this he evolved the electrostatic doublet theory of the atom.

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Figs. 6 and 7. To demonstrate his early theory of the structure of matter, Professor Fessenden makes use of the models shown. The balls below represent potassium atoms and occupy a space of 45.5 cubic inches, while the group at the right, representing chlorine atoms, has a volume of 15 cubic inches. Fessenden's investigation shows how these two sets were assembled to form potassium chloride occupying only 37.4 cubic inches. (The volumes here indicated are numerically equal to the atomic volumes of the substances considered.)

which explodes the charge," and gives directions for varying range, etc.

The editorial comment was very kind. "All these difficulties (referring to previous obstacles which had prevented the gyrostat's coming into use) it seems may be successfully overcome by the employment of electricity as a driving power, and the description in another column of a gyrostat made by Mr. Fessenden may well serve to bring the instrument once more into desired prominence. . . . As Mr. Fessenden points out, it is clear that the gyrostat, when ranged toward the geographical north for instance, would take the place of the compass on board ship." (A slight misapprehension of what I had said, as no ranging is necessary.) So I felt quite proud of my first scientific article.

And it may be said here that this was the method which finally did come into use, but not for nearly twenty years. Many attempts were made to have it taken up, but ship owners did not then see any object in supplanting the magnetic compass. It was not until the submarine was developed by Lake and became a serious means of warfare that the inability, of the magnetic compass to work inside the steel shell of the submarine, forced the adoption of the gyro-compass. A number of experiments were made, however, during these years, and it was found that a frequency many times that of standard commercial motors was necessary, and 500 cycles was finally settled upon as best. A patent for this method of drive was granted later (Fessenden, British Patent 21,481, October 31, 1907), the claim reading:

"The method of driving shafts at high angular velocities which consists in mounting upon the shaft to be driven, the rotor of a high frequency alternating motor which is supplied with current from a high frequency current generator," and the illustration Fig. 3, showing a high frequency dynamo (100,000 cycles) driven by a 500-cycle motor, and having a smooth surface rotor. The first commercial gyro-compass was made in Germany, for the German submarines, about 1908, but it has since been immensely improved and the principle applied most ingeniously to a great variety of other uses, on aircraft as well as on shipboard, by Sperry.

SCIENTIFIC WORK IN CONJUNCTION WITH DR. KENNELLY

The day's routine was rather full. Work started at nine. The last half of the noon hour was spent in mathematical work, at first by myself, later generally with Dr. Kennelly. At five o'clock Kennelly and I walked at top speed to the Y. M. C. A. gymnasium at Orange, put in fifteen minutes on the bars and trapezes and with the medicine ball and fifteen minutes hand ball. Then a shower and, more leisurely, back to supper. At 8 P. M. we went back to the laboratory, Kennelly to his electrical building, I to my chemical building. John Dorr and I then worked till midnight, then stopped short on the minute and drank strong hot coffee made in a big agate iron-ware dishpan and ate some biscuits. The agate-ware dishpan always got eaten full of holes in a short time, and we never could find what did it. Then John started home on his bicycle and always took a hot bath before turning in, to the distress of the other members of his most charming family, who found him asleep in his bath a number of times and were afraid he would be drowned. I stayed behind at the laboratory half an hour or so, turning in about 2 P. M. after an hour's theoretical physics or chemistry. Only two things broke this routine, *i. e.,* the periods, quite frequent, when we worked all day and night, and the less strenuous intervals when Dr. Kennelly and I got a chance to solve experimentally electrical problems together.

Perhaps the most important piece of work we did in this way was the determination of the resistance temperature coefficient of copper. There were a considerable number of formulæ for this, some curves concave upward, some concave down. The discrepancies were due apparently to uncertainty and non-uniformity of the temperature of the copper wire and inaccuracy of the thermometers used. Kennelly had the beautiful idea of putting the wire coil inside the bulb of an air thermometer and heating it electrically, thus at the same time insuring uniformity of temperature and certainty as to its value. I had the idea, based on some theoretical chemical investigations, that the curve was neither concave nor convex, and was equal to the reciprocal of the volume expansion of a gas. Kennelly's method worked beautifully. We had some trouble getting the apparatus blown, the laboratory glass-blower finally deciding, after a number of attempts, that it could not be done, and I, with sinful pride, taking over the job and demonstrating that it could; and the results came out absolutely consistently and gave a straight-line curve. The results were published in the Proceedings of the Electrical Congress which met at Chicago in 1893, and were shortly afterward adopted officially by the British Post Office authorities.

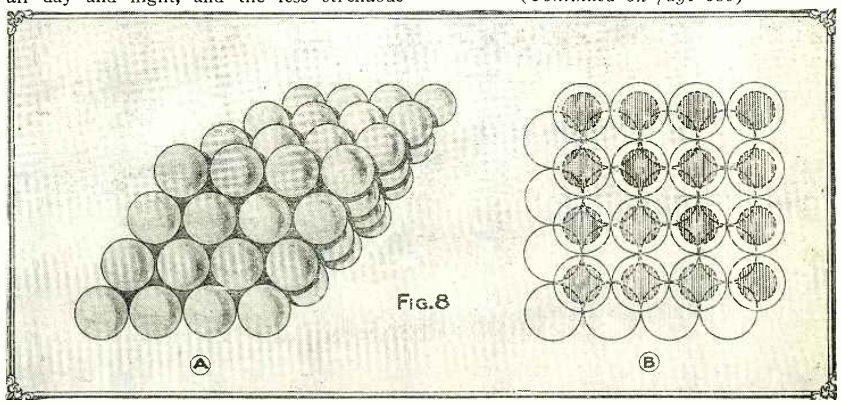
Dr. Kennelly will perhaps remember the long hours we spent one sweltering summer night chasing an elusive variation of from 5 to 20 milligrams in the weight of the mercury content of the air thermometer bulbs, traced at last, by an irritated buzz, to a mosquito who had been trying to roost on the arm of the sensitive balance, and had at last lost patience at being disturbed so many times. And another hot Sunday afternoon when after lugging the Kew Magnetometer far out into the country so as to be away from all iron and to get an accurate standardization of our galvanometer we got such remarkable readings that we searched around through the long grass of the field to find that we had set up the apparatus within ten feet of the only magnetic object probably within miles, an iron cannon ball fired, as we found later, during the war of 1776.

ELECTROSTATIC DOUBLET THEORY AND COHESION

Perhaps the most important and revolutionary of the discoveries which it has been my good fortune to make, and one which led, as will be seen later, to many inventions, *i. e.,* the discovery of the electrostatic doublet theory of matter and of the nature of cohesion and of elasticity were made during these years, and in this way:

In the previous article I have referred to a job set by Edison, to make a non-in-

(*Continued on page* 380)



The structure of potassium chloride according to Fessenden's theory of the structure of matter. The stack of balls (A) contains potassium and chlorine atoms, the latter being located in the interstices between the potassium atoms. The arrangement is indicated at B where the shaded circles represent chlorine atoms.

See With Your Radio

By W. B. ARVIN

As has been predicted by RADIO NEWS *for years, here is television at last. The first practical demonstration was held at Washington in June.*



D. MacFarlan Moore, inventor of the lamp for the Jenkins-Moore machine.

THE last week in June, seven men stood in a laboratory in Washington, D. C., watching the arms of a miniature wind-mill revolving on a small screen of white blotting paper. The real wind-mill was five miles away in Anacostia. The picture on the laboratory screen was being transmitted by radio through the intervening space.

It was the first time in history that real television had been demonstrated or motion pictures had been transmitted by radio—the little moving wind-mill picture.

The men present at the demonstration were Mr. D. MacFarlan Moore, inventor of the lamp upon which the receiver depends; Mr. C. Francis Jenkins, inventor of the prismatic disc used in the transmitter; representatives of the Navy Department; Mr. Burgess, Director of the United States Bureau of Standards, and Judge Taylor, advocate of the Department of Commerce, who presides over radio under Secretary Hoover.

After the demonstration, everyone was unanimous in the opinion that this long-sought-for goal is at last actually in sight. In a more or less perfect form it will be a common thing within a year. The main difficulties in the problem have been successfully worked out.

No few pages have been written on this subject. Indeed, it is a barren month which does not find the radio press carrying some sort of scheme for the transmission of pictures by radio. But the point with most of them is that they are usually very plausible on paper but hold little promise of practicability when reduced to practice. The present scheme is practical. It works. This is the real point.

Probably the most outstanding characteristic about the whole scheme is its simplicity. Great inventions are usually simple, however. The success of their makers is primarily a matter of removing the complexities. With the Jenkins and Moore machine, simplicity is noticeable from the first.

As to the technical description, it can be made plain enough for the man in the street to understand.

The first of the two prerequisites of any picture transmitting apparatus is a photo-electric cell which will take the blacks and whites of the photograph or picture to be transmitted and turn them into electric current in direct proportion to their shading. The whites must transmit a heavy current when it is focussed on the cell, while the intermediate grays and the blacks must transmit little or no current in accordance with their approach to dead black.

With electric energy in direct proportion to the shading of the picture, the transmission of this energy to a distant point is a comparatively simple matter. We may use radio or fall back upon the land-line.

Then the second point of importance is a lighting device at the receiver which will take the currents after they have been amplified, and turn them again into light and shadow in exact step with the transmitter and in exact synchronism with the shade changes in the picture at the transmitter.

Practically, these two problems have been solved very well. The light at the receiver is one developed by Mr. Moore. It depends upon the glow about the negative pole of a lamp in an inert gas, such as neon. The characteristics of this little tube are such as to make it excellent for television—or telerama, as Mr. Moore chooses to call it.

Tests in the laboratory have shown that the lamp may be lighted or extinguished at the rate of more than a hundred thousand times a second. The superiority of the lamp in this direction may be appreciated when one calls to mind that with the ordinary hot filament type of light, more than one-tenth of a second is often required for the hot filament to radiate sufficiently for the glow to cease. Its second point of superiority is its ability to follow exactly in illumination the current fed to it.

In one stroke, this little lamp, which is shown in an illustration, eliminates two very complicated and bulky pieces of apparatus which have heretofore been incorporated in television receivers. Previously, in order to get comparative light and dark, it has been necessary to install and use some sort of magnetic shutter to govern the amount of light passed to the screen. The Moore lamp remains in exact step and does away with the quantitative shutter.

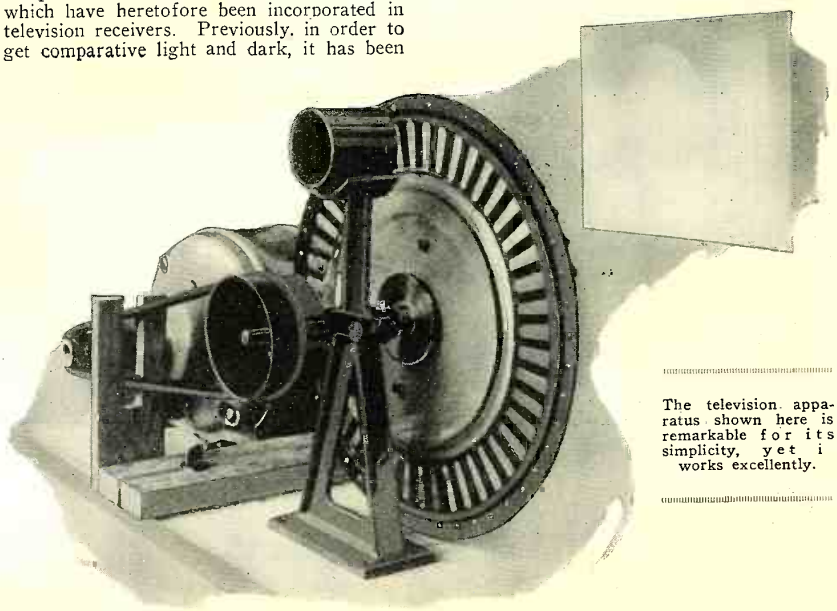
At the transmitter, the photo-electric cell which turns the light and darkness of the photo or scene into electrical energy is a commercial product. It seems that there is a great deal of misinformation afloat concerning the effectiveness of present-day photo-electric cells. Two large manufacturers have in the open market at the present time two designs of these instruments which will fulfill almost any conditions which might be imposed upon them. One of these cells is employed in the Moore-Jenkins apparatus.

With a capable method of converting the light into electric energy and back again into light, the only other important consideration for the operation of the machine, is that some method be employed for breaking the picture up into small signals. This simply means that the picture must be transmitted in dots, or that it must be broken up in some fashion so that a large number of impulses are employed to transmit the picture. In the last analysis, it simply amounts to telegraphing at high speed.

This part of the process may be likened to the use of half-tones in the printing of photographs. Everyone knows that a half-tone consists of innumerable dots. Yet when the printing process is complete, the reader does not see the dots, he simply views the composite effect of them. It is the same with the transmission of pictures. The great number of dots, differing in their intensity, tend, when put together properly, to give the complete effect of a picture.

This breaking-up process in the Moore-Jenkins machine is accomplished so simply that it is almost absurd. With the aid of the prismatic disc spoken of before and a second ring containing a number of lenses, the process is done with the least possible complication and with the greatest clarity

(*Continued on page* 384)



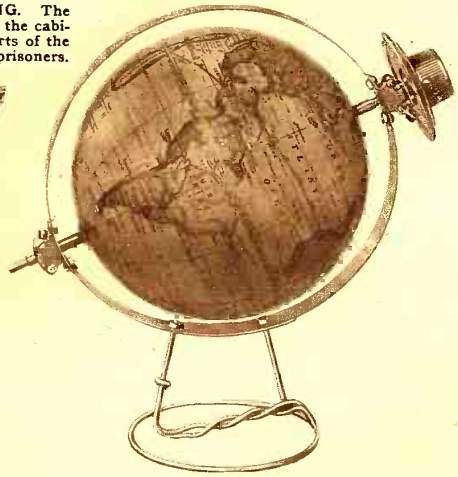
The television apparatus shown here is remarkable for its simplicity, yet it works excellently.



RADIO IN SING SING DEATH HOUSE. The cells shown are those of the old death house at Sing Sing Prison at Ossinging, N. Y. On the warden's desk may be seen a radio receiver for the entertainment of the prisoners in the block. © Kadel & Herbert.

MAIN RADIO EQUIPMENT AT SING SING. The receiver, on the left side of the cabinet, remains in the cabinet and the amplifier is carried to the different parts of the prison when it is desired to entertain the prisoners. © Kadel & Herbert.





NOVEL METHOD OF ADVERTISING ROTOR BEARINGS. If the bearings shown will support the world they certainly should support the rotor of a variometer or coupler.





SING SING PRISONERS ENJOY RADIO. Prisoners that have good records are permitted to have radio receiving sets in their cells. Many of the prisoners have built their own receivers, some of them being very elaborate affairs. © Kadel & Herbert.

LARGEST PORCELAIN INSULATOR EVER CONSTRUCTED. The massive insulator is ten feet high and two feet in diameter at the widest part. It was built by a German company for a new high-power radio station near Berlin. It is constructed in three sections, each of which may be used alone, if desired. © Kadel & Herbert.

Radio In Foreign Lands



JAPANESE GIRLS LEARN SHORTHAND BY RADIO. At the right is shown a group of students of the Aoyama Institute in Tokyo, utilizing broadcasting to practice shorthand. © Henry Miller News.

TEACHING RADIO THEORY TO CHINESE. Prof. C. H. Robertson, a Y. M. C. A. lecturer, shows the natives of Shanghai the latest in radio, the set being mounted on the hand cart shown. © Underwood & Underwood.

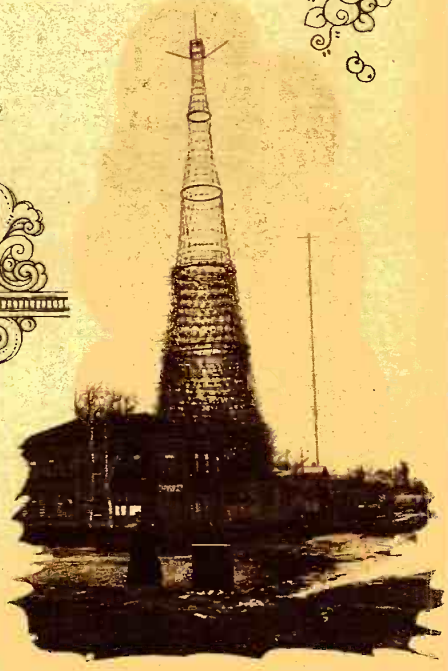




RADIO ON THE WINDSON. Judging from their smiles, this English boating party floating down the Windson must be enjoying the radio concert. © Underwood & Underwood.

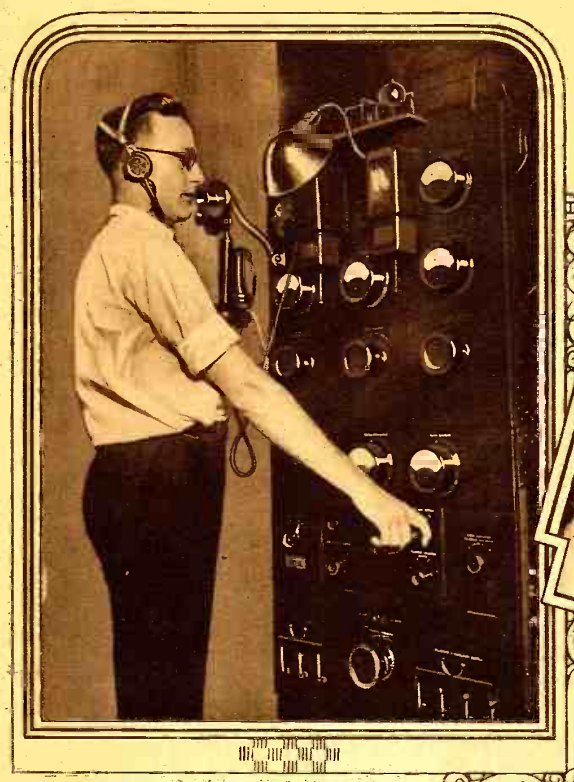


THE RIGHT OF SENIORITY IN SOVIET RUSSIA. The head of the family enjoys the programs while his son awaits his turn to listen to the Moscow station. © Wide World Photos.

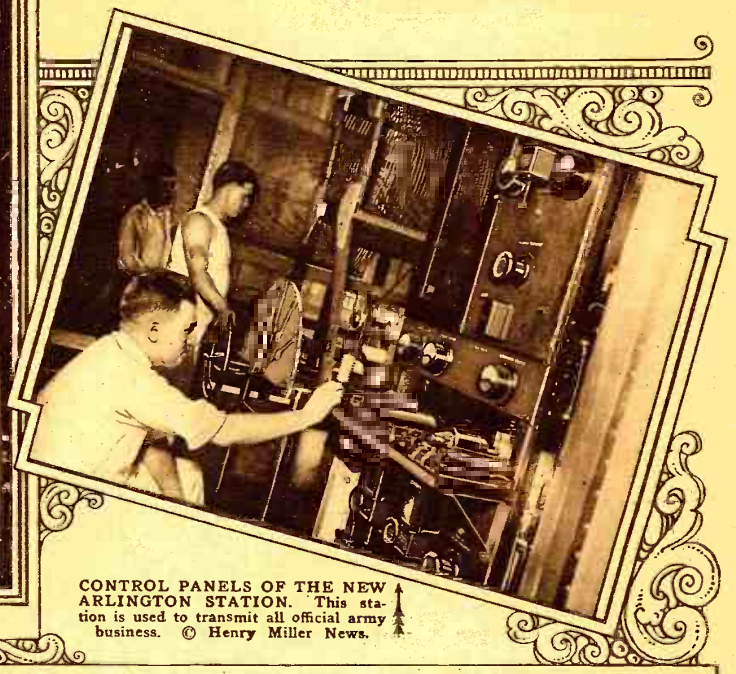


WHERE THE RED PROPAGANDA COMES FROM. The Tower of Shablovka, the "Eiffel Tower" of Russia, which the Soviet Government has made the center of the Moscow broadcast station. © P. & A. Photos.

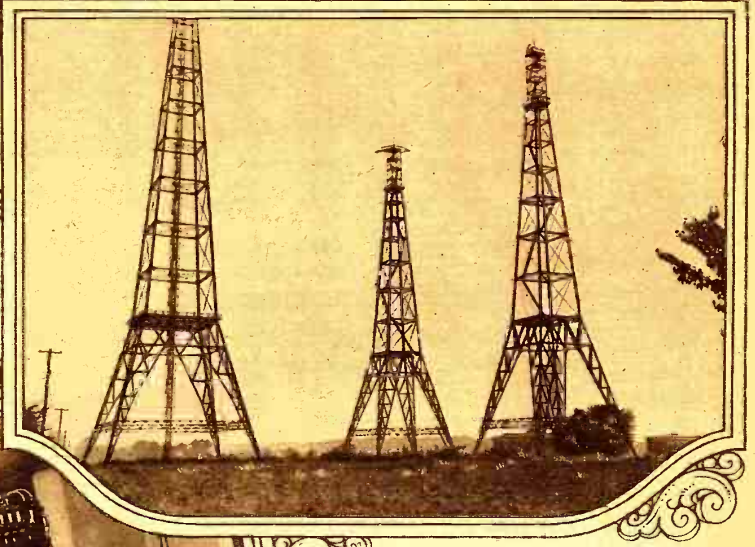
New Arlington Transmitter



TESTING THE NEW 500-WATT PHONE TRANSMITTER AT ARLINGTON. This station will be used for the broadcasting of weather and market reports and departmental information. © Henry Miller News.

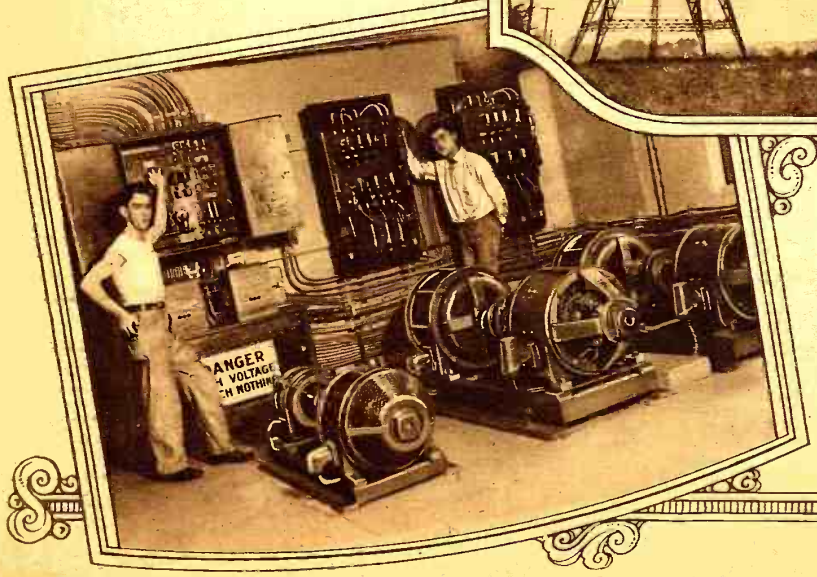


CONTROL PANELS OF THE NEW ARLINGTON STATION. This station is used to transmit all official army business. © Henry Miller News.



TOWERS AT ARLINGTON. Above is shown a general view of the towers for the new station. Two of the towers are 459 feet and the third is 600 feet high. This station will be one of the most modern in the United States. © Henry Miller News.

POWER GENERATING ROOM BUILT UNDERGROUND. The power room of the new Government station at Arlington is built underground to eliminate any possible interference. © Henry Miller News.



The Poor Fish



"At any event, they seemed to like the music and came in flocks. I had no trouble in catching them and was kept busy pulling out the fish that were so numerous around the horn."

By MOHAMMED ULYSSES SOCRATES FIPS
Head Office Boy

AS Head Office Boy, the duty often devolves upon me to keep things running in apple-pie order. Particularly so during vacation time, when all the editors, sub-editors, sub-sub-editors, and others are away on supposed vacations, and the magazine has to be gotten out in spite of them. That is when I begin to shine and when my great talents become apparent. The rest of the year I am usually squelched, but during vacation time everybody is so busy that I can slip in an article once in a while—which is the reason, of course, for this joyous outburst.

Ever since last year, when I described to you my now famous Cookoodyne, I have been laboring hard and valiantly to get up something original. So after all my plans had been completed, one nice sticky morning, when the temperature was hovering around 95, I took sufficient courage into my arms and walked into the sanctum of the editorial Maharajah.

The All Highest was sitting on his throne. I should correct myself right here and say that, not only was he sitting, but he was actually stuck on it—on account of the heat. This reassured me, for it gave me a distinct advantage in case I had to clear out in a hurry.

I approached him with three deep salaams, and after I had kissed the hem of his garments, I proceeded as follows:

"You know that at the present time it is impossible to give applause to the radio artists or performers, except by sending a telegram or a postal card, or maybe a letter, or then again, a brick. Or you telephone to the station and get the 'busy' signal. This leaves the performer with a cold and clammy feeling after he gets through, and he wishes he had never gone on the air. He craves immediate applause, but the four well-draped studio walls don't even echo his own voice. Now, my venerable master, here is my scheme. You know that most receivers squeal or howl when you turn one of the dials too far. *Why not utilize this squeal?* Suppose at the end of the performance every one listening in on the station's wave-length would rapidly twist his dial back and forth. Now every broadcast station could have a dozen super-sensitive radio receiving sets to collect *all* of these squeals and amplify them with a half dozen horns scattered all over the studio. The minute the performer or artist finished his selection he would be greeted with a blast of several million loud squeals that would be the equivalent of clapping. What do you think of the scheme, and can I get a patent on it?"

I had hardly finished when the Potentate threw two ink stands at me—one with black ink and one with red. These lit upon the opposite side of the wall and made two very pretty patterns.

Inasmuch as the King was stuck fast to his seat and could not move, and since no heavy missile was left, and the air seemed clear, I broadcast as follows:

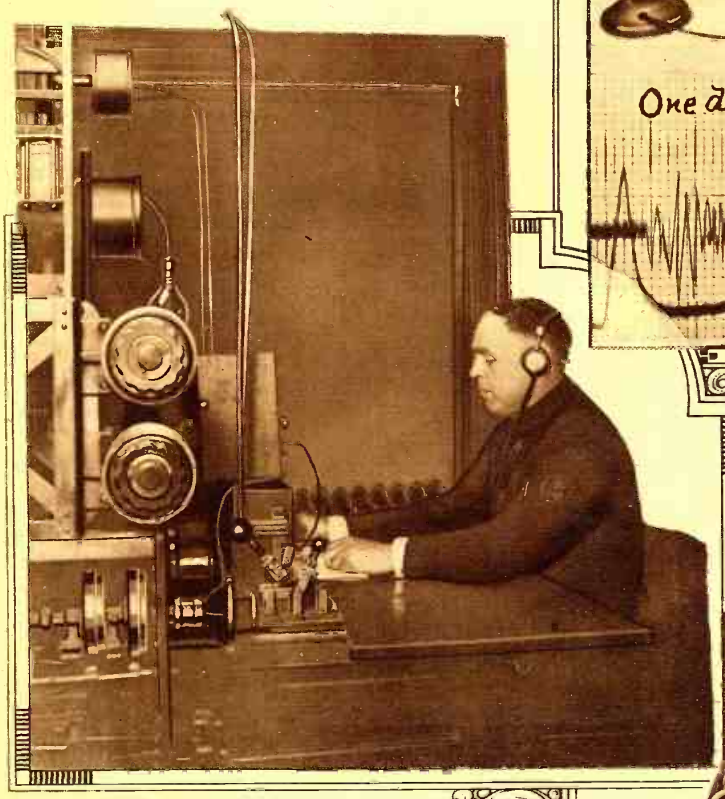
"Your Majesty," said I, "What would you give if I could lay before Your Honor a scheme whereby every fisherman in the United States would buy a radio outfit? There are, according to the latest statistics, not less than 8,649,008 fisher-

(Continued on page 387)

NEW YORK COPS HAVE POWERFUL SPARK SET. A 2 KW. spark transmitter has recently been installed at the headquarters of the New York Police Dept. © Underwood & Underwood.

DIAGNOSE ILLNESS BY RADIO. A Chicago doctor received the teleophotographic chart of a patient's heartbeats and then, by radio, sent his opinion to the American Medical Association convention at Atlantic City that the trouble was leaky heart valve. © Underwood & Underwood.

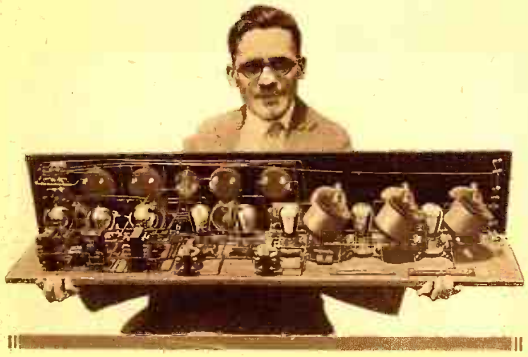


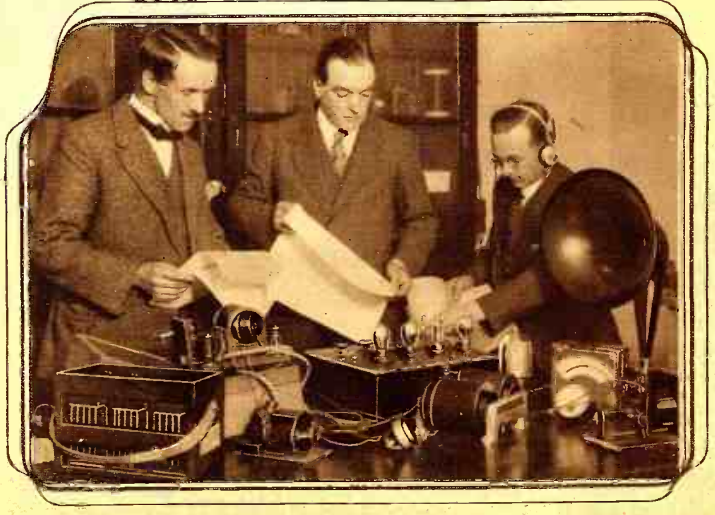


MEASURING GRID LEAKS. By light fluctuation or ear-phones the resistance of gridleaks may be measured with the new instrument invented by Capt. Forshay. © Foto Topics.



EIGHT-TUBE NEUTRODYNE. George Tolley of New Rochelle, N. Y., wanted volume as well as quality and it is reported that his receiver can be heard over a mile away. The power amplifier operates on the push-pull principle. © Kadel & Herbert.





AND NOW SECRET RADIO? An organization known as Secret Wireless, Ltd., claims to have a process which enables messages to be sent out over the air which can be received only with a special receiving set. The new company seeks competition with the British Broadcasting Co.

The Staccatone at WRNY



THE Staccatone which you now hear between numbers when listening to station WRNY, the radio broadcast station of RADIO NEWS, is the invention of Mr. Hugo Gernsback, and was developed and built in the RADIO NEWS Laboratories.

Fundamentally, the Staccatone comprises an audio frequency oscillator for furnishing the audible tones, and a special clock-driven switch for connecting condensers in and out of the oscillator circuits, so as to furnish the several different tones.

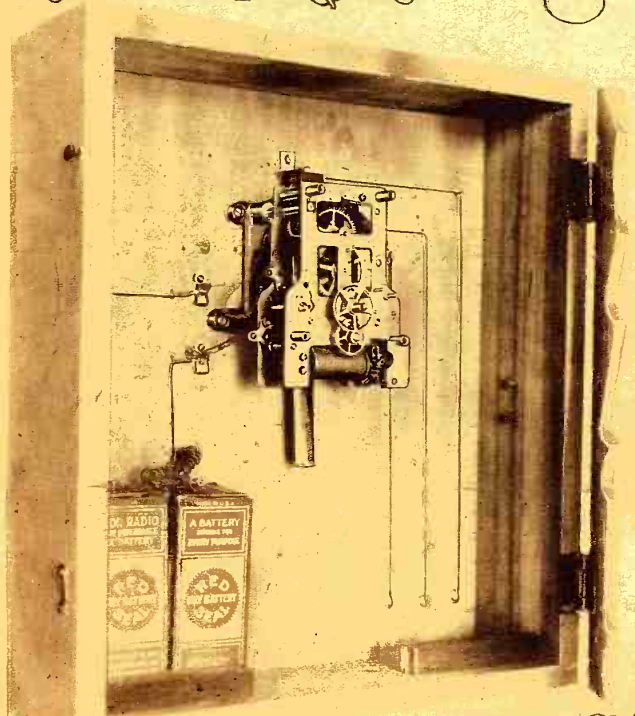
Simplicity of construction and operation is obtained by using a self-winding clock, which never runs down excepting when the two dry cells in the bottom of the case wear out.

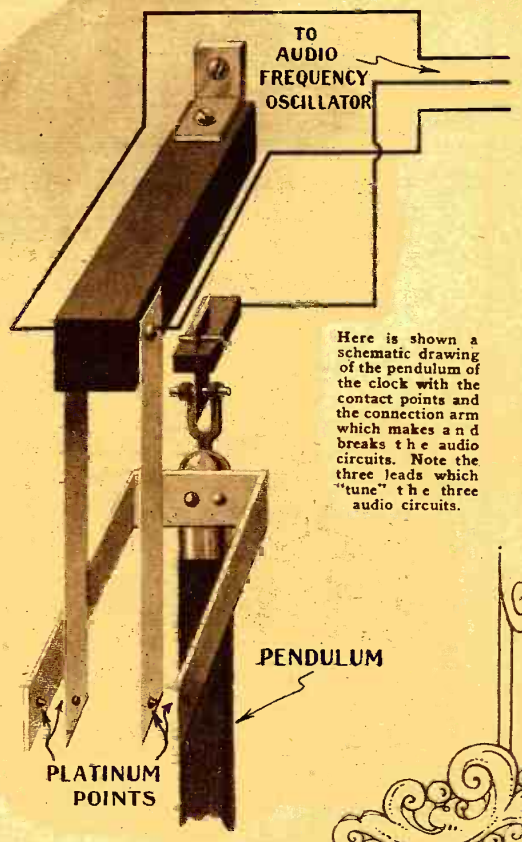
The clock mechanism is shown at the lower left-hand corner of this page. The switching arrangement is shown in the right-hand corner. The stationary part of this switch is mounted on the back of the clock case, while the movable part is fastened to the pendulum. The latter has been cut short, so as to increase the speed and cause the tones to change rapidly enough so that a person receiving WRNY cannot by any chance pass over it if his set does not whistle.

The contacts on the switching arrangement are platinum points, and once the apparatus is adjusted properly it requires no further attention excepting to replace the dry cells about every six months.

The photograph at the top of the page shows the whole assembly while in the process of development. While trying it out, the tones were simply fed into a loud speaker from the audio frequency oscillator, whence they were picked up by a microphone and then fed into the transmitter. The oscillator is on the table with the loud speaker and microphone on top of the clock. When finally installed, the clock and associated apparatus was mounted on a wall and the loud speaker and microphone eliminated.

Above is the complete view of the Staccatone. The clock with the face removed furnishes the circuit-breaking arrangement which cuts the various condensers in and out of circuit. The condensers act as tuners for the audio frequency oscillating circuits, which give rise to the pure oscillations that form the characteristic sequence giving the Staccatone its note.

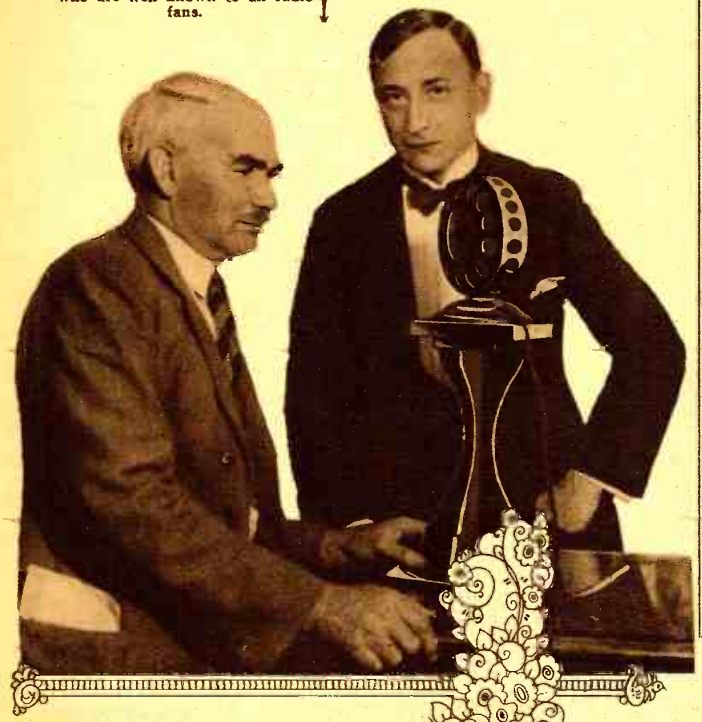




Here is shown a schematic drawing of the pendulum of the clock with the contact points and the connection arm which makes and breaks the audio circuits. Note the three leads which "tune" the three audio circuits.

At the left is a close-up of the complete clock arrangement. The audio frequency generated by the oscillating vacuum tube passes to the loud-speaker which is set near the microphone. The microphone picks up the signals and carries them to the transmitter panel, where the Staccatone is used to modulate the carrier wave of the station.

WRNY OPENING



LEE DeFOREST AND HUGO GERNSBACK. On June 12, 1925, the station of RADIO NEWS, WRNY, broadcast talks by these gentlemen, who are well known to all radio fans.

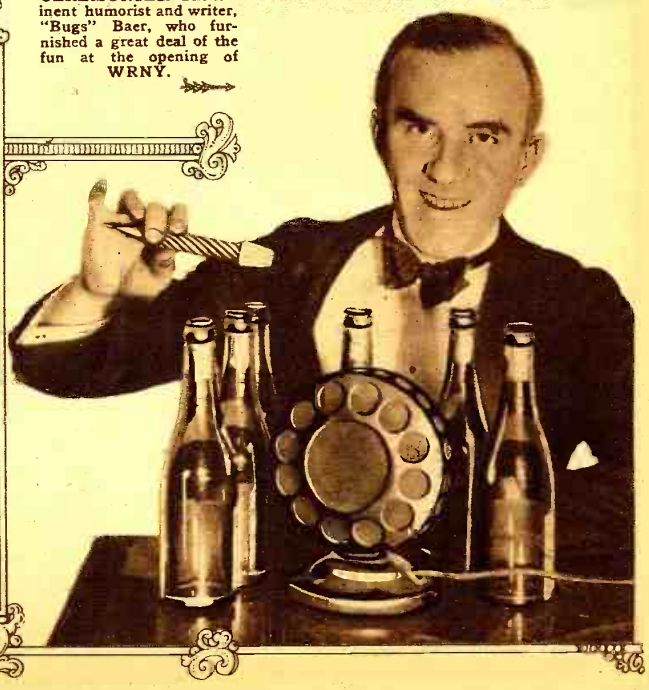


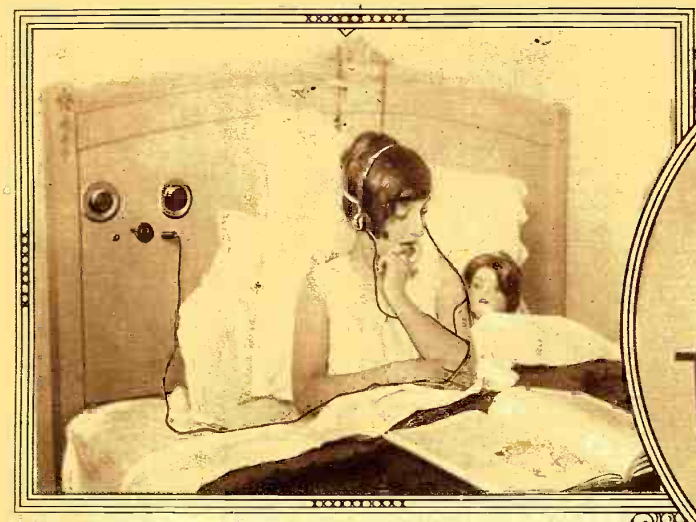
GILSON V. WILLETTS AND WENDELL C. HALL. Mr. Willetts, the chief engineer of WRNY, being congratulated by Mr. Hall, who is widely known as the composer of "It Ain't Gonna Rain No More."

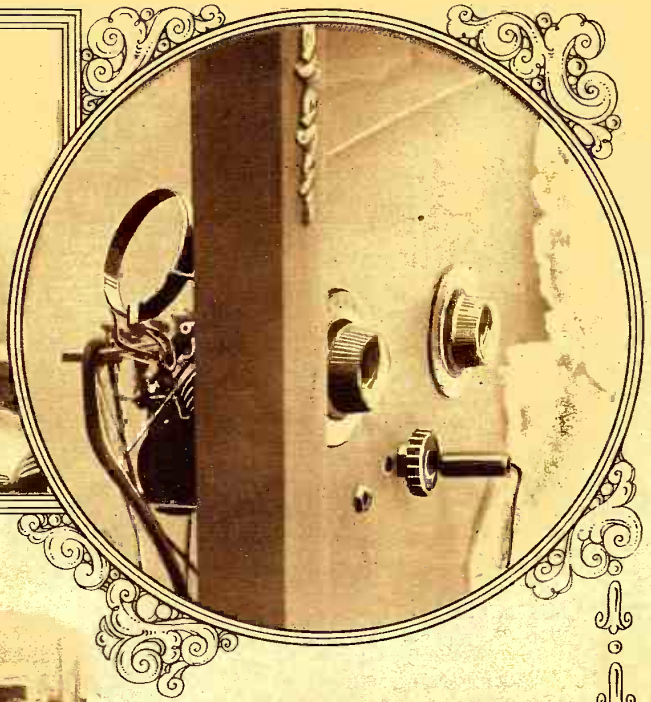
CHRISTENING WRNY. Elsie Janis, musical comedy star, broke a bottle of Adam's Ale over the microphone at the opening ceremonies of WRNY.



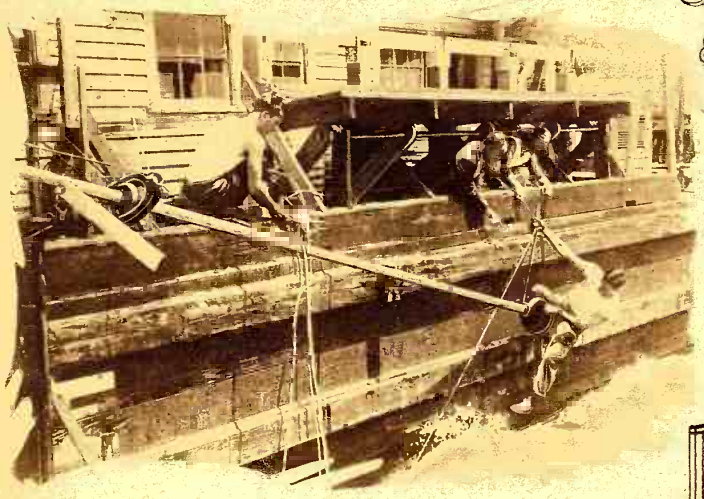
THE MASTER OF CEREMONIES. The eminent humorist and writer, "Bugs" Baer, who furnished a great deal of the fun at the opening of WRNY.







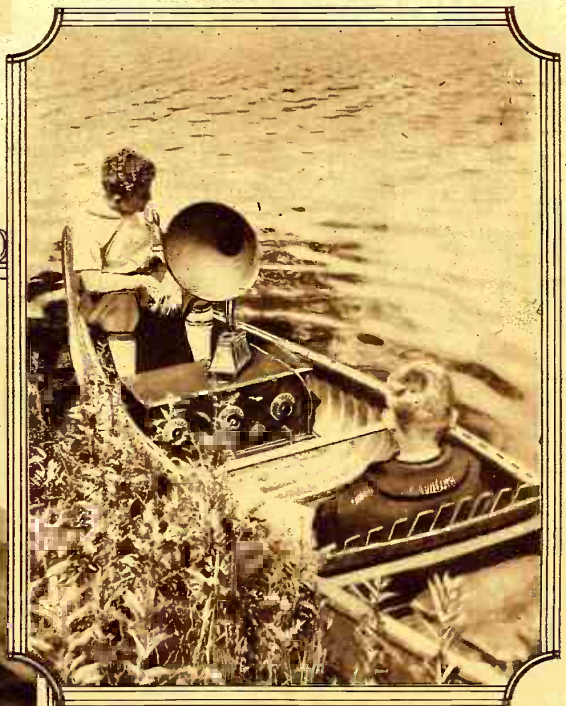
THE CORRECT WAY TO GET A BED-TIME STORY. Mr. Freisinger of New York City installed a two-tube receiver as shown in the above photographs, so that Muriel could get the bed-time stories after she was tucked in the covers. © Underwood & Underwood.



ANTENNA FOR UNDERSEA TELEPHONE PERFECTED BY NAVY. Lowering the antenna into the water for communication between submerged submarines. This system was recently perfected at the Government Research Laboratory at Bellevue, D. C. © Wide World.

MAKES UNDERSEA TELEPHONE CONVERSATION POSSIBLE. Here is shown Dr. H. C. Hayes, U. S. Naval expert, who is in charge of the experiments that have proved successful for submarine communication. © Wide World.





CANOEING UP-TO-DATE. There are not many better ways to spend a summer afternoon than out on a lake in a canoe listening to strains from the sweltering city. © Underwood & Underwood.



The Life and Work of Lee DeForest

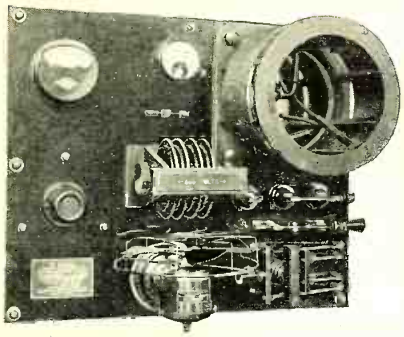


PART XII

NECESSITY is always the mother of invention, so it is said. The old adage holds true in regard to DeForest's discovery of the amplifying characteristic of the audion amplifier. It was during his work on the old telegraphone for the Federal Telephone & Telegraph Company, on the Pacific Coast, that he recalled an experiment made in 1907 at the time he was bringing the audion to perfection. At that time he had needed an amplifier of some sort and decided to try his new detecting device in that capacity. Accordingly, he rigged up an audion to a pancake coil, placed a microphone in the primary circuit of the pancake, took the grid lead off the secondary and placed a telephone receiver in circuit. It might have been his own enthusiasm that prompted him to say that it *did* amplify a little, and it might have been the actual result of the experiment. Anyway, after a long and particularly hard night with the telegraphone, in which he broke three of the Einthoven wires and nearly blinded himself repairing them, he decided to try the audion again as an amplifier.

THE AMPLIFIER INVENTED

So the following day when he came to the laboratory, his first step was the assembly



It was during the time covered by this chapter that DeForest developed his famous quenched spark transmitter shown above.

of the necessary parts for the experiment. He fell back upon the first instrument at hand for the transformation of the current from the microphone. It happened to be a telephone repeating coil . . . and thereby hangs the tale of the oscillating audion to which we owe radio broadcasting, as well as the three-electrode amplifier.

It was imperative to circumvent the use of the telegraphone if the ideal of high-speed reception was to be attained. Therefore, DeForest worked hard and long with the amplifier.

The apparatus was set up and the microphone spoken into. The resultant speech coming from the plate circuit was louder than it was when it entered. Then he made some changes in the impedance of the circuit. Another test was made. There was another addition to the volume of reproduced speech

DeForest immediately rushed out and called to all the engineers who were about the laboratory to examine his new device. Van Etten, who was afterwards one of the foremost witnesses in the suit brought by DeForest for the ownership of the oscillating audion, was one of the engineers. He was also one of the most skeptical of those gathered to see the latest advance made by DeForest. Several trials were necessary with the microphone before the men believed that DeForest's claim was true. They finally had to admit it, however, and once having had the fact proved to them, were as enthusiastic about the new development as the inventor himself.

IMPORTANCE OF HIS DISCOVERY

The most obvious use for this new principle at once made itself known. With radio, of course, it would be a boon to those stations and operators troubled with reading weak signals and signals through static interference. But the great adaptation was, of course, to the telephone service.

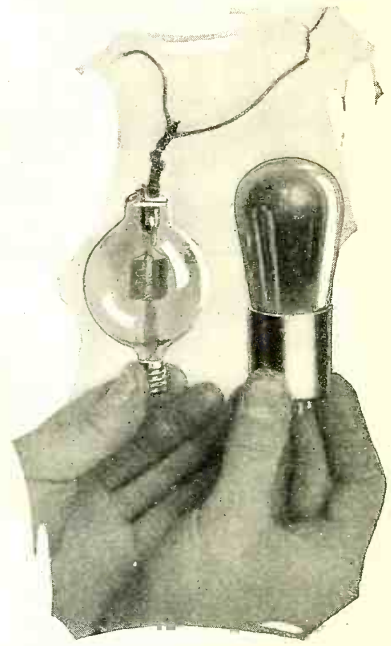
With the successful operation of one tube as an audio frequency amplifier, DeForest immediately set about finding a method for employing two tubes in that capacity. Then three were tried. With the principle thoroughly discovered, the remainder of the work was easy. It consisted in finding the proper impedance values for the circuit and the correct biasing of the grid.

It was in the course of one of these experiments that the ability of the audion to act as a generator of high frequency currents was discovered. The audio transformer which was being used to increase the voltage ratio was a standard piece of telephone equipment with four windings on primary and secondary. Only two of these were employed in the experiment. But it so happened that in placing them in the circuit there was accidentally a magnetic connection between the grid and the plate. The results in the light of our present-day knowledge, were to be expected. At that time it was a queer piece of business, however, and a stunt that immediately set the doctor off on a new trail of experimentation. The result of the accidental connection of the two circuits resulted in a very marked audio frequency howl.

In the various patent interference suits filed after the disclosure of this experiment, one of the strongest proofs in favor of DeForest was the fact that immediately after the discovery of this new and astounding principle he explained his invention, in considerable detail, to his friend, John Stone Stone, telling all about the oscillating of the audion.

NEGOTIATIONS WITH THE A. T. AND T.

These events occurred in the late summer of 1912. As soon as DeForest had perfected the amplifier to a point at which it was dependable and some quantitative study had been made of the characteristics of the circuit and the apparatus used, he wrote again to Stone, asking him to arrange a demonstration before the engineers of the American Telephone & Telegraph Company.



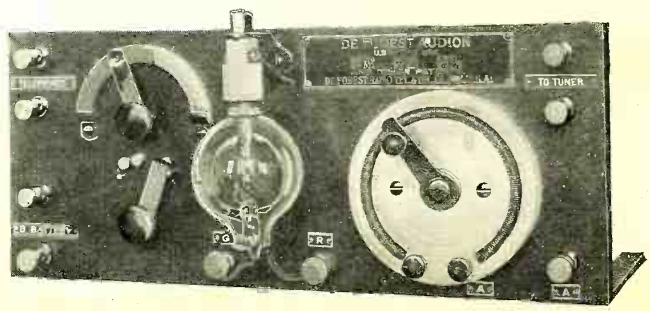
The daddy of the present-day radio tubes shown with the modern product.

Mr. Stone was intimately acquainted with John J. Carty, then Chief Engineer of the A. T. & T. It was only a short time after he had dispatched the letter that the answer arrived, stating that the appointment had been made for the first two weeks in October. DeForest immediately set his affairs in order with the Federal. It was arranged that his salary was to continue within a reasonable limit of time while he was making the demonstration, and that he should go to New York immediately for the test of the new amplifier.

He arrived the first week in September, and went immediately to the National Arts Club in Gramercy Park Square, where he met Mr. Stone and told him at length of the amplifier and the oscillating audion. As soon as his apparatus arrived, DeForest went to the attic of the club where the two large boxes were stored and began to set up the component parts for a private demonstration.

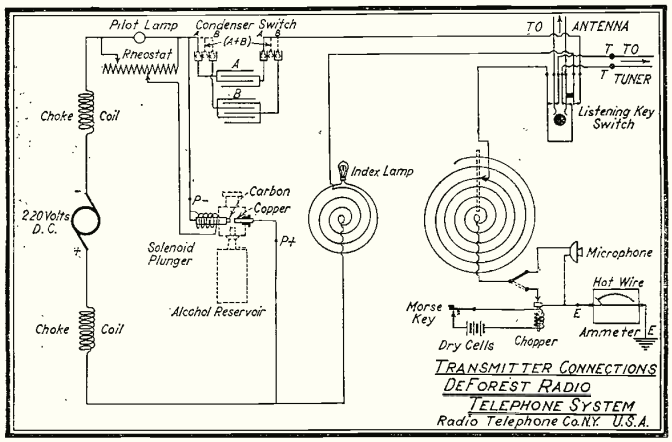
THE DEMONSTRATION

Then the trouble began. Mr. Carty was busy with one thing and another and was out of town for a short time, so that the demonstration before the engineers of the



Here we show one of the DeForest audion sets of the before-the-war vintage. DeForest cultivated the amateurs by manufacturing a complete line of apparatus for their use.

Biography recorded by W. B. Arvin of RADIO NEWS, *under the personal direction of Dr. DeForest. Copyright, 1925, by E. P. Co.*



The forerunner of the quenched spark set shown on the previous page was the arc telephone, the wiring diagram of which is shown at the left.

Telephone Company could not be arranged until the 30th of October. At that time, however, DeForest took his paraphernalia to the laboratories, and before the representatives of the technical staff of the Telephone Company and the Western Electric Company he gave the first public demonstration of the audion as an amplifier of weak electrical currents. He showed the use of a single stage, two stages in cascade and finally the three-stage adaptation. At first the engineers were enthusiastic. The new scheme of amplification, they thought, showed great promise of revolutionizing the current practice in long-distance telephony. These remarks, of course, came from the smaller engineers. Those in charge of affairs kept their opinions pretty closely to themselves. This was as it should be, for the engineers must wait upon a few conferences and depend upon the acceptance of reports before they may take any final action upon the purchase of the patents.

DeForest put the thing through all sorts of antics at the behest of the technical men. When he left the telephone laboratory he was in the highest of spirits. He thought that in eight weeks at the very most he would receive an offer from the Telephone Company of about $500,000 for the use of his new amplifier. He settled down to some of the problems he had brought with him from the Federal to consume his idle hours until the messenger from the Telephone Company should arrive.

But after the eight weeks, nothing at all happened. He continued to wait. When three months had been consumed and nothing had been done, he wrote to Carty, asking for some explanation, saying that any further demonstration or information would be given gladly, if the engineers were not convinced of the practicability of the new device. The answer was that the engineers were still investigating the device and had not yet come to a decision on the matter. He would, he said, inform DeForest as soon as any definite action was taken on the matter. This state of affairs continued for some months. The status lasted, to be exact, until the end of January, 1913. At that date, the Federal Company informed DeForest that it would be impossible for them to continue the payment of his salary. DeForest, being at that time very anxious to put the old Radio Telephone & Telegraph Company again on its feet, took an early train for the California shores and his old laboratory.

DE FOREST RETURNS WEST

Temporarily, he plunged again into the work of the Federal Company on their high-speed transmitter and receiver. One of the first steps in this direction, of course, was the adaptation of the new amplifier to the reception of undamped arc signals from the stations in San Francisco and Hawaii. His second experiment was in connection with the key tape puncher and the automatic keying system which picked up the signals from the tape and transmitted them to the antenna circuit.

Incidentally, this system is still in operation and is utilized in many of the long-distance circuits where the extremely long waves are generated by arc and high frequency generators.

It was in connection with this work that he finally proved, without room for any doubt, that the audion would oscillate at its own period. At the time DeForest had made the original disclosure to Stone, he had tried the heterodyne method of reception of undamped waves, thus eliminating the tikker and at the same time increasing the effective range of the sending station by making the receiver much more sensitive. He first attempted it with San Francisco from the Palo Alto station.

At the time he gave the first description of the oscillating audion to Stone, he told pretty fully the account of the method and showed how the pitch of the note could be changed with a variable condenser in one of the tuned circuits.

On April 17, 1913, at the San Francisco station of the Federal Company he received and copied the signals of the Palo Alto station and called in the engineers of the company to witness the feat.

DeForest amplifier was a godsend to the development of their scheme.

Their idea was simply to use the telegraphone record, which was a piano wire with a magnetic record of the musical vibrations, as an adjunct reel to the film with the pictures. Through this method there was perfect synchronism at all times. The chief trouble was, of course, the reproduction of the music in proper volume and with proper timbre.

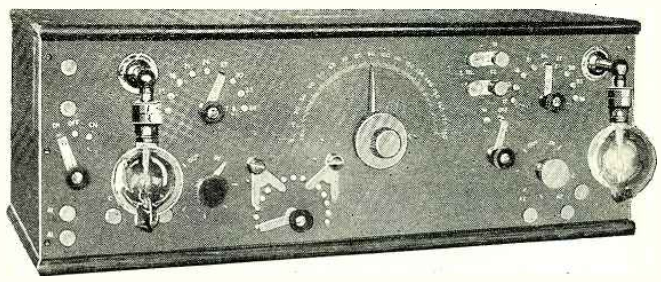
As soon as DeForest made his appearance again in New York, the officers of the company making the development went to him with their plans and submitted a proposition. He went to work with them as a consultant and spent a great deal of time at the old Biograph studio, supervisiong the production and reproduction of the new talking motion pictures.

WORK AT BIOGRAPH CO.

All the time he was at work at the Biograph he was keeping a weather eye on the doings of the Telephone Company with regard to the disposition which they intended to make of his amplifier. It was his dream to again establish the Radio Telephone Company on a sound basis and go ahead with his former experimental work under his own direction. The price the A. T. & T. would pay for the use of his patent would, he thought, be sufficient to resuscitate the treasury of the company so that the regular routine could again be established.

He continued with the Biograph outfit, trying to sell them a license under his patent. They were enthusiastic about it, but after several attempts to raise the necessary funds for the purchase of the rights found that their resources were extremely limited. They could not finish the deal. Once again DeForest was thrown back solely upon the prospects of the A. T. & T. sale alone. Month dragged after month, and still there was no word from them. DeForest's financial condition was becoming constantly more acute. Something had to be done. He importuned Carty for some sort of answer, hoping to obtain word upon which he could capitalize. Carty was non-committal; he had, he said, nothing to say in the matter, since it was entirely in the hands of the Supervisory Board and DeForest must await their decision.

DeForest waited.



Here is a photograph of a typical DeForest commercial receiver. It was sold to many ship and shore stations.

TALKING MOTION PICTURES

The first of the following month, DeForest again left the Federal to come back East. Before he had returned to California—while he was in New York demonstrating the amplifier for the telephone engineers—he had met two gentlemen who were interested in the commercial development of the telegraphone arrangement attached to a motion picture machine for the production of talking motion pictures. Music was attempted in the reproduction, and if the thing was to be made a success, it was necessary, for the development, that there should be an amplifier with an absolutely true characteristic. None of the devices developed up to that time for use in telephony were suitable, since they were constructed to give amplification at a certain characteristic frequency. Therefore, the appearance of the

The situation was worthy of an old backstairs thriller. DeForest was penniless and desperate. The big corporation, squeezing, etc., . . . when the climax arrives.

DeForest was sure his invention was worth at least $500,000 to the Telephone Company It would make possible telephony over any distance and would rid the problem of all the difficulties which had faced the engineers for such a time.

ENTER MR. MEYERS

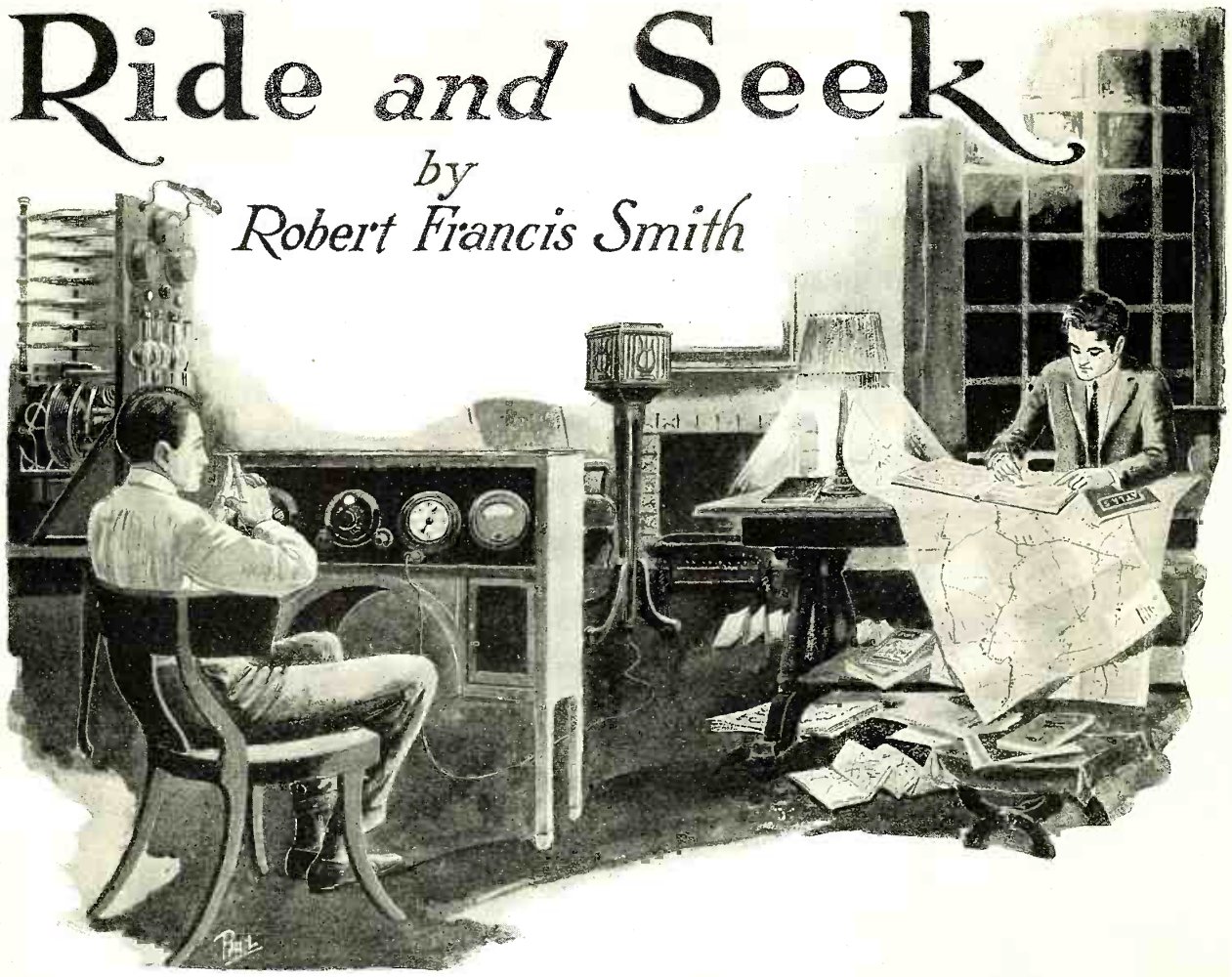
Then one day Mr. Myers—Sidney Myers—sent his card in to DeForest. It seemed that the gentleman was an attorney He wished to have a few words with the doctor concerning his amplifier. DeForest asked that he be sent up. There followed the usual amenities working toward the business

(*Continued on page* 356)

Ride and Seek

by

Robert Francis Smith



The Master and Joe Hammerstein tracing the Doctor by the latest radio invention of the world's foremost scientist.

IT'S one of those balmy summer's evenings and the crowd's all there, not a very goodly one, but a warm one. If being the last week of August, everybody's telling everybody what a nice time they've had this summer, and how they hope they'll meet again—somewhere. In our particular gang there's five more or less rational radio fiends, all gathered on my front porch, passing the time of night, mixed with a little bull.

"Well, folks," I says—oh, pardon me, I'm Joe Hammerstein, of vaudeville—"what say we take in a few concerts *à la* heterodyne?"

Doc Maxwell shakes his head. "Oh, I don't know," he says. "Radio is all right, but this eternal broadcasting is really, well, you know, so much the same."

Doris, my eagle-eye, admits the fact. "All we hears is mixed bed-time stories and market reports to the tune of 'Oh, Katharina.' If they ever gets far enough along to have radio movies, it'll be the grand old game once more."

"A possibility, isn't it?" inquires Doc, of a tall, thin, horn-rimmed individual seated in a camp chair. "Jerry, what's the latest on radio movies?"

The Master—that's Jerry's reception hall monicker—sits up, in his abstract way. "Radio movies?" he queries. "So far they've not done more than send stills, although they're working on it. For myself, I've not tried."

You see, Jerry—Gerard Lawson by name, rich, regal and rummy—is our local inventor. Some of his things works; others—well, there's been some question. But we all respects his opinions, even Doc, who's no mean authority on science himself, pays attention when The Master voices his sentiments.

To keep up the chatter I horns in and asks Jerry what's new in radio. I only asked him the same question about 2,447 times in the past two years, but he responds bravely.

"Not a thing, Joe," he says, musing. "The possibilities of radio, insofar as anything supplementing broadcasting is concerned, seems to have been exhausted. We have death rays, radio pictures and numerous other devices that have been proved, to say nothing of hundreds of quack ideas that've never been tried out. I have several myself."

I could agree with him, but I'm polite and don't.

"Nothing at all new?" queries Doc, casually. "Isn't there something being done that hasn't been published?"

The Master shakes his head. "Nothing by anyone of repute, aside from those things which I've mentioned. However, radio control of remote objects is receiving a large amount of attention in all lines. This, I believe, will be the biggest development in the future of radio. And then, of course, there are improvements to be made on devices already proven. Oh, the field will be busily occupied, but the newer ideas will be slower from now on. Really, I can't think of one use to which radio has not been either put or suggested."

Doris butts in with the happy suggestion that we ankle into the food emporium and watch the lemonade play with the sandwiches. We does, but the air of radio is still with us—no crack intended.

"Along what lines are you working?" queries Doc, while Doris and Mrs. Maxwell get the chow in order.

Jerry meditates. "Of late I have been trying to devise some scheme of things whereby radio could be used by the average man for something more than listening to concerts. Programs lose their novelty after a few months, and the listener desires new fields to conquer. Right now, some way of utilizing radio in a different way than listening in would be worth a small fortune to the inventor."

Which we soaks in along with the delicatessen. After we're through annoying the digestive organs, we decides we'll see what's being thrown into the ether, for lack of anything else to do.

The Master tunes in and gets WGY, and we listens in for a while It's plain most of us are bored. A suggestion for something new is in order, but don't seem to be forthcoming. The Master's got a lot of his devices on my set, and finally he tunes into another station, in the middle of a program. Then the little innocent utters the fateful remark.

"That's WEAF," says Jerry, absent-like.

(*Continued on page* 368)

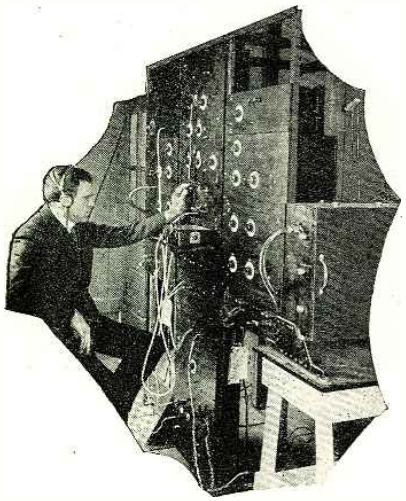
Directional Reception Reduces Interference

By PAUL C. HOERNEL

The reduction of interference in radio reception is a problem that has long been under consideration. The following article describes one of the phases of this problem and its solution.

IT was early realized by radio engineers that the future possibilities of radio transmission were greatly dependent upon some effective means for the reduction of the effects of static. Long distance radio transmission from continent to continent is still somewhat an uncertain means of communication, both telegraphically and telephonically, due mainly to nature's broadcasting of "static." The radio enthusiast who is interested in the reception of broadcast radio programs knows only too well the havoc that static plays during the summer months. Various types of wave antennae, etc., have been suggested from time to time as means for effective static reduction, but all of these have proved more or less impracticable for the radio amateur and are more satisfactory in general for the reception of telegraphic signals.

Mr. H. T. Friis of the Bell Telephone Laboratories has recently suggested an effective means of static elimination by directional reception which is an important step toward the final solution of the problem. The scheme is not outside the realm of possibility of construction for the radio amateur.



Panel view of twin-loop receiver as developed By Mr. Friis.

THE NATURE OF STATIC

Static in general is due to the occurrence of electrical discharges in nature which usually result in highly damped waves being "broadcast." The effect of such highly damped waves upon a tuned radio circuit is to set up in the circuit free oscillations having a frequency and a damping determined by the constants of the circuit. A mechanical analogy is the tuning fork; when struck a sharp blow by a hammer it continues to vibrate at its own natural pitch. The properties of electrical vibrating systems are very similar to those of mechanical vibrating systems; if either is struck an impulsive blow, it will tend to set the system vibrating at a rate or a pitch determined by the electrical or physical dimensions of the vibrating system. Static is impulsive in nature and this property makes it impossible to discriminate against it by frequency selective means.

A rather interesting property of most summer static is that it has definite points of origin and definite directions of propagation. A receiving system of the usual type has no directional selectivity and is, therefore, subjected to static impulses from all directions. Mr. Friis' scheme for effective static reduction takes advantage of the directional characteristics of static and reduces its effect by the use of a highly directive receiving system. Of course, static waves which approach the receiving station in the same direction as the wave from the transmitting or broadcast station cannot be effectively eliminated.

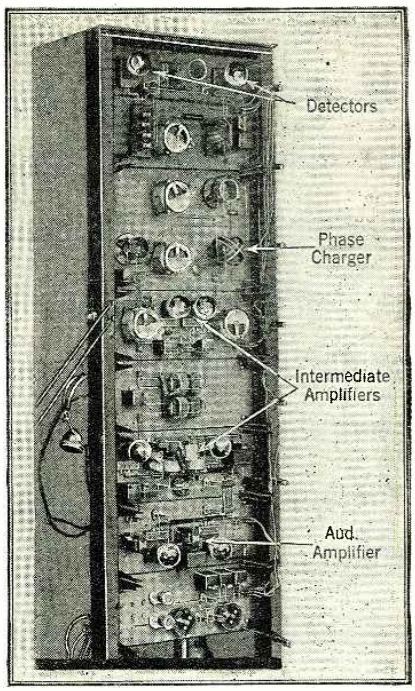
THE FRIIS DIRECTIONAL SYSTEM OF RECEPTION

The receiving system developed by Mr. Friis in the Bell Telephone Laboratories is shown schematically in Fig. 1. The receiving system consists essentially of two similar loop antennae, arranged to have their planes substantially coincident and perpendicular both to ground and to the plane of the wave which it is desired to receive. The mid-points of the loops are connected to the "ground" of the set in order to reduce open antenna effects.

The main feature of the system is the arrangement for controlling the output voltages of the two loop antennas so that they may be combined to neutralize each other or to enforce each other, as desired. A super-heterodyne receiver is employed, making use of an intermediate frequency detector for each loop; the plates of these intermediate frequency detectors are connected in parallel to the intermediate frequency filter.

The secondary winding of a variable coupling transformer is inserted in series with the lead connected with loop No. 1 to the grid of its detector tube. This transformer supplies the beating oscillator current to the antenna circuit No. 1. The beating oscillator current is supplied to antenna circuit No. 2 through a *phase-shifting transformer* which comprises two fixed coils having their planes mutually perpendicular, and a third coil which is rotatable inside the fixed coils. One of these fixed coils, the primary windings of the beating current input transformer to antenna circuit No. 1, and the primary winding of a coupling transformer and a tuning condenser comprises the primary circuit tuned to the beating current frequency. The other fixed coil in the phase-shifting transformer is part of the secondary tuned circuit, which is loosely coupled to the primary circuit.

At resonance, the currents in the primary and secondary circuit are 90 degrees out of phase. Any desired phase angle of the beating current input to antenna circuit No. 2 and the beating current in antenna circuit No. 1 can therefore be obtained by rotating the phase coil. The amplitude of the intermediate frequency current is proportional to the product of the *beating* and *signal*



Rear view of the receiving equipment.

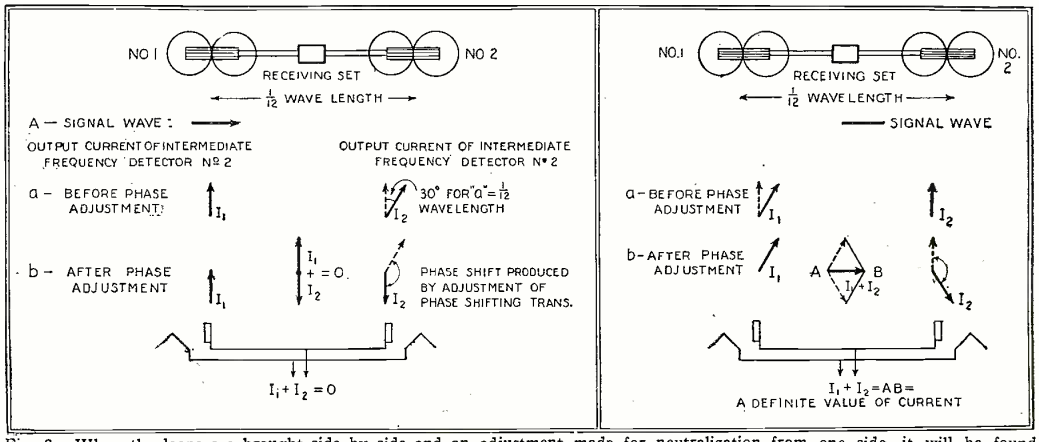


Fig. 2. When the loops are brought side by side and an adjustment made for neutralization from one side, it will be found that static interferences from the other side are also neutralized.

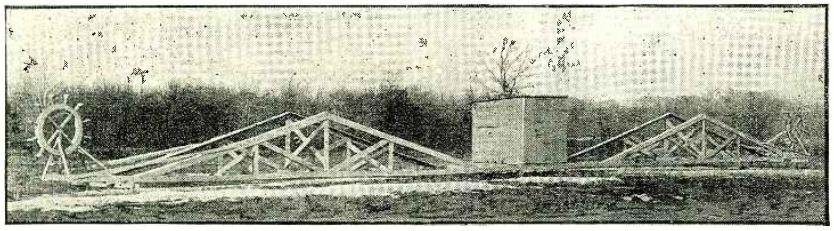
currents. Hence, any phase difference between the outputs of the two loops, or between the beating oscillator currents in the two loops will appear also as a phase difference between the outputs of the intermediate frequency detector tubes. This will shortly be fully discussed.

The rest of the set, namely, the intermediate frequency amplifier, the intermediate frequency filter, the low frequency detector and low frequency amplifier are all well-known apparatus of the type usually employed in double detection, and no detailed description of them is necessary.

SPACING OF THE LOOP ANTENNA, ETC.

An analysis of the system shows that the resultant current entering the intermediate frequency band filter is dependent among other things upon two essential factors:

(1) The separation of the loop antennae. The magnitude of the signaling current entering the intermediate frequency band filter increases proportionately to the separation of the loops and, for the optimum adjustment, reaches one-half the maximum possible value (the same value as one loop alone would give) when the separation is one-twelfth of the wave-length. The phase difference between the outputs of the loops under these conditions is 30 degrees. As the separation is increased beyond one-twelfth of the wave-length, the increase in signal current entering the intermediate frequency band filter increases more slowly than the separation and reaches a maximum value at one-quarter of the wave-length. As we increase the separation of the loops beyond one-twelfth of a wave-length the relative amount of interference increases.



Two loops mounted on a turn-table arrangement make possible the neutralizing effects herein described.

(2) The phase difference between the beating oscillator currents in loops No. 1 and No. 2.

Fig. 2 gives a top view of a two-loop system, showing the two loops, No. 1 and No. 2, with the receiving set in the middle. There is also shown in this figure the well-known directional characteristic of one of the loops, which indicates that the received current will be a minimum when the plane of the loop is perpendicular to the direction of an approaching wave. A single loop then is "blind" in two directions. The condition for obtaining a blind spot in a third direction, for instance, for waves coming from the left, is indicated under case A in Fig. 2. The vector I_1 represents the resulting current in the output of the intermediate frequency detector No. 1, if we assume for the moment that the beating oscillator currents in the two loops are in phase. On account of the fact that the wave reaches loop No. 2 a little later, the vector I_2, representing the current in the output of the intermediate frequency detector No. 2, has a phase angle 30 degrees behind I_1 for the case where the separation of the loops equals one-twelfth of the wave-length, *i. e.,*

$$\frac{360^\circ}{12} = 30^\circ.$$

We wish to neutralize I_1 by I_2, so the phase of the currents from the intermediate frequency detector No. 2 must be changed an angle of 150 degrees before they are added. This is accomplished by changing the phase of the beating oscillator currents in the two loops by the adjustment of the phase-shift transformer. I_1 and I_2 are now equal and opposite, hence their resultant equals zero. Under case B is shown the resulting current when the waves arrive from the right. Here I_1 is behind I_2 in phase, and after the same phase shift of 150 degrees of I_2, the two currents are now separated by 120 degrees only, instead of 180 degrees, as before. The resultant current is equal to I_1 or I_2—that is, equal to the current in one loop alone.

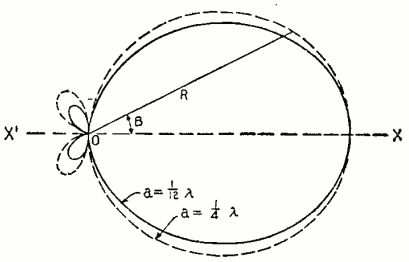


Fig. 3. The general form of the direction characteristics in which polar co-ordinates are used.

For waves coming from other directions, I_1 and I_2 do not balance out entirely.

An inspection of the diagrams of Fig. 2 shows that when the loops are brought side by side and adjustment made for neutralization of signal waves from the left, there will result also a neutralization of signal waves from the right. The system will then be "blind" to waves in all directions.

The general form of the directive characteristic is shown in Fig. 3, in which polar co-ordinates are used. It is seen that a very much more directive characteristic is obtained with the two-loop system than with the single loop. The dotted figure represents the characteristics corresponding to the antenna separation of one-quarter wave-length and the full line characteristics for a limiting condition which is closely approximated for all antenna spacing less than one-twelfth of a wave-length. It is evident that a distinct advantage in respect to the relative amount of interference received may be obtained by reducing the antenna separation to one-twelfth of a wave-length, although this is accompanied by a reduction of signal strength. To decrease the spacing still further will economize on the land required for the system, but will require more amplification with a corresponding increase in "set noise" and a higher degree of stability of the system.

SHORT-WAVE, TWO-LOOP SYSTEM

The system described in the foregoing paragraphs was tried out at the Bell Telephone Laboratories' experimental station at Cliffwood, New Jersey, with signals in the broadcasting frequency range, because the short wave-lengths of these signals make it possible to mount these two loops on a construction similar to a turn-table which is rotatable in a horizontal plane. Some of the accompanying photographs show the general construction of the antenna equipment. The distance between the loops is 34.4 meters, giving an upper limit of the wave-lengths of the signals to be received of approximately 600 meters. The loop antenna diameter is 1.76 meters and each of the loops are wound with six turns of bare No. 16 copper wire. It is quite important that both loops point in the same direction, although a variation of a few degrees is permissible. The circuit is the same as that shown in Fig. 1, except that the tuning condenser and loops are mounted in the receiving sets to improve the facilities of tuning adjustments. The experimental receiving set was installed in a house 6 feet square, which is shown between the two bridges. The ends and mid-points of each loop are connected respectively to the tuning condenser and ground of each set by three wires suspended in the horizontal plane about 30

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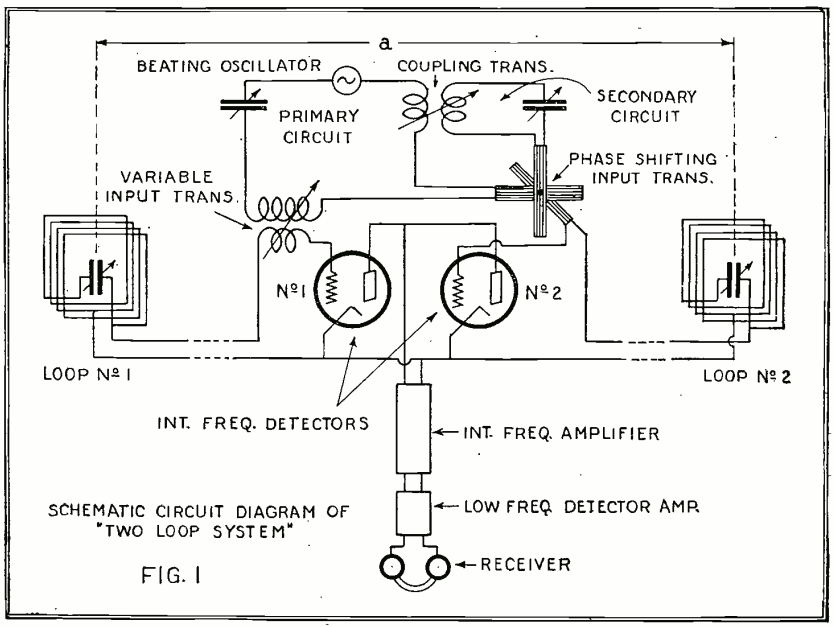


Fig. 1. Circuit diagram for static reduction system using two loop antennae.

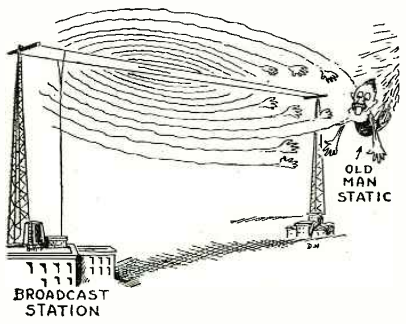
—The Listening Post—

Being a digest of the odd, interesting, more human side of America's greatest indoor sport. A treatise on the fads and foibles and general effect of Radio on civilization.

Conducted by Don C. Walk

Let's have an end to this anti-radio talk during the summer months. By far the most significant feature of this summer's broadcasting has been the putting aside of all doubt that static and other hot weather interference can be overcome. There have been few nights—and my notes cover a surprisingly large amount of intensely humid weather—when it has been impossible to tune in the most interesting and entertaining musical and feature programs.

There is static, to be sure. But it is a tamed, vanquished enemy which snarls at the broadcasters these days. There are too many superb broadcast stations, sources of surging waves which over-ride static with utmost ease, and leave the loud speaker as limpid, beautiful music, for any would-be fan to heed the doubting ones who are too blind to see—or, more literally, too deaf to hear. It has been a pleasure this summer to unearth new stations and to welcome older ones with increased power.



At the present writing, super-power seems to be the solution. Super-power, which rises above the crackle of static to bring one the best there is in the air. It is my earnest conviction that the summer of 1925 will go down in radio history as the season when it was clearly demonstrated that radio is an all-the-year-round source of entertainment.

More power to you, lustiest infant of the ages!

* * *

Those listeners-in who live in the Middle West, and therefore must receive the full ringing tones of the new pipe organ at WLW, are to be congratulated. This instrument, under the deft hands of Miss Johanna Grosse, enters one's living room with a pleasing sonority and volume, to say nothing of its fidelity of tone. I recall particularly the evening during the course of which the organ's ringing tones were accompaniment to the fine baritone voice of Mr. Ferguson, who sang, "Come, for It's June," "Give a Man a Horse He Can Ride" and "King of the Forest Am I."

* * *

Let us all extend congratulations to WGN for its magnificent scoop in broadcasting a number of selections by the *maestro,* Leopold Auer, accompanied at the piano by Mme. Auer. Here is adequate evidence of the hold radio entertainment has upon the public affection. This station was swamped with letters, wires and telephone calls following this recital by the illustrious *virtuoso* who taught Jascha Heifetz and scores of other artists the violin. Auer's radio appearance is another luminous milestone in the progress of this advancing art.

To this same station must be handed credit for another prize-winning musical event—the first radio introduction of John Philip Sousa, the master of all bandmasters. Such radio events can but mean the recognition of this Herculean infant as an accepted medium of musical dissemination.

* * *

Sousa's radio adventure makes me think of the excellent band music there is at hand for the listener-in who will dial to any of several stations. I recommend especially WEAF, New York, where during the summer recitals of the Goldman band are broadcast; WCX, where Sloman's Concert Band entertains almost daily from Belle Isle Park, and WDAF, where the Ivanhoe Band is a feature each week. All of these organizations are highly specialized, abundantly talented. Any one of them is worthy of the attention of the music lover.

* * *

Among the Far West stations which penetrate the pall of static and register well is KOA, Denver. I have listened to several most inviting dance programs from this Rocky Mountain station by the Harmony Peerless Orchestra, playing from one of the leading Denver hotels. This station—one of the super-power string operated by the General Electric Company—reaches my loud speaker with fine volume, and usually with an above-average program. Its magnificent voice easily overcomes the handicaps of hot weather broadcasting.

* * *

Dialing farther west, I must report with dismay, that KFI, Los Angeles, nightly recedes farther and farther into the crackle of Rocky Mountain static. I have kept faithful vigil, when all about me was silent and asleep, and the only sound was the mystic tinkle of distant music. I look forward with foreboding to the night when there will be naught but the crackle of the static and the snores of the non-radiotic individual in the next apartment.

* * *

Shakespeare has been acted by everybody of note on the stage, and some not of note. He has but recently reached the newest of media for the greater propagation of his magic talent.

I refer to the recent broadcasting of selected passages from "The Merchant of Venice" and "Twelfth Night" by the Community Players at WMAQ, Chicago. This event was successful to a marked degree. All the sagacious wisdom and enchanting beauty of this immortal bard's lines were retained in the radio rendition. The scenes broadcast were of special interest since they were those omitted from the stage versions in order to hold such presentations to reasonable length. The WMAQ players neglected no touch, no method of enunciation, which would tend to maintain the illusive quality of the poet's writing. I sincerely hope that WMAQ's success with this program will move other program arrangers to delve into the endless mass of material offered in the dramas of Shakespeare for further broadcast material.

* * *

Speaking of new stations brings to mind the best of the new crop—in my estimation—KPRC, Houston, owned and operated by the *Houston Post-Dispatch.* Here is a station which surely has the very best in transmitting equipment, as its power rating is only 500 watts, a fact I noted with the utmost surprise. KPRC comes over for me with astonishing clarity, consistency and general excellence of modulation. Its programs, at least those to which I have listened, are as fine as its equipment merits.

KPRC is one of the loudest stations now on the air. On the night I listened it came over louder and clearer than KDKA, WLW, WGY or any other of the many other super-power stations now in the air. Its program, also, on that night, was of exceptionally high standard. I refer to my notes, and find that I want to extend heartiest congratulations not only to the station, but to Miss Jane Camack, lyric soprano, Mrs. W. A. Stubblefield, organist of Trinity Episcopal Church of Houston, and the staff in general. Mrs. Stubblefield's accompaniments had much to do with the success of Miss Camack's renditions of "Will o' the Wisp" and "At the Well," and her playing of Chopin's Opus 28, No. 17, on the piano was a treat for the music lovers who must have been listening in.

To the directors of this station I wish to make this suggestion: Somewhere in this broad land there is a code transmitter with a sparker which played havoc with some of the program to which I listened, as it must have done for countless others. Run him down—and out!

* * *



The Thursday night offerings from WEAF, New York, and its associated stations are looked forward to eagerly by the writer. The Eveready Hour, the Atwater-Kent artists, and the Goodrich Silvertown Cord Orchestra are to be numbered among the best the air offers. If this be advertising, make the most of it!

A New Neon-Filled Rectifier Tube

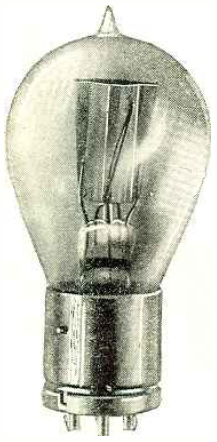
By JOSEPH RILEY

In this article is described a new development in rectifier tubes. There is no filament in this tube and its life is said to be much longer than that of the average tube on the market today.

MODERN radio is built up on the use of the thermionic vacuum tube. These tubes with two electrodes are used as rectifiers in battery chargers and as detectors in radio circuits; with three electrodes they serve as amplifiers of unequalled power and flexibility. They have in these uses become very familiar to radio amateurs. The conduction of electricity through such tubes, first investigated and explained by O. W. Richardson in 1903, is easily understood. The electrons, driven out of the filament as a result of its high temperature, are drawn across to the positively charged plate, and this electron transfer constitutes the current. Such a stream of electrons is called a "pure electron discharge." If this discharge is to remain simple in character, it is necessary that there should be a high vacuum in the tube so that the electrons strike few or no molecules of gas as they pass over from the filament to the plate. This condition is easily met in these days of high vacuum pumps. It is possible to draw out so much of the air that even if the filament-to-plate distance were three feet or more, only a few electrons out of each hundred would strike any molecules. Such high vacua have been obtainable, however, only during the last ten years. Prior to that time, partly through lack of suitable pumps and partly through ignorance of the proper procedure in getting gas out of the electrodes, vacuum discharge tubes always contained perceptible amounts of gas so that when in operation glows of various colors and locations were generally visible in them. Veterans in the radio field who used the old original "audion" bulbs and the various "soft" tubes of 1909 to 1914 will remember this peculiarity.

GAS-FILLED TUBES

The conduction of current through gas-filled tubes is not nearly so easy to explain as is the pure electron discharge. From 1895 on to 1910 a great deal of time was spent by physicists in investigating gas conduction, and a theory of what takes place in such discharges was finally formulated. During these investigations much was learned, but the concentration of efforts since 1912 on the hot wire tube has distracted the attention of workers from the earlier experiments which are now not so well known as their importance warrants. Within the last few years, however, workers have been turning back to gas-filled tubes, which, for certain purposes, possess special advantages. As a consequence of this renewed activity a number of such tubes have appeared on the market, designed for practical applications.



The two-element tube without a filament, which is used for the rectification of plate voltage for vacuum tubes. These tubes, when used with a suitable transformer and filter, will supply a "B" voltage without any hum.

A NEW GAS-FILLED RECTIFIER

Prominent among these new tubes is one sold as part of a "'B' battery eliminator." A "B" battery eliminator is a device for delivering a direct voltage when connected to a source of alternating current supply, such as is used almost universally for house lighting. Such a device must include, in the first place, a rectifier to convert the alternating current to pulsating direct current and, in the second place, a filter combination of inductances and capacities to smooth out the pulsations and deliver a steady D.C. voltage. The gas-filled tube here referred to acts merely as a rectifier in the eliminator.

The tube (Fig. 1) resembles on the outside an ordinary radio tube and fits into an ordinary four-prong radio socket. Two of the prongs, however, are dead, since the tube contains but two electrodes—a hollow cylindrical one about 1½ inches long and ½ an inch in diameter and a much smaller one supported on a glass rod near the center of the hollow cylinder. This second electrode has less than 1/100 the area of the cylinder. Both electrodes are of aluminum. The tube contains neon gas at a pressure of between three and six millimeters of mercury. In other words, the gas pressure of neon in the bulb is something less than 1/100 the pressure of the air in the free atmosphere.

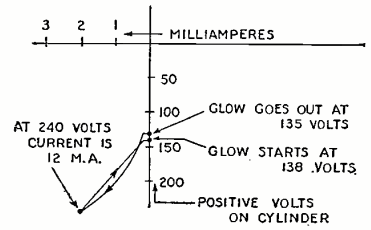


FIG. 2

Fig. 2 shows the current change in the tube as the plate voltage is varied from 138 to 240 volts and back.

PROPERTIES OF NEON

Neon is one of the "rare gases" of the atmosphere discovered by Sir William Ramsey and his associates in 1898. Since the percentage of neon in the air is exceedingly small, it was, up to about five years ago, very difficult to obtain. Now, however, it can be bought rather easily as a commercial article. As furnished commercially, neon always contains traces of helium, argon and hydrogen, but these impurities have no important effect on the action of the rectifying tube here under description. This gas, neon, has a number of peculiar properties which render it useful in electrical work. It can

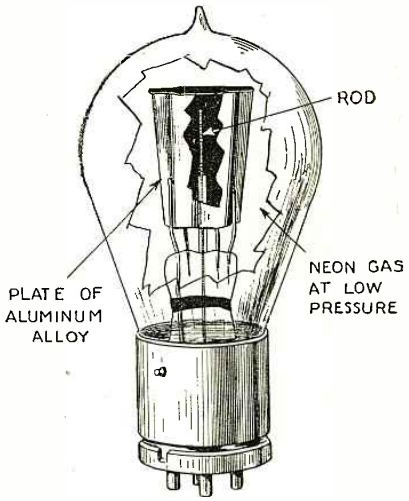


FIG. 1

There is no filament to burn out in the rectifier tube shown above, the only elements being a rod and plate.

be made to glow under a small electrical potential, and practically all of the light which it then gives off is of a sort to affect the human eye. The scientist says, consequently, that neon has an extremely high "luminous efficiency." This is the gas which is contained in the little tubular devices used by automobilists to find out whether their spark plugs are operating.

THE NEON RECTIFIER IN A D.C. CIRCUIT

When the neon rectifier tube is placed in a D.C. circuit with the outer cylinder connected so as to be charged positively and the voltage on the cylinder is gradually increased, no current passes across until 135 volts is reached. Then a glow appears on the small central electrode and a current of about 1/20 of a milliampere will pass. This glow comes on and off as the potential is raised above or pushed below the critical value of 135 volts. If the voltage is raised from 135 to 200, the current rises to perhaps two milliamperes as a maximum.

If now the lamp connections be reversed, the effects are quite different. No current passes and no glow appears until the cylinder is at a negative voltage of 175 volts. At that voltage the characteristic pink glow of neon appears suddenly all over the cylinder, inside and out, and the voltage falls back to a lower value, perhaps 140. If now the potential of the cylinder is lowered, this glow remains until 110 volts is reached, when it sharply goes out. The current passed when the cylinder first glows at 175 volts is about 150 milliamperes, and increases to 200 or more as the voltage is raised ten volts or so above the starting value. These figures will be found to differ slightly in different tubes, largely on account of variations in the pressure and purity of the gas.

For those seriously interested, these conditions are best represented graphically, as in Fig. 2 and Fig. 3. Fig. 2 shows how

(*Continued on page* 364)

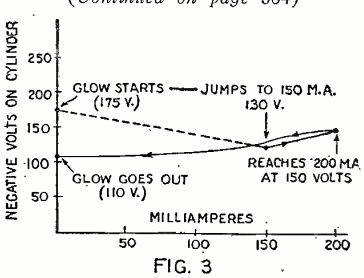
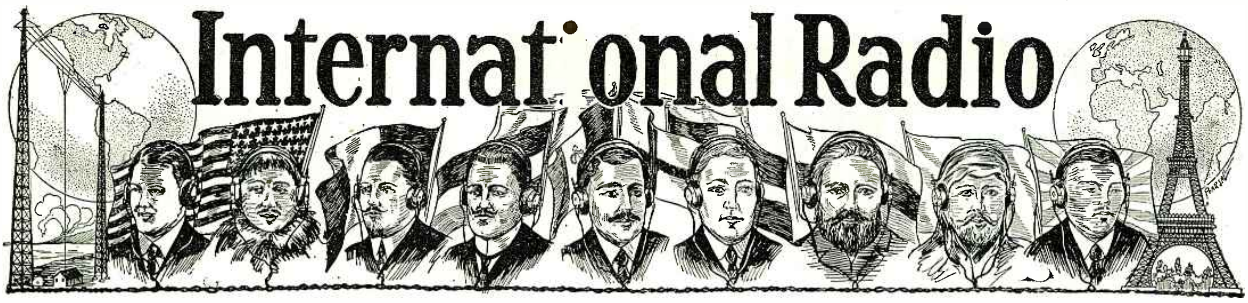


FIG. 3

How the current varies as a negative charge on the plate varies from 135 to 150 and return.

International Radio



ENGLAND

Committee on Standards

On the initiative of the Radio Society of Great Britain a committee is being formed to attempt the standardization of radio apparatus and parts. This has been done to the extent of the bases of vacuum tubes in the United States, but that is about the only thing that is standard, except static and like disurbances.



The French tube here shown uses, instead of a grid, a concave strip, which is placed on the opposite side of the filament from the plate. This new element is shown at the right in the sketch. The filament is heated by one dry cell and the tube may be used as either a detector or an amplifier.

A Sequel to Rainy Season

As a result of the unusually wet season in Northern Ireland, the Director of the Belfast station of the B. B. C. has received a number of letters begging him to close down the station until the autumn, as the writers are positive that broadcasting is the cause of all the bad weather.

Radio Mal-De-Mer?

A Scotch radio amateur recently picked up the signals from the SS. *Samaria* at sea, and and it was then that the new malady first attacked him. The ship was rolling badly and this caused the pitch of the C.W. note to vary in sympathy, so that it was not at all hard to picture the rising sea and the unsteady decks. Of course, this happened in Scotland and it might well be that the amateur had partaken too freely of his native brew.

Secret Wireless Limited

The British method of leaving broadcasting to be carried on by a monopoly is threatened by the formation of a new company, whose product is an instrument for attachment to sets. Its main purpose is to permit reception of broadcast programs which will not be accessible without it.

The new invention is designed mainly for transmitting messages which cannot be tapped and is also free from interruption by static. Rapid changes in wave-length are possible, such as have been used in Naval circles to avoid listening-in by the enemy. The only explanation given is that under the new system the message would be transmitted like a chord in music and that the special receiver, which could be fixed to any set, crystal or tube, would split up the message into its component parts or words.

The new company is frankly out to break the monopoly of the B. B. C., whose programs and policies have been freely criticized ever since its start. However, the system of broadcasting now in use in England permits the transmission of a program to every part of Great Britain. An experimental station has been established and Secret Wireless. Ltd., has secured official permission to carry out experiments on allotted wavelengths.

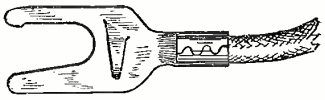
As the majority of the International Radio News items are obtained from foreign magazines there is necessarily quite a lapse between the event and the time that it may be presented to our readers. RADIO NEWS would be glad to publish such articles of interest to broadcast listeners as may be sent by fans in foreign countries. Make the letters as brief as possible. The subject matter should concern chiefly items that will be of interest to the radio public in general, such as experiments, unusual broadcast features, etc. Address all communications to Editor, International Radio, c/o RADIO NEWS.

GERMANY

Law Court Now by Radio

A new feature of the programs from the Frankfort station is the daily summary of law cases, in which the decisions of the German Higher Courts are given together with resumé of the trials. It is hoped that these items will stimulate interest in the law. At all events they will probably serve as warnings to many.

Radio is now used in Germany to warn the inhabitants of the river valleys against probable floods. Large stations, situated at the danger points in the rivers' courses, will broadcast signals whenever the waters seem likely to overflow their banks, while warnings will be shouted to the people by means of loud speakers placed in prominent positions in the town or village.





The lug shown in the accompanying illustration is a Norwegian product and is made of "argentan," an excellent alloy for use as an electrical conductor. The lugs may be used as connectors to binding posts or they may be clipped together by means of the small projections that are raised on the side.

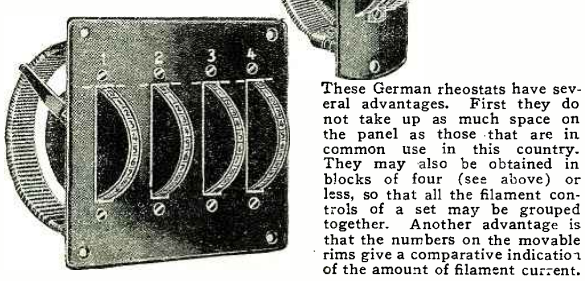
RUSSIA

Radio Influencing CountryLife

Radio is changing slowly but surely the cultural aspects of life in backward Russian villages. Millions of peasants, whose whole world was formerly bounded by the happenings within a few square miles, now throng to the village reading rooms several times a week to listen to the news of the world from the loud speakers. The type of transmission is the same as in the United States, but there are more agricultural talks.

In the Moscow province alone, two hundred additional receivers were installed this spring. In the city of Moscow there are 350 radio clubs with a total membership of about 15,000. The use of private receiving sets was not authorized by the Government until last fall. Two months after the new radio law was passed, 50,000 receivers were in use in Moscow. Persons using them are required to pay a small annual license fee. Aside from this, there are no restrictions.

Everywhere radio is being accepted with pleasure and great enthusiasm shown. The radio audience is increasing by leaps and bounds.



These German rheostats have several advantages. First they do not take up as much space on the panel as those that are in common use in this country. They may also be obtained in blocks of four (see above) or less, so that all the filament controls of a set may be grouped together. Another advantage is that the numbers on the movable rims give a comparative indication of the amount of filament current.

Recent Radio Progress Abroad

AUSTRIA

Radio broadcasting started as a regular service in Austria, with the opening of the Vienna broadcasting station on October 1, 1924. Considerable interest in radio has developed since that time and it is now estimated that there are approximately 50,000 receiving sets in use in that country.

Individuals desiring to purchase and operate radio receiving sets must apply for and procure a license from the Austrian government. The annual receiver's license fee ranges from 15,000 to 30,000 crowns and is effective for the balance of the calendar year in which it is issued. It is also necessary to procure the permission of the government to erect an outside aerial.

Protected by an import duty against foreign competition, Austrian radio manufacturers are doing a fairly satisfactory business in their home market. Nevertheless, radio apparatus of American manufacture is sold in Austria and although high prices militate against the American exporter, it is believed that super-heterodyne kits, neutroformers, condensers and variable grid leaks should find a fair market in Austria.

CZECHOSLOVAKIA

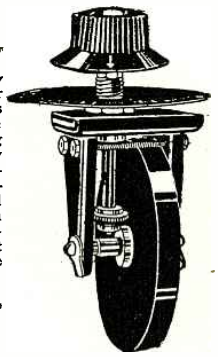
The Ministry of Posts and Telegraphs of the Government of Czechoslovakia has recently contracted with an American firm to erect and equip a broadcast station at Prague. This station, which will have a power of 5 kilowatts, will be used for broadcasting over the entire republic. It is further planned that smaller stations will be constructed in Brno, Bratislava, and Kosice.

SPAIN

Public interest in radio and the resulting market in Spain varies considerably throughout the kingdom. The operation of two broadcast stations in Madrid has created a considerable market for radio sets and parts in that city and vicinity. There is also a radio periodical published in Madrid.

In Bilbao, two broadcast stations were recently put into operation. A good market for receiving sets, chiefly of the crystal type, resulted. Most of the radio apparatus on this market is of British and French origin, due principally to the fact that local dealers prefer to carry a limited stock and make frequent small purchases. This practically prohibits the radio dealers in Bilbao from purchasing their supplies in distant markets.

That this situation does not obtain throughout the entire kingdom is evidenced by the fact that during the first quarter of 1925, Spain was the leading European market for American radio manufacturers. During that period, shipments of radio apparatus from the United States to Spain totaled $108,370.



The English mercury variable condenser shown in the sketch is said to eliminate the necessity of shielding against hand capacity effects. As the condenser is hermetically sealed it is dust-proof and the tuning is sharp on account of the micrometer adjustment. It may be obtained in three different capacities.

Latin-America

ARGENTINA

Interest in radio is growing rapidly in the Argentine—the foremost Latin-American market for American radio apparatus during the first quarter of the current year.

The Argentinian government has not as yet issued regulations governing broadcasting and the sale and use of radio receivers. However, a number of broadcast stations have been erected in Argentina and are now in operation. The most important of these is in Buenos Aires Wave-lengths ranging from 250 to 600 meters are used throughout the republic.

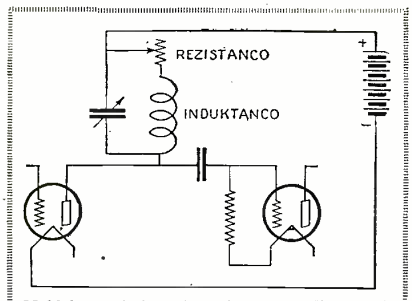
Rezistanca Kuplita Amplifikatoro*

De FRED A. PARSONS

Por klareco kaj fideleco en reaudigado neniu audio amplifikatoro egalas la rezistancan kuplitan tipon. La priskribo donita ci sube detalas la konstruon de tia amplifikatoro kiu estas kaj efika kaj bonorda.

KUNE kun la publika prezentado de la novaj konusoformaj laŭtparoliloj kiuj nun estas en la vendejoj, estas pli necesa ol iam havi preskaŭ perfektan amplifikadon en audio frekvencaj amplifikatoroj tra la tuta etendiĝo de la voĉfrekvenco, pro la fidela reaŭdigpovo de ĉi tiu tipo de laŭtparolilo. Multfoje oni kondamnis ĝin pro ĝia emo aŭdigi ĉion kio ekzistas en la amplifikatoro, speciale la distordajojn. Estas la manko de ĉi tiu ĝeno en la rezistanca kuplita amplifikatoro kiu faras ĝin ideala por perfekta reaŭdigado. Tamen, estas du notindaj malplaĉajoj en ĉi tiu formo de amplifikado, nome, ke pli alta plata tensio ol la kutima 90 voltoj "B" baterio kiu devas esti uzata por trapenetri la internan rezistancan perdon trans la plata rezistilo kaj, pli grava, la grado de amplifikado, laŭ ĉiu sekcio estas multe malpli, bezonante tri sekciojn por egali la gajnon en du-sekcia kuplita aparato. Se la ĝustaj lampoj estas akirèblaj, ĉi tiuj malplaĉajoj povas esti tuj venkitaj. En la amplifikatoro priskribita ĉi sube, Western Electric 102d lampoj estis uzataj en la unuaj du sekcioj kaj 250B "E" lampo en la tria sekcio.

La kaŭzo de la kompare malgranda gajno aŭ amplifikado laŭ ĉiu sekcio en la rezistanca kuplita aparato estas ke la tensia amplifikado estas limigita ĝis iom malpli ol la tensia amplifikada povo de la lampo (tipo 201A, 301A), kiu estas normale ĉirkaŭ 6. Tamen, per la uzado de transformatoroj, la pligrandiga proporcio de la fadenvolvoj estas granda decidilo en la malkovro de necesa tensio kiu devas esti turnata al la krado de la proksima lampo. Klarigante ke la amplifikada povo de 102D lampo estas 30 montros tre videble kiaĵ ĝi estas ideala en la rezistanca kuplita amplifikatoro. La karakterizajoj de ĉi tiu lampo estas jenaj: Filamenta kurento, .950 amperoj; filamenta tensio, 2; plata kurento, .0005 amperoj; plata tensio, 120; amplifikada povo, 30; plata impedanco 100,000 omoj, kaj la kurentapova rezulto, .0045 vatoj. Pro la treege malgranda plata kurento la interna rezistanca malgrandiĝo ĉe la plata rezistanco estas



Maldekstre: Tri-sekcia rezistanca kuplita amplifikatoro, kiu disponas remarkindan kapablon sen disordo.

malalta kaj 100 voltoj estos sufiĉe por doni deziratajn rezultojn. Je ĉi tiu tensio la plata kurento estas .0005 amperoj ĉiu lampo en la unuaj du sekcioj, ĉar la interna plata impedanco de 100,000 omoj kune kun egala valoro en la plata cirkvita rezistilo donus, per la uzo de la Leĝo de Ohm, ĉi tiun kurenton.

Pro la decidiganta tensia malgrandigo trans la filamentoj de la 102D lampoj, ĉi tiuj estas kunligitaj en serioj tra ses-oma reostato al la sesvolta "A" bateria fonto, dum la "E" lampo en la tria sekcio estas senpere trans la baterio sen reostato, la permesebla voltricevo ĉe la filamento de ĉi tiu tipo estanta 6.5 voltoj. En ĉi tiu cirkvito la kurento en la filamentoj de la 102D lampoj estas .750 amperoj, pli granda valoro en amperoj disponus pli da povo en la produkto ol la laŭtparolilo povus estri. Pro la malgranda kurenta kapablo en la plataj cirkvitoj de la 102D lampoj, "E" tipo estas uzata en la tria sekcio, la maksimuma povo disponebla estanta proporcie al kvin vatoj. Kelkaj statistikoj montrantaj la kurentajn valorojn en la produktanta cirkvito estos interesa ĉi tie. La programanoncisto de iu 500-vata disaŭdiga stacio 30 kilometrojn for, kaŭzus al la plata kurento en la "E" lampo, normale havanta .004 amperojn kun 9-voltan negativan inklinon, svingi al .019 aŭ .020 amperoj, estrita kurento de 15 aŭ 16 miliamperoj, tio estas, pli ol la plimulto da laŭtparoliloj povas efike uzi. La avantajo en havi ĉi tian grandan kvanton da povo estas ke tuj kiam la energio disponita je la eniro ("input" sur diagramo) estas pasigita sen distordo tra la tri sekcioj de la amplifikatoro kaj liverita en la sonprodukto kun tonopovo pli ol sufiĉa por ordinaraj celoj.

La valoroj de la diversaj rezistancaj kaj kuplitaj kondensatoroj estas montritaj en la cirkvita diagramo. La fadeninterligado povas esti farata tre simpla en rezistanca kuplita amplifikatoro, se la aparato estas projektita en la progresa sinsekva maniero montrita. Car ne ekzistas problemo de atmosferajoj, kiel en transformatora amplifikilo, neniuj kriaĉoj aŭ aliaj malbonaj rezultoj kunestas, kaj la amplifikatoro restas tute kvieta. Ankaŭ ŝajnas esti multe pli malgranda proporcio de atmosferajo kaj aliaj eksteraj malhelpajoj por interrompi amplifikadon de signaloj.

*Esperanto translation, by James Denson Sayers, President New York Esperanto Club, of "A Resistance Coupled Amplifier," by Fred A. Parsons, appearing on page 59, RADIO NEWS, for July, 1925.

History of Radio Inventions

By A. H. MORSE, A.M.I.E.E., Member I.R.E. New York*

CHAPTER VI

REGENERATION: ITS RECEPTION

In the experimental days of the triode, it was found that under certain conditions audio frequency oscillations were set up, causing singing noises in the telephones. These noises would disappear (or their pitch would be varied) when the adjustments were altered; they were a nuisance and came to be known as the "canaries." Their cause and its possible use seem to have been discovered almost simultaneously by a number of persons, and thereafter it soon became apparent that a revolution was about to take place in the art of radio reception.

The singing was a manifestation of a property which was, in more or less degree, inherent in the triode, and which could be increased and brought under control for useful purposes by means which became the subject of numerous patents to different inventors in various countries. In some cases one use of the property was patented, and in other cases another. The consequence is that the patent situation on this feature is much involved, particularly in certain countries.

In the United States of America the first invention of the regenerative use of the triode was, until recently, credited to E. H. Armstrong, who, according to Professor J. H. Morecroft, accidentally placed two coils "much nearer to each other than they should normally be," heard a strange noise in the telephones. This was a "beat" note,

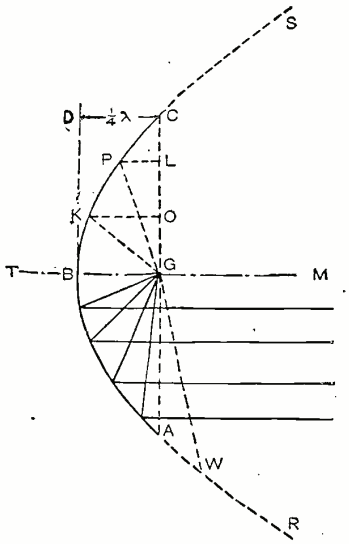


Fig. 29 shows the relation between the curve of the beam reflector and the wave-length used.

between the oscillation frequency set up by his triode or "audion" and that of an incoming signal which was being impressed on his aerial circuit. Thus was invented (if not for the first time) not only triode regeneration, but the detecting self-heterodyne, the simplest possible instrumentality to reduce to practice the masterful invention of Fessenden.

The *Year Book* for 1923, which is published by a Marconi subsidiary in London, credits the invention of the self-heterodyne to Meissner of Berlin in 1913, whereas it was specifically patented to H. J. Round in Britain by Patent No. 28,413 of that year, and Meissner expressly disclaims it. (Br. Pat. 252/14.) Nevertheless—and despite the further disclaimer of the British patented inventions of Franklin (13,636/13) and Armstrong (24,231/14)—Meissner's specification carries claims which appear to cover all three. If the reader is fond of mental exercise, he will enjoy studying the latter (amended) specification in the light of the others mentioned therein.

The specification of Round's patent makes the following clear reference to the inherent capacity for regeneration in the triode: "By suitably adjusting the circuits, signals produced by continuous waves can be heard in the telephones. If the capacity between the grid and the third electrode is insufficient, a small condenser may be connected across the grid and the third electrode, or the oscillation circuit may be made to interact with the aerial or with an intermediate oscillation circuit by so arranging the circuits that there is mutual inductance between them."

Precisely the same circuit arrangement was previously patented in Britain to C. S. Franklin (13,636/13), whose invention was the use of regeneration to nullify or reduce the resistance of the receiving system.

An important development of the regenerative principle in receivers is the super-regenerative circuit, in connection with which the following patents and applications therefor are held to be more or less relevant: Br. 182,135, U. S. Serial 807,388 (?). Armstrong; Br. 156,330, U. S. 1,407,245, Br. 130,408, U. S. Serial (?) 276,856, Februrary 13th, 1919, Turner.

Whether or not the U. S. Patent Office differentiates, or will differentiate, between the use of the "feed-back" circuit for the (*a*) generation of oscillations for transmission purposes, (*b*) generation of oscillations for "heterodyne" reception, and (*c*) amplifying received signals, the author does not know.

CHAPTER VII

THE TRIODE AS A GENERATOR OF RADIO FREQUENCY ALTERNATING CURRENT

By causing a telephone receiver to react on a telephone transmitter, A. S. Hibbard, in 1890, discovered the principle of the Hummer or Humming Telephone (Fig. 27). Later, Professor Larsen, of Copenhagen, used the same principle in the production of alternating current from a direct current source (13). Therefore, the use of reaction or regeneration in the production of alternating currents from a direct-current source was well known when the triode came into being. Nevertheless, it is not recorded that anyone sought to duplicate the hummer phenomenon with the triode, which latter seems to have been accidentally developed as a generator, without reference to any prior art.

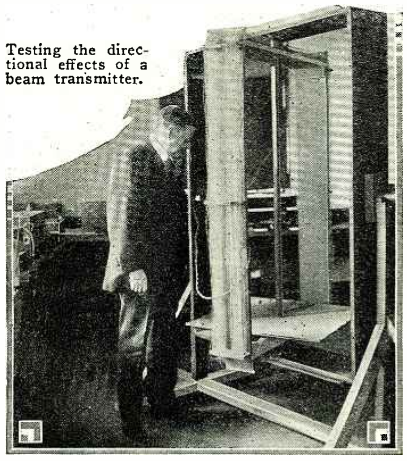
Since 1913 it appears to have been generally recognized that under certain conditions, which were only too easily established, the generating property of the triode was inherent and inevitable.

In Armstrong's (American) specification we read: "It will be understood from what has been said that the ratio of transformation of the transformer should be adjusted to get the maximum signals without causing the audion to generate oscillations."

In the specification of his British Patent 13,636/13, Franklin also directs attention to the danger of persistent oscillations being set up in the triode, and at about the same time DeForest, too, had mentioned the precautions necessary to prevent singing.

The first reference in the records of the British Patent Office to the use of a triode as a useful generator for transmission purposes seems to be in the specification of Br. Pat. 252/14 to Von Arco and Meissner.

From the foregoing it would appear that the possibility of generating radio frequency alternating currents by means of a triode was fairly well known for some time before anyone suspected that it could be developed



Testing the directional effects of a beam transmitter.

for transmission purposes. The first to use the triode in a transmitter appear to have been Round in England, and Von Arco and Meissner in Germany; but such use does not appear to have been specifically patented anywhere, unless, perhaps, in the latter country.

CHAPTER VIII

BEAM AND SHORT-WAVE RADIO

In an address to the shareholders of Marconi's Wireless Telegraph Company, Limited, on December 3, 1923, Senator Guglielmo Marconi made the following statement in reference to beam signalling:

"This system is, I believe, destined to bring about somewhat of a revolution in the methods hitherto employed for communicating by wireless with distant countries. According to this system the electric waves which carry the messages are projected and propagated in a beam in any desired direction only, instead of being allowed to spread around in all directions. The advantages of the new method are at least four-fold, because:

"1. Due to the better utilization and concentration of power a much smaller amount of electrical energy need be employed for a given distance, resulting in a substantial economy in capital and working expenses.

"2. Only stations inside a certain restricted angle or sector are enabled to receive, and this increases the privacy and secrecy of communication, besides greatly reducing the possibility of mutual interference with other stations.

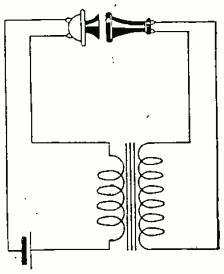
"3. Owing to the employment of comparatively short waves, the speed of transmission and reception can be several times greater than what is attainable with existing long-distance systems.

"4. The disturbance caused by the effects of atmospheric electricity are greatly minimized.

**Late Supt. Dom. DeForest Wireless Telegraph Co. and United Wireless Telegraph Co.; Engineer, Marconi's Wireless Telegraph Co.; Wireless Adviser, Indo-European Telegraph Co.; Managing Director, Marconi Wireless Telegraph Company of Canada.*

"During the tests which I have already referred to, communication was successfully carried out on this system between England and many places abroad, including St. Vincent (Cape Verde Islands), up to a distance of 2,250 nautical miles, by the employment of only a fraction of the electrical energy hitherto found necessary to cover such distances. I am now completing arrangements which will enable me to give this system a thorough test between England and the United States of America."

It was by means of very short waves and parabolic reflectors that Hertz carried out his experiments and laid the foundation of radio, and it is recorded that he produced waves of 30 centimeters in length, which he concentrated into a single beam. It is also recorded that Senator Righi produced waves



The fundamental circuit of the Hummer. This humming effect is familiar to anyone who has held a telephone receiver close to the transmitter.

FIG. 27

as short as 2.5 centimeters, while Senator Marconi used waves of ten inches in length in 1896-97.

In Marconi's provisional specification of June 2, 1896, we read that when it is desired to transmit to the greatest possible distance and in only one direction, "I place the oscillation producer at the focus or focal line of a reflector directed to the receiving station, and I place the tube or imperfect contact at the receiving instrument in a similar reflector directed toward the transmitting instrument," while in a Marconi (Canadian) prospectus (undated, but apparently published in 1907) we read:

"Com. Marconi has recently perfected instruments by means of which he is enabled to so direct the waves of wireless that they will travel in a direct line from the point of transmission to the point of receipt, and cannot be received at any other station or point than the one at which they are intended to be received. By this means wireless waves are conducted through the ether in focal lines of force exactly as though wires were used.

The practical utility of short-wave "beam" and, in greater degree, "broadcast" signalling, is now established, but, on account of the attenuation of short waves during sunlight, it has yet to be proved that they will be useful for continuous long distance communication. Moreover, the known fluctuations of the apparent path of signal waves of the length now in use, suggest that beams will be impracticable for long distance work, unless they are very little concentrated, and consequently not beams at all. It is possible, however, that very short waves may be found to be more persistent in their direction than the longer waves.

As to to prospect of energy economy, to which Senator Marconi refers, there can be no doubt as to the efficacy of short waves, *per se*. This has frequently been demonstrated during the last few years by the performances of amateurs. In fact, it is getting to be a commonplace thing, particularly in the winter months, for these enthusiasts to engage in two-way telegraph communication over distances of the order of two thousand miles, with only one hundred watts of energy. If they used "reflectors," their performances no doubt would be credited to the efficacy of the "beam."

Before any opinion can be expressed on the efficacy or practicability of the "beam" method, as such, over long distance, it must be demonstrated that, as compared with what can be accomplished on the same wave without a reflector, the beam method secures:

(1) Useful economy of the ether.
(2) Useful secrecy.
(3) Any appreciably greater distance, and
(4) Any considerable economy of power.

The first alone will justify the method, if maintenance costs are not excessive.

There seems to be little likelihood of the second.

The third is important, and the fourth is likely to be negligible, except in so far as the operating speed may be governed by the power used.

Having regard to the power economies which, as is well known, can be effected by the use of short waves, *per se*, and in view of operating costs and overhead charges which, within certain limits, are independent of power consumption, there appears to be little benefit to be derived, in terms of power economy, from the use of reflectors, even when the latter are developed to perfection. If, however, reflectors are evolved whereby radiation is limited to an angle of even 30 degrees, their use will be amply justified, although no useful "secrecy" objective will be attained. In this connection it must not be overlooked that a 30 degrees "beam" in trans-Atlantic communication would give a wave front of approximately 2,000 miles at the receiving terminal. Even if reflectors prevent only rearward radiation —and this is theoretically possible by other methods—their use will be amply justified, since the major problem today is rather how to effect economies in the ether than in power consumption.

The generation and radiation of power at very high frequencies present many difficulties, when twenty or thirty kilowatts have to be radiated; and herein lies the chief concern of technicians; moreover, when reflectors are used, the problem is further complicated.

Reference to Fig. 29 will show the importance of wide aperture reflectors. For practical purposes Marconi proposes to use an aperture of eight wave-lengths which, for the Canadian stations of the proposed Imperial Chain, will involve reflectors 840 meters wide, since the said stations are licensed for waves of from 85 to 105 meters (but with no angular limit, except that imposed by the British contract). On the other hand, in Marconi's Society of Arts paper (10*d*), there is reference to a new type of flat aerial and reflector invented by Franklin, which may indicate that the parabolic form of reflector is losing favor. The new type suggests the directional radiator patented (Br. 130,064; U. S. 1,360,167) to Alexanderson, who claims for it "a directive effect comparable with the focusing of a beam of light by a lens or mirror."

It is popularly believed that a radio beam has been successfully focused on Sydney, Australia, from Poldhu, England, and this belief is no doubt due in some measure to the title of Marconi's recent paper, "Results obtained over very long distances by short-wave, directional wireless telegraphy, more generally referred to as the Beam System," in which communication with Australia was mentioned. The paper itself, however, makes it clear that this is not so; moreover, the efficacy of such focusing would need to be proved, not only at the objective, but at other points outside of the prescribed path of the beam, as is required, in fact, in the British contract.

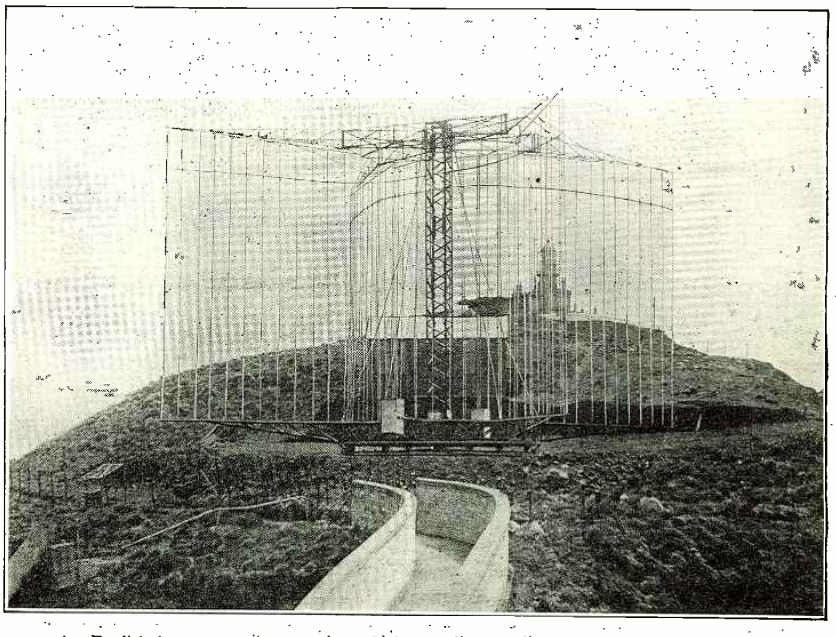
The practicability and utility of the beam method of transmission and reception of waves of the order of ten meters in length appear to be unquestionable, but it is early yet to form an estimate of the distance that may be accomplished thereby. It has to be borne in mind that the shorter the wave, the greater is the limitation upon the power that can be radiated, while the longer the wave, the greater are the difficulties of reflection and focus—until a parabolic reflector becomes out of the question.

A useful method of precise measurement of short waves has been evolved by the United States Bureau of Standards, and is described in a paper by F. W. Dunmore and F. H. Engel in the Proc. I.R.E. of October, 1923.

The higher telegraphic speeds that will be possible with short waves—as compared with those now in general use—will, of course, be largely facilitated by the comparative smallness of the power required.

It is necessary that there should now be an accepted scientific definition of a "Radio Beam"; otherwise it would be well to de-

(*Continued on page* 358)

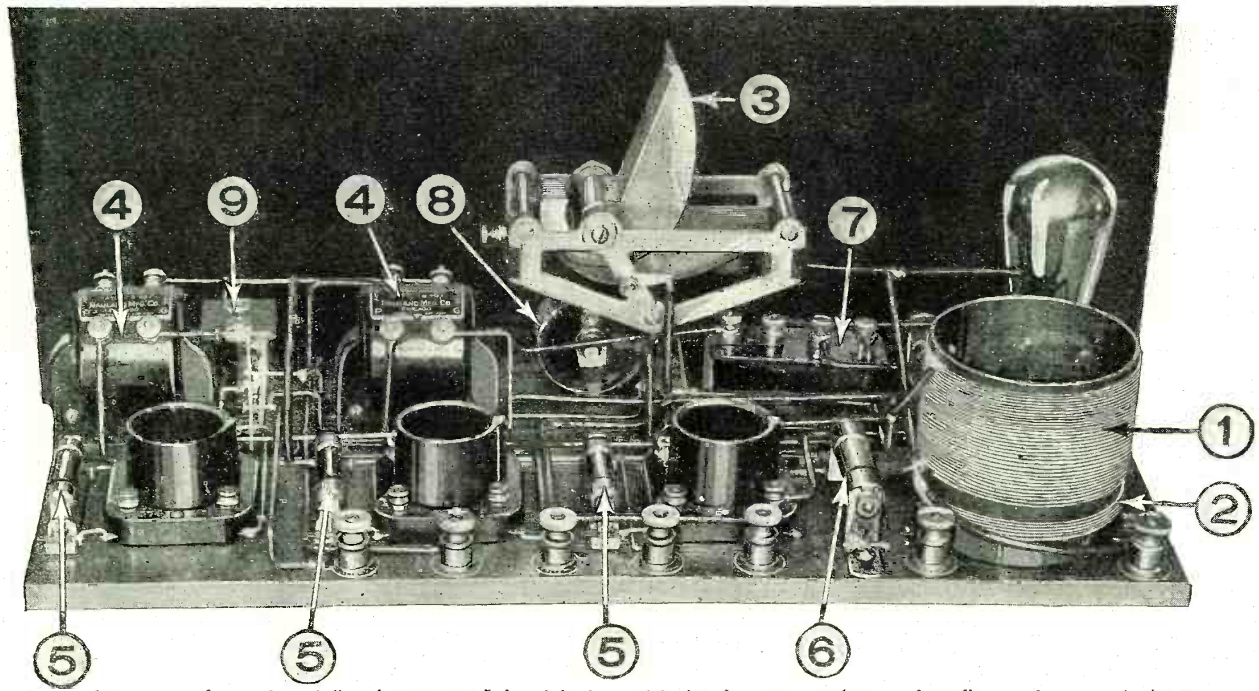


An English beam-transmitter station which can direct radio waves to any desired point.

The Interflex Circuit

By HUGO GERNSBACK
Member American Physicial Society

The author here describes a rather unusual set that bids fair to become popular. It has several original twists and brings out a principle that is but little known.



1 and 2 are secondary and aperiodic primary respectively. 3 is the straight-line frequency condenser. 4, audio transformers. 5, Amperites. 6, fixed carborundum crystal. 7, radio frequency transformer. 8, potentiometer. 9, fixed by-pass condenser.

SOME years ago, while experimenting with a crystal-vacuum tube combination, we fell upon a circuit shown in Fig. 1, in which a crystal detector is connected right into the grid circuit. The writer at the time thought that this was original, but later on found that the principle was known, having been previously described in some scientific papers.

The final circuit evolved is the one shown in Fig. 1. The coil L-1 is a 3-inch tube, wound with about 55 turns of No. 20 S.C.C. wire, while the condenser C should have a capacity of 0.0005 mf. The crystal A may be any good crystal, although the writer in his experiments has found that a fixed carborundum crystal is the best, because it is the most stable. Any good vacuum tube may be used.

This circuit is not a reflex, nor is there regeneration. The crystal in the grid circuit acts as a detector, while the first tube acts as an amplifier; the amplification depending upon the crystal is from 10 to 20. In other words, if you use a crystal detector alone, the addition of the tube will give an amplification of 10 to 20 times. The same is the case, in this particular circuit, if you use a tube alone, when the addition of the crystal will give you great amplification.

Stations Logged By the Author Within 2 Hours in New York City

Station		Dial Setting	Meters
WNYC	Local	13	526
WEAF	Local	21	491.5
WJZ	Local	31	454.3
WJY	Local	46	405.2
WGY	Schenectady, N. Y.	55	379.5
WHN	Local	63	361.2
WCBD	Zion, Ill.	67	344.6
WMCA	Local	74	340.7
WGBS	Local	89	315.6
KDKA	Pittsburgh, Pa.	91	309.1
WJAR	Providence, R. I.	94	305.9
WPG	Atlantic City, N. J.	98	299.8
WORD	Batavia, Ill.	108	278
WCAU	Philadelphia, Pa.	115	278
WRW	Tarrytown, N. Y.	120	273
WBBR	Staten Island, N. Y.	121	273
WAAM	Newark, N. J.	132	263
WRNY	Local	135	258.5
WNJ	Newark, N. J.	139	233
WOKO	Local	157	233
WODA	Paterson, N. J.	164	202.6

The Interflex takes in the entire broadcast range

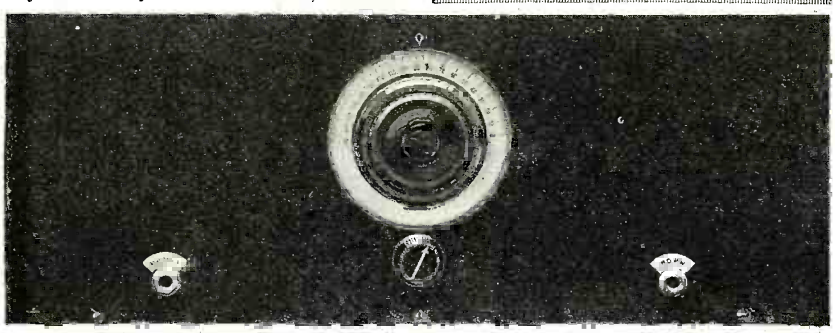
This circuit is remarkable in that there is no distortion, and the reception of the signals is about as clear as the writer has ever heard. The only drawback with this circuit is that it tunes broadly—that is, for local stations.

A surprising fact, which the writer believes has not been recorded heretofore, is that this circuit is really excellent for DX work. With a single-tube set of this kind the writer has listened repeatedly, in New York City, using a 60-foot aerial and ground, to stations in Philadelphia, Atlantic City, Pittsburgh, Springfield (Mass.), all of the Chicago stations and WOC, Davenport, which was the furthest station recorded on this circuit and is at a distance of 1,100 miles.

On DX the tuning is quite sharp and a vernier dial should be used, otherwise, you are likely to pass over the signals. It should be remembered that *you hear no squeal in this circuit*, since it works exactly like a crystal set. The tuning, therefore, is absolutely silent—hence, the tuning motion must be slow if you want to hear the far-distant stations. It goes without saying that you will not be able, with this hook-up, to receive the DX stations unless the locals are silent. But you will be surprised at the great clarity of the signals.

If you do not care for very sharp tuning, then you may construct a 3-tube set along these lines, merely adding a 2-step amplifier, and the signals will come roaring in, as with the best 4-tube circuit.

This set, mind you, gives you quality and no distortion at all.

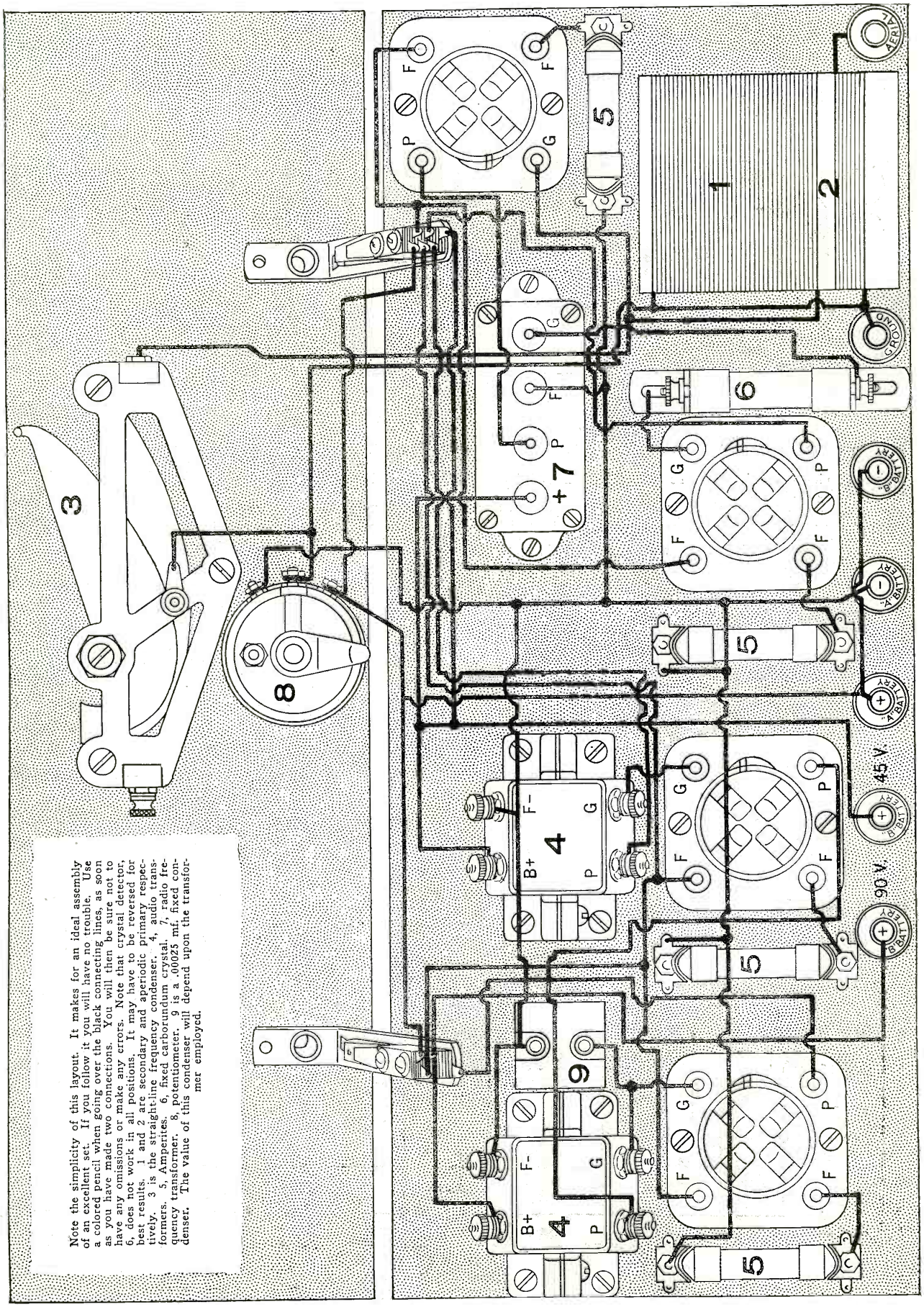


Note simplicity of panel. Only one vernier tuning dial is used. The indicator knob below is the potentiometer. No filament switch is used. Instead, two automatic filament jacks are incorporated in the set.

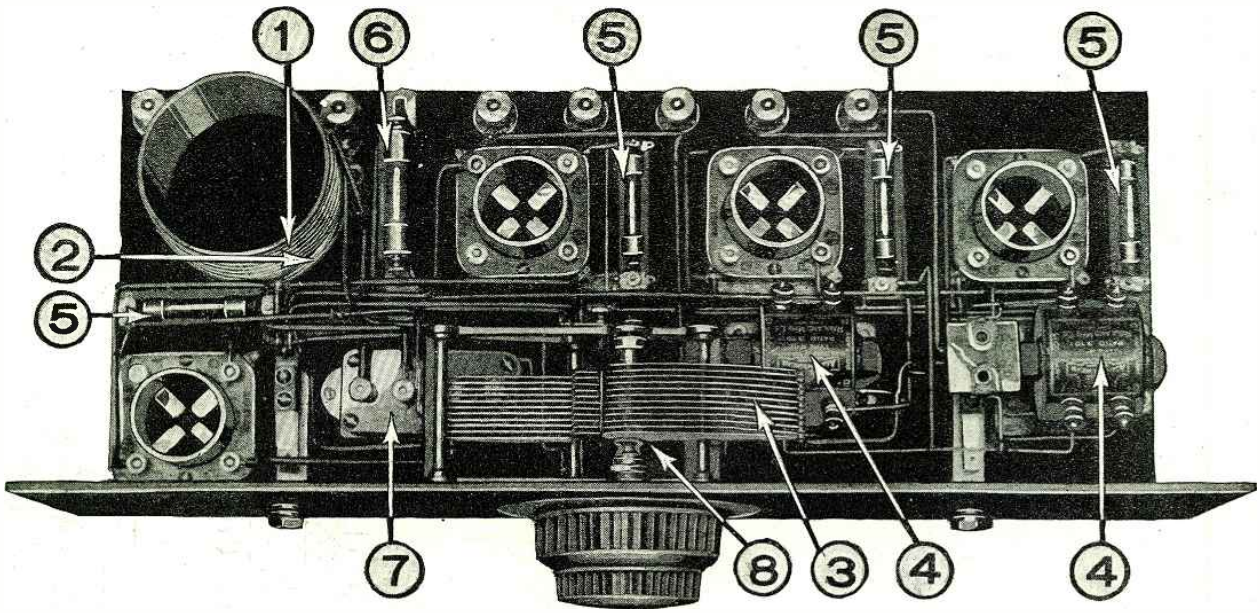
THE INTERFLEX-FOUR

The circuit has given such good results that

(*Continued on page* 300)



Note the simplicity of this layout. It makes for an ideal assembly of an excellent set. If you follow it you will have no trouble. Use a colored pencil when going over the black connecting lines, as soon as you have made two connections. You will then be sure not to have any omissions or make any errors. Note that crystal detector, 6, does not work in all positions. It may have to be reversed for best results. 1 and 2 are secondary and aperiodic primary, respectively. 3 is the straight-line frequency condenser. 4, audio transformers. 5, Amperites. 6, fixed carborundum crystal. 7, radio frequency transformer. 8, potentiometer. 9 is a .00025 mf. fixed condenser. The value of this condenser will depend upon the transformer employed.



The numbers given here correspond to those on the drawings in the preceding pages. Note the compactness of this set.

it seemed a pity that it should not be used in a real set. So the writer set about rectifying this, and the Interflex-Four, shown in Fig. 2, as well as in the accompanying photographs, is the result.

This set has been used for some time by the writer and he heartily recommends it to those who wish to have a set of great simplicity, where there is practically but a single control to be handled, where sharpness of signals is desired, and where, most of all, clarity of signals and absolute absence of distortion is wanted. Also, the set should be good for DX work.

All of this is incorporated in the Interflex-Four, and the writer particularly recommends the set to your home folk who do not know much about radio, and do not care to handle many dials, which, as a rule, confuse them.

The set is simplicity itself and can be constructed easily by any one. Although it contains only four tubes, the writer has made repeated comparisons between some of the well-known five-tube sets and this one, and he has yet to find one which gives louder reception and is as clear as the Interflex-Four.

Furthermore, the tuning can be done in a fraction of the time of the standard five-tube sets so much in vogue now.

The circuit, as will be seen from Fig. 2, comprises one stage of radio frequency, coupled to the fixed crystal detector. The second tube, therefore, is not the detector tube,

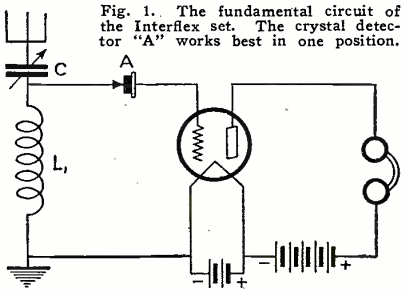


Fig. 1. The fundamental circuit of the Interflex set. The crystal detector "A" works best in one position.

but is an amplifier. The third and fourth tubes are amplifiers as well.

From this it will be seen why these four tubes equal five or more of the conventional tuned radio frequency sets.

CONSTRUCTIONAL DETAILS

The usual panel and baseboard are used. Two filament control jacks, (the one at the left being for the phones—the one at the right for loud speaker) are used. The writer recommends the use of a straight-line frequency condenser. A potentiometer of 400 ohms *must* be used. A lower-resistance one is not recommended, because no really sharp DX tuning can be accomplished with it. No rheostats of any kind are used. Instead, automatic filament resistances, which work exceedingly well in this circuit, are used throughout. This does away with two extra controls, which are not needed in the circuit.

The inductance consists of a bakelite or other good tube three inches in diameter, three inches in length. The aperiodic primary consists of 10 turns of No. 20 D.C.C. wire. A blank space of $\frac{1}{16}$ inch is left between the primary and the secondary. The secondary consists of the same wire, of which 50 turns are wound upon the tube, which almost fills up the remaining space.

Note in the connections that a jumper lead is connected between the ground and the fila-

(*Continued on page* 334)

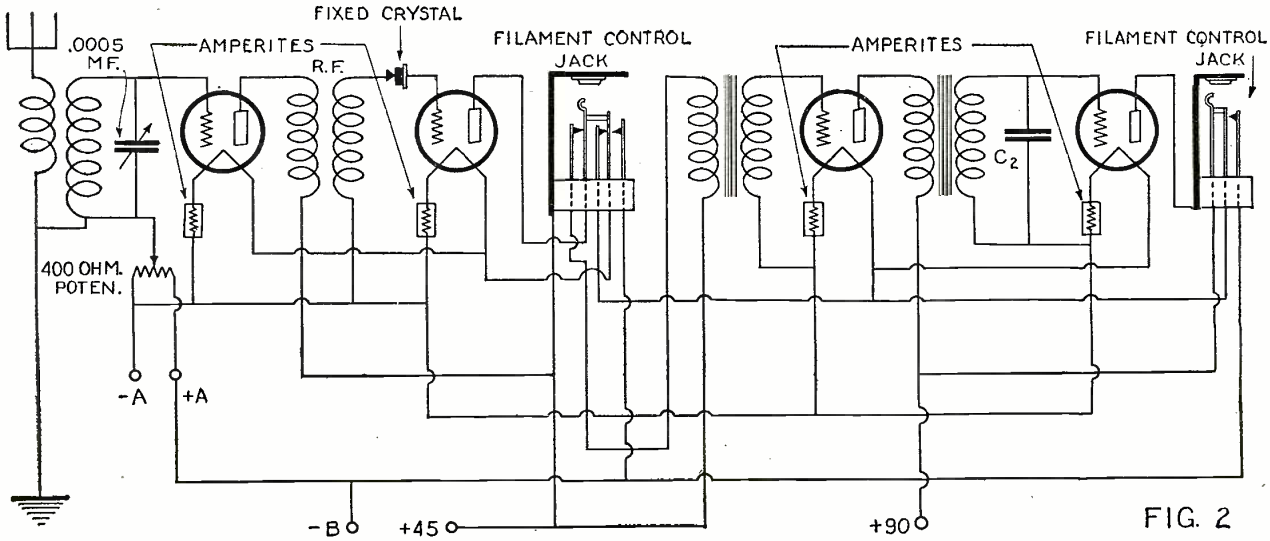


Fig. 2 Diagram of connections for Interflex-Four, consisting of one stage of radio frequency amplification, crystal detector, and three stages of audio frequency amplification, of which two stages are transformer-coupled. No switch is used in this circuit. The automatic filament control jacks are used instead. Note particularly that, for best results, the aperiodic primary should be grounded on the filament side. Condenser C_2 is to be used only if set develops audio frequency howl.

Underground Radio

By W. HASKELL M. WATSON

These two articles should appeal especially to those fans who are interested in experimenting with different types of antennae. The second article appeared about four years ago in RADIO NEWS.

NO longer has anyone the right to say that he would have a transmitting station if he had the room, or if it were not for the trees in the yard. Those things now do not interfere with radio.

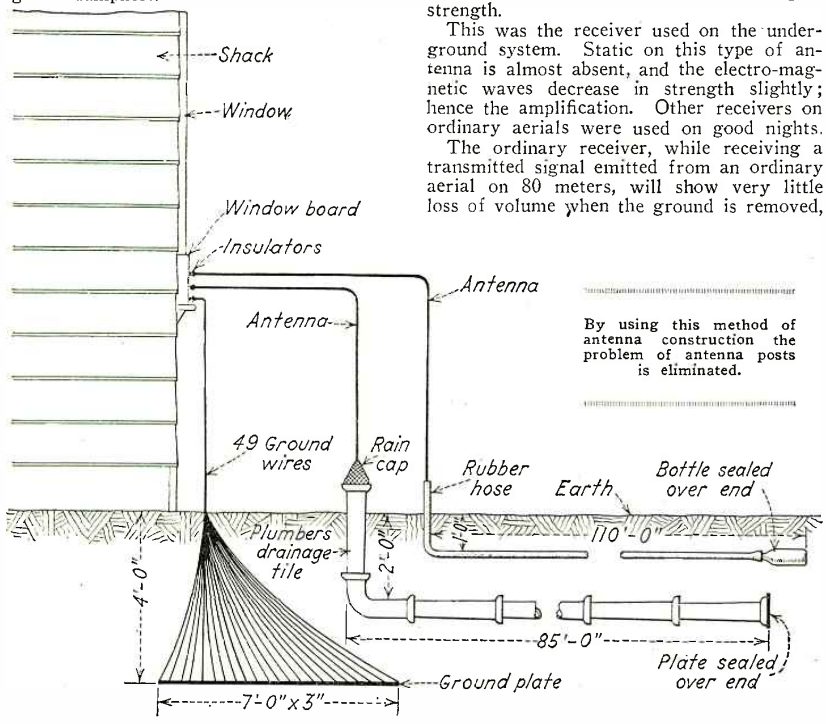
Realizing that the average amateur transmits as far with a few watts of power as the commercial stations do with thousands of watts (although the results of the commercial stations are more consistant, of course) gave me reason to believe that there would surely be some degree of success in my venture. Experiments were made for about five months, and during that time Mr. Smith, my assistant, dug more than a dozen trenches of different sizes. Careful notes were kept of all that happened.

The reader will probably recall that Dr. Rogers, the inventor of this system, carried on quite a number of experiments and accomplished a great deal in the development of underground radio; I will now try to present an amateur's version of the system.

With much less power than has ever been used before on this system, the writer has been able to communicate with stations at an amazing distance. The calls used were 5BX and 5XAY.

THE BURIED ANTENNA

An antenna of No. 12 heavy rubber-covered copper wire 100 feet long was used. This antenna was enclosed inside an ordinary rubber hose, about 110 feet in length, and sealed up at both ends. The far end had a small neck bottle over it and the open spaces sealed with sealing wax; then at the end coming out of the earth and connected to the transmitter the hose was allowed to project perpendicularly one foot above the earth (see drawing); this end was also sealed with sealing wax as a precaution against dampness.



By using this method of antenna construction the problem of antenna posts is eliminated.

This antenna was made with the thought in mind that it might succeed some of the tall poles now used; therefore, I fully realized that to make it a success in amateur circles it must, of necessity, be cheap. That is why the ordinary hose was used for insulation, and also why, at first, it was buried only one foot underground, for digging a 100-foot trench is no joke—especially if you live in Texas.

The antenna was laid so that it would point in a northeasterly direction, for the bulk of the amateur stations lie in that direction and to get reports from tests it seemed the best try.

THE TRANSMITTER

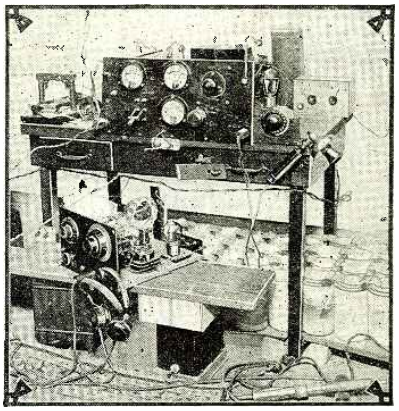
The transmitter is another idea developed by the amateurs of today. It uses very low power and is of moderate cost. The inductively coupled Hartley circuit was used with the five-watt tubes as oscillators. For plate power supply, 500 volts of rectified alternating current did the work. This current, after coming through the large chemical rectifiers and chokes, was decreased to just a little above 460 volts of really good, smooth current. The antenna current obtained by this arrangement was .2 ampere on 80 meters, and .5 ampere on 95 meters. At the time of the tests the transmitter drew exactly 100 milliamperes at 80 meters.

With the antenna system mentioned it was possible to tune the transmitter to waves of 50, 60, 95, 100 and 120 meters, using the experimental license of 5XAY, and waves of 80 and 180 meters using the regular call of 5BX.

The receiver, as the photograph will show, was what is best known as a 1BGF tuner with low-loss coils, slightly modified to take care of the very sharp incoming signals. One stage of audio-frequency amplification was added to take care of the decrease in signal strength.

This was the receiver used on the underground system. Static on this type of antenna is almost absent, and the electro-magnetic waves decrease in strength slightly; hence the amplification. Other receivers on ordinary aerials were used on good nights.

The ordinary receiver, while receiving a transmitted signal emitted from an ordinary aerial on 80 meters, will show very little loss of volume when the ground is removed, but will show a considerable decrease of signal strength when the aerial connection is removed. The case is nearly opposite with the underground system. My experiments with Mr. Abraham Lincoln, a fellow amateur about five miles distant, who informed me by telephone of every move that was made, thereby eliminating a great loss of time, showed that with the ordinary receiver attached to an elevated aerial the elimination of the aerial on the receiver at his home made very little difference in the strength of the signals received. But when the ground connection was removed the signal decreased to such an extent that it was barely readable This practically proves that the electro-magnetic waves emitted from the transmitter which employs the underground system use the earth as a conductor for the most part, and do not come out into the ether to any considerable extent.



The author's transmitting equipment, with which an underground antenna is used.

CURRENTS IN THE EARTH

In the common aerial systems the heat generated in the earth by the currents from the lead-in of the transmitter has always been considered one of the greatest sources of loss of energy, especially with the use of short waves. But this does not prove to be the case with the underground system.

The audibility of the signals emitted into this buried type of antenna seems to be, for the most part, equal in volume to the signals emitted into the same sort of antenna, whether it is day or night.

Of course, the earth has different powers of conductivity, and the better the ground in which the antenna is buried, the better will be the results obtained. I have tried three different depths and have found by tests with long distance stations that there is no noticeable difference. But on another occasion, an antenna was laid on the ground, and then covered with a very poor grade of soil, namely sand, cinders and gravel. Enough soil of this type was scattered about to make the level, and then experiments began. A switching arrangement was made so that any one of four underground systems could be switched to the transmitter in a few seconds' time. With three antennae that were buried in the good soil I made the record mentioned in other parts of this article, but with the antenna that was covered with the poor soil described above, I was unable to get an answer from any station outside of this city Later, a trench two feet deep was dug in

the good soil, lined with the poor soil and an antenna put into it. The same results were received—no one answered.

WAVES USED AND COMPARISONS

As mentioned before, a wide range of wave-lengths was used in these tests, and the best was found to be 95 meters, with the size of antenna described. My tests on 180 meters were very discouraging and practically worthless.

Most of the tests were carried on at 80 meters, for it is that band which houses the majority of the amateurs, and to get results from a test one must have answers.



On the left side of the "shack" is the author's receiving set and on the table on the right side of the photograph is the transmitting station. The underground antenna is used for both receiving and transmitting.

They came, and from nearly a hundred stations in the short time that was devoted to the test.

One of the first things that will be noticed about the underground system of transmitting will be that of the directional characteristics.

Stations in Fort Worth, a small city only 35 miles away, and in an opposite direction to that in which the antenna is pointing, have answered my calls several times, but they report that my signals are very weak and hardly readable. But stations in New York City, a distance of about 1,800 miles, report my signals strong and steady. *The antenna points toward New York.*

Although the system is highly directional, I have been able to communicate with stations about thirty degrees from each side of the antenna.

RESULTS

Results are, of course, what count in the radio game, and I feel sure that you will immediately see that such results as I have obtained from my experiments are entirely satisfactory, even though this idea is far from being fully developed.

The first distant station with which I communicated was 2JL, operated by Mr. W. A. Cohen, of Long Island, N. Y. He reported receiving me on a loud speaker! The next night I succeeded in reaching the first district; the station worked was 1BZP, located at Plymouth, N. H., and operated by Mr. Leon Sherman. Later I received a card from another station in the same state, 1BFT, and he said that he had heard me working station 1BZP, and that my signals were very clear and strong.

The points which stood out on all cards received were the facts that there was no swinging, and that the operators which received my station thought that I was using high power in the ordinary radiating system.

Then, about the same time as I was receiving cards from all the Eastern states telling me that my station was pounding in steadily, a card was received from Mr. Palmer, of station G6TD of North Wales, British Isles, a distance of some few thousand miles; his date of reception corresponded with my log of transmitting.

PAST EXPERIMENTS WITH UNDERGROUND SYSTEMS

For over a year experiments on underground antennae have been carried on. The first idea was that of an underground receiving antenna. It worked fairly well, and static was hardly noticeable on it, although the signal strength was decreased to some extent; however, this difficulty was remedied by adding a stage of audio frequency to the receiver. This antenna was built for the purpose of eliminating static, and of course when the ether was clear, the ordinary aerial was used.

But while receiving, it was noticed that the receiving set was more directional than a similar set using a loop method of reception. In other words, if the station was not in the general direction that the antenna pointed, it was not heard.

Later experiments were carried on in transmitting with a vertical underground antenna. This was accomplished by the use of an abandoned artesian water shaft, but somehow the thing never worked.

At the present time experiments are being carried on along the same lines, but with more precaution taken against power leaks. Ordinary plumber's drainage tile of four-inch diameter has been laid for 85 feet and several wires run through it. Although this method may seem expensive, it is really cheap compared to raising a mast or two, buying insulators and putting up a counterpoise.

Another experiment being tried is the employment of two underground antennæ, one for an antenna and the other for a counterpoise. There are at this station at the present time four underground antennæ, two running horizontally and two at an angle of 45 degrees.

IN PARTING

If you try this method, and it does seem that there is quite an interest in it, judging from the number of letters already received, *please* do not put a wire underground, and if it does not work at the first attempt, give it up. The manner of tuning your transmitter when the antenna is underground will probably be altogether different from the way you have been accustomed to tuning it.

Be very careful, when laying the antenna, that you do not leave bare wire touching the ground after the ditch is filled in. This would ruin everything, and since the trouble would be underground, it would be very difficult to detect.

For the information of those who would like to know about the better way of going about this job, let me repeat that, although the hose system has been found OK so far, the plumber's four-inch tile will cost only about $15 or $20. It comes in lengths of two feet and is about as good a material as you can find for this purpose.

The writer would be very appreciative if anyone hearing the calls of 5BX or 5XAY would write a card or letter. This is practically the only way experiments may be developed.

In 1919

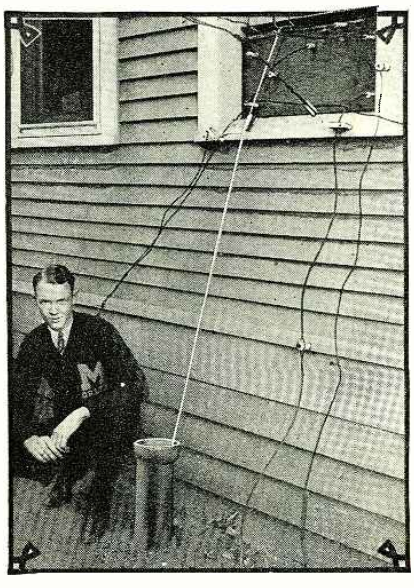
Following is a reprint from the December, 1919, issue of Radio News. *It shows that construction work was being done along the same line years ago.*

THE readers of Radio News will undoubtedly greet this article with open arms, since it deals with an underground system accessible to all, no matter how small the back yard.

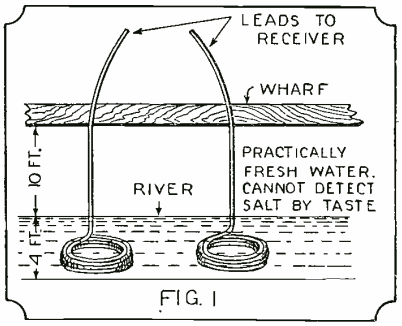
As is well known, the Rogers system with its lengthy wires stretching in all directions cannot be employed by the amateurs of today. Take, for instance, reception of long wave-lengths where a stretch of two thousand feet is required. This would mean that the amateur would have to dig under fences, etc., for three city blocks in each direction—IMPOSSIBLE—and worse than that. This state of affairs bothered me considerably and I was determined to find some possible substitute for this impracticable method.

Up with the curtain—for here is how the idea struck me. . . . One sleepless night visions began to parade before my half-conscious vision and in the crowd was a coil of wire rolling merrily along—*AH!* the problem was solved. Not trusting my memory, I leaped from the bed as if it were on fire and, grasping a pencil, I drew roughly as best I could in the glare of the night lamp of .000005 candlepower, what might have passed for two coils of wire and an ordinary audion circuit connected.

After getting up some five or ten times to make corrections and to jot down new circuits, I finally fell asleep.



How the lead-in is carried through the window and into the tile pipe that leads to the buried antenna.



The position of the two coils in the lake for the first experiment. The distance between them was varied from 2 to 10 feet.

In the morning I went forth with vim and vigor to plant some coils in old Mother Earth. Finding labor scarce, I decided to throw them into the lake for a trial. *OUCH!*—then the fun began. Now to get back to business we will begin with the first experiment carried out at this lake, in order to prove my sanity.

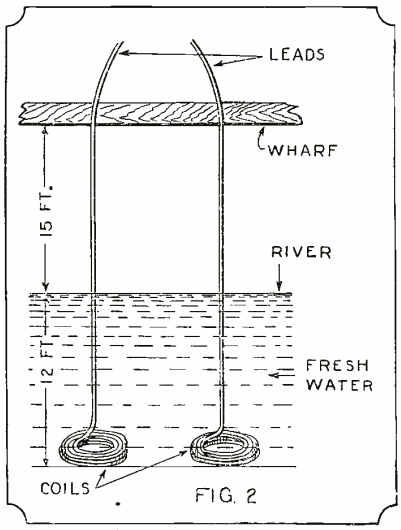
The first experiment made use of two coils, each two hundred feet of Packard auto cable, wound to have an overall diameter of two feet. After being bound so as to hold their form, they were lowered into the water (Lake Pontchartrain, Louisiana), and rested on the bottom at a depth of approximately four feet. The coils were spaced about ten feet apart, but bringing them as close as within two feet of each other did not seem to have any noticeable effect upon their proper functioning. There was, of course, no directional effect, in that the coil was in a favorable position to respond from practically all directions. Later on it will be shown how coils embodying directional effects were used.

FIRST RESULTS

The *exceptional* results obtained with this arrangement prompted me to believe that such an antenna would, if consistent in operation in different localities, eliminate the present practice of digging lengthy and costly ditches in which to lay the wires for underground work. Besides, since it is recognized that the picking up of strays is governed by the length of the wire, it is to be expected that a great reduction in respect to such disturbances would be noticeable under actual operation. When employing such small concentrated inductances for underground antennae, what little static is picked up on the wires is entirely eliminated, and the strength of signals is not weakened in the least by employing such small coils. The position of the coils is shown in Fig. 1.

The second experiment followed immediately after obtaining such remarkable results from the first, and the two coils which were used in the first experiment at Lake Pontchartrain were taken up and put into the Mississippi River. The leads from the two coils were brought into a Naval building. In this instance the coils were sunk to a depth of 12 feet in the water; they rested upon the mud bottom of the river, and the distance between the waterline and wharf was approximately 15 feet. Reception commenced at 8:10 P. M. and continued until 10:45 P. M. that night, at the end of which time it was demonstrated that the possibilities of such antennae were indeed remarkable. The following stations worthy of note were received:

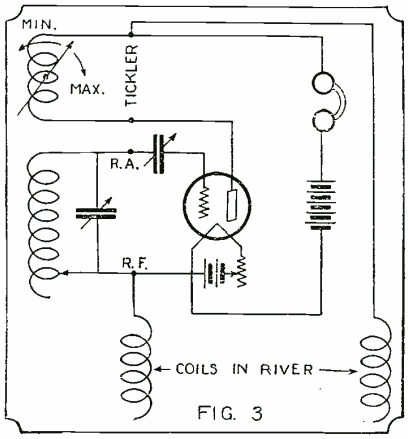
8:10 P. M., Swan Island, signals good; 8:26 P. M., Burrwood, signals strong; 8:27 P. M., Colon, Panama (NAX), signals strong; 8:30 P. M., Key West (NAR), signals strong. (On small set): 8:43 P. M., Miami, Fla. (WST), signals strong; 9 P. M., time from Arlington, Va. (NAA); 9:15 P. M., Guantanamo calls (4——), signals strong; 9:46 P. M. (NAJ), Great Lakes, 600 meters, very strong; 9:56 P. M., Mexican (XAB), very strong; 10:25 P. M. (BZQ), Bermuda, very strong, 1200 meters; 10:40 P. M. (NAN), Beaufort calls CQ, signals very strong. Many ships were received, but there was no method at hand of ascertaining their distance, so they were not included in the above.



By employing this pick-up system local strays and static annoyances were eliminated.

Of course in this experiment, as well as the first, there were practically no directional effects present, as expected when making use of coils as described; but the exceptional results obtained through the employment of same was more than gratifying, and I think that the results of the foregoing experiments, if consistent in various localities, will provide a means of saving considerable expense involved in installing the usual Rogers system. Likewise, the ratio between signal and static audibilities will be increased, *since the inductance is concentrated, and not distributed at considerable lengths.*

The coils employed in both experiments were, at each location, drawn from the water and placed on the dock at various angles with absolutely no results in respect to signals, but local strays and heavy jolts were picked up. Of course, the local stations NJK and NAT could be heard, but this was of no value. Immediately after placing the coils back into the water the static and strays disappeared and signals were picked up from the various stations outlined previously. Very heavy jolts of static and lightning were recorded by faint clicks.



The circuit first used by the author in the underwater antenna.

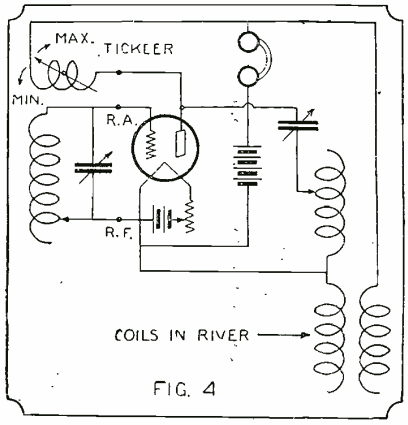
This may have been augmented by making use of non-shielded wires for the leads from the coils to the receiver proper. They acted as an open antenna from the waterline to the receiving apparatus; besides, the apparatus was not screened nor shielded. See Fig. 2 for the details of coils in river.

TWO GOOD CIRCUITS

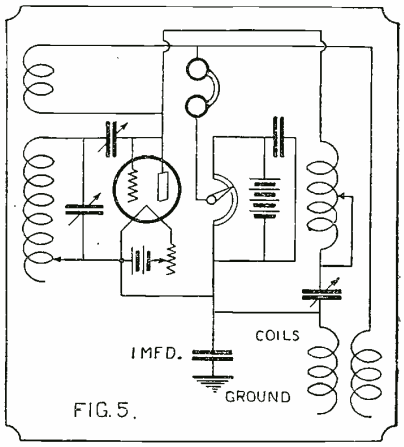
Two circuits, which gave exceptional results, are shown in Figs. 3 and 4. In Fig. 3 the tickler arrangement was employed to complete the regenerative circuit; however, the connections shown in Fig. 4 greatly increased the selectivity of the system. In this case the plate circuit was tuned by making use of the variable condenser C-2 and inductance L; and the tickler coil was set at "minimum" adjustment or relation to the secondary coil. As the inductance in the secondary or tuning circuit was increased, the inductance L also had to be increased, and maximum response was obtained by varying condenser C-2 until the tube began to oscillate. This arrangement provides a much wider range of tuning and instead of acting in a manner similar to the tickler coil, which has practically a very sharp point of resonance, the plate tuning circuit commences to oscillate slightly at first and gradually increases until maximum response is obtained.

In the next experiments the coils were increased in size to ascertain what effect this change would have upon the reception of signals and strays. These coils were wound and supported by the cross sticks and had a diameter of four feet, as shown in the photos. The strength of signals was greatly

(*Continued on page* 352)



This circuit proved more selective than the one shown in Fig. 3.



By inserting a 1 mf. condenser in the ground circuit, the reception of the set was greatly improved.

Home-Built Set Contest

Sidney Kasindorf Wins Third Prize of $75

In this article are described two more of the prize-winning receivers entered in the RADIO NEWS *Home-Built Set Contest*

THE receivers that were awarded the first and second prizes in the Home-built Set Contest were described in the August issue of RADIO NEWS, and it may be that some fans are not particularly interested in either of these two types. The majority of the sets entered in the contest were worthy of description, but space will not permit, so only those embodying special features in their make-up will be described.

The third prize was awarded to Sidney Kasindorf, of New York City, for the portable set shown in the accompanying photographs. This receiver is especially interesting as either UV-201A or UV-199 tubes may be used.

Realizing the convenient size of the type writer case, it was determined to confine within this the assembly of all necessary parts which, when completed, would produce the following results:

Reception on a small loop antenna.

D.X. reception.

Faithful tone reproduction.

Reception of all wave bands between 250 and 800 meters with equal intensity.

One dial control with calibrated setting.

Use of dry cell tubes and batteries.

Use of storage battery tubes and batteries.

Elimination of external antenna and ground, with option of using same for increased volume and distant reception.

Greatest possible elimination of static.

R. F. AMPLIFICATION USED

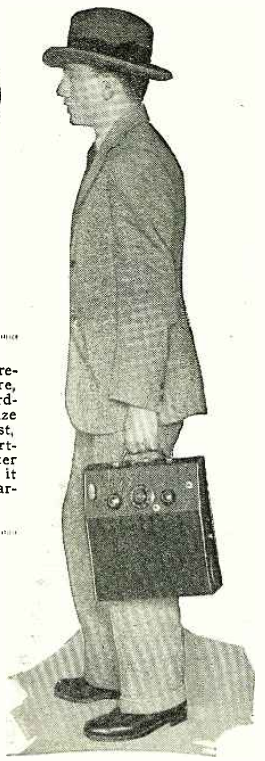
In the selection of the circuit used, it was evident that in order to use a small loop antenna, some form of radio frequency amplification must be resorted to.

This was accomplished by the use of three stages of fixed transformer-coupled radio frequency, in which the transformers selected amplified with almost equal intensity over a comparatively flat amplification band.

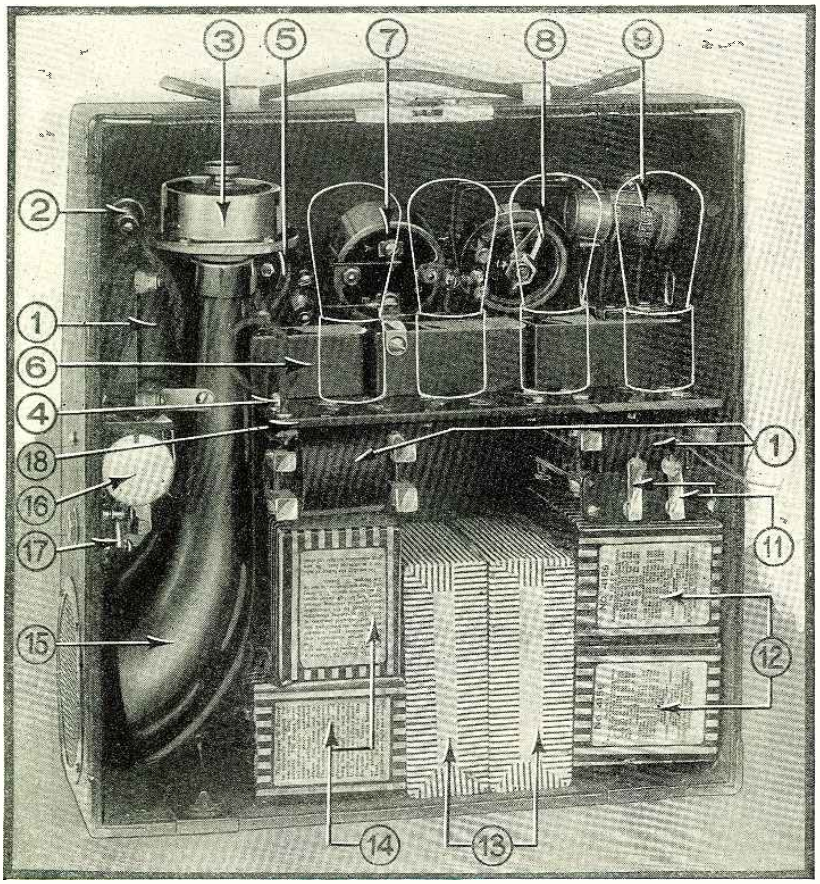
This method would impress sufficient voltage upon the crystal detector which, as yet, apparently holds its own for rectifying qualities.

In order to compensate for the reduced size of the loop (which is contained within the cover), and the amplification factor lost through the use of the crystal detector, a third stage of audio amplification is used. This is so controlled as to prevent any distortion on all broadcast frequencies.

In order to obtain the greatest return for the number of tubes used, all but the first were reflexed. A method was devised so that the tubes and sockets are removable as one unit, permitting the tubes to be changed with the least amount of trouble. This is done by means of spring contact strips with bent ends inverted into holes drilled through the sub-panel. These holes are drilled at points corresponding to the positions of long screws, reversed downward through the socket corners, and making perfect contact with the springs.



The portable receiver shown here, which was awarded the third prize in the contest, is built in a portable typewriter case, so that it may be easily carried.



1 A.F. transformers; 2 switch; 3 loud speaker unit; 4 "A" battery terminals; 5 potentiometer; 6 R.F. transformers; 7 variable condenser. 8 rheostat; 9 "C" battery; 11 loop terminals; 12 "B" batteries; 13 auxiliary "A" batteries for UV-199 tubes; 14 "B" batteries; 15 horn; 16 "C" battery; 17 storage battery binding posts; 18 shelf for tubes and transformers.

For best results a six-volt storage battery, 90 volts of "B" battery and one and a half volts of "C" battery are used, an additional one and a half volts of "C" being applied in the grid circuit of the first tube when UV-199 tubes are used. The use of the smaller tubes requires the substitution of three "C" batteries connected in parallel for its "A" battery. A 30-ohm rheostat is employed so that close filament adjustment may be obtained on both types of tubes. This also allows sufficient voltage drop when plugging into a 12-volt automobile lighting system.

The sub-panel is made of a bakelite strip $\frac{3}{16}$ inch thick, cut and drilled as per sketch.

NECESSARY APPARATUS

The following is a detailed list of parts comprising the completed set:

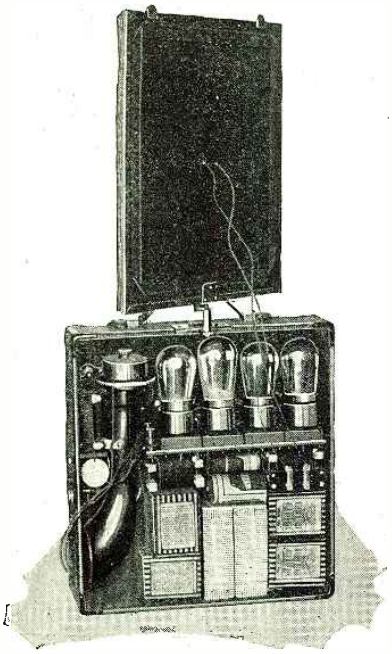
1 Remington portable typewriter case, $10^{9}/_{16}$ inches wide, $11\frac{3}{8}$ inches high and $3^{13}/_{16}$ inches deep.
3 audio frequency transformers.
3 radio frequency transformers.
1 panel-mounting crystal detector.
1 variable condenser.
1 loud speaker horn.
1 adjustable loud speaker unit.
1 400-ohm potentiometer.
1 30-ohm rheostat.
1 strip bakelite $\frac{1}{8}$ inch thick for loop connection block.
2 filament toggle switches.
4 UV-201A type sockets.
4 "B" batteries, 22½ volts each.
4 Eveready Mono-cells No. 950.
1 Eveready Mono-cells No. 935.
2 "C" batteries.
2 .00025 mf. fixed condensers.
1 .002 mf. fixed condenser.
1 .005 mf. fixed condenser.
8 two-inch lengths of bus wire.
4 mounting clamps for "C" batteries.
1 mounting bracket for loop antenna.
1 loud speaker jack (double circuit).

5 tip jacks.
4 UV-199 adapters.
4 UV-201A or 199 tubes.
68 feet of No. 20/38 inch "Litz" wire for loop.
3 ounces No. 20 x ¼ inch brass escutcheon pins (for loop).
1 soft rubber bushing for loud speaker.
16 socket contact springs.
2 loop contact strips.
6 feet No. 18 flexible double-twisted wire and plugs for automobile dash-lamp.
1 brass ring No. 24 gauge, 3½ inches O.D. 3¼ inches I.D.
1 piece of fine screen mesh to cover above for loud speaker outlet.

The weight of the entire set when completed is only 16½ pounds.

OPERATION OF SET

The operation of this outfit is simplicity itself. The loop may be left in its closed



The loop antenna, which is built in the back of the case, is supported by a removable bracket that fits in the lock of the case.

position and the set rotated or the set may remain stationary and the loop be pivoted on its bracket.

The latter method is the more efficient. The filament switch in the upper right-hand corner is pressed down, and the rheostat below is turned clock-wise to its maximum position. The potentiometer (near the crystal detector) is then turned counter-clockwise, just up to the point of oscillation, meanwhile turning the condenser dial across its entire range until reception takes place. When this is obtained, the loop is turned to its best position, followed by a slight re-adjustment of the potentiometer. Occasionally the crystal detector is re-set to a more active spot.

The toggle switch (near the center dial), when thrown down, raises the variable condenser value to that of a 43-plate, and when in its open position to that of a 13-plate for the lower wave-length range.

It may be interesting to relate a practical experiment conducted with the aid of this instrument. A wire was plugged into the dash-lamp of an automobile for the filament supply and the loop pivoted into position, and then an automobile cruise throughout the city was begun. It was noted that the firing of the spark plugs interrupted reception only while the motor turned over at slow speed while starting, this annoyance becoming negligible with an increase to normal traffic speed. Although local broadcasting came in uninterruptedly, it was most interesting to observe the variation in the reception in different localities throughout the city, due to absorption by metal masses.

As to the actual capabilities of this outfit, such stations as WCAR—Akron, Ohio; WSAI—Cincinnati, Ohio; KSD—St. Louis, Mo.; WLW—Detroit, Mich., and WJAZ—Chicago, Ill., are quite consistently brought in on the loud speaker, using the loop antenna under normal conditions while local stations are operating.

FIFTH PRIZE SET

W. A. Knight, of Columbus, Ohio, was awarded the fifth prize for the receiver which is described below.

The neutrodyne hook-up was followed in the construction of this set because of the general all-around excellence of this type of receiver.

As a result of trial and experiment, standard construction was not followed in several particulars: The panel is made 8 inches high instead of the usual 7. This gives more clear space around the coils. The radio frequency tube sockets are placed directly on the baseboard, so as to get them as far away from the coils as possible. The coils are set out from the condensers by studs 1 inch long in order to keep down loss and

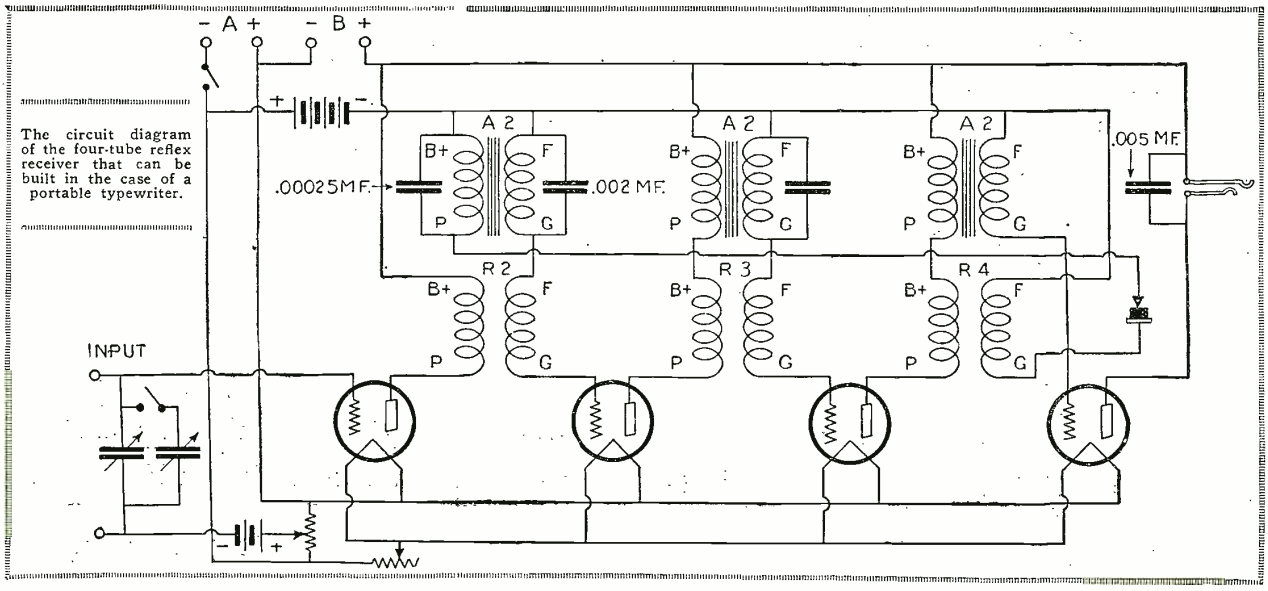


Sidney Kasindorf of New York City, constructor of the set which won third prize.

mutual reaction between coils and condensers. One of the studs which supports a coil is tapped directly into the bakelite end-plate of the condenser. This prevents the high potential of the condenser from being carried out to the low potential end of the coil. The high potential ends of the coils are placed at the top. This lengthens the grid lead slightly, but on the other hand gets the high potential ends of the coils away from absorbing material. Note, too, that the grid leads are of No. 24 wire instead of the usual No. 14. The keynote of all the foregoing was to keep the coils in the clear and away from all absorbing material, whether that material be metallic or a dielectric.

The neutralizing condensers are of my own design and construction. One is shown in Fig. 1. There is a hard rubber shell ¾ of an inch in diameter by ¾ inch long. A brass base is threaded and screwed into this shell, the upper surface of which forms one plate of the condenser. This brass base also forms a nut which fits the grid terminal of the socket. Thus the condenser takes the place of the usual binding nut on the grid terminal. The upper plate of the condenser has a threaded stem that works through the top of the rubber shell. Adjustment is made with a screw-driver, and a lock-nut locks the stem in place when once its correct position has been found. A thin mica disc is

(*Continued on page 332*)



The circuit diagram of the four-tube reflex receiver that can be built in the case of a portable typewriter.

A Super-Heterodyne for Neatness and Tone Quality

The trouble with many super-heterodyne receivers is their size. The set herein described has been designed with the idea of eliminating this difficulty.

WE HAVE yet to see a super-heterodyne that did not claim to be the "last word in radio receivers." What we like about this one is that it doesn't make any unreasonable claims for its distance-getting properties, and it does lay stress on neatness and compactness; but, best of all, is the clearness and completeness of the wiring directions, which make this set remarkably easy to build right, instead of a pretty difficult job, as it would otherwise be.

THERE is a widespread idea that a standard super-heterodyne, because it has eight tubes instead of five, is about three-fifths again as good a set as a standard five-tube receiver. Without attempting to say whether this is or is not a fair estimate of the general superiority of the super, it should be pointed out that there are quite important differences of a fundamental nature between the usual five- and eight-tube receivers which make it unfair to both types to judge by the number of tubes alone.

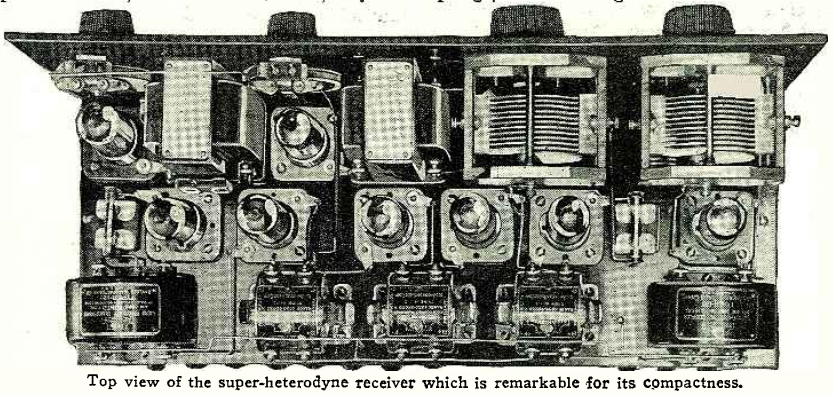
The super-heterodyne has no need of more than two main tuning controls, and at least one of these can be made practically as sharp as the builder desires to make it. The degree of selectivity secured in a properly designed super-heterodyne is a compromise between the desirability of extremely sharp tuning and the necessity of preserving tone quality.

QUALITY VS. SELECTIVITY

A set which will separate stations a fraction of a meter apart may be an interesting plaything, but a set which will put into the loud speaker actual musical tones from distant stations 2 or 3 meters apart is a much more useful piece of property. The set here described has sufficient selectivity, when operated at Chicago, to tune through the 16 local stations and pick up Los Angeles and other Pacific Coast stations whenever their signals are distinguishable from static in Chicago. With this degree of selectivity, there is preserved a quality of tone which differentiates the set at once from the "tuning-stunt" super-heterodyne. With the addition of laboratory-grade audio transformers to carry this same completeness of overtones into the loud speaker, we have a set which leaves little, indeed, to be desired in a musical way.

The set is built on a panel 7x18 inches and a sub-panel 7x17 inches. It can thus be slipped into any standard 18-inch cabinet, and is also splendidly adapted for use as a portable set.

No attempt will be made here to outline the general theory of super-heterodyne operation. The circuit of the present set is practically standard. Some will object that it is not possible to get the last degree of amplifying power out of a super without potentiometers, numerous rheostats, adjustments of oscillator coupling and other complications. These claims may be admitted at once: it is generally found that when all such aids are utilized to best advantage even a seven-tube super will receive any signal down to the noise level. In the present design it has been considered better to get an added margin of sensitiveness by using the additional tube (which introduces no extra operations in using the set) rather than to adopt these extra sub-controls and assume that they will be used to their full effectiveness. Much the same applies to the possibilities of saving in the number of tubes through reflexing and combining of oscillator and first detector. These are complications which have been purposely avoided.



Top view of the super-heterodyne receiver which is remarkable for its compactness.

ASSEMBLING THE SET

The sub-panel construction, employing the binding posts of the tube socket very largely to carry connections from one side of the sub-panel to the other, enables the set to have a clean-cut appearance from above, which is almost never attained in supers.

Before any of the tube sockets are mounted they should be carefully prepared by reversing the necessary screws, as shown, in each socket; two or three are reversed in each case, and these serve to attach the sockets to the sub-panel, as well as to carry electrical connections through the sub-panel.

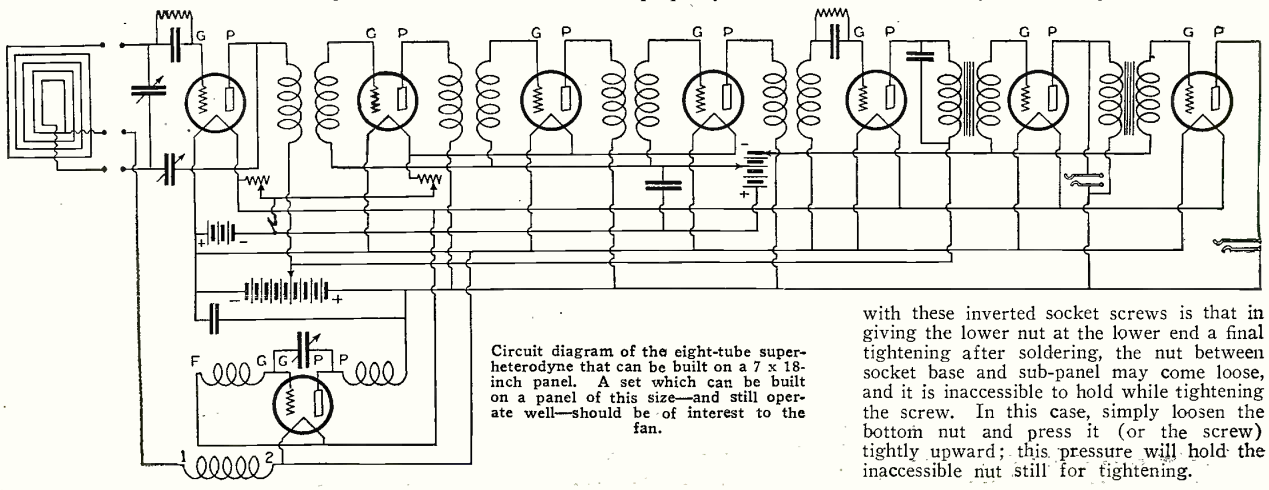
All of the reversed screws must be finally tightened, with nuts holding the contact springs, before being mounted on the sub-panel; then, before the nut is attached on the bottom of the sub-panel the lug should be attached there also, and turned in the proper direction. Lugs are to be bent up.

First, the set can be wired quickly and neatly without using "spaghetti" tubing, except in two or three places where specified.

Second, wires need never run over the ends of screws so as to prevent access with a socket wrench.

If wiring directions are followed exactly, it will be found possible to *remove* and *disconnect* any instrument in the entire set *without disturbing* any other—a feature which is too frequently lost sight of in the building of elaborate radio sets.

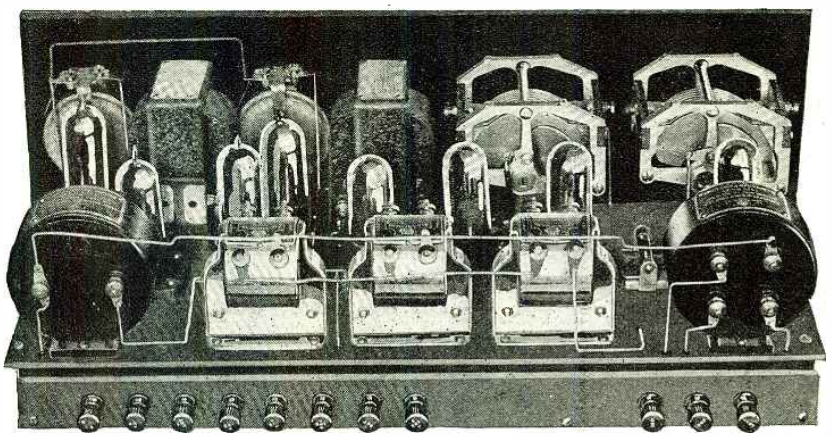
A difficulty which may be encountered with these inverted socket screws is that in giving the lower nut at the lower end a final tightening after soldering, the nut between socket base and sub-panel may come loose, and it is inaccessible to hold while tightening the screw. In this case, simply loosen the bottom nut and press it (or the screw) tightly upward; this pressure will hold the inaccessible nut still for tightening.

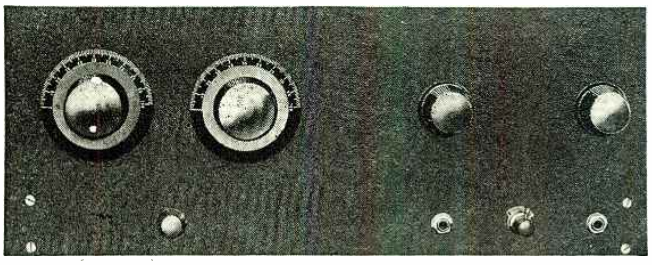


Circuit diagram of the eight-tube super-heterodyne that can be built on a 7 x 18-inch panel. A set which can be built on a panel of this size—and still operate well—should be of interest to the fan.

When the set is completed, it is best, before connecting the "B" batteries, to connect the "A" battery to the "B" battery terminals and turn on all tubes, to make sure that they do not light. If they do, it of course indicates the presence of a wiring error, which would blow the tubes if the "B" battery was connected. If this test shows no trouble, the batteries may be connected for regular operation.

The three "loop" binding posts are to be connected to any standard tapped loop, the center post going to the tap. Loops are commonly tapped at the center of the winding. It may be found with this super that slightly better results are obtained by tapping a little off center. The feed-back provided by this tapped loop is controlled through the .000045 variable condenser. Increasing this capacity up toward the point of oscillation will be found to sharpen the tuning and probably increase the volume of signals.





Rear view of the super-heterodyne receiver, showing how, by this arrangement of the apparatus, it is possible to build the set on a 7 x 18 panel. Panel view of the receiver shown at the left.

The small variable condenser is for controlling the loop regeneration, and in operation it is simply left "out" entirely until the set is working satisfactorily on reasonably strong signals. Throwing this small condenser part way in then introduces a feed-back which sharpens the tuning and materially increases the sensitiveness of the set for use in long-distance reception. It should, of course, never be turned on enough to cause oscillation of the first detector tube —which is indicated, when it occurs, by a click and mushy signals.

Wanted—Official WRNY Observation Station Posts

IN connection with the new RADIO NEWS Station WRNY, the editors of RADIO NEWS desire to ascertain a number of scientific facts pertaining to radio transmission and reception. There are many things in radio on which the best authorities today do not agree. There are many things of which we are still ignorant. All of these matters can be cleared up to the satisfaction of all and to the enrichment of science only by getting all the facts together.

Station WRNY will be the first broadcast station in the country that will have a number of official observation stations. RADIO NEWS, therefore, makes an appeal to a number of scientifically inclined readers to become Official Observers for Station WRNY. Each observer is to report not less than once a week on special blanks furnished by WRNY, and reproduced on this page, certain scientific data, which will later be studied by the engineers of WRNY, as well as the editors of RADIO NEWS. Once every two months the results of the official observers will be published in RADIO NEWS. It is hoped that from these observations, extending over the period of a year or more, much scientific information may be gathered that will be of great help, not only to broadcasters and listeners themselves, but to the science of radio as well.

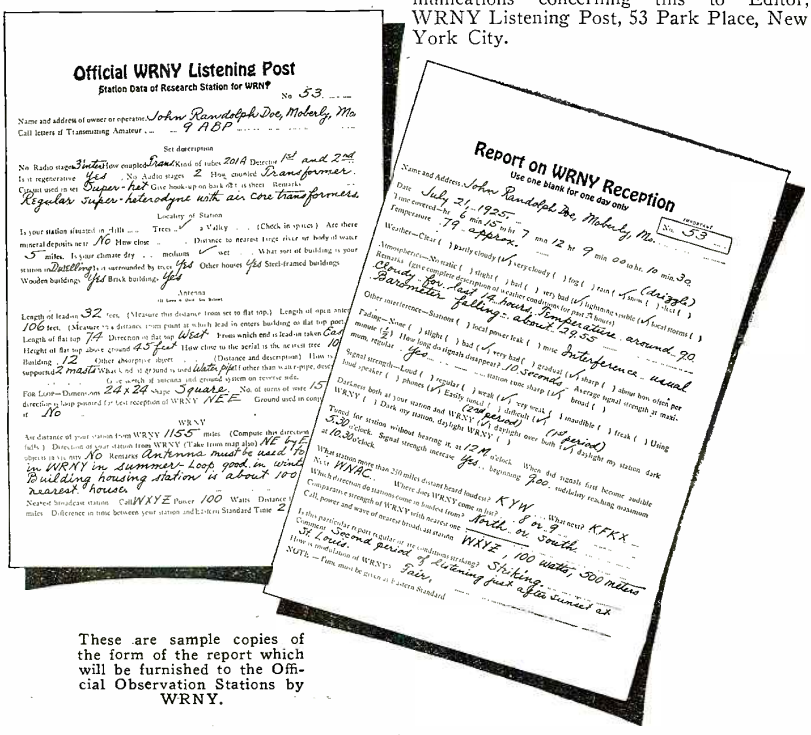
We should like to have two or three official observers in every state of the Union. In order to be eligible, it is necessary that you be located at least 50 miles from any broadcast station. It is necessary that you have a first-class set that is in good condition at all times. It is, furthermore, required that you fill out a weekly blank of observations on WRNY, which blanks are furnished free to you.

If the board accepts your application, you will be enrolled as an official WRNY observer for an indefinite period. A set of blanks will be furnished to you, as well as an engraved certificate for display in your station. At frequent intervals you will receive correspondence or telegrams from WRNY informing you of special programs, or special entertainments that are to be given and on which you are to report.

There is no monetary consideration in either event, the entire idea being the advancement of the radio art and science.

If you wish to act as an official observer, be good enough to send in your application. Upon receipt of same, you will be furnished with the necessary blanks, which you are to fill out and return to the board.

It is, of course, necessary in all events that you are able to receive Station WRNY at the present time. Please address all communications concerning this to Editor, WRNY Listening Post, 53 Park Place, New York City.



Official WRNY Listening Post
Station Data of Research Station for WRNY
No. 53

Name and address of owner or operator: John Randolph Doe, Moberly, Mo.
Call letters of Transmitting Amateur: 9 ABP

Set description

No. Radio stages 3 Intervalve Low coupled Transf. Kind of tubes 201A Detector 1st and 2nd
Is it regenerative? Yes No. Audio stages 2 How coupled? Transformer.
Circuit used in set: Super-het Give book-up or book ref. if known: Remarks:
Regular super-heterodyne with air core transformers.

Locality of Station

Is your station situated in: Hills — Trees ✓ Valley — (Check in spaces) Are there mineral deposits near? No How close — Distance to nearest large river or body of water? 5 miles. Is your climate: dry — medium ✓ wet — What sort of building is your station? Dwelling. It is surrounded by trees: Yes Other houses? Yes Steel-framed buildings: Wooden buildings: Yes Brick buildings: Yes

Antenna
(If loop is used, see below)

Length of lead-in: 32 feet. (Measure this distance from set to flat top.) Length of open antenna: 106 feet. (Measure this distance from point at which lead-in enters building to flat top part.) Length of flat top: 75 ft. Direction of flat top: West. From which end is lead-in taken? East. How many wires in flat top? 10 Height of flat top above ground: 45 feet. How close to the aerial is the nearest tree? 10 Building: 12 Other obstruction: (Distance and description) How is lead-in supported? Mast. What lead-in ground is used? Water pipe (other than water pipe, describe)

For Loop—Dimensions: 24 x 24 Shape: Square. No. of turns of wire: 15 Ground used in connection with loop: No

Direction in loop pointed for best reception of WRNY: NEE

WRNY

Air distance of your station from WRNY: 1155 miles. (Compute this direction from your station.) Direction of your station from WRNY (Take from map also): NE
Objects in the way: No Remarks: Antenna must be used in summer. Loop, good in winter. In WRNY in summer. Loop, good in winter. Building housing station is about 100 feet from nearest house.

Nearest Broadcast station: Call WXYZ Power: 100 Watts Distance: 2 miles. Difference in time between your station and Eastern Standard Time: 2

Report on WRNY Reception
Use one blank for one day only
No. 53

Name and Address: John Randolph Doe, Moberly, Mo.
Date: July 21, 1925
Time covered: 6 min 15 min
Temperature: 79 - approx.
Weather—Clear ( ) Partly cloudy (✓) Very cloudy ( ) fog ( ) rain ( ) snow ( ) sleet ( )
Atmospherics—No static ( ) slight ( ) bad ( ) very bad (✓) lightning visible (✓) local storms ( )
Remarks (give complete description of weather conditions for past 24 hours): Cloudy. Temp. Mostly falling: about 15 degrees in 24 hours. Barometer falling: about 29.55 Temperature around 90.
Other interference—Static ( ) slight ( ) bad (✓) very bad ( ) power leak ( ) mine Interference - usual
Fading—None ( ) slight ( ) bad (✓) very bad ( ) period (✓) sharp ( ) slow hum, often per minute, regular. Yes
Signal strength—Loud ( ) weak (✓) very weak ( ) station tone sharp (✓) broad ( )
Loud speaker ( ) phones (✓) speaker ( ) Distance both at your station and WRNY ( ) Equal (✓) Unequal ( ) Difficult (✓) inaudible ( ) leak ( ) Using WRNY ( ) Dark my station, daylight WRNY ( ) daylight over both (✓) daylight my station dark
Distance both at your station and WRNY (Equal period) (1st period)
Tuned for station without hearing it, at 5:30 o'clock. Signal strength increase Yes ... o'clock. When did signals first become audible? 5:30 o'clock. Signal strength increase Yes ... o'clock. When did signals first become audible? 7:00 o'clock. Suddenly reaching maximum
What station more than 250 miles distant heard loudest? WNAC. Where? KYW
Which direction do stations come in loudest from? North or South
Where does WRNY come in? ... (What next) KFKX
Compare strength of WRNY with nearest one: ...
Call, power and wave of nearest broadcast station: WXYE, 100 watts, 500 meters
Is this particular report regular, or are conditions striking? Second period of listening just after sunset at St. Louis
Compare: Same
How is modulation of WRNY? Fair. Striking.
NOTE.—Time must be given in Eastern Standard

These are sample copies of the form of the report which will be furnished to the Official Observation Stations by WRNY.

More About Straight-Line Frequency Condensers

By SYLVAN HARRIS

The previous issue of RADIO NEWS *did not by any means tell the whole story about straight-line frequency condensers. Here are some more of Mr. Harris' ideas on the subject.*

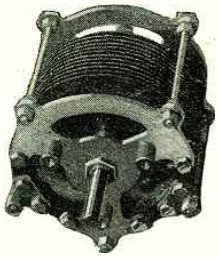
THE article in the last issue of RADIO NEWS on the straight-line condensers is, without doubt, the most complete discussion of the subject that has yet appeared in any popular journal. But this does not by any means tell the whole story, as one may easily judge by the amount that has been written on the simple circular-plate condenser.

In this article some of the points that are sure to arise in the fans' minds are discussed. The reader will find much in this article that will clear up, not only his coming problems with the straight-line frequency condenser, but also some of those which have arisen in the past with regard to other types of condensers.

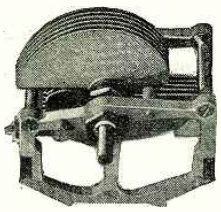
It is certainly a pleasant thought to us that we have acquired considerable precedance over all other publications in the thorough discussion of this subject, indicating the desire of RADIO NEWS to keep its columns up to the minute, as it has always done.—EDITOR.

IN THE preceding issue of RADIO NEWS a rather comprehensive article was presented on the straight-line frequency condenser, which explained various questions being raised as to its operation and advantages. In that article the principles only were discussed. In this article I will endeavor to talk in a somewhat general fashion on the straight-line frequency condenser, especially in its connection with the average user, the broadcast listener.

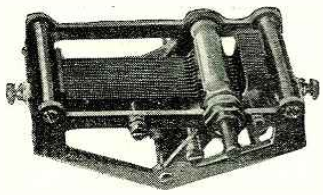
During the last year and the year previous, we saw considerable confusion in the condenser situation, which was originally stirred up by the "low-loss engineers."



MIN. CAPACITY



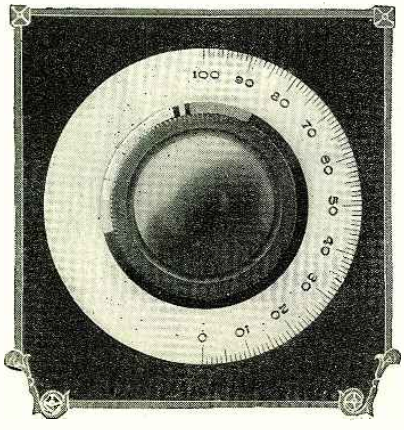
MIN. WAVE-LENGTH



MIN. FREQUENCY

The dial setting for the conditions shown here, for the three types of condensers, is indicated at the right.

Later on, there was more confusion in connection with the straight-line wave-length type of condenser, and, it is very likely, this year we shall see more confusion in connection with the straight-line frequency condenser.



The main trouble will be, as far as I can discern the future, in getting the condensers to furnish the straight-line calibration which will undoubtedly be claimed for them. The question of the relations existing between the consumer and the manufacturer will enter here, and it is well to point out that the radio fan must not expect or demand too much.

Nearly all users of variable condensers in the past have insisted that the condensers have very low minimum capacities. Naturally, the manufacturers have given them what they asked for, regardless of whether or not they asked for the best thing. The fact is that the insistent radio fans decided that they wanted to cover the wide broadcast range in one step, without having to bother with tapped coils. It just simply *had* to be done—so it *was* done. It was done by making the minimum capacity as small as possible, so that the total capacity ratio of the condenser should be as great as possible. It is not necessary to have a very low minimum, however, because the complete range can be covered by the usual condensers using loose coupling.

The main point is that the radio fans will naturally continue to ask for low minimum capacities, and if the manufacturers attempt furnishing it they will not be able to build straight-line frequency condensers which will have a perfectly straight-line calibration.

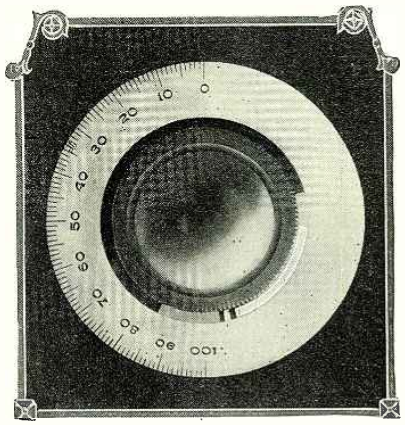
In Fig. 1 we have the calibration curve of a straight-line frequency condenser recently measured by the writer. Over the greater part of the dial range the calibration is perfectly linear, but a microscope is not required to see the bend at the upper end of the curve. This is due to the efforts of the manufacturer to produce a straight-line frequency condenser with a very low minimum capacity.

A low minimum capacity could have been produced without destroying the straight-line characteristics of the condenser if the maximum capacity of the condenser had been small, but it was to the manufacturers' condenser, as this size is probably the best seller. It is for this reason that the calibration curve of the condenser shows the upward bend at the high dial settings.

But, at best, the curvature is not great enough to cause the user any alarm. The curve is certainly straighter throughout its whole length than the curve for a circular plate condenser; moreover, the curvature is so small that it will not produce any appreciable crowding on the dial.

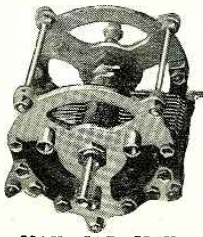
I should like to call attention right here, to the incorrectness of determining the straightness of the calibration curve by measuring the capacity at different dial settings, and then calculating the curve. This is the method that many experimenters will use, as a few have already done. It is incorrect for the reason that it does not take into consideration the operating conditions. A condenser is always used in combination with a coil and other associated apparatus. The capacity, inductance and resistance of the associated apparatus will have some influence on the operation of the condenser, so it is correct to make measurements only under the same conditions as apply in actual practice.

If this method of measuring the capacity and calculating the curve is used, the calibration curve will generally *not* be a straight

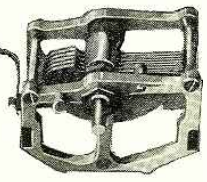


line. Take, for instance, the curve shown in this article. It *is* straight over its major portion. This curve was obtained by measuring the frequency of a driver exciting a circuit containing the condenser and a coil. The writer attempted to plot the curve by measuring the capacity and performing the calculations, and a decided curve resulted. (The condenser to which I refer is not the one shown in the photograph in this article.)

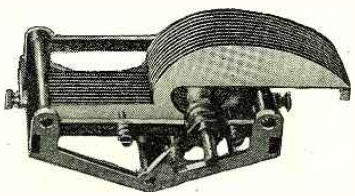
The radio fan must regard carefully the practical side of the question. Many straight-line frequency condensers will be



MAX. CAPACITY



MAX. WAVE-LENGTH



MAX. FREQUENCY

The dial setting for the conditions shown here, for the three types of condensers, is indicated at the left.

put on the market during the coming season which will have characteristics like this one. The slight curvature should not deter the radio fan from buying them or using them. Even with a slight curvature he will be surprised to find the relief that comes when tuning in the short-wave stations.

Somewhere above I have intimated that it is not well to tune on a variable condenser with the plates nearly all the way out. The reason for this is that the resistance of the condenser rises to relatively large values under such conditions, just in the same way as the resistance of a wire rises when its cross-section becomes very small. The tuning circuit of the radio receiver should be so designed that it is not necessary to tune so low on the condenser. This can be accomplished by using slightly larger condensers and slightly smaller coils. To tell the truth, the writer is more inclined to the .001 condenser and the 100 microhenry coil, especially in the simple types of sets, than to the general practice of using very small condensers and large inductances. This is for two important reasons, *viz.*, the high resistance of large coils, and the high resistance of the condensers when the plates are almost all the way out.

There is a point in connection with straight-line frequency condensers which may be of considerable interest. Although the writer has not yet made any measurements of the resistance of straight-line frequency condensers, he suspects that the resistance of this type may rise much more rapidly as the plates are turned out of mesh than does the resistance of the circular plate type. This is for the reason that the cross-section of conducting material in the plates is so much reduced in attaining the straight-line shape of plate. I have noticed the effect of this increase in resistance when using a straight-line frequency condenser in a regenerative receiver. When the condenser plates were turned out about three-quarters of the way, it was found impossible to make the set oscillate without either raising the plate voltage or adding turns to the tickler coil. This was probably due to the increased resistance of the tuning circuit, which was not changed excepting for the substitution of the S.L.F. condenser for the circular type.

A great deal of confusion may arise among the users of straight-line frequency condensers on account of their "left-handed" construction, as it might be called. Many will say that the dials read backward when used with this type of condenser. This is not so, because most of the manufacturers will design their condensers to open in such manner that the dials will read 100 when the plates are entirely *out of mesh*.

The reason for this is very easily understood with the aid of the illustrations of Fig. 2. Here the three types of condensers

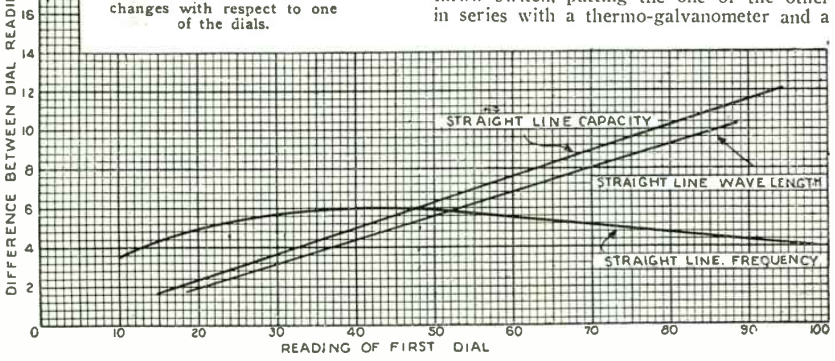


Fig. 2. This chart shows how the difference between the dials of an R.F. receiver changes with respect to one of the dials.

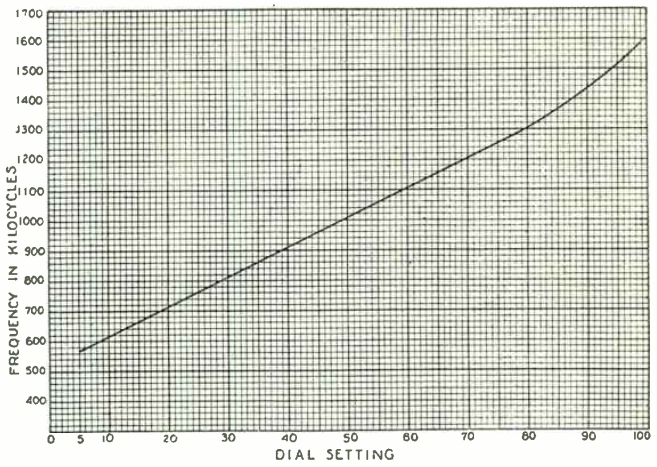


Fig. 1. This is a calibration curve of a straight-line frequency condenser recently measured by the writer. Note the curvature at the upper end.

are shown, one set for a dial reading of zero, and another set for a dial reading of 100. The number 100 is the maximum or largest number on the dial. Therefore, it is obvious that the conditions in the tuning circuit for which the condenser is particularly designed should also be maximum. This means that at 100 on the dial, the capacity should be maximum for the straight-line capacity type, the wave-length should be maximum for the straight-line wave-length type, and the frequency should be maximum for the straight-line frequency type. In the last type, to obtain the highest or maximum frequency, the condenser plates should be all the way out of mesh.

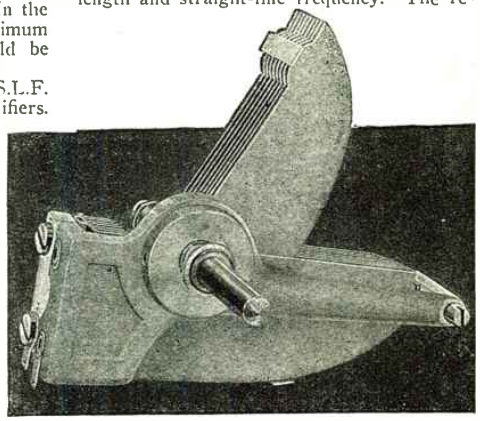
We have now to consider how the S.L.F. condenser acts in radio frequency amplifiers. Everyone is more or less acquainted with the way in which the settings of the dials change. Take any receiver, for example, which employs two stages of radio frequency amplification. We will not consider the condenser connected to the antenna coil, for the logging of this dial is influenced somewhat by the action of the primary connected to the antenna and ground. But if the R.F. transformers tuned by the other two condensers are identical and if these two condensers themselves are identical, they should log at identical points for all wave-lengths.

Nearly all of us know that this is not usually the case, generally because of differences in the inductances of the coil. Small differences in the capacities of the condensers would not, in most cases, account for the great difference in the dial readings. To investigate the matter, the arrangement shown in Fig. 2 was employed in the RADIO NEWS Laboratory to determine how the dials vary.

This figure shows a simple oscillator acting as a driver for a simple measuring circuit. In this measuring circuit are included two coils which may be thrown in and out of circuit by the double-pole double-throw switch, putting the one or the other in series with a thermo-galvanometer and a condenser. The two coils were purposely made slightly different in inductance, so that when the condenser plates were all the way in, there would be an appreciable difference between the dial reading taken with one of the coils in circuit and the reading with the other coil in circuit.

COMPARISON OF CURVES

Measurements were taken with this arrangement, for the three types of condenser, *viz.*, circular plate, straight-line wave-length and straight-line frequency. The results are shown in Fig. 2, wherein the curves for the three different types of condensers are shown. To visualize this curve, the reader should think of the second and third dials of his three-dial tuner. The dial readings of one of the dials are shown at the bottom, and the differences between the dial readings are shown vertically at the left.



Here is another straight-line frequency condenser recently put on the market. Note the original construction.

Many have noticed that oftentimes the difference is at the long wave-lengths, decreases gradually as we turn the dials to the short wave-lengths. This is the case shown by the curve marked "straight-line capacity" in the figure. In many other cases, however, the difference between the dial readings increases again at the lower end. This is due to excessive coil capacity in the R.F. transformers.

The variation is not as great when the straight-line frequency or wave-length condensers are used and, furthermore, the law of variation is not linear as is the case of the circular condenser. The curves show as straight lines in the figure because the curvature is extremely slight when the coil capacities are small. To be exact, the curves marked "straight-line wave-length" and "straight-line frequency" are combinations of straight lines and hyperbolas.

Single-Tube Circuits

By L. W. HATRY

This is a review of regenerative circuits using but one tube—an excellent article for the beginner and the experimenter.

THE amateur has come to the conclusion that for this short-wave work he can seldom, if ever, surpass the regenerative receiver, and some broadcast fans are of the same opinion. There are a number of circuits that one encounters when he prepares to build a set, all one-tube regenerative hook-ups—which serves rather to confuse him than to simplify his choice. So many and various are these receivers that one is at loss to what to do or how to do it, even if he has not delved into super-regeneration, or investigated any of the dynes or the plexes. It is with the hope of clarifying this muddle specifically in reference to the simple regenerative hook-ups that this article is written.

We must start off with this understood: in spite of the fact that all these circuits differ in some detail or another, they are based on the two fundamental circuits of Fig. 1, the inductively coupled A or the capacitatively coupled B; and in spite of the fact that all are apparently different, they will prove equally effective under the same conditions and similar construction. Thus, understand that it is not for superior results that any of these circuits may be considered, but for practical facts of constructional simplicity or operating ease. So the viewpoint in every case is entirely that of practicality; data to fit concludes the article.

We stick to these simple regenerative circuits and laud them because in them is both economy and satisfaction. Furthermore, there is little chance of the perpetration of a new "wonder" one-tube circuit without the discovery of a new principle or the invention of new "tools."

We take up the well-known tickler circuit in Fig. 2. Everyone seems to know it, for all seem to have used it at one time or another. Yet there remains the fact that although it can be said to be practically the first regenerative circuit, it has not been surpassed. In Fig. 2 the coil labeled "tickler" is variable in its relation to the coil labeled "secondary." Its sole electrical drawback lies in the fact that the tickler

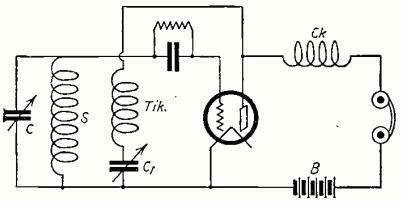


Fig. 4

A regenerative circuit with fixed coils that is smooth of operation and very uncritical.

causes some change in the secondary wavelength when tuning. This can be overcome by the proper design of the tickler. When this last condition is fulfilled, the dial settings are reproducible and the set's log can be depended upon. However, the diagram is shown essentially to discuss the methods of coupling to the antenna circuit.

This article by Mr. Hatry is a general review of single-tube circuits. If the experimenter would stop to realize that the extra tubes in multi-tube receivers merely amplify, single-tube sets would come into the prominence which they really deserve. Whenever a new circuit involving some hitherto unexploited feature is published, invariably but one tube appears in the diagram.

So let more attention be paid to the "one-lungers" of radio, for if the principles underlying these circuits are mastered, the rest is comparatively simple.—Editor.

METHODS OF COUPLING

Three methods are shown for coupling to the antenna, one in which the antenna is coupled by means of a coil similar to the tickler and with a similar type of variable relation. This is an excellent method from a result viewpoint, but it is open to the same mechanical drawbacks as the rotable tickler. This is indicated schematically by a, in Fig. 2. This sort of primary construction, contrary to usual practice, is still better when at least one tap is provided which allows a variation of the number of turns in the antenna circuit. This last generally makes the construction hopelessly difficult, but is mentioned because it is an improvement. This method of coupling the antenna circuit is the best of the three, but

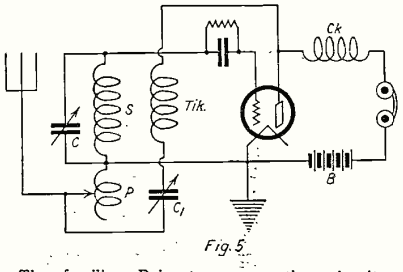


Fig. 5

The familiar Reinartz regenerative circuit, not quite as selective as that in Fig. 4.

it is so difficult in construction that for the fellow who makes his own, one of the other methods is to be preferred. The second method is indicated by the dotted line of b in the same figure. It consists of fixed coupling between the secondary and primary, with the primary necessarily smaller on account of the closer coupling necessary in such an arrangement. Its greatest disadvantage lies in having the period of the antenna circuit affect the secondary circuit at that wave-length. This last can be overcome with either an antenna loading coil or a tapped primary, in which manner it becomes possible to shift the antenna period off the secondary tuning. On the amateur wave-bands very loose coupling is necessary, which is best provided by a single primary turn an inch to two inches from the secondary. The last method, c of Fig. 2, consists in using a very small fixed condenser to provide the necessary coupling. In two respects it is the poorest method of the three. It generally results in less signal strength and has the same disadvantage of fixed coupling as b. However, it must be admitted that it is easy to install, works satisfactorily and is effective. It is certainly worth a trial, for trial finds for us the things we like, as well as those we dislike.

In Fig. 3 is illustrated another method of controlling regeneration. This is excellent and deserves trial. It is a variation of the tickler circuit that provides greater mechanical simplicity. The tickler is coupled rather closely to the secondary and is fixed in that relation. Control of oscillation is effected by means of a variable by-pass condenser across the high R.F. resistance of the head-set and "B" battery. This con-

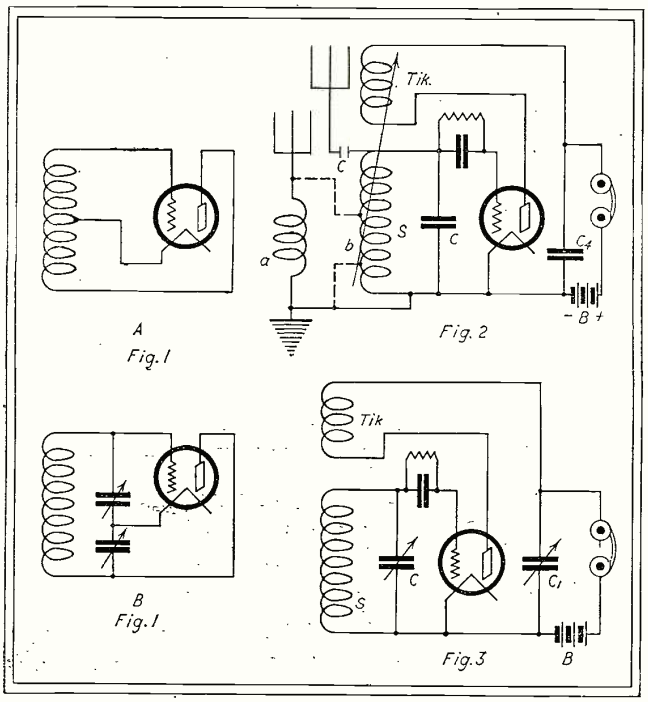


Fig. 1. A and B show fundamental regenerative circuits. Fig. 2 is an old favorite, where regeneration is obtained with a tickler coil. In the diagram shown in Fig. 3 regeneration is again obtained with a tickler, but it is in fixed relation with the secondary.

A variation of the ultra-audion circuit will be found in Fig. 11. In Fig. 12 is shown the tuned plate circuit, which is excellent because plug-in coils may be used. Both condensers in the circuit in Fig. 13 may be mounted on the same shaft, with satisfactory results.

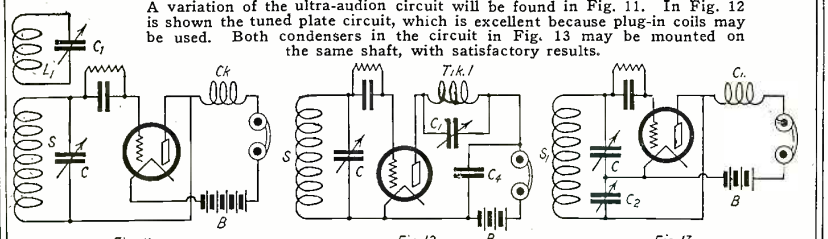


Fig. 11 Fig 12 Fig. 13

denser, controlling as it does the R.F. resistance of the plate circuit, very satisfactorily controls the feed-back. This effectively eliminates the trouble encountered in the tickler construction. Then, too, there is no need of using a low-loss condenser for the variable by-pass, which fact is mentioned in the interests of economy. This method of controlling regeneration has its foibles, too. It requires careful choice of grid leak, "B" battery voltage and tickler size to avoid howling and attain smooth operation. This difficulty generally appears in the form of an audio frequency "fuzz" which makes itself known just where oscillation breaks off or starts. Yet, it is possible to adjust the circuit so that it will operate as smoothly and quietly as any other. Because it is possible to use fixed coils, the circuit offers a definite advantage. It permits of easy interchange of coils, so that different wave-length ranges may be covered.

A FAVORITE CIRCUIT

Fig. 4 depicts a circuit which the writer admits is his favorite. Therefore, if the description in this paragraph becomes too glowing, you are fairly warned to discount accordingly. It has the preference for two reasons: the coils necessary are fixed in relation to each other and the circuit is uncritical and smooth of operation. Like Fig. 3, it reduces the oscillation and tuning controls to two condensers, which certainly simplifies the construction. It requires the addition of a choke coil, but this is not critical and is therefore easy to make. By using as small a tickler as possible, both in diameter and the necessary number of turns, the affecting of the tuning by the oscillation control can be reduced to the negligible. (This is just as true of Fig. 3.) For short-wave telegraph reception it is usually possible to leave the series stopping condenser fixed, and to do all tuning with the secondary capacity, which gives a single-control circuit. This last is not true for the circuit when used for broadcast reception, although careful choice in tickler size will permit an accurate log

The circuit in Fig. 5 is easily recognizable as the Reinartz. It is purposely shown in a somewhat unusual manner so that you may recognize in it the Weagent circuit of Fig 4, on which it is based. The Reinartz possesses all of the qualities of Fig. 4, with the weakness of lower selectivity due to close primary coupling It is also a very effective transmitter (blooper) because the plate and antenna circuits are conductively coupled. By paying but little attention to the conventional directions given for it and using a little time and care in the choice of the tickler size, it is possible to adjust the circuit so that the regeneration control does not affect the tuning. If the antenna coupling is loosened and the plate circuit connected direct to the filament, we no longer have the Reinartz, but Fig. 4.

Fig. 6 shows a modification of the Reinartz later offered by that persistent experimenter. It allows the use of a tapped coil without the losses due to dead-end and with a theoretical gain of grid voltage—the effective signal-producer—due to the use of a great amount of inductance for relatively short wave-lengths. A number of experi-

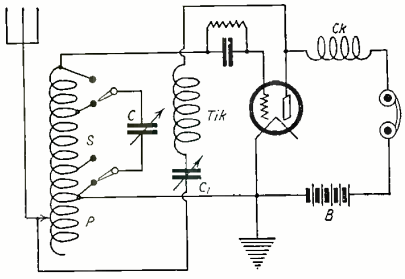


Fig. 6

A modified Reinartz circuit using a tapped coil to eliminate dead-end effects.

menters who have tried the arrangement feel that it delivers subnormal signal strength, which is the writer's opinion, also. Certainly it has failed of the popularity of the original circuit.

The use of the "C" battery in place of the grid condenser to make detection possible is illustrated in Fig. 7. This occasionally suffers rediscovery and the nascent enthusiasm of its discoverer; it fails of the popularity of the grid condenser because it complicates both care and operation. It certainly gives no increase in sensitivity, which could be the only justification for its use.

THE HARTLEY CIRCUIT

The Hartley circuit is shown in Fig. 8. A tuned antenna circuit provides the control of oscillation by the introduction of resistance through load. When the antenna circuit is in tune, provided proper coupling is used, the tube will not oscillate. This tuning of the antenna then becomes a satisfactory method of producing an effective two-control receiver, and having the antenna circuit tuned on the wave-lengths above 200 meters is an advantage that shows itself in greater volume and sensitivity. With proper choice of the number of turns of L, which is the plate coil or feed-back coil, although it is part of the secondary, it is possible to adjust operation so that the primary can be used with loose enough coupling to give good selectivity. If L is too large, the tube will oscillate with unnecessary vigor and the primary will have to be coupled excessively close to the secondary to control oscillation. Oscillation is a persistent condition with this hook-up, save when the antenna circuit is in tune, and even then it is present if insufficient coupling is used.

Fig. 9 is the same Hartley circuit with a variable stopping condenser to control oscillation and regeneration. This can be used with fixed antenna tuning of the usual sort. In fact, it should be used with the fixed antenna coil, to avoid the complication of control which results when there are three knobs to turn on a regenerative receiver. Because the plate coil L is a portion of the total coil making up the secondary—there being, thereby, tight coupling between it and the grid circuit—the effect of the regeneration control C1 on tuning is

(*Continued on page* 340)

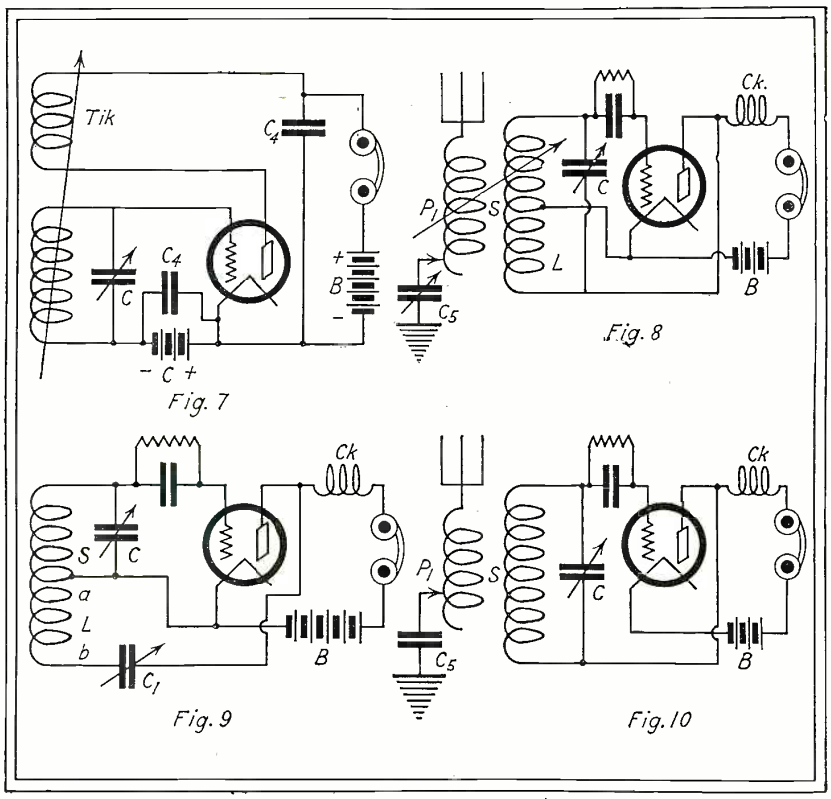


Fig. 7 Fig. 8 Fig. 9 Fig. 10

Fig. 7 shows the use of a "C" battery instead of a grid condenser and leak. Figs. 8 and 9 are variations of the Hartley circuit with two different methods of controlling oscillations. Fig. 10 shows the ultra-audion circuit having a tuned primary circuit.



How Your Detector Tube Works

By A. P. PECK

FOR the last several months this department has continued discussion of the purely practical side of the radio technique. By this time the reader should have a pretty clear knowledge of the actual operation of the set and should, therefore, be prepared for a simple technical discussion of the function of the most important tube in his radio set. Do not let the word technical scare you. The description, the writer hopes, will be in such terms and will use such analogies as to make it understandable to the veriest tyro in the game.

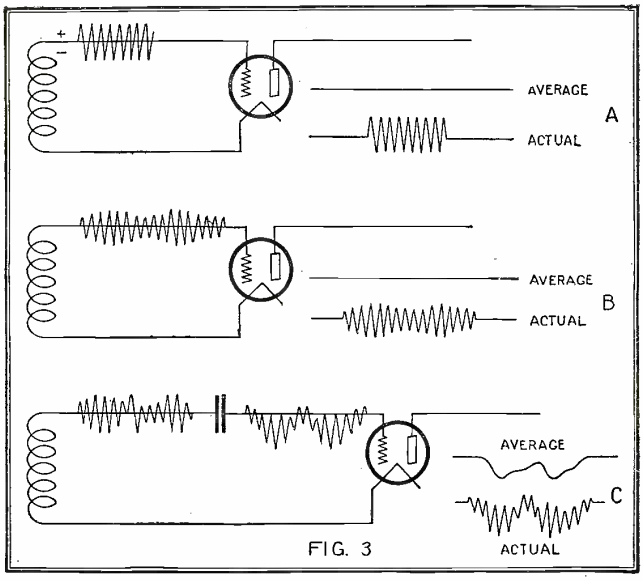


FIG. 3

Here we show the simple tube circuits and the voltage in the grid circuit with the current in the plate circuit. Note how the average current in the plate end makes audibility and the difference the condenser causes in the grid voltages.

Now we shall proceed to the description of how a detector tube works. In one of the past issues of this department, there was a discussion of tuning. We saw how the coil and condenser used to tune the radio set are very much like a violin string. That is, changing the setting of the condenser is very much like changing the tension of the string, it changes the note at which the string will vibrate or which it gives off. At that time we also showed that if a second string were tuned to the same note and if the string were struck, our tuned string would vibrate without being touched. In other words, some of the energy generated by the first string would be picked up by the second and turned into music. The case with the radio set is the same. When the receiver is tuned to the transmitter it picks up the music or speech put into the microphone at the transmitter.

THE CARRIER WAVE

Now we must discuss very briefly the carrier wave. In the issue to which we referred, there was a description of this. We shall repeat it here in order to save the reader looking through the old file.

The carrier wave is that wave to which the set is tuned. It is the oscillation which passes through space and is picked up at the receiver; it is the thing to which we set our receiver when we wish to pick up the program.

Also, it is this carrier alone which is used in radio telegraphy by ships at sea and other radio telegraph stations. The only difference between the broadcast stations and the radio telegraph stations is that the former controls the carrier wave with the voice of the speakers and the music played before the microphone, while the telegraph stations simply turn the carrier wave on and off with the aid of a telegraph key.

Now let us explain more about the nature of this carrier wave and just how it carries the voice and why a detector is needed to hear the voice. The carrier wave determines the wave-length or frequency upon which the station operates. The programs usually give the wave-length of the station: for instance, WRNY, the Radio News station, broadcasts on 258 meters. This is simply the wave-length of the carrier.

Now, the voice and music we hear is a vibration, just as the carrier wave is a vibration, but—and here is the important thing—the voice frequencies or vibrations are much lower in number per second than the carrier. The human ear can only hear vibrations between 16 per second and about 16,000 per second. Now the carrier wave frequencies in the broadcast range are between 300,000 and 1,000,000 per second. Obviously, they cannot be heard and must be changed.

An explanation of how the voice frequencies are placed on top of the carrier frequency must be given here. Note Fig. 1. At A we see the carrier. The frequency may roughly be said to be the number of times the vertical line passes the horizontal one per second. As long as the microphone is not attached to the transmitter, each vibration will go equally far out on each side of the zero line. This is called the *amplitude* of the wave. Such a wave could be heard even if it were passed through a detector, that is, not what is known as oscillating. There would be a click when it begun and another when it ceased, but nothing more.

Now, suppose we place a musical instrument before the microphone. It gives out its own vibrations, which are in the audible range. Take, for instance, the violin note, which is somewhat after the fashion of the illustration at B in Fig. 1. Note how much slower it is than A. Its curve is long and not very steep. It rises slowly to a maximum and falls to a minimum very slowly in comparison with the carrier.

The broadcast transmitter simply takes this slow vibration and puts it on the carrier in such a way that the strength of the carrier increases and decreases with the vibrations. This process is called modulation and will be explained at another time. How it is done need not worry us, let it simply be understood that the broadcast station consists of one piece of apparatus to generate the carrier wave which has always the same power from one vibration to the next, as shown in A of Fig. 1, and of a second piece of apparatus which takes the voice and music vibrations given directly into the microphone and makes these vibrations change the strength of the carrier. Now, instead of a carrier of unchanging strength, we have a carrier wave growing weaker and stronger in accordance with the voice or music which is literally put on top of it, as at C.

All this is very well, but, you say, why cannot we hear the voice frequency on top of the carrier?

The answer is easy, we cannot hear it simply because in the radio set, up to the detector, the current travels as weaker and stronger carrier wave currents. We need something to take the carrier wave out and leave just the voice frequency. The tuned

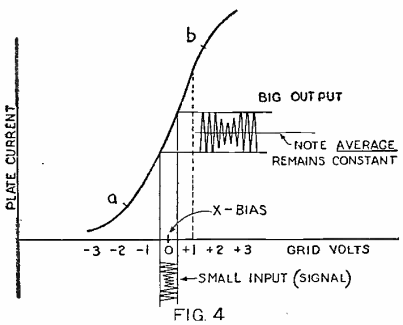


FIG. 4

Here is that horrible thing, the characteristic curve of a vacuum tube. It is really easily understood and fully explained in the text.

circuit vibrates at the carrier frequency, granted that this grows stronger and weaker in exact step with the modulation placed upon it at the transmitter, but the currents still travel at the high, or radio, frequency. What we need is a device to do away entirely with the carrier wave and leave only the slower, or audio, frequency, which the ear can distinguish and understand, and which is the electrical component of the program. The telephone receivers will change the electrical energy into audible energy, so, as we said, we must have something to erase the steep, fast-vibrating lines in Fig. 1 and leave us only the slowly curving line at B, which is the electrical equivalent of the sounds entering the microphone.

The device which does this is the detector.

ACTION OF THE VACUUM TUBE

Before we give a detailed explanation of how the vacuum tube detects or changes the fast-vibrating lines into the slowly moving vibrations which represent the voice or music, we must give a short description of the action of the vacuum tube generally. In other words, we must explain in the simplest possible language the actions which occur inside the tube.

All know the construction of the tube, with its three *elements*. This was described in one of the previous articles printed in

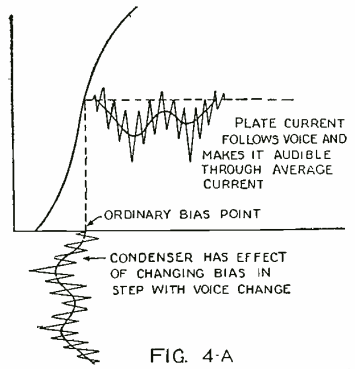


FIG. 4-A

The slight modification of the characteristic curve shown here tends to make the explanation of the operation of a vacuum tube as a detector a great deal more simple. The bias line is changed.

this department. There is the grid, the filament and the plate. Simply put, the filament is for the purpose of throwing electrons, which are formed by heating the filament, through the grid to the plate. The grid acts as a shutter, allowing them to pass or holding up the stream in much the same manner as a traffic officer holds up a procession of cars or allows them to pass. The plate catches all the electrons thrown at it and attracts them from the filament to itself.

The electrons are very small particles of matter. As a matter of fact, they are the foundation stones upon which matter is built. They are so small that the most powerful microscope cannot make them visible to us. However, the reader must take the word of scientists for their existence and activities.

Now consider the stream of electrons. They are attracted to the plate in the tube and can carry an electric current, for in the final analysis they are nothing more or less than small charges of electric current. It is their traveling through the wires of the lighting company and their passage through the filament of the ordinary light bulb which illuminates our homes and turns our motors.

The plate always has a positive potential. That is, there is a difference in electrical pressure between it and the filament. This condition is maintained by the "B" battery whose positive terminal is attached to the plate lead. Refer to Fig. 2. This explains the nature of a difference of potential. There is a difference of potential between the top tank and the bottom one. If the cock is opened in the pipe leading from the top one to the one below there will be a stream of water. This difference between their pressure and the tendency of the water to flow from the top down is called a difference of potential. It has nothing to do with the amount of water in the tanks or the size of the pipe. It is simply a statement of the pressure difference between the two.

The positive plate of the "B" battery always attracts the negative electrons to itself. If, however, the grid is made negative, it repels the electrons. This attraction by unlike potentials and repulsion between likes is simply a brute fact which the reader will have to take for what it is worth. That is the way it always happens.

Now, if the grid is made negative, it repels the electrons and, therefore, decreases the current which is carried on them from the plate to the filament. In other words, the grid is just like the traffic cop—or, by another analogy, we may call it the trigger which controls the flow. If the grid is made negative, very little current will flow from the plate to the filament; whereas, if it is made positive, the positive charge helps pull the tiny electrons from the filament and, therefore, makes the tube pass much more current.

To explain in another way, a very small change in the voltage of the grid will make a very great change in the current of the plate circuit. This quality of the vacuum tube is what makes it so valuable to radio work. We can take the infinitesimal changes in voltage coming in to the antenna from the distant transmitter and impress them on the grid of the tube and take out several times as much current from the plate. Of course, the energy taken out at the plate comes from the "B" battery attached to the tube, but the beauty of the device is that we can make the incoming signal control the passage of the local current through the tube and, consequently, through the telephone. This is what makes the tube so superior to the crystal detector. In the latter, the only available source of current is that from the distant station picked up by the antenna.

Now we come a little closer to the question of detecting the signal as sent out from the transmitting station. We have seen that the voice is carried through space on the very swiftly oscillating radio frequency current which vibrates always at the same frequency and understand how the strength of these

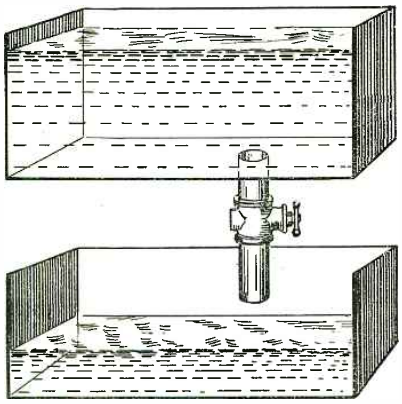


FIG. 2

There is a potential difference—or electrical voltage—between the two tanks. That is, if the spigot is opened the water will fall from the top one into the one below. This is exactly the situation of voltage. The water is the current and the tendency to flow from a higher level to a lower one is the voltage.

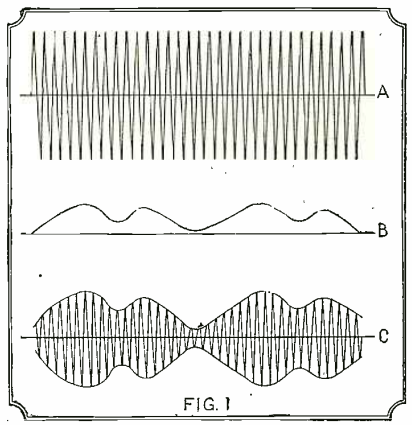


FIG. 1

Above, at the top, is a schematic diagram of the carrier wave; in the center, the voice wave, and at the bottom, the modulated carrier.

oscillations is made to vary in accordance with the ever-changing voice frequency which is much slower, at its swiftest, than the carrier current. And we have discovered, further, that if we can find some method whereby we can take the very swiftly oscillating carrier current and, wiping out the carrier, causing only the change in its strength to be passed, we shall be able to hear the program being put into the microphone at the transmitting station.

We have said that the vacuum tube takes the incoming signal from the antenna and by the ability of the grid controls the great stream of current flowing through the tube until it acts exactly like the incoming signal. Look at Fig. 3. At A is shown the carrier, without any voice on it, coming into the tube. Note the small oscillations on the grid lead. They pass out into the plate circuit in exactly the same shape as they entered at the grid with the exception that they are comparatively much stronger. This is the graphic illustration of the tube in the rôle of amplifier. More of this anon.

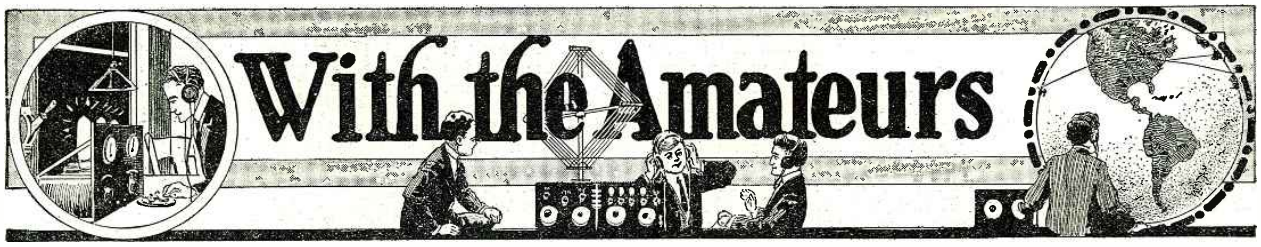
ACTUAL AND AVERAGE CURRENT

Now take the second case. See B in the same figure. In the plate circuit here we have a larger current following exactly that put in at the grid. Above the plate current which is marked actual, there is a second line which is noted as average; that is, the effect which the current passing has on the telephones in the circuit with the plate and the "B" battery.

Now this actual current and the average current have a very prominent part in the detector action of the tube. It is through the average current that we hear the music. If we had to depend upon the actual current the only solution to the problem would be the use of a crystal or some other similar device.

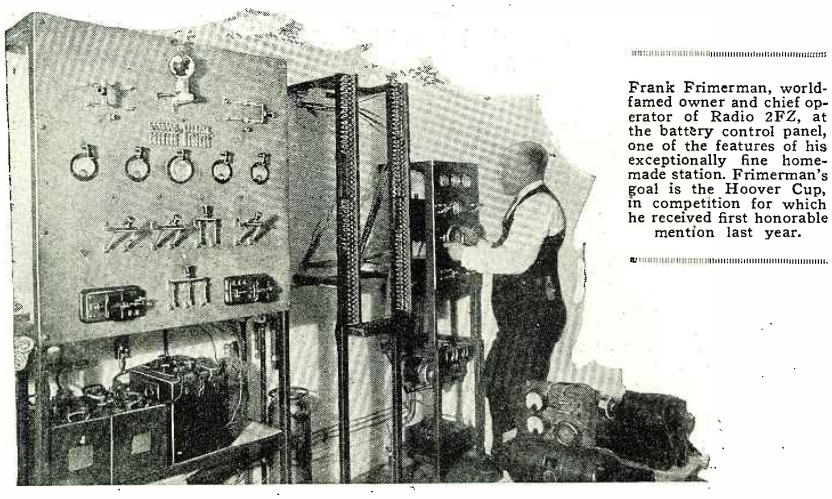
Back to the operation of the tube again. Immediately the filament is lighted, there is a current following through the tube. This current has a certain value and remains the same as long as no change is made in the polarity of the grid. But if the charge on the grid is changed, either by an incoming signal or by placing a battery in circuit with it, the current flowing from the plate to the filament changes. By putting a heavier and heavier positive charge on the grid we get more and more current up to a certain point. By putting a heavier and heavier negative charge on the tube we get less and less current in the filament plate circuit, likewise up to a certain point. This characteristic of the tube may be plotted on paper and is drawn for almost all tubes. It is called the "tube characteristic." Fig. 4 shows such a curve and how it is applicable to the study of tubes in action.

(*Continued on page 372*)



Help Wanted!

By Jay Hollander



Frank Frimerman, world-famed owner and chief operator of Radio 2FZ, at the battery control panel, one of the features of his exceptionally fine home-made station. Frimerman's goal is the Hoover Cup, in competition for which he received first honorable mention last year.

WE WILL be perfectly frank, we want some help. A few months ago, from this pulpit, we exhorted the brethren to cultivate the experimental attitude. Since that time there have been a lot of developments in the game. As a matter of fact, the hams seem to be able to create more new ideas, and to stick their noses into more interesting places where the secrets of the science make their burrows, than an Englishman hunting big game with a complete retinue of servants and gun carriers.

More and more of the boys are going in for the development of these strange and interesting points. They are finding the beauty of the untrodden paths, they are seeking out the joys of the discoverer—in other words, they are true scientists. But this is a plea for help——

Perhaps it is a little too soon to ask such a thing, but we should like to point out one more piece of spleen. It is that there is no complete ham literature. Whenever we begin an investigation on a new line, we must, if we wish to take advantage of the previous work which has been done on the subject by others, fall back on the old brass in order to get the information.

Now the brass is a good way to chew the fat, it is an excellent means of carrying on tests, it is even an excellent method for getting msgs. from place to place and comes in handy for a lot of entertainment, *but* when one tries to copy the text of a scientific treatise and get a clear scientific idea from it, that's an elephant with a different set of spots. Entirely different.

The main point being that the other day a friend of the writer decided to try a sort of modified Leicher wire system for a radiating system hooked to a five-watter after the Reinartz-MacMillan fashion. He asked us about it. Now there was a time, when we were wading through Hertz with the aid of a musty old prof. and an admonition from home that if we did not pass it we would get no further allowances, that we knew Papa Hertz pretty well. But, at present, we are sort of misty as to the doings of the old crankshaft. However, after the request from the friend—he knows our weakness for theory—we dug out the old book which had caused us to spend our hard-earned means for midnight oil, and tried to brush up on some of his notions as to the nature of propagation over parallel wires in certain wave-length relation to the emanations traveling over them.

In ham parlance, we sopped up a lot of ideas which we could see little use for in practice. We, in turn, gave the information to the friend. He laughed and we did, too, for the way he had worked the Tom Sawyer.

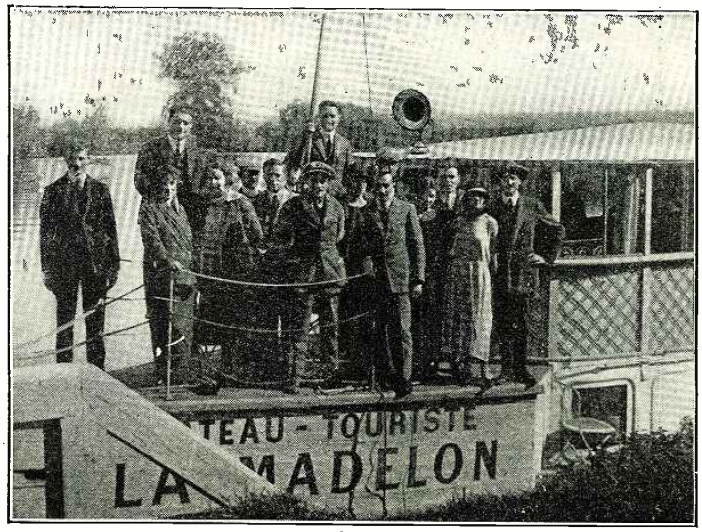
We even went so far as to look up all the dope in the "Proceedings" of the various I's and E's and Royals in search of further information, if any. There wasn't any. Then we took the next logical step, which was a thorough perusal of the indices of the publications, ham and otherwise, in which the experiences of fellow workers might be recorded through the grace of the editor's guardian angel. Evidently the angel had been off the job, for we found exactly nothing.

But this is a plea for help——

Through various channels and much brass-pounding, we found a two and a three who had done some work on the idea in a modified form. But the method of collecting scientific data—as we said before—by listening to C.W. is a laborious process. Reminds one of the old pictures in the geography showing the Oriental children learning the Koran. Boy, it takes a lot of devotion to a cause to collect dope on it by the brass!

As time went on, more and more dope began to filter in from one point and another. In RADIO NEWS there was an article by Reinartz with some stuff which proved of value. In other magazines there was a scrap here and there which proved to throw light on some points. But, on the whole, the process was very unsatisfactory. Why cannot the fellows take the time to write a little squib now and then just on the results of their various tests? They might easily be both qualitative and quantitative. It is really a small matter to take a few notes and turn them into a small report gotten up after the regular fashion.

As a matter of fact, the best thing in the world for the experimenters would be the establishment of some sort of organization



Not that we recommend the practice, but the F hams shown at right chartered the scow they are on, one vacation, sailed down the Siene and made some experiments. Yes, there was a lot of food—and other things.

for this purpose alone. The I.R.E. is fine stuff for the gents in the commercial end. They rely upon it and make their reports rather bombastic and take the whole thing as a sort of ritual. But the ham needs a lot of information which is not neccssarily correct to the fifth or sixth place, but which, at the same time, contains the results of experiments.

Some development along this line has been done by the A.R.R.L in one form or another. There is the experimental section and a lot of reports, but it seems to me that this branch of the work is possibly not given as much attention as it deserves.

There is, and always will be, expense attached to the idea. With the various commercial organizations and large engineering societies, the reports are elaborately printed and gotten up. That sort of thing is not at all necessary for our work.

A very workable plan could be arranged simply by having each man give his report to a stenographer after he had finished his work to let her type it. Then he could take a couple of shirt cardboards, make a binder for the pages and send the complete unit in to some designated center where it would be kept on file. A list could be issued from time to time on the reports in the library, and for a small fee the keeper would send the books and reports desired to the ham asking for them.

Such a system would give us a permanent record for all experiments performed. The fee would be ample to cover the cost of postage and keeping the books in place. Preferably, it should simply be a function of some organization already in force. The trouble is very often too much organization. But there are any number of bodies already functioning which could take over such work without any additional labor or difficulty.

Many look to the magazines for this need, but, obviously, there are a lot of experiments which would be extremely valuable to a ham beginning an investigation along a similar line which would not attract the slightest bit of attention from a great majority of a magazine audience, particularly if the magazine happened to be the popular sort.

This circulating idea would at once solve the problem and at the same time require little, if any, trouble on the part of the organizers or those interested in fostering the work.

And this brings up another point which might be slightly touched upon. The ham is not like other men. He is above them perforce of his hobby. He is an amatcur, the highest rank any man can have. The professional must be good at his job or he does not keep it. He makes it a paramount aim in life, mostly because his crullers and coffee depend upon his following the work with vim and might. But the ham is doing his work solely and simply for the love of the thing.

But, at the same time, he often does not do his job so thoroughly as the professional, many times because, looking on it purely as fun, he is not impressed with the importance of exhausting the possibilities of some line or point upon which he happens to be working.

And here is where the report and circulating library may come in and do another great service at the same time it is performing its primary function of disseminating knowledge. When an experimenter is keeping notes and knows that when he has finished his job there may be a number of other men interested in the same point, he will be a bit more careful and explicit, first to find the exact goal toward which he is working and, second, to keep his *modus operandi* clear and concise, so that those who come after may follow more easily.

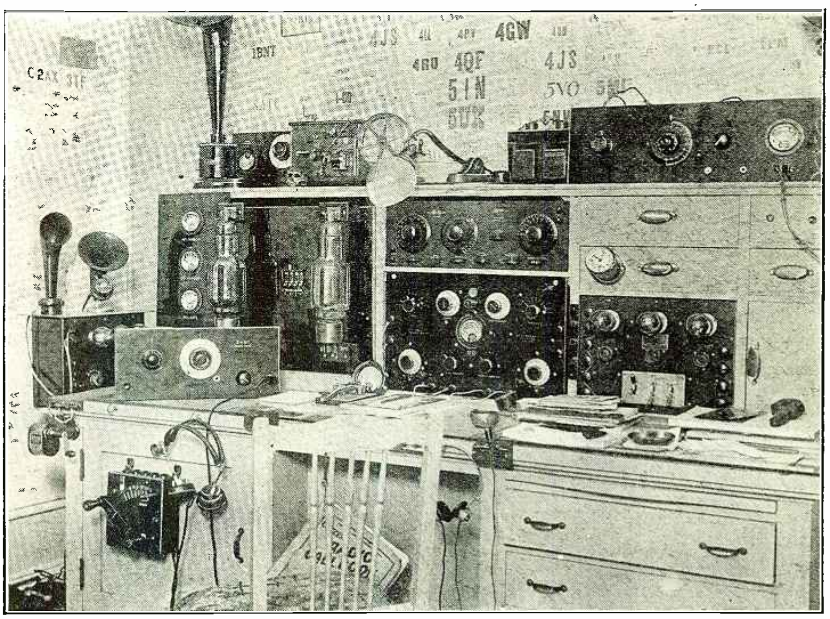
All of us like to lasso a little fame now and then, and it sends us back to work with a more healthy view of ourselves, if someone knows we're pretty good, and if we can see that we are filling a more or less important place in the general scheme of things.

We all like to look at ourselves and salute the touseled head that confronts us in the mirror each morning with the knowledge that we are not quite as other men. Now, this simple expedient of performing an experiment with a notebook in view and always waiting for our enlightening comment on some of the mysteries of our craft is sure to help this mirror greeting to be more cordial. It will add zest to the before-breakfast watch at the shack.

And, above all, it will help along the good work and cut out a lot of duplication of energy and investigation which is now going on. And, too, it will help to keep our minds clear as to exactly what we are searching for.

This last will be of great value, for it will prohibit, to a greater or less extent, the so-usual dropping of a piece of work before any definite conclusion has been reached.

Think it over, me bucks, think it over!



This is the layout of 2ABT. The bottles are enough to cause two or three murders. There is a long list of F's, etc., in the log-book and the station has a fair reputation for crashing in.

The Month's Crop of New QRA's

1ABW—Edgar L. Deslawiuers, 12 Lafayette Street, Alttleboro, Mass. CW. on 80 and 40 meters. All repts ansd by crd immediately.

9QQ—Change location—now at 127 Third Ave., West Cedar Rapids, Iowa. QSL's appreciated.

2ANR—F. Madlinger, 110 Kingstand Ave., Brooklyn, N. Y.

9AHD—Change location—now at 255 West 15th Place, Chicago Heights, Ill. 50 watts on 20-40 meters. All crds ansd.

2AHK—Changed location—now at 554 South Clinton St., East Orange, N. J. All crds QSL'd. 50 watts on 80 and 40.

9AXQ—(Ex 9AOM)—F. O. Dixon, Knoxville, Iowa. Crds QSL'd.

2KG—John T. Guymon, 2382 Chauncey Street, Astoria, L. I., New York. 5 watts C.W. on 80 meters. All crds QSL'd.

2ASJ—Charles Ernest Spitz, 2382 Chauncey Street, Astoria, L. I., New York. 5 watts, 20, 40, 80, 165. Wud appreciate any reports. All crds QSL'd.

9EAZ—Roy Anderson, Astoria, S. D.

Calls Heard

CB8, BERNAL, BUENOS AIRES, ARGENTINE

Calls Heard Below 45 Meters

1xu, 1af, 1xz, 1pl, 1cmp, 1yb, 1ow, 1pm, 1gv, 1cmx, 1ck, 1bhm, 1aac, 1rd, 1za, 1var, 1aci, 1at, 1px, 1ckp, 1qm, 1bdx, 2xi, 2zv, 2gk, 2cxw, 2aqk, 2als, 2qs, 2rk, 2br, 2bee, 2bur, 2qh, 2qr, 2bsc, 2bcc, 2agw, 3il, 3ea, 4xe, 4ag, 4jr, 4au, 4sa, 5uk, 5ajj, 6no, 6df, 6cmq, 6cgw, 6ts, 6oi, 6cto, 6awn, 6bve, 6cgo, 6bad, 6lj, 6ut, 6cix, 6qi, 6vc, 6xh, 6ahp, 6xap, 6im, 6aiq, 6alf, 6bgz, 6chs, 6asv, 6clp, 7ya, 7nx, 8ex, 8bgn, 8er, 8bwb, 8chk, 8xlo, 8aul, 8brc, 8qq, 9xi, 9zt, 9bht, 9nv, 9cfi, 9fj, 9dqu, 9bdu, 9cld, 9ejy, 9alo, nrrl, nkf on 20.7 meters 45 minutes after the sun set here.

G. WEYNTON, "TALGAI" LINDFIELD, SYDNEY, AUSTRALIA

2 Tubes (October, 1924, to April, 1925)

C.W.—1aac, 1acb, 1acd, 1atj, 1bnt, 1pw, 1sw, 1zx, 2rk, 2brb, 2bx, 2kx, 2xq, 3bz, 4cq, 4fq, 4gr, 4gw, 4kw, 5acm, 5ba, 5ng, 5shl, 5uw, 6age, 6ahp, 6aus, 6ac, 6aoi, 6anx, 6bcp, 6bad, 6bau, 6bir, 6cgo, 6cp, 6cgw (consistent), 6cw, 6cnl, 6cqe, 6cvn, 6cmd, 6cgl, 6awt, 6fn, 6grr, 6ih, 6jby, 6lrz, 6qd, 6ugt, 6vc, 6xi, 6yos, 6zac, 7fa, 8abb, 8brb, 8brx, 8sf, 8ze, 9abo, 9acb, 9acd, 9bi, 9at, 9cjc, 9cy, 9eky, 9mm, 9ms, 9zy, 9ui.

Wgh (110 m.), woc, wjz, kfi, kgo.

Pse send a crd. om. all cards answered card for card.

OS1D, A. S. FAULL, 16 MAIN ST., STRAND, CAPE PROVINCE, SOUTH AFRICA

January, 1925

UNITED STATES: 3apr, 1clj, 2cbx.

May, 1925

UNITED STATES: 5apm, 8xaf, 9bct, 9ees, 9ek, 9ncv.

ARGENTINE: cb8 (without aerial but with earth and vice versa).

OTHERS: ane, ihu, wgh, ocdj, kel, xw9, 8xk, kel, kdka (qsa).

A card is waiting for each of above Hams, so qsl oms.

LIVIO G. MOREIRA, RUA PAULA GOMES 6, SOUTH BRAZIL, CURITYBA

Between 11th to 31st May, 1925

1aak, 1amd, 1bcc, 1bs, 1bz, 1ckp, 1kl, 1uk, 1xav, 1yb, 2ag, 2agq, 2bee, 2bs, 2gk, 2my, 2rde, 2wb, 2xee, 3il, 4xe, 4ry, 4smy, 6aji, 6bsz, 6chl, 6cst, 6csw, 6vw, 8aul, 8ayy, 8chk, 8xl, 9bdk, 9ejy, 9ek, 9xh.

ARGENTINE: ag4, ah2, ai5, cb8, db2 de2, df3, ds2, fa4, mn9, lor.

BRAZIL: 1ab, 1ac, 1af, 1at, 2sp.

CANADA: 2aa.

(*Continued on page* 338)

An Automatic Tickler Adjuster

Mr. H. G. Möller, a German physicist, has employed a milliammeter to adjust the tickler coil of a regenerative receiver. Such an adaptation as this should prove of interest to American radio fans.

EVERYONE is more or less acquainted with the difficulties that arise in operating regeneration receivers. Their proper operation necessitates much experience and a skilled hand for the proper adjustment of the tickler coil. Otherwise either the regeneration will not be a maximum or—what happens quite as frequently—the antenna will be set in oscillation and the consequent re-radiation of the received signals will be superposed on waves radiated by the transmitter, resulting in whistling and squeaking noises in the receivers of the neighborhood.

To lessen this annoyance numerous methods have been suggested. There are a long series of circuits which, while allowing for complete regeneration, reduce the radiation to a small amount. These hook-ups depend chiefly on the use of several circuits which are not coupled back to the antenna circuit directly, but to a coil which is in comparatively loose coupling with the antenna. Should oscillations be set up in this coil through strong regeneration, very little energy will be transmitted to the antenna and, therefore, little will be lost through radiation. The interference with other receivers is also slight, if at all noticeable.

Such circuits, however, have the disadvantage that the reduction of damping which results from regeneration is applied to oscillatory circuits which, by themselves, have low decrements, while the greatest advantage of regeneration lies exactly in the reduction of the decrement (in other words, of the effective resistance) of the antenna for the desired frequency, below that for any other oscillations which may be received at the same time. The oscillation energy, just as much as the sharpness of resonance, will be considerably increased as a result of reduced decrement. Therefore, hook-ups with reduced antenna radiations achieved through a regenerative coupling with the secondary coil must pay dearly for this advantage and, for this reason, have not met with very wide approval.

Another method for the reduction of disturbances arising from regeneration is employed by the Telefunken broadcast receivers. The tickler coil is rigidly attached to the tuning condenser of the receiving circuit and adjustment is so made in the laboratory that for every desired frequency a definite regeneration will be established. According to the German government regulations, however, the receiver must not oscillate under any circumstances. The best regenerative coupling, therefore, cannot be easily predetermined, for the oscillation energy of various tubes differs by as much as 100 per cent. and depends also on the intensity of the filament current and plate voltage. It is, therefore, almost impossible to permanently establish the best regenerative coupling for more than a single wavelength. Through a slight excess over the most favorable regeneration, oscillation will promptly set in and a slight decrease of regeneration below this value will considerably decrease the volume. Therefore, broadcast receivers with tickler coupling automatically adjusted by the variable condenser are not very efficient for preventing oscillations in all cases, as the best regeneration cannot in any case be established.

Other arrangements for the elimination of disturbances arising from regeneration are so involved that they are practicable for the practiced radio experimenter only who requires no apparatus for this purpose anyway, since he knows how to manage his equipment and, in tuning, will have his antenna oscillating for only an instant at most.

Recently H. G. Möller, a German physicist known for his work on vacuum tubes, designed a device which, it is claimed, automatically adjusts the regeneration to a most favorable value.

This device of Möller's depends on the following phenomenon: If through a close coupling undamped oscillations are impressed on the receiving circuit, the grids of the vacuum tubes will undergo a potential variation. That is, the grid will be alternately charged positive and negative, while previously the grid potential was almost zero. During every interval of grid potential a number of electrons flow to the grid and then tend to return against the grid filament resistance. As a result of the high value of this resistance, the electrons cannot altogether leave the grid before the next positive interval, and therefore the grid will accumulate a negative charge. In consequence, the mean plate current which can be measured with a milliammeter is decreased, for the negatively charged grid tends to hinder the passage of electrons to the plate.

Möller connects a milliammeter in the plate circuit and employs the movement of the needle, in case oscillations start, to prevent by *mechanical* means any further increase of coupling. He does not, however, use an ordinary milliammeter, for no scale or pointer is needed here, but employs the device shown in our illustration. On the right side of the illustration an ordinary vacuum tube hook-up is represented. The tickler coil R is pivoted on a knob K and through a flexible shaft is attached to a cog-wheel Z, which is a part of the device for preventing excessively close regenerative coupling. This device is represented in light lines on the left side of the diagram, while the current-carrying conductors are drawn in heavy lines. Between the poles of the strong permanent magnet N S is a coil D, rotatively pivoted, as in the usual moving coil measuring instruments. A light, pointer-like strip is rigidly attached to the coil. Its end is shaped into a hook which grips the teeth of the cog-wheel Z when the coil is slightly turned. Besides this, the pointer carries a transverse arm c which, upon the least motion of the coil to either side, opens one of the two contacts a and b and so breaks the plate circuit. Finally, there is a tension spring F acting on the pointer which, by means of the adjustment screw M, serves to make a fine setting of the coil D.

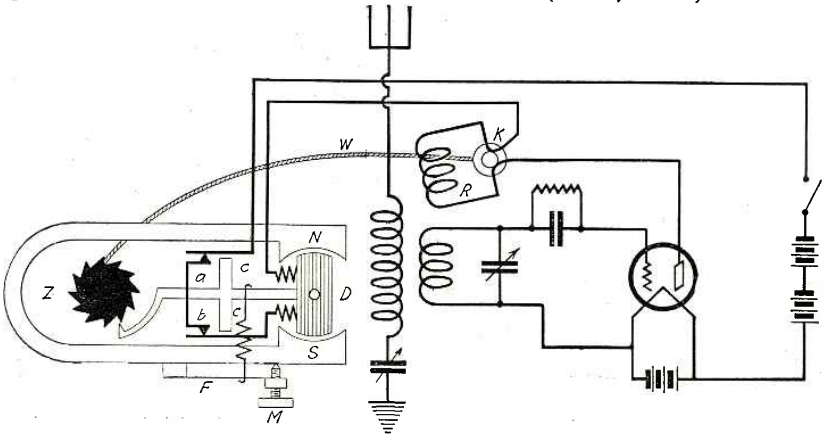
The operation of this apparatus is as follows: Both variable condensers of the receiver are set to the desired wave-length, while the regenerative coupling is quite loose. The knob K is then turned to make a closer tickler coupling, approaching the point of best regeneration. At the instant when this point is exceeded, oscillations begin which immediately cause the movement of the coil D, and consequently a turning of the cog-wheel Z, and a simultaneous interruption of the plate current at the point a. The knob K is released and through spring action it is turned back slightly from the point of oscillation to the most favorable operating regeneration for radio reception.

Oscillations are set up even in the Möller apparatus, for the adjustment to the proper regenerative coupling depends upon them. The duration of these oscillations, however, is so short that hardly any neighboring stations will be affected by them.

A special advantage of the arrangement is that it can be installed in any receiving apparatus with regenerative coupling. In the illustration it is not indicated that by means of a gearing system the rotation of the wheel Z is made greater than that of the knob K. It should be observed here that the apparatus is apparently open to the objection that it is not sufficiently sensitive. The tickler coil will be turned at most through an angle of 90 degrees, and this motion, of course, must be produced by a much greater rotation of the wheel Z, if the device is to fulfill its purpose. A special contrivance is provided to protect the pointer of the instrument when it grips the cog-wheel while the knob K is turned further. The instrument cannot in this way be damaged, even when one with unpracticed hand exerts an unduly great force in turning the tickler coil.

Naturally, only practice can demonstrate whether Möller's device will succeed. In this matter the question of cost plays a not unimportant rôle. Among all attempts in this direction, the device under discussion is without question the best and fulfills most satisfactorily the requirements.

(*Radio für Alle*)



R, the tickler coil is pivoted on a shaft, K, which is attached by a shaft W, to a cogwheel, Z. Through the coil, D, being moved by the magnetic field set up by the plate current from the tube, the tickler is constantly automatically adjusted.

—Radiotics—

NO MORE COAL TO HEAVE



On June 12, the *Albuquerque Morning Journal*, of Albuquerque, Ariz., ran the following advertisement: "Modern, up-to-date bungalow, RADIO HEATING SYSTEM, hardwood floors THROUGHOUT GAS RANGE." That sure is one modern home, and we wish the owner would send us the hook-up for the radio heater, as we are tired of feeding the furnace coal. As for the hardwood floor in the stove—that is not our idea of economy.

Contributed by Ivan Hancock.

BLUE LAWS FOR RADIO

In the June issue of *Popular Radio* there was a condenser advertisement announcing that the condensers "provide a free BATH for the radio frequency currents." We never thought that the waves needed cleaning but then—somebody is always taking the joy out of life.

Contributed by Jos. H. Christie.



HARD FOR THE POOR RADIO WAVES



On May 17 the *Minneapolis Journal*, of Minneapolis, Minn., printed the following advice: "Don't use high RADIO transformers in your audio frequency amplifier." We think that a sort of dirty trick to play on the waves after their long journey through the ether. Why, they would not know which way to turn if they bumped into a R.F. transformer after the detector tube.

Contributed by D. M. Bender.

BOY, PAGE THE DRY AGENT

From an article in the *Philadelphia Inquirer*, of May 31: "—Although the station is only a few months old, it has played host to many distinguished visitors; who have BEER ——" To tell the truth we should like to have a job broadcasting from that station, if it is such a host.

Contributed by Ray Barber.



AT LAST!



The *Baltimore Evening Sun* of Baltimore, Md., on May 14, announces in the heading of an article on static that "U. S. Experts Study STATIC ILLUMINATORS." Well, at last we are going to harness old man static and put him to work lighting our homes. But what we can't dope out is why it is dark on a night when there is lots of static.

Contributed by J. S. Maynard.

SELF ADVERTISING

In the July, 1925, issue of *Science and Invention* there appeared the following advertisement: "Radio LOUD SPEAKING FACTORY GUARANTEED set." Such a set may be great for the folks that live in the country, but how on earth could you get one in the average size apartment?

Contributed by J. H. Kucera.





WOOF! WOOF!

The *Evening Telegraph*, of April 17, Toronto, Canada, carried the following advertisement: "U.V.201A TYKE tubes." This is clearly the oft-referred-to radio hound that howls whenever he is lit up.

Contributed by Edward Pratt.

SOME NEW INSTRUMENTS



In the classified advertisements of the *Los Angeles Examiner*, Los Angeles, Calif., on May 29, under a column headed Radio Equipment, is the following: "2 WHEELING JAW-CRUSHERS, 1 60 h.p. locomotive type boiler." Evidently the jaw-crushers are some kind of gadgets that are sent out after station directors who put on poor programs, and the boiler must be to keep the electrons warm on a cold winter night.

Contributed by E. E. Swanson.

HERE'S NEWS

The *Radio Record* of May, 1925, in telling of new apparatus tested, says of the Phenix Condenser that it has "CUT-GLASS stator plates." We consider this rather unwise to tell, because someone might chop up a window pane if he needed a plate for a variable condenser.

Contributed by C. J. Crawley.



A BROBDINGNAGIAN RECEIVER



In the *Chicago* (Ill.) *Herald and Examiner National Radio Weekly* for May 24 was a list of parts required to build a receiver, among which was the following: "One 24½-inch dial and twenty-five feet of TURNED hook-up wire." We cannot imagine why dials of this size are recommended, and as for the turned wire in this hot weather we try to avoid doing any more strenuous work than we have to and such things smack of *labor.*

Contributed by Thomas A. Lanier.

If you happen to see any humorous misprints in the press, we shall be glad to have you clip them out and send to us. No RADIOTIC will be accepted unless the printed original giving the name of the newspaper or magazine is submitted. We will pay $1.00 for each RADIOTIC accepted and printed here. A few humorous lines from each correspondent should accompany each RADIOTIC. The most humorous ones will be printed. Address all RADIOTICS to

Editor RADIOTIC DEPARTMENT,
c/o Radio News.

WANTED: SIX TWINS



This from the May 28 issue of the *Chicago Evening Post*, Chicago, Ill.: "It will be best to take all TWINS, except five or six, off the rotor of the detector coil. For this particular circuit, only five or six TWINS are needed." This is all very well for the married radio fans, but what are the poor bachelors to do?

Contributed by Robt. L. Nelson.

ROUGH ON THE SOLDERING IRON

A caption under the picture of an alcohol torch in the *Radio World* of May 30 reads: "An alcohol lamp serves nicely to BEAT a soldering iron, if you have no electricity. With the high cost of alcohol these days we should think that almost anything other than *that* liquid would be used. We suggest heaving the soldering iron out the window if it is misbehaving.

Contributed by D. P. Finch.



THE NOVEL OR THE LABORATORY?

The *Wireless Magazine* of London, England, in the April number informs us that "—the rules of Ohm, Ampére and VOLTAIRE hold good and are firm masters." This is the first time that we were aware that the famous novelist had played around much in the electrical lab. We think it rather hard on Volta.

Contributed by William Down.



EVER PROGRESSING



Popular Radio of June, 1925, in telling of a tube that works from the house lighting circuit, says that "as audio frequency amplifiers they operate best with 90 TURNS ON THE PLATE." Whether they are 90 turns of ship's hawser or 90 turns of a dancer is not divulged to the eager world.

Contributed by R. F. Scheibeck.

HAIL, THE LOW-LOSS DETECTIVE!

The May issue of RADIO NEWS has an advertisement which in part reads: "—you will find LOW LOSSES WITH this coil." In this low-loss era such an instrument is most welcome. It will also be useful when buying apparatus, as the salesman can be checked up.

Contributed by W. F. Jepson.



DOES THIS MAKE YOU HUNGRY?



On May 22 the *Roanoke World-News*, Roanoke, Va., ran an advertisement under the heading, "Good Things To Eat," which reads: "For Sale—Five-tube Neutrodyne with accessories." Of course, the battery "currents" might be served in a pie, but we draw the line at fried condensers or boiled transformers.

Contributed by Aikman Faris.

A MENACE TO AVIATORS

In the March issue of *Radio News* there appeared an advertisement concerning "AMPLIFLYING transformers." This should be looked into carefully as the mail planes fly at night and a transformer taking a joy ride through the ether might cause a lot of trouble.

Contributed by Wm. Cosulas.



THE HEIGHT OF SIMPLICITY



The January issue of *Radio in the Home* relates that "—Mr. Kardon, in presenting his unit to the public, says that a loud speaker set can be built with FIFTEEN WIRES IN FIFTEEN MINUTES." What could that gent do with fifty wires? At least a broadcast station would doubtless be forthcoming.

Contributed by Russell Lewis.

"IN THIS RING, LADIES AND GENTS——"

The *Radio World* of May 16 in an article about "B" batteries states that "—'B' batteries should last about six months, but sets employing five or more tubes would TRAIN THEM MUCH FASTER." Evidently these "B" batteries are hard to teach new tricks. Anyhow, we are going to send in an order for a couple to while away the time between program numbers.

Contributed by Virgil T. Olson.



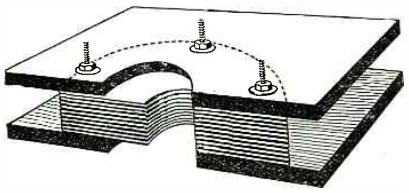
Awards of the $50 Radio Wrinkle Contest

First Prize

HOME-MADE STRAIGHT-LINE WAVE-LENGTH CONDENSERS.

By FRED W. DAVEY

It is more or less a useless task to compare the advantages of a straight-line wave-length condenser with the average condenser that is on the market to-day, as they have been listed in many magazines. Many fans have purchased condensers of the old type and would like to have those of the straight-line variety, so here is a method of converting the condensers that have been around the work-bench to the new type.



With little effort a straight-line wave-length condenser can be made from an ordinary condenser, by the above method.

The end plates of the condenser are first removed and the rotor shaft carefully withdrawn, touching no plates on the rotor shaft and disturbing none of the adjustments. Then remove the stationary plates, noting the number of washers that are next to the end plates.

Two pieces of ¼-inch board are cut to 2½ by 5 inches. Using one of the plates as a template, lay out on one of the boards the outline of the plate with the mounting holes. Clamp the two pieces of wood together with the marked one on top, and drill three holes at the points where the mounting holes are outlined. These holes should be of such a size as will just accommodate a 6-32 machine screw, if that size screw will go through the holes in the plates. Screw in one of the boards three 6-32 bolts that are at least one inch long. In the top board ream out the three holes so there is just enough clearance for the bolts.

Next is drawn on the top board the curve indicated by the cut portion in the sketch. In the shape of this curve the builder must use his own judgment, as nearly every condenser will have a different curve. Place the stationary plates between the two boards and clamp them tightly by means of the bolts, taking care that all the edges of the plates are even. Then cut through the wood and plates, following the marked curve, with a coping saw. Before removing the plates from the clamp, file the edges smooth with a half-round file and smooth off the burrs with a piece of fine sandpaper.

If the dials of the condensers read clockwise, the cut portion of the plates is placed on the *right* and *vice versa* if the dials read in the opposite direction. In assembling the condenser be sure that there are the same number of washers on the supporting screws as there were when the condenser was taken apart.

This conversion of condensers is not a great deal of trouble, and it will be found that the set can receive on lower wave-lengths than before. The tools necessary can be bought in the five-and-ten-cent store, so there is not much expense attached to the change in condensers.

Prize Winners

First Prize $25

HOME-MADE STRAIGHT-LINE WAVE-LENGTH CONDENSERS

By FRED W. DAVEY
43 Fifth Ave., Brooklyn, N. Y.

Second Prize $15

CONDENSERS FOR TUNING INTERMEDIATE STAGES

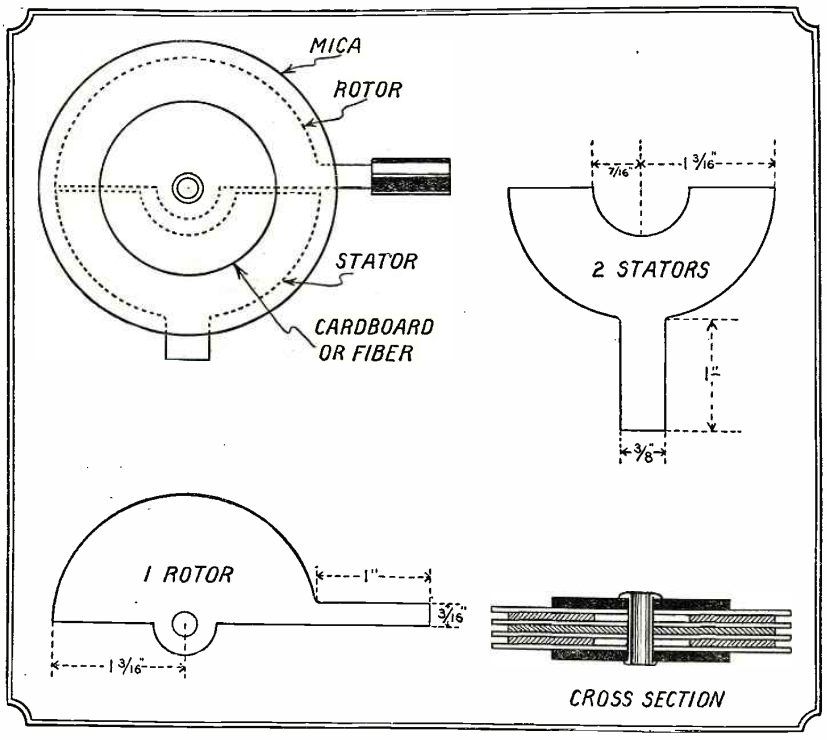
By CHAS. W. HAYNES
32 Galiano, Ferrol, Spain

Third Prize $10

HONEYCOMB-COIL GALVANOMETER

By CLARENCE SAMPSON
Box 378, Fosston, Minn.

Note: The next list of prize winners will be published in the November issue.



The details are shown above for making a small capacity condenser for tuning the intermediate stages of a super-heterodyne. The assembly cross-section is shown at the right.

Second Prize

CONDENSERS FOR TUNING INTERMEDIATE STAGES

By CHAS. W. HAYNES

Experimenters have often found it necessary to use condensers in the intermediate stages of a super-heterodyne receiver to tune them to the same frequency. These condensers have presented a problem, mainly because of the lack of space. The condenser shown here is one that will take very little space and should prove efficient in operation.

The materials needed are four discs of 1/64-inch sheet mica, 2⅝ inches in diameter, having a ⅛-inch hole drilled in the center; two brass stator plates, 1/32-inch thick and cut to the size shown; one brass rotor plate of the same thickness, cut to the size shown; two cardboard washers 1/16-inch thick and 3⅛ inches in diameter, and an eyelet, 3/16-inch in diameter and about ¼-inch long.

Shellac one side of each of the stators and place on each *concentrically* one of the mica discs. It is a good idea to bake these pieces in a *slow* oven, so that all the alcohol in the shellac will be driven out and the two plates will be firmly attached. The condenser is then assembled as follows: Over the eyelet are slipped the parts in this order—one of the cardboard discs, one of the mica discs, to which has been fastened a stator plate with the plate up, another plain mica disc, then the rotor plate, another plain mica disc, the other mica disc with its attached plate with the latter downward, and then the other cardboard disc. The eyelet is then expanded, holding the entire condenser tightly, with the exception of the central plate, which should revolve easily, yet remain in any position in which it is placed.

The lugs of the stators may be soldered together and bent and drilled for mounting in any convenient manner. There is a flexible wire soldered to the rotor. If necessary, the lug on the rotor may be covered with an insulating material to eliminate hand capacity effects.

Third Prize

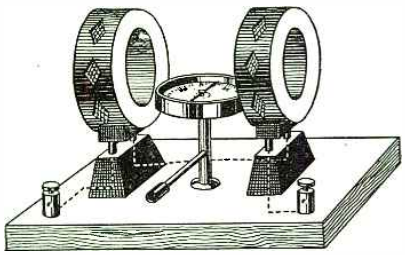
HONEYCOMB-COIL GALVANOMETER

By CLARENCE SAMPSON

A very handy instrument to have around the experimenter's work-bench is a galvanometer. However, most of us would prefer to have a voltmeter and ammeter instead of a galvanometer, if we were going

to purchase any measuring instruments, so the indicating device herein described should appeal to the fan who does quite a bit of experimenting.

This galvanometer is very simple to construct, if the apparatus is placed as shown in the accompanying sketch. Two 1500-turn honeycomb coils are mounted on the baseboard by means of the coil mountings. Care should be taken that the fields of the coils are assisting each other, *i. e.*, that the coils are so mounted that the windings are in the same direction; 1500-turn coils are specified, as these make a very sensitive instrument, but coils having fewer turns may be used.

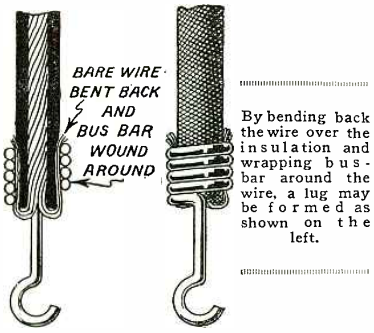


Two coils and a compass make an efficient galvanometer.

A small compass is mounted on a movable stand so that it can be placed in line with the center of the coils. If desired, four binding posts may be mounted on the baseboard, connecting one to the end of each coil. With such an arrangement either or both of the coils may be used. This instrument may be used in many experiments where it is necessary to ascertain whether there is a current flowing.

BUS BAR LUGS

One of the best ways to connect a wire to any instrument in a radio receiver is to use lugs. However, inexpensive as these lugs are, there may come a time when they are needed and there are none on hand. Here is an easy method of making them from ordinary bus bar.



By bending back the wire over the insulation and wrapping bus-bar around the wire, a lug may be formed as shown on the left.

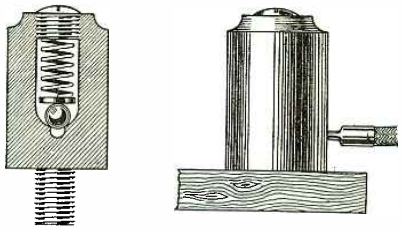
If an insulated wire needs a lug, remove the insulation from the wire about half an inch from the end and bend the wire back over the remaining insulation. Three turns of bus bar are then made around the bent wire and insulation, and the rest of it bent as shown in the sketch. It will be unnecessary to solder this connection of the bus bar to the wire, as the bus bar can be wrapped very tightly.

Contributed by A. A. Blumenfeld.

IMPROVING THE PHONE TERMINAL CONNECTIONS

There are many times when it is desired to make a quick change from head-phones to loud speaker. If the receiver is not equipped with phone jacks, but with binding posts, the operation will consume valuable time. The phone terminal shown in the accompanying sketch will facilitate matters to a great extent.

The top of a binding post is removed and



A quick-change binding post may be easily made, as shown above.

the hole is redrilled and tapped, to take a steel ball, such as is used in ball bearings, about $\frac{3}{16}$ inch in diameter. A spring is wound so that it will fit into the hole, long enough so that it will hold the ball bearing down firmly at the bottom of the hole. The spring is held in position by a cap screwed into the threads at the top of the post. There are no specific sizes given here, because of the varying sizes of binding posts.

With this connector the cord connection is simply slipped into place, where a good contact is made without variation by the spring-held ball.

Contributed by G. A. Luers.

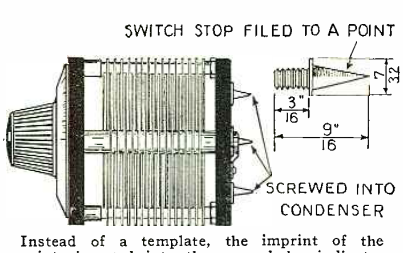
AID FOR MOUNTING INSTRUMENTS

The little device shown in the accompanying illustration is a great aid in the mounting of instruments on a panel, particularly the placing of condensers. The paper template usually furnished with variable condensers is not always accurate and a slight deviation from the screw-hole center will cause a bind. (Sometimes so slight that it is not noticed.)

Cut off the threaded ends of three switch-points ¼ inch from the collar. File the other end of each one to a sharp point. Time must be taken to do this properly. Roll the switch-point frequently while filing in order to have the points in the middle and all the same length. Of course, if a machine shop is handy, do the filing in a lathe. With these operations completed, file a small slot in the edge of the collar, as a hold for a pen-knife or screw driver by means of which you can remove the pins if they should become tight in the instrument.

First determine the position of the condenser on the panel and drill the hole required for the shaft. Screw one of the prepared switch-points into each of the mounting holes of the condenser, just far enough so that the collar of the point is snug against the top of the condenser. Place the shaft of the condenser through the hole in the panel and press firmly against the back of the instrument. Upon removing the condenser, you will find dents in the panel sufficient for the punch, and you will have the satisfaction of knowing that they are accurate.

It is plain to be seen that with a supply of these points, it would not matter if condensers had several mounting screws, as a template would be unnecessary. The above



Instead of a template, the imprint of the points inserted into the screw-holes indicates on the panel where holes are to be drilled.

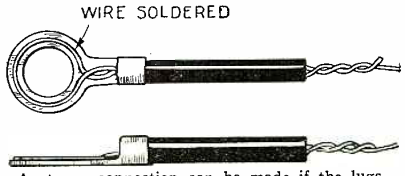
applies, of course, to all other panal-mounted instruments having more than one mounting hole. A set of these points, machined from cold-rolled steel, case-hardened, would hold their sharpness indefinitely.

Contributed by Geo. E. Murphy.

GREATER EFFICIENCY IN SOLDERING LUGS

One of the most important points in building any sort of radio apparatus is the connections that are soldered, and too often this point is neglected, causing endless trouble to the constructor. Soldering lugs help in many ways, but even these may cause trouble if the job is not performed properly.

If the lugs are soldered to the connecting wires as shown in the accompanying sketches, a good electrical connection will result. Instead of the wire being slipped into the end of the lug and soldered there, it is carried around the loop of the lug and fastened to it. This may then be filed flat.



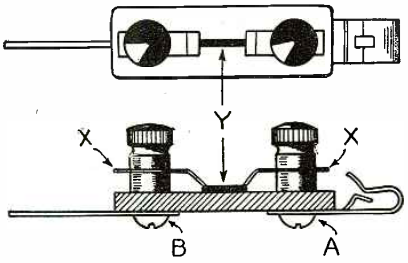
A strong connection can be made if the lugs are soldered to thin wires in this manner.

The advantages of this method of soldering are that it gives a metal-to-metal contact between the lead wire and the binding post or tube socket; it eliminates chances of high resistance connections due to poor soldering or low-grade solder; the heavy, flat face of the lug insures a tight connection without injury to small size wire; and it improves the appearance of the set.

Contributed by V. S. Benson.

VACUUM TUBE FUSE

Every experimenter in radio thinks himself to be the one fellow who will never get the plate and the filament circuits mixed, but after once burning out two or three tubes, Mr. Experimenter thinks that he had better use some precaution. And here it is, at a very small cost.



A filament fuse is a money-saver for the experimenter. Above is one which is easily constructed.

Hunt the following articles in the old junk box: a piece of hard rubber or bakelite ½ x 1½ inches, two binding posts, two pieces of spring brass about ½ x ¼ inches, a Fahnestock clip and a piece of thin tin foil. Bore two holes that will take the binding post screws in the middle of the bakelite, ¼ inch from each end. Bend the spring metal as shown in the diagram, after drilling a hole in each end the same size as those that were drilled in the bakelite. These springs are then placed on the binding posts so that they make a firm contact with the base. Special attention should be given to the preparation of the tin foil strips. These should be cut about 1/64x3/4 inches and several should be prepared and kept for future use.

(*Continued on page* 384)

Correspondence from Readers

DON'TS FOR BROADCASTERS

Editor, RADIO NEWS:

Radio broadcasting affords wonderful entertainment and brings untold pleasure to millions of listeners, but there seems to be one feature of it that is being abused and overdone. I refer to the practice at many stations of acknowledging by radio large batches of telegrams that mean nothing to the general listener and probably are lost even to those who send them, through the vagaries of the ordinary receiving set.

Just why the average radio listener should be surfeited with that sort of bunk is not quite clear, for it detracts from and usurps a large part of the program that otherwise might be extended. Most listeners are in nowise interested in the ordinary wires from John Smith, of Yuba Dam, Ariz.; Bill Jones, of Chicken Bristle, Ky.; Sam Brown, of Devil's Hollow, Ark., and others of that ilk. The radio public is being fed up on: "Program coming in fine. Please play 'Red-Hot Mama!'" and guff of that sort, in the doling out of which some of the largest stations are the worst offenders.

Of course, it is praiseworthy for a listener to let a station know he likes the program or any special feature, but the public acknowledgment over the microphone is being overdone to an extent to cause many radio fans to tune away from such stations.

In striking contrast to the telegram-soliciting stations that take up more time in acknowledging messages than in anything else, is the dignified attitude and policy of WHAS, Louisville; WGY, Schenectady; WTAM, Cleveland, and others that might be mentioned, that are, no doubt, in receipt of their share of appreciative telegrams, but do not bore their listeners with a repetition of them over the microphone.

W. S. KALTENBACHER,
Louisville, Ky.

"BOUQUET A LA KING"

Editor, RADIO NEWS:

I congratulate you on your cover of the April issue of RADIO NEWS. I have had it framed.

H. R. VAN DEVENTER,
Dubilier Condenser & Radio Corp.,
43 West Fourth St.,
New York.

FROM CHINA

Editor, RADIO NEWS:

I am very much pleased to read the elementary lessons of Esperanto in the February issue of your magazine. Evidently, this is a path that will eventually lead to international peace. No doubt, by this time many hams of your country have learned the universal language.

As far as I know, it seems as though there is not yet a standard telegraphic code for Esperanto alphabets. Of course, the International Continental Morse and the Q series should be adopted. In addition to these, there are the superscribed letters ĉ, ĝ, ĥ, ĵ, ŝ and ŭ in Esperanto, which in ordinary print may be represented by ch, gh, jh, sh and u, but these cannot be done at the key, for they are very cumbersome. May I propose the following code:

— — — — for ĉ
— — — . " ĝ
— — . — — " ĥ
.. — .. " ĵ
. — . — " ŝ
.. — — " ŭ

The above are arranged according to the frequency with which the letters are met in Esperanto words. Although in Esperanto the letters q, w, x and y are non-existent, yet the letter q is being used in the q series and the letters w, x and y are allotted to various countries as call letters, for example, w to United States, x to China and y to Great Britain.

I shall be very much pleased if you will give this matter due consideration and publish a standard Esperanto code in your magazine, so that those who speak Esperanto may learn to pound brass in that tongue.

TANGFONG LAUM,
c/o Compradore Department,
Admiral Oriental Line,
4, Des Voeux Road Central,
Hongkong, China.

ON A CRYSTAL

Editor, RADIO NEWS:

Several days ago I took my first plunge into the realm of radio. It consisted of a little bit of a crystal set, equipped with two sliders—and a paper seal reading: "Approved by RADIO NEWS."

That your "Approval" was well founded seemed certain by the clear transmission of all our local stations.

But Saturday night at about 11:15 I put on the phones just to see if anyone was still on—locally.

The following is what I stumbled onto:

WOR—11:20. "I Wonder What's Become of Sally." (Location unknown.)

WGY—11:30. Band concert. General Electric Experimental Station, Schenectady.

WGP—11:45. Dance program, "Direct from the Traymore Hotel."

WOC—12:00. "Sugar," "The program of the Palmer School of Chiropractic, Davenport, Ia." Again at 12:18. Vocal "Shadowland."

——12:05. "Instrumental," "Chicago—next selection will follow."

KSD—12:15. (Very clear.) "Piano Solo—a short intermission before our next selection——"

Indistinct, WJN or WGN—1:12. "Signing off (sounded like 10:10) Central Standard Time."

WQN—1:15. Apparently dance program. "Chicago ——."

——1:18. "—— Moline (heard this twice)——, Ill." (Not distinct.)

——1:26. "—— Hotel, Chicago, Ill." This was Hawaiian Stringed Instrument Concert. Heard two numbers. Not distinct.

——1:30. "Star-Spangled Banner" latter part. Station sounded like WCCA, though not clear enough to be distinguishable.

——1:33. "Palmer (?) House, Chicago."

WSAI—1:38. "Cincinnati, Ohio, broadcasting the program of the United States Playing Card Co." Stringed Quartet. (Clear.)

Sunday night, March 29:

WCDD (?)—1:15. Old, well-known hymns.

WLW—11:20. "Man lost, 65 years old, 140 pounds, seen last in Mt. Vernon (?).

I think this is fair enough, but my friends brand me the twin of Ananias. Is such reception unusual?

C. A. GOULD,
3220 Fadette St., Pittsburgh, Pa.

(Long distance reception on a crystal is by no means uncommon. RADIO NEWS *has published such results for several years. The phenomenon, however, is little understood as yet by radio scientists.—Editor.*

THE RADIHOO—A SUGGESTION

Editor, RADIO NEWS:

Shall we continue to call that important personage who gives us the next thing on the air, "the announcer?" That is somewhat too formal for the American people to continue in use. We have a resourcefulness—an inventiveness—about this matter of our English speech, so something new and picturesque might be expected. But what shall we call him. The ballyhoo? That won't do at all. At any rate, it has been preempted by a certain field. There is no use in robbing the circus for a term. But that leads to a suggestion, just the same. Let us call him "the radihoo." And if you want to, you can spell it "radiwho."

HARRY PRESSFIELD,
Oakdale, Calif.

PITY THE INVENTOR

Editor, RADIO NEWS:

Being a regular patron of RADIO NEWS, I cannot refrain from congratulating you on your most recent achievement in the magazine field. I have reference to the forethought and progressive spirit you have shown in the publishing of Professor Fessenden's inventions. The experience of such an eminent inventor will, undoubtedly, be extremely interesting to inventors at large. Therefore, in the publishing of the Professor's life work you are doing the inventors of the world a service which can never be repaid.

As a teacher of general science, I am personally interested in articles pertaining to inventions or inventors. Professor Fessenden's statement that "no organization engaged in any specific field of work ever adopts any important development in that field until forced to do so by competition" seems to be a proven fact. Only a short time ago two inventors asked me to examine an invention they had patented and requested me to give them my candid opinion as to the practical possibilities of their invention. I complied with their request and found that the invention was not only practical, but also an improvement that is needed. I promptly advised the inventors to get in touch with manufacturers doing business in the specific field to which the invention referred. I was exceedingly susprised to learn that the invention had been placed before no less than thirty different concerns, the results being negative in every instance.

After reading Professor Fessenden's article I realize that the above-mentioned instance is not something to be surprised at, but something to be expected. I asked the inventors referred to in this letter if they had any hopes of profitably disposing of their invention. With a hopeless gesture they told me they had disposed of it by having the original copy framed and were using it as a wall decoration. There probably are many original patent copies giving their owners unexcelled service in a decorative capacity!

Considering the attitude of the average capitalist toward the average inventor, it is a wonder that inventive genius has not been absolutely stifled. The men of money seem to forget that all the wonderful progress science has made up to this time must be credited to inventors.

The question arises, are there any manufacturers in the market for ideas? The answer is yes, several, but they offer the inventor a price that will barely cover the cost of patenting the invention in which they are interested. This method of doing busi-

(*Continued on page* 374)

STANDARD HOOK-UPS

EVERY month we present here standard hook-ups which the Editors have tried out and which are known to give excellent results. This leaf has perforation marks on the left-hand margin and can be cut from the magazine and kept for further reference. These sheets can also be procured from us at the cost of 5c per sheet to pay for mailing charges.

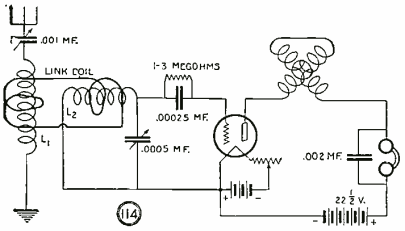
RADIO NEWS has also prepared a handsome heavy cardboard binder into which these sheets may be fastened. This binder will be sent to any address, prepaid on receipt of 20c. In time there will be enough sheets to make a good-sized volume containing all important hook-ups. Every year an alphabetical index will be published enumerating and classifying the various hook-ups.

Handy Reference Data for the Experimenter

MARCONI LINK CIRCUIT

Circuit No. 114. For experimenters who wish a circuit that is very selective, the one in the accompanying diagram is recommended. The inductances, L1 and L2, are wound of No. 22 D.C.C. wire on 3-inch tubing and each coil has 50 turns. These two coils should be mounted at right angles, and there should be at least 12 inches between centers. For extreme selectivity a separate unit might be built consisting of L1 and the .001 mf. condenser. These two coils are linked together by the coils indicated by the heavy line in the diagram. This connecting link is a rubber-covered wire, having as low a resistance as possible. There is one turn of this link coil around each inductance. If a separate unit is built, as mentioned above, it might be placed two feet away from the rest of the circuit. The variometer in the plate circuit of the tube is for regeneration.

The type of vacuum tube that may be used is a UV-201A or C-301A. The length of antenna should be about 125 feet, although this is not very important, as the circuit is quite selective.



The link coil is the medium of coupling that makes this set very selective.

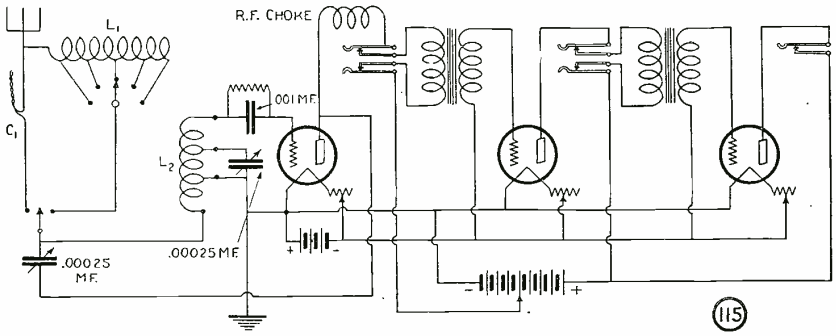
THE REINARTZ ALL-WAVE TUNER

Circuit No. 115. Those experimenters who are familiar with the Reinartz circuit will notice in the accompanying diagram several changes, *viz.*, the absence of the plate coil and the addition of a coil in the antenna circuit, which is for the purpose of detuning this circuit so that the effect on the tuning will be zero. Through this means the tuner can be calibrated before being connected to the antenna, and its calibration will remain constant, regardless of the size and type of antenna to which it may be connected. The great advantage of this detuning coil is the fact that it cuts receiver radiation to zero.

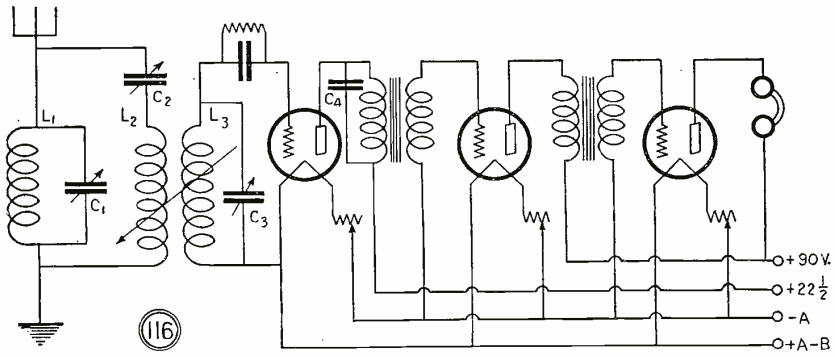
For the R.F. choke coil, wind on an ordinary size drinking glass about 2½ inches in diameter, 75 turns of No. 24 D.C.C. wire in jumble fashion. Slip off the tumbler and wind a few turns of thread around the coil so that it will be self-supporting. The coil should be mounted as near the plate of the tube as is consistent with good wiring practice and should not be placed near any of the other coils.

Around the same drinking glass wind 50 turns of the same size wire, making a loop for tapping at every tenth turn. This coil L1 is mounted on the tuner panel near the antenna connection. Connect one end of a 2-foot length of lampcord to the switch-point and antenna, leaving the other end open. Two pieces of magnet wire may be used if desired, rolled into as small a coil as wanted. If selectivity is too great, add to the length of wire. It should be remembered that the signal strength will be reduced if the condenser C1 is too small.

If the wave-length is to be 150 to 220 meters, the coil L2 is made as follows: On the same tumbler wind in jumble fashion, as before, 5 turns of No. 16 D.C.C. wire, making a 3-inch loop for tapping; then continue for 15 turns with another tap loop and then 5 more turns. Bind, as before, with thread. It will be noticed that there is a 4-to-1 turn ratio of antenna to ground and grid to ground. Maintain this ratio in any other coil that is made. Also notice that the tuning range is 150 to 220 meters, and that if a cipher is added to the 15 turns that are shunted by the condenser, you will have 150, and if a cipher is added to the total number of secondary turns, which is 20, you will have 200, meaning that the approximate range of any coil made with the turn ratio, as above, may be determined beforehand. If additional information is desired about this receiver, it may be found in the June, 1924, issue of RADIO NEWS.



This set can be built to cover any wave range, by varying the amount of inductance in the circuit.

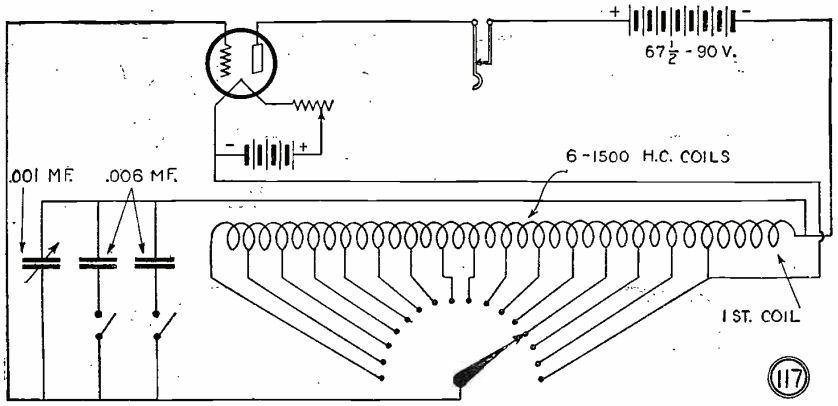


By the use of the wave trap principle this circuit becomes one of the most selective known.

THE SELECTOR CIRCUIT

Circuit No. 116. For the fan who lives in a district congested with many broadcast stations which are difficult to separate, the receiver circuit shown in Fig. 116 should prove of great interest. Nearly every fan who has built a set has given some thought to wave traps, and it is this principle which is used in this circuit.

The coils used in the receiver may be wound in basket-weave style or may be the single-layer inductances. In either case, however, they should be wound with No. 14 D.C.C. wire in order to reduce the resistance of the circuit as much as possible. The inductance L1 has 20 turns and is shunted by the variable condenser C1 which has a capacity of .001 mf. The coils, L2 and L3, which are in inductive relationship to one another, have 50 and 15 turns, respectively. If the coils are single-layer wound, the diameter of the tube should be



The audio frequency oscillator circuit will be valuable for testing loud speakers and apparatus needing audible tones.

3 inches. It should also be noticed that the inductance L1 should not be near the other two inductances, L2 and L3. The condenser C2 has a capacity of .0005 mf.

The "rejector" circuit, composed of L1 and C1, when tuned to the wave-length of the station wanted, rejects the current at this frequency due to the high impedance that it introduces in the path of the current, but it also acts as a low resistance path to ground for currents of all other frequencies. Now the series circuit, or the "acceptor" circuit, behaves in the opposite manner, as it offers a high impedance to interfering frequencies, but negligible impedance at the resonant frequency. Therefore, it accepts the current that was rejected by the parallel circuit and transfers it to the receiver through the inductance L3. The operation, therefore, is simply that of tuning the rejector and the acceptor both to the frequency of the desired signal. Any additional information on this circuit may be found in the June, 1925, issue of RADIO NEWS.

AN AUDIO FREQUENCY OSCILLATOR

Circuit No. 117. The audio frequency oscillator circuit, shown in the accompanying sketch, should recommend itself to the experimenter who is interested in making tests on loud speakers or any instrument that needs a source of audio frequency current. By employing sufficient inductance and capacity in the circuit and using a tap switch for varying the inductance, different tones may be obtained.

The inductance is made by connecting six 1500-turn honeycomb coils in series and bringing out to the tap switch-points 12 taps. These coils may be placed side by side and clamped in position by some suitable means. Care should be taken that the fields of the coils assist one another, *i. e.*, that the winding is all in the same direction. If the outside end of one coil is connected to the inside end of the next, the circuit should operate correctly. It will be noted that the negative side of the "B" battery is connected to one of the end coils, which we will call the first coil. The filament of the tube is connected to the other lead of the first coil, where it is attached to the second coil.

It will perhaps be difficult to procure two condensers having a capacity of .06 mf., so if the experimenter will build up ten condensers of .006 mf. capacity each and connect them in parallel, he will have the equivalent of a .06 mf. condenser. The variable condenser shown will act as a vernier adjustment to the frequency. If a greater variation is desired, taps may be made on the two condenser piles, in addition to the taps on the inductance.

When all the condensers are connected in the circuit, the note will be the lowest obtainable, and by shorting out one of the .06 mf. condensers, the frequency will be increased. By shorting both of the fixed condensers and turning the variable condenser almost to zero capacity, the frequency will be almost inaudible. The oscillator may be roughly calibrated by comparing the frequencies with the notes of a piano, as follows: Middle C has a frequency of 256 cycles per second, the next C above has 512 cycles, the next 1024 cycles, and the next 2048 cycles. Down the scale from middle C, the first C has 128 cycles per second, the next 64 cycles and the next 32 cycles.

The best tube to use as an oscillator is a UV-201A or C-30IA, if it is desired to have great volume; but for ordinary purposes a dry cell tube of the WD-11 type may be used with a corresponding reduction of the plate voltage.

The oscillator controls may be mounted on a panel and the apparatus placed within a cabinet in order to avoid the collection of dust on the parts.

SUPER-HETERODYNE RECEIVER WITH NOISELESS INTERMEDIATE AMPLIFIER

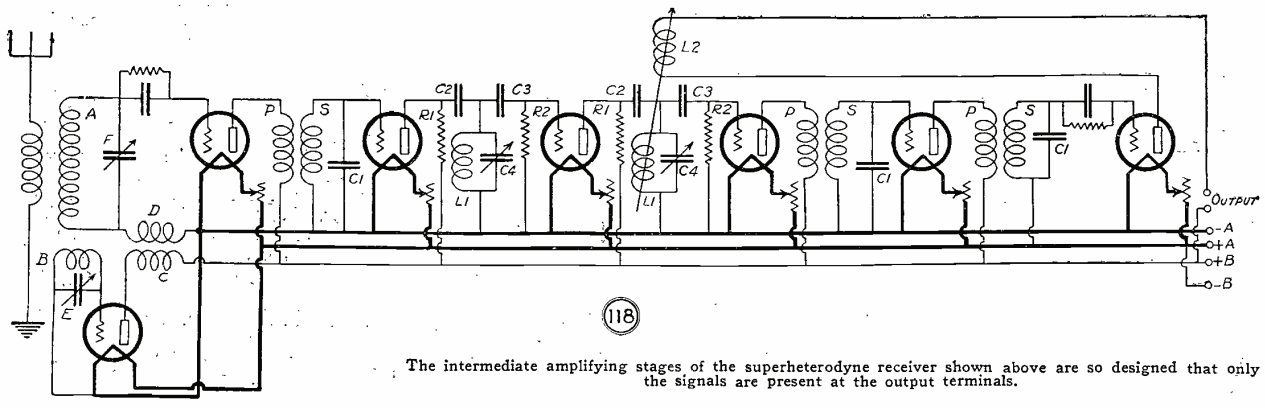
Circuit No. 118. One of the complaints sometimes heard from users of super-heterodyne receivers is that the intermediate stages are wont to pass through to the second detector all the noises that are picked up, as static and the like. Through the process embodied in the receiver shown in Fig. 118, the majority of these unwelcome noises are eliminated. No deviation from standard super-heterodyne practice will be noticed in the circuit up to the plate circuit of the third tube. Instead of the intermediate frequency transformer there is a resistance, a tuned circuit and a grid leak.

The heterodyned signal delivered to the plate circuit of the first detector is passed through the transformer PS to the grid circuit of the first intermediate frequency amplifying tube. Here it is again amplified. It is well to note that everything passing the first detector is also amplified to some extent. This included static, atmospheric noises, other signals than the one desired, on account of the broadness in tuning of the tuned grid circuit of the first tube, and a certain amount of extraneous noise arising from the transformers, the tubes and the oscillator.

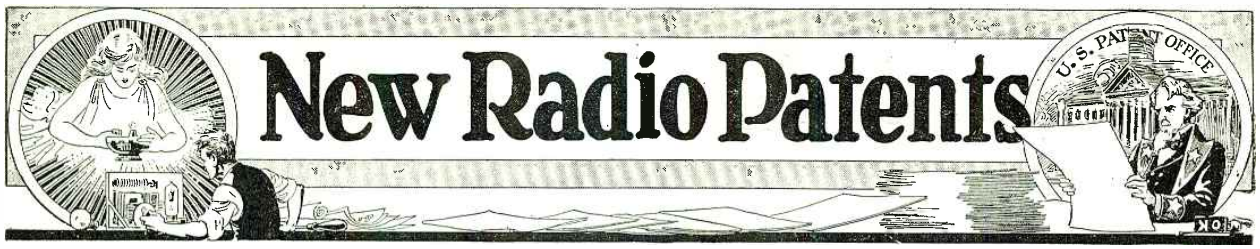
The condensers C2 and C3 are of small capacity, .00025 mf. or less. Experience will show that the static and tube noises are of audio frequency and are usually loud in ratio to the signal intensity. Therefore, the size of C2 effectually prevents their passage into the grid of the next tube. The only possibility left to them is to take the alternative path through the resistance R1, which is approximately 25,000 ohms. Here they are dissipated in the form of heat, leaving only the higher frequencies to pass on.

The detector and oscillator are of the standard type. The tuning coil A may be made by winding 64 turns of No. 18 S.C.C. wire on a 3-inch tube. The condensers E and F have a capacity of .0005 mf. The pick-up coil D may be 10 turns of No. 18 wire wound at the end of the oscillator inductance tube, which is also 3 inches in diameter. The plate and grid coils, B and C, for the oscillator may consist of 40 turns for the former and 64 for the latter, separated about one-half an inch from each other on the tube. The resistances R2 have a value of about three megohms. L1 is a 400-turn honeycomb coil and C4 has a value of .001 mf. capacity. L2, the tickler coil for obtaining regeneration, has between 8 and 15 turns of No. 18 wire wound on a 3-inch tube. The definite number of turns cannot be given as they will vary in different sets. Additional information on this circuit may be found in the May, 1925, issue of RADIO NEWS.

In the hook-up no audio frequency is shown. Any type amplifier may be added at the output posts or incorporated in the set.



The intermediate amplifying stages of the superheterodyne receiver shown above are so designed that only the signals are present at the output terminals.

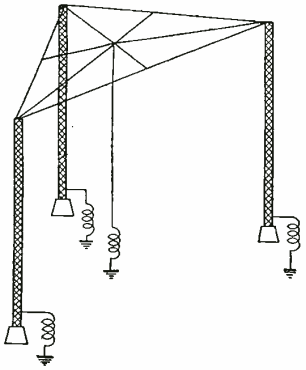


Digest of Latest Canadian Radio Patents

Compiled by G. F. SELLECK, Jr.

ANTENNA SYSTEMS FOR WIRELESS COMMUNICATIONS

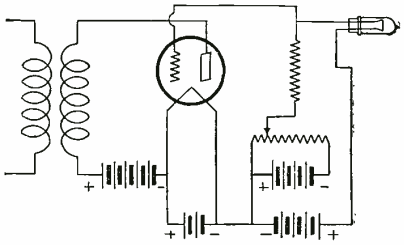
(Canadian Patent No. 246,370, E. Y. Robinson. Filed August 28, 1923; issued January 27, 1925.)



The invention consists of an antenna system comprising an elevated capacity area and a plurality of supporting members therefor; the method of insulating the antenna and reducing power losses consists of inducing in the supporting members of the antenna, currents which are substantially in phase with the antenna current.

REPRODUCING AMPLIFIERS

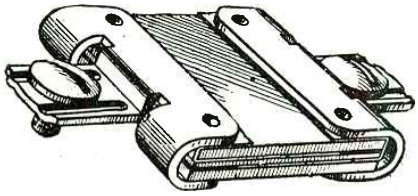
(Canadian Patent No. 247,320, T. W. Case. Filed June 4, 1924; issued March 3, 1925. Assigned to Case Research Laboratory, Inc.)



The invention consists of a reproducing amplifier comprising a bulb containing a filament and a grid, a circuit connecting the filament and grid and containing a source of potential and a light-reactive resistance, and means connected across the filament and grid for controlling the grid potential.

ELECTROSTATIC CONDENSERS

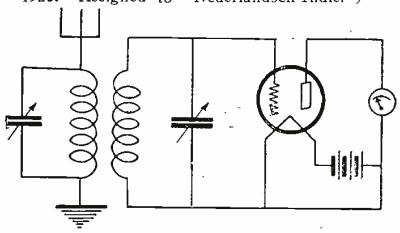
(Canadian Patent No. 247,126. A. J. Carter. Filed April 22, 1924; issued February 24, 1925. Assigned to Carter Radio Company.)



The invention consists of an electric condenser including two plates of insulation, a solid dielectric between said plates of insulation, two electrostatic charge-receiving sheets, one individual to each of the insulating plates and interposed between such insulating plate and the dielectric, each charge receiving sheet having an extension folded over an insulating plate, these folded extensions being at opposite sides of the condenser; and two metallic terminals of U form, each individual to and embracing a side of the condenser and engaging the folded extension of the charge-receiving sheet thereat, each side of each terminal having an indentation at each end projecting into the insulating plate adjacent thereto.

RECEIVING OF WIRELESS SIGNALS

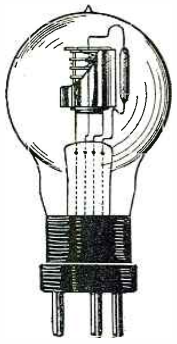
(Canadian Patent No. 246,737, W. F. Einthoven. Filed November 16, 1922; issued February 10, 1925. Assigned to "Nederlandsch-Indie.")



The invention consists of a method of receiving wireless signals according to which the received oscillating currents, after amplification but without rectification, are fed to the fibre of a string galvanometer, the size and tension of the fibre being so adjusted that its natural frequency is the same as the radio frequency of the received oscillations.

VACUUM TUBES OF THE THREE-ELECTRODE TYPE

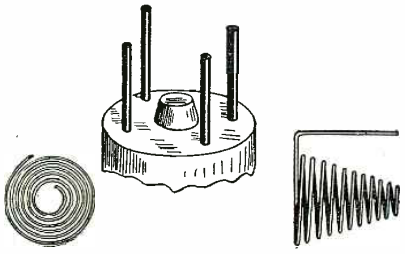
(Canadian Patent No. 246,367, Francois Peri. Filed June 13, 1923; issued January 27, 1925.)



The invention consists of a vacuum tube having three electrodes, characterized by a "partitioned" plate composed of vertical elements curved inwardly in the direction of their lengths (or planes) spaced at equal distances apart and arranged concentrically around the filament, these elements being clipped upon two heads which assure their assemblage, for the purpose of bringing the plate nearer to the grid, whilst enabling it to have a maximum superficial area and a maximum heat radiation.

BASE SOCKET

(Canadian Patent No. 244,361, A. B. Reynders. Filed November 16, 1922; issued November 11, 1924. Assigned to Canadian Westinghouse Company, Limited.)



This invention relates to socket devices and has special relation to base sockets adapted for use with vacuum tubes.

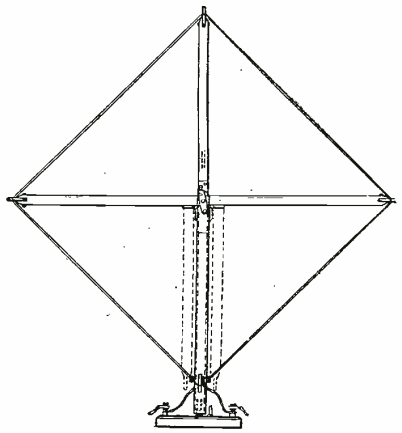
One of the objects of the invention is to provide a socket device of such design as to make an exceptionally firm electrical contact and a smooth mechanical contact with an engaging plug.

Another object is to provide a base socket which offers a resilient mounting for vacuum tubes, thereby eliminating tube noises resulting from vibration.

The invention consists of a socket device, a conical-spring contact element adapted to yieldingly engage a plug member, said element having a terminal tab integral therewith, and extending therefrom.

FOLDING LOOP AERIAL

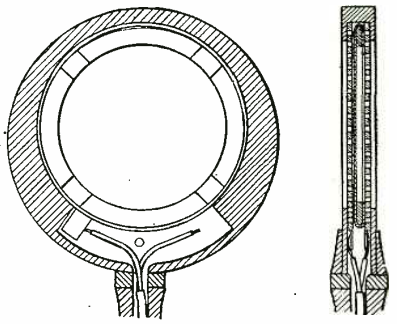
(Canadian Patent No. 246,132, Marius Mathiesen and W. J. Sandberg. Filed May 10, 1924; issued January 13, 1925.)



The invention consists of a folding loop aerial comprising a base upon which is mounted a vertically extending frame member, said frame member being formed of two telescoping parts, means for wedging apart the two parts of the vertical frame member, horizontally extending arms hinged to said vertically extending frame member, and antenna wires and insulators on the ends of said arms for receiving said antenna wire.

ELECTRICAL CONDENSERS

(Canadian Patent No. 244,810, N. W. McLachlan. Filed December 10, 1923; issued November 25, 1924. Assigned to Marconi Wireless Telegraph Co. of Canada.)



In this invention a condenser is constructed by spraying or otherwise coating with metal a sheet of tissue paper or the like and placing this sheet upon a perforated sheet or plate of metal which is coated on the side next to the tissue with insulating varnish.



RADIO manufacturers are invited to send to RADIO NEWS LABORATORIES, samples of their products for test. It does not matter whether or not they advertise in RADIO NEWS, the RADIO NEWS LABORATORIES being an independent organization, with the improvement of radio apparatus as its aim. If, after being tested, the instruments submitted prove to be built according to modern radio engineering practice, they will each be awarded a certificate of merit, and a "write-up" such as those given below will appear in this department of RADIO NEWS. If the apparatus does not pass the Laboratory tests, it will be returned to the manufacturers with suggestions for improvements. No "write-ups" sent by manufacturers are published on these pages, and only apparatus which has been tested by the Laboratories and found to be of good mechanical and electrical construction is described. Inasmuch as the service of the RADIO NEWS LABORATORIES is free to all manufacturers whether they are advertisers or not, it is necessary that all goods to be tested be forwarded prepaid, otherwise they cannot be accepted by the Laboratories. Apparatus ready for the market or already on the market will be tested for manufacturers, as heretofore, free of charge. Apparatus in process of development will be tested at a charge of $2.00 per hour required to do the work. The Laboratories will be glad to furnish readers with technical information available on all material listed here on receipt of a stamped envelope. The Laboratories can furnish resistances of the various instruments, amplification curves of transformers, losses in condensers, etc., and other technical information. Address all communications and all parcels to RADIO NEWS LABORATORIES, 53 Park Place, New York City.

ECHO LOUD SPEAKER

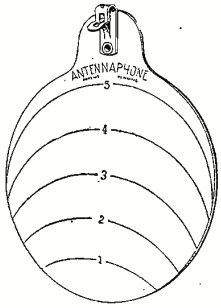
This speaker was submitted to the RADIO NEWS LABORATORIES for test by the Echo Radio Co., 2512 Irving Park Building, Chicago, Ill. It operates satisfactorily with regard to both quality of reproduction and volume.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 839.

ANTENNAPHONE

The antennaphone shown in the illustration was submitted to the



RADIO NEWS LABORATORIES by the Antennaphone Co., 90 West Street, New York City. This instrument is used for dividing capacity coupling between receiving set and telephone lines and is merely placed under the base of the telephone desk set.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 740.

PREMIER BATTERY CABLE

This battery cable, submitted for test by the Crescent Braid Company, Providence, R. I., is shown in the

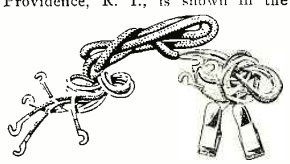


illustration. It consists of five independent, insulated wires braided into a single cable. These wires are covered with insulation of different colors, and have clips and attachments at the ends.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 813.

OVENSHIRE LOUD SPEAKER

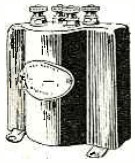
This loud speaker, submitted to the RADIO NEWS LABORATORIES by Howland and Dewey, gives very fine reproduction with regard to both quality and volume. It is well made and attractive in appearance.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 854.

ERLA AUDIO TRANSFORMER

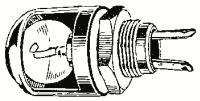
This audio transformer was submitted to the RADIO NEWS LABORATORIES for test by the Electrical Research Laboratories, Inc., 2500 Cottage Grove Ave., Chicago, Ill. The transformer has a ratio of six to one and operates satisfactorily in audio amplifier circuits, giving very satisfactory reproduction both as regards quality and volume.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 821.

PANELITE

The panelite pictured in the illustration was submitted to the RADIO NEWS LABORATORIES by the Walbert Manufacturing Company, 925 Wrightwood Ave., Chicago, Ill. This panelite presents a very attractive appearance on the receiver panel.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 830.

MAGNADYNE

These coils, submitted by the

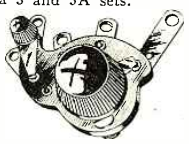


Coast Coupler Co., 245 East 7th Street, Los Angeles, Calif., were constructed specially for reflex circuits. They operate very satisfactorily and are well and strongly made.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 843.

ANTENNA SELECTOR SWITCH

The antenna selector switch shown in the illustration was submitted for test to the RADIO NEWS LABORATORIES by the Barkelew Electric Mfg. Co., of Middletown, Ohio. It is made for use as a tap switch in the antenna circuit. The particular switch submitted for test, No. 605, is especially adapted for use with Radiola 3 and 3A sets.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 822.

NAVY BRAND SOLDERING FLUX

This soldering flux, submitted by the Paul H. Brattain Company, Albee Bldg., Washington, D. C., to



the RADIO NEWS LABORATORIES for test, works satisfactorily with the ordinary solder, producing plain, well-made joints.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 820.

CUNNINGHAM TUBES

These tubes, shown in the illustration, were submitted by E. T. Cunningham, 154 West Lake St., Chicago, Ill., to the RADIO NEWS LABORATORIES for test. The tubes are well known among our readers and have been reported in detail in many articles in RADIO NEWS.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 838.

NON-CORRODING SOLDERING PASTE

This soldering paste, submitted by the Harco Laboratories, 11-48 Island



Avenue, Wilminton, Calif., can be recommended for use in building radio sets. Firm, workmanlike soldering joints can be made with the use of this flux.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 852.

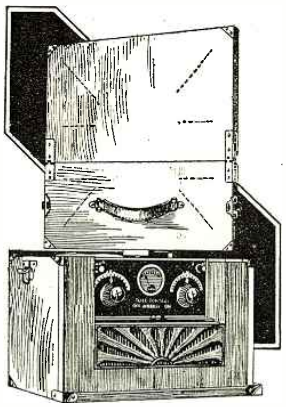
KAYNITE RADIO COIL WINDING MACHINE

This machine, submitted to the RADIO NEWS LABORATORIES for test, by the A. W. Knight Company, Ltd., 167 Rye Lane, London, England, is a very convenient device for winding honeycomb coils. It possesses a form for holding a coil and a guide for the wire. There is a dial provided which, by means of a worm and gear, automatically counts the turns.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 772.

OPERADIO SET

This set, furnished the RADIO NEWS LABORATORIES by the Operadio Corp., 1476 Broadway N. Y. City, is a portable set, having the batteries included within the cabinet and the loop formed of two sides of

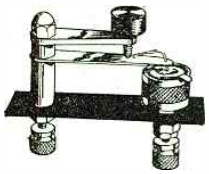


the cabinet, which can be mounted on the top when in use. There are five tubes in the set tuned by two condensers. Very satisfactory results will be obtained in this set, on receiving both local and distant stations.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 809.

ARGENTITE DETECTOR

This mounting and crystal detector was submitted to the RADIO NEWS LABORATORIES for test by the Argentite Radio Corporation, 303 E. 4th St., Los Angeles, Calif. The method of construction affords a very fine adjustment on the cat-whisker contact. It is well designed and will operate very satisfactorily in any kind of circuit employing a crystal.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 782.

VICTOR BATTERY HYDROMETER

The hydrometer shown in the illustration was submitted by the Victor Manufacturing Co., 236 West 55th street, New York City. This instrument can be used very satisfactorily in determining the state of charge of storage batteries of the lead cell type.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 881.

MEGGITT RESISTOR

This resistor, submitted by the Cole Radio Mfg. Corp., 535 Bloomfield Ave., Bloomfield, N. J., is shown in the illustration. It operates satisfactorily in radio sets wherever high non-inductive resistances are required.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 861.

CROSS RADIO ADAPTER

This adapter, furnished by the Cross Gear and Engine Company, 3248 Bellevue Ave., Detroit, Mich., is well and substantially made, and will operate satisfactorily in any receiver. It will fit any size phonograph.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 835.

MOZART-GRAND LOUD SPEAKER UNIT

The loud speaker unit shown in the illustration was submitted by the Mozart-Grand Co., 235-49 Elizabeth avenue, Newark, N. J. It is very satisfactory for use in obtaining clear and strong reproduction from radio sets. The diaphragm spacing is adjustable by means of a screw in the rear. Reproduction may be obtained from this unit without appreciable distortion.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 878.

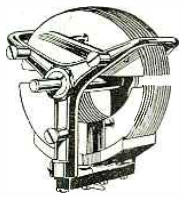
KELLOGG LOUD SPEAKER

This loud speaker, submitted to the RADIO NEWS LABORATORIES by the Kellogg Switchboard and Supply Co., 106 West Adams Street, Chicago, Ill., gives very fine reproduction with regard to both quality and volume. It is well made and presents an attractive appearance.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 850.

PHENIX CONDENSER

The condenser shown in the illustration was submitted to the RADIO

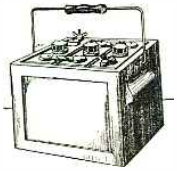


NEWS LABORATORIES for test by the Phenix Radio Corp., 114 East 25th St., New York City. It is of the straight-line wave-length type and has a maximum capacity of .0005 mf.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 862.

THOMAS BATTERY

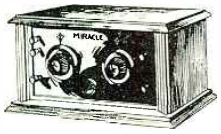
This battery, of the standard type, made by the Thomas Battery Corp., 511 West 50th street, New York City, was submitted to the RADIO NEWS LABORATORIES for test. The cells are of the lead acid type. It is very sturdily built and operates very satisfactorily. Case entirely of hard rubber.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 885.

MIRACLE RECEIVER

This receiver, submitted by the Uncle Al's Radio Shop, 3015 Dakota



St., Oakland, Calif., is of the crystal type, having a multiple-tuner circuit including two tuning controls. It operates satisfactorily over the broadcast range.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 858.

EMPIRE-TRON VACUUM TUBE

This vacuum tube was submitted to the RADIO NEWS LABORATORIES by the American International Trading Corp., 24 Stone street, New York



City. It is made to operate on a filament voltage of 46, using the accustomed plate voltages. It operates very satisfactorily as amplifier and detector.

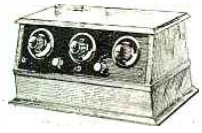
AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 882.

CORRECTION

The illustration shown for the CeCo tube in the August issue was incorrect. The CeCo tube is tipless.

BLAIR RADIO RECEIVER NO. 11

This radio receiver, submitted by the Blair Radio Laboratories, Mc-

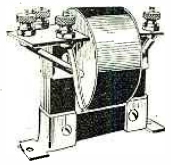


Creery Building, 23rd St. and Sixth Avenue, New York City, is of the six-tube type. It operates very satisfactorily both as regards quality and volume over the whole broadcasting range.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 864.

AMACO AUDIO TRANSFORMER

This audio transformer, submitted by the American Apparatus Company, Richmond, Ind., has a ratio of 3 to 1. It operates satisfactorily as an interstage coupler in audio amplifier circuits, giving satisfactory reproduction both as regards quality and volume.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 819.

CRYSTAL DETECTOR

This crystal detector, submitted by the C. D. Tanner Co., 528 W. Washington Street, Los Angeles, Calif., to the RADIO NEWS LABORATORIES for test, is very well made and offers the advantage of very sensitive adjustment of the crystal contact. The detector is shown in the illustration.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 847.

MUSSELMAN CERTIFIED TUBE

This tube was submitted by the Van Horne Company, Franklin, Ohio, to the RADIO NEWS LABORA-



TORIES for test. The tube operates very satisfactorily in radio receivers in the capacity of either amplifier or detector. Each tube is furnished with its individual characteristic curve drawn on a printed form enclosed in the box with the tube.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 875.

NEODYNE RADIOFEET

The illustration shows the radiofeet submitted by the Neodyne Asso-

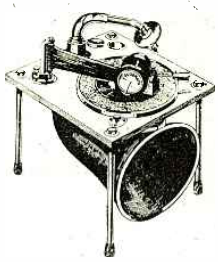


ciates, 3121 Benenson Building, 165 Broadway, New York City. These radiofeet act very well in reducing microphonic noises in the radio set.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 876.

DUOGRAPH

The Duograph, shown in the illustration, was submitted to the RADIO NEWS LABORATORIES for test by the Willson Company, Stamford, Conn. It consists of a Pathé photograph



machine on which is mounted a reproducing arm actuated by a Baldwin unit. This Duograph may be used to reproduce, on aluminum disks, radio concerts which are received on the usual radio sets. It also affords provision for using these records after they are made.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 856.

FERI RADIO FREQUENCY TRANSFORMER

The radio frequency transformer shown in the illustration was sub-



mitted by the Feri Radio Mfg. Co., 1167 Bedford Ave., Brooklyn, N. Y. It is very well made and substantial. It operates very satisfactorily in radio receivers.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 879.

CLEARCO CRYSTAL

The crystal shown in the illustration was submitted by the Clearco



Crystal Company, Idaho Springs, Colo., to the RADIO NEWS LABORATORIES for test. These crystals function very well in radio receivers, being sensitive and uniform in operation.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 877.

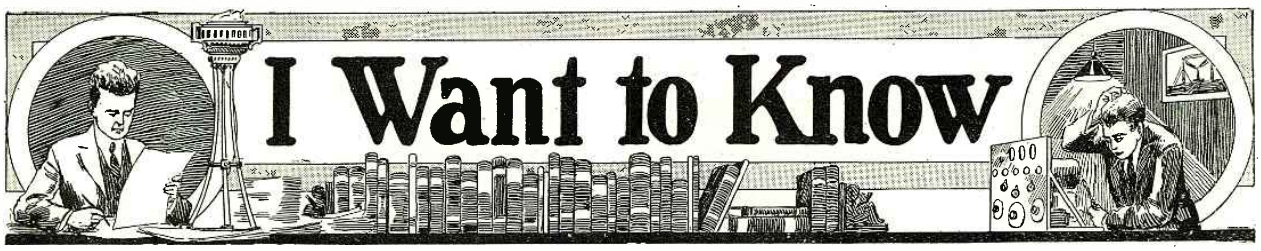
VOLUMAX LOOP

The Volumax loop, made by the Scott & Fetzer Company, West 114th street and Locust avenue, Cleveland, Ohio, was submitted to the RADIO



NEWS LABORATORIES for test. It is a collapsible loop having dimensions of approximately 1 foot by 7 feet when open. Very good signal strength can be obtained with this loop; it is also sensitive and directional.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 880.



Conducted by R. D. Washburne

THIS Department is conducted for the benefit of our Radio Experimenters. We shall be glad to answer here questions for the benefit of all, but we can publish only such matter as is of sufficient interest to all.

1. This Department cannot answer more than three questions for each correspondent. Please make these questions brief.
2. Only one side of the sheet should be written upon; all matter should be typewritten or else written in ink. No attention paid to penciled matter.
3. Sketches, diagrams, etc., must be on separate sheets. This Department does not answer questions by mail free of charge.
4. Our Editors will be glad to answer any letter, at the rate of 25c for each question. If, however, questions entail considerable research work, intricate calculations, patent research, etc., a special charge will be made. Before we answer such questions, correspondents will be informed as to the price charge.

Mr. Washburne answers Radio questions over WRNY every Thursday at 8:30 P. M.

PICTURE DIAGRAMS INDEX

This is a complete listing of picture diagrams for the novice, shown in the "I Want to Know" department of Radio News. Back issues may be secured through the Subscription Department.

(1) **Inverse Duplex.** December, 1924. The Grimes reflex circuit using 3 tubes (one being detector) and a loop aerial. Two stages of radio frequency and two stages of audio frequency amplification.

(2) **Ultra-Audion.** December, 1924. Tube detector and one stage of audio frequency amplification. The most simple tube set.

(3) **Honeycomb Set.** January, 1925. The diagram shows how to make a standard three-coil honeycomb set for all wave-lengths, and how to add radio frequency and audio frequency amplification. Three tubes.

(4) **New Flewelling.** March, 1925. The latest Flewelling Super-Regenerative 1-tube circuit.

(5) **Freshman.** April, 1925. Two stages of transformer-coupled audio frequency amplification.

(6) **3-Slide Tuner Regenerative.** April, 1925. How a 3-slide tuner may be used in a 1-tube regenerative circuit.

(7) **2-Stage Amplifier.** Both stages push-pull. May, 1925. The diagram shows the use of an "interstage transformer." Four tubes.

(8) **2-Stage Amplifier.** May, 1925. How to wire up a standard transformer-coupled amplifier, using phone jacks adaptable to any receiving set. Two tubes.

(9) **Crystal Set.** June, 1925. The most simple crystal set.

(10) **1-Stage Amplifier.** June, 1925. Standard diagram of connections for a standard audio frequency amplifier which may be added to any set. Quality controls are shown. One tube.

(11) **Crystal Set.** June, 1925. This circuit requires two variable condensers, a home-made coil, a crystal detector, a pair of head-phones and a fixed condenser.

(12) **Crystal Set.** June, 1925. This set requires the same number of instruments as enumerated above, but a different coil construction.

(13) **Multi-Circuit Set.** July, 1925. By using the same tube unit, but changing the tuning unit, one may have the "2-variometer, variocoupler," "2-coil variocoupler," "3-coil honeycomb," or the "untuned primary" regenerative circuit.

(14) **1-Tube Reflex.** August, 1925. The detector is a crystal. Few parts are required. The set is easily made. One stage of radio frequency and one stage of audio frequency amplification.

(15) **Deaf Set.** August, 1925. A circuit arrangement for exceptionally great amplification of sounds picked up in a room by a microphone. One tube.

THE SUPER-UNIDYNE

(2140) Mr. H. S. Harris, New Albany, Miss., asks:

Q. 1. What is the diagram of connections used in the Super-Unidyne receiver? This is a seven-tube set employing the super-heterodyne principle. The receiver has three stages of short-wave, high frequency amplification, a first detector, an oscillator, a second detector and two stages of audio frequency amplification. The unusual part of the set is that no intermediate frequency amplification is used.

A. 1. We are showing the circuit of this very interesting receiver in these columns.

The radio frequency transformers marked "L" may be the standard type of so-called "tuned radio frequency transformer" designed to cover the broadcast wave-length band. Freshman, Toroformer, Syckles, Erla "Balloon" Circloid, Andrews "Paddlewheel," Hammarlund, Rasco "R. F. Spiderweb," or even Neutrodyne coils may be used in the three radio frequency amplifier stages, if care is used in building this part of the set. The value of the condensers marked "C-1" will be dependent upon the constants of the particular coils selected for "L." The most important points to remember in placing these coils are the two we have stressed in almost every issue of RADIO NEWS for the past six months or more: the coils *must* be in *non-inductive* relation; leads *must* be short. The latter refers most strongly to the grid leads; the plate leads are next in importance.

Both potentiometers are of the 400-ohm type. The four rheostats may all be of twenty- or thirty-ohms rating, the first-named rating being best for the usual quarter-ampere tubes.

There is only one intermediate frequency transformer in this set and even this is more properly termed a "filter coupler."

It is the coil with the .00025 mf. condensers across the primary and secondary (P and S) coils. These condensers will, in practice, necessarily vary from this value. In order to tune this filter coupler properly, these two condensers should be of the very small, variable mica type having a maximum capacity of about .0005 mf. There are at least three such instruments on the market, the Amplex "Grid-Denser," the X-L Laboratories "Vario-Denser," and the "Turn-It" condenser.

Both primary and secondary filter coils have the same constants, in the regular set, but other, nearly similar coils may be used; anyone having a stray Ultraformer or Tropaformer around will find it adaptable to this set.

An ambitious experimenter can make his own coil by winding 500 turns of No. 30 D.S.C. wire in a groove one-quarter inch wide and one inch in diameter. This is the primary. Duplicate this for the secondary. Both coils are wound in the same direction. The outside of the primary goes to the plate and the outside secondary lead goes to the grid. By the time you have filled the two grooves, the diameters will have grown to about three inches. This groove proposition is easily attended to by having some cigar-box wood cut to the diameters of one inch and three inches. You will need three 3-inch, and two 1-inch disks. These are placed together alternately this way: 3-1-3-1-3, with a brass screw running through the center of the five pieces, to hold them together. Four sets of such coils may be used in any super-heterodyne. It is best to make the cigar-box wood impervious to moisture by painting it with collodion or thin shellac. The finest treatment is to place the wood in melted paraffin until air bubbles stop coming to the surface, then remove and allow the excess paraffin to drain off.

The three-coil oscillator L-1 is next on the construction list. All three coils are wound in the same direction, with No. 24 D.C.C. wire on a three-inch tube. Wind "A" to about 18 turns; leave one-quarter inch space and wind 45 turns for "B," and, lastly, 12 turns for "C," one-quarter inch from "B."

There is nothing new or unusual about the filament control jacks for the audio stages.

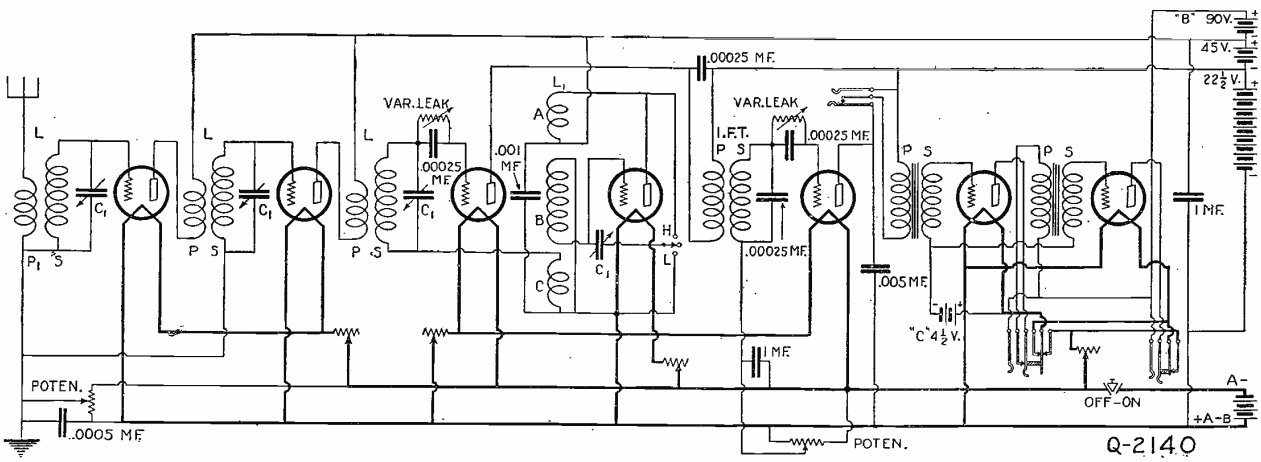
Right here we wish to voice a warning. Keep the oscillator in non-inductive relation to the other coils in the set.

As in all multi-tube sets, good tubes are a prime requisite.

Condenser rotor plates are indicated by the arrowhead. Body-capacity effects will be strong, at the oscillator condenser, unless a separately grounded frame condenser is used. Straight-line wave-length or straight-line frequency condensers should be used—not straight-line capacity.

The oscillator variable condenser dial readings may be made to closely match the remaining three variable condensers in the set, if they are of the same capacity, by changing the number of turns in grid coil "B." A little experimentation here will do the trick.

Q. 2. Why does removing the catwhisker from



The Super-Unidyne circuit. Storage battery tubes are best. Two stages of radio frequency amplification are used. The fourth tube from the left is the oscillator tube. There is no intermediate frequency amplification. The oscillator is used only to furnish selectivity and a certain amount of amplification which is the result of heterodyning.

the crystal of my reflex set cause a loud howl in the loud speaker? And, why is it necessary to change the catwhisker location when changing from one extreme wave-length to the other, in order to prevent a loud howl? Other reflex sets I know of do not have this trouble.

A. 2. Both these experiences are caused by the same major effect—the crystal detector has a variable resistance. This resistance is varied as the contact is changed. Your receiver is similar to thousands of others. in that a loud howl is heard when the catwhisker is lifted from the crystal. All this is understood when one considers the fact that the damping, or oscillation control of the circuit is governed largely by the amount of resistance in the circuit. By reducing the number of turns in the plate coil of the tube circuit that is oscillating, it is possible to stop the oscillation of the circuit. The effect of reducing the number of plate turns is obtained by connecting a resistance in the secondary circuit of the R.F. transformer, the primary of which is in the tube plate circuit. The crystal is this resistance. At the longer wave-length adjustment, less resistance is required in the circuit to stop oscillation, than at the short wave-length. This variable resistance requirement is met by varying the catwhisker location and pressure, as stated above. Some receivers use fixed crystals. In this case, where other special conditions exist, such as a reduced number of plate coil turns, it may not be necessary to make any change in the detector resistance to control circuit oscillation. In general, it may be said that receivers having such a critical adjustment of the crystal are more sensitive than those not so blessed (?).

THE HETEROPLEX

(2141) Mr. I. F. Coleman, Rentz, Georgia, asks:

Q. 1. What does "Hi!" mean? I often hear amateurs use this expression when radiophoning to one another.

A. 1. This means "Ha! Ha!" It is the radio laugh.

Q. 2. Is it possible to add a push-pull audio frequency amplifier to the Heteroplex receiver, without using the usual system employing center tapped transformers? I do not want to use resistance-coupled push-pull amplification, because the amplification is not as great. Please give construction details for the Heteroplex.

A. 2. A very clever arrangement permitting push-pull audio frequency amplification with standard audio frequency transformers of any good make is incorporated in the Heteroplex circuit shown in these columns. The values for "R" and "R-1" are somewhat experimental. For "R" we suggest two one-half or one-megohm leaks. For "R-1" we suggest two 10,000- to 100,000-ohm resistances.

If you have never seen a Heteroplex coil, you may find it difficult to catch on to the way this unit is made. It consists of three windings which we have lettered "A," "B" and "C." Grid tuning coil "C" consists of 40 turns of No. 26 S.S.C. wire wound on a tube three inches in diameter. Note that this coil has every turn spaced the distance of a No. 22 wire. This was accomplished by winding 40 turns with two wires, one a No. 26 and the other a No. 22. This makes a total of 80 turns (40 turns to each size wire). The last maneouvre is to count down 11 turns from end "5", of the coil and cut the No. 22 wire. Count 24 turns of the No. 22 wire, from end "4", and again cut the No. 22 wire. Throw away the five turns of No. 22 wire remaining. Coil "B" is the 11-turn coil separated from the 24-turn coil "A" by about one-quarter of an inch. Try reversing the connections to coil "C". Sketch Q. 2141-A shows "C" as solid lines; coils "A" and "B" are represented by the dotted lines. To reach the full wave band it will probably be necessary to use a good fixed condenser connected across the variable one, as shown by the dotted lines in Fig. Q. 2141.

Q. 3. Please print general information on the present status of broadcasting, such as number of stations, minimum and maximum power used, etc.

A. 3. We have had a goodly number of our readers ask that question. The data is as follows:

Radio broadcasting is considered to have started when station KDKA, East Pittsburgh, Pa., broadcast the Harding-Cox Presidential Election returns, November 2, 1920.

Although not done originally, new stations are given the prefix "W" if located East of the Mississippi, and "K" if located West of that river.

There is a total of 580 stations operating within the broadcast limits of 200 and 545 meters. (July 1, 1925).

If found necessary to prevent congestion, new class "A" stations may be assigned to wavelengths as low as 150 meters (2,000 kilocycles). Also, a few of the present class "A" or class "C" stations may be transferred to the lower region (of wave-lengths).

Station WGY, Schenectady, N. Y., is now doing experimental simultaneous transmission on four wave-lengths: 1,660 meters (2XAH), 379.5 meters (WGY), 109 meters (2XX), and 38 meters (2XAF). Reports on comparative reception are desired.

On Independence Day, July 4, 1925, 28 stations were linked for simultaneous transmission, the largest number mobilized to date. This was "some" hook-up."

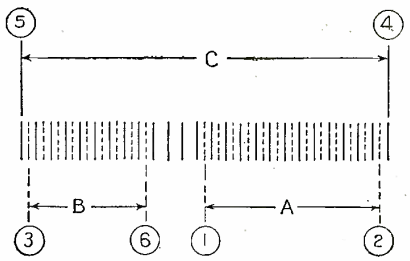
Stations are listed as class A, B or C. Details appear below.

Class A

Broadcast stations in this class operate on the wave-length band between the limits of 200 and 280 meters. There are 465 of these stations. No minimum power specified; lowest listed, five watts. Maximum power permitted, 500 watts. Mechanical music (phonograph or player piano) may be broadcast. No regular studio requirements to be met. Operating hours may be easily changed. The shortest wave station. WIBD, Joliet, Ill., (200 meters; 1,500 kilocycles) is in this classification.

Class B

Wave-length range. 280 meters (1,070 kilocycles) to 545 meters (550 kilocycles). There are 115 of these stations. Minimum power permitted, 500 watts. Maximum power so far permitted, five kilowatts. Class B stations are the cream of all the broadcast stations. To retain their licenses, they must abide by a lofty standard of efficiency. They must continue a program, even though an accident occur to the apparatus. Insurance against interruption must be made in the form of duplicate equipment. If the origin of the program is outside the studio, even duplicate telephone lines must be maintained, in anticipation of possible telephone line trouble. (The use of a portable, short-wave transmitter eliminates the need for telephone line maintainance). A standardized studio is required. Mechanical music is not permitted.



Q-2141 A

A cross-section of the Heteroplex tuning unit. The three windings are clearly indicated.

Class C

This was the classification given to stations that were formerly assigned to the 360-meter (833 kilocycles) wave-length only. The unexpectedly rapid growth of broadcasting quickly caused a congestion at this wave-length. They have all been transferred to the A or B classification, with new wave-length assignments. Class C is extinct.

Super-power stations are being talked of nationally and internationally. Those opposed to the idea are in the minority.

Subcommittee No. 6 (Interference Problems), of the Third National Radio Conference, called October 6, 1924, reported to the Secretary of Commerce, Herbert Hoover as follows: "From such data as is now available it is believed this object (signal strength not exceeding that of stations local to populous centers) will be attained if the station is so located with respect to populous centers that the distance between it and the boundary of such community will not be less than the quotient obtained by dividing the product of antenna current in amperes times effective antenna height in meters by a constant tentatively set at 100. Experience may make it advisable to modify this constant, but it seems sufficiently conservative to serve for the initiation of this experimental work." It is interesting to notate here that station power increase of two or three times the normal amount is noticeable to local receivers only as a slight broadening of the tuning; at a distance, however, reception is far better than with the lower power. Super-power is a successful combatant of strong static conditions.

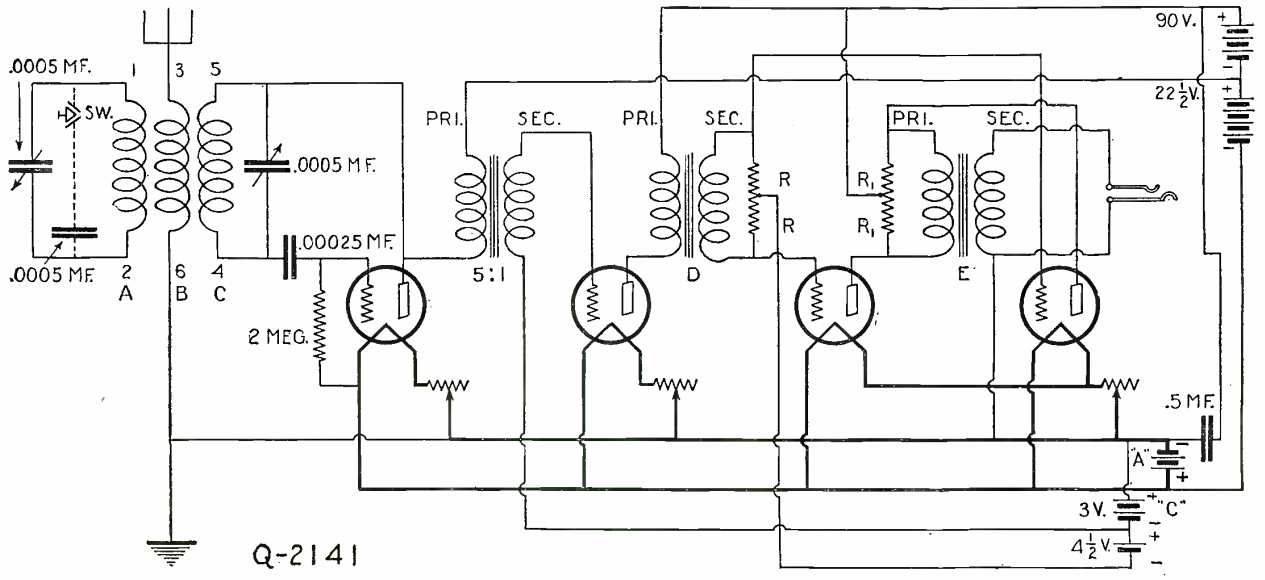
There is talk of operation at 25 and even 50 kilowatts (25,000 and 50,000 watts) but whether this transmission will be permitted outside of experimental regulations is a question. The only installations we could consider at this time as being in the Super-power class would be the following class B stations rated at over one kilowatt power input:

1½ Kw.

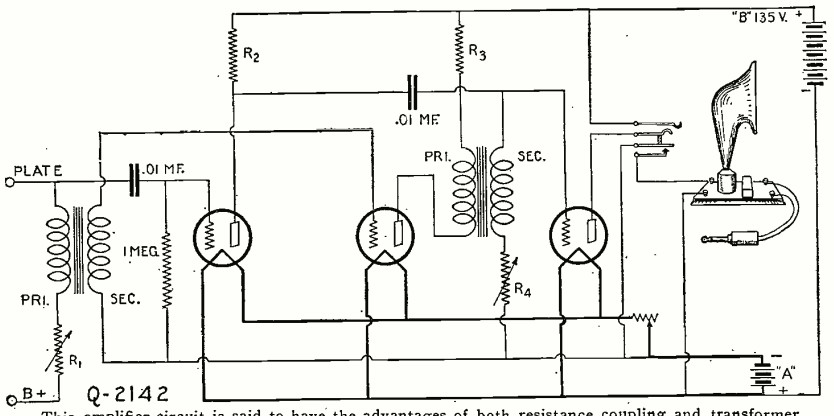
WTAM	Cleveland, Ohio
WCCO	Minneapolis, Minn.
KYW	Chicago, Ill.
WHT	Deerfield, Ill.

2 Kw.

KGO	Oakland, Calif.
KFI	Los Angeles, Calif.
KFKX	Hastings, Nebr.
KOA	Denver, Colo.



The Heteroplex circuit with two stages of audio frequency amplification added. Regular push-pull transformers are not required for the stage of push-pull amplification. High selectivity, excellent sensitivity and considerable amplification with little distortion are the virtues of this system of connections.



This amplifier circuit is said to have the advantages of both resistance coupling and transformer coupling. If a standard loud speaker is used, the special out-put jack connection is not required. Do not place the audio transformers too close, and connect their cases or cores to "A" minus.

WBZ	Springfield, Mass
WGY	Schenectady, N. Y.
WORD	Batavia, Ill.
2½ Kw.	
WCBD	Zion, Ill.
3 Kw.	
WEAF	New York, N. Y.
5 Kw.	
WLW	Cincinnati, Ohio
WSAI	Cincinnati, Ohio
WOC	Davenport, Iowa

Two class B stations, KSD, St. Louis, Mo., and KFUO, St. Louis, Mo., operate on the longest wave employed for regular broadcast transmission, 545 meters.

It is estimated that there are approximately 6,000,000 receiving installations in the United States at this date.

Stations that pick "out of the air" programs transmitted on one wave-length and re-transmit them on another wave-length, are called "relay stations." The wave-lengths reserved for "relay broadcasting," as it is termed, are:

Meters range	Frequency range (Kilocycles)	Width of the Band (Kilocycles)
26.3 to 27.3	11,400 to 11,000	400
30.0 to 33.3	10,000 to 9,000	1,000
52.6 to 54.5	5,700 to 5,500	200
60.0 to 66.6	5,000 to 4,500	500
105.0 to 109.0	2,850 to 2,750	100

Radio broadcast regulation authority is vested in the United States Department of Commerce.

THREE GOOD CIRCUITS

(2142) Mr. Charles A. Sidney, New York City, asks:

Q. 1. Please show, in the "I Want to Know" department, the audio amplifier circuit of Carl E. Gerlach. This circuit appeared in the Saturday radio section of one of the Metropolitan dailies. Also, please incorporate a filament control jack in such a way as to connect the "A" battery to the field coil of a Magnavox loud speaker.

A. 1. We are showing the circuit in these columns. Plate resistors "R-1," "R-2" and "R-3" may be variable between the limits of 25,000 and 250,000 ohms. The operating value will be about 100,000 ohms. Grid leak "R-4" should be variable for best determination of the correct value. Standard good quality audio frequency transformers are used. This amplifier has given an exceptionally good account of itself in every instance of its use that has come to our attention. Notice that there are two stages of resistance coupling and two stages of transformer coupling. The object of this, as claimed by the inventor, is to build up the volume, by resistance amplification, of frequences to which the transformer is not responsive. Whether or not this explanation satisfies the theorist, results are what count.

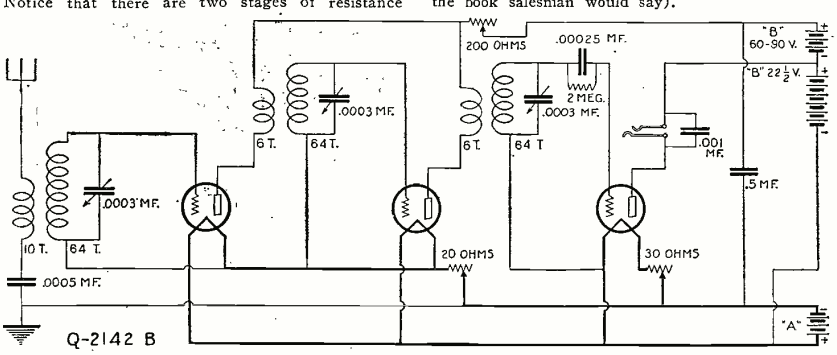
If the detector unit does not incorporate a phone condenser, it will be necessary to connect a fixed condenser of .001 to .002 mfd. capacity across the two in-put, or "plate," "B" posts of the amplifier.

The loud speaker battery posts are wired to the jack in the manner shown, while the loud speaker out-put is connected to the usual plug.

Q. 2. Is it not possible to use the Hartley transmitting circuit in a broadcast receiver?

A. 2. Yes, this may be done, and diagram Q. 2142-A shows how. Wind 90 turns of No. 22 D.C.C. wire on a 3-inch tube. Tap this in the center, as shown. The aerial coil is wound over the grid half of the 90-turn coil, near the tap.

If your purse, or other equally powerful reason, motivates you to use only one tube, the headphones may be connected "on the dotted line" (as the book salesman would say).



The principle of the Kompentrol is illustrated. It is seen that a series resistance of 200 ohms, connected in the plate circuit of the radio frequency stages, controls the tendency of the circuit to oscillate. In making up such a receiver it is quite necessary that the coils be in non-inductive relation, in order to have maximum amplification from each tube.

For local reception, a 45-volt "B" battery may be used. For distant reception not over 22½ volts can ordinarily be used. This necessitates an extra battery in order that the audio amplifier may have sufficient plate voltage. This extra potential, between 22½ and 45 volts, may be supplied by connecting a battery of this rating at "X".

There are four oscillation controls, the "B" voltage, the filament heat, the grid leak value and the resistance of "R." It is necessary, as in any set, to have a perfect grid leak; a poor one will be noisy. The variable resistance range of "R" will probably have to be from about 200 ohms, to possibly 5,000 ohms.

Q. 3. I hope you will not mind furnishing the construction data and circuit diagram of the Kompentrol receiver. It seems very selective, even though a resistance is used to stop circuit oscillation.

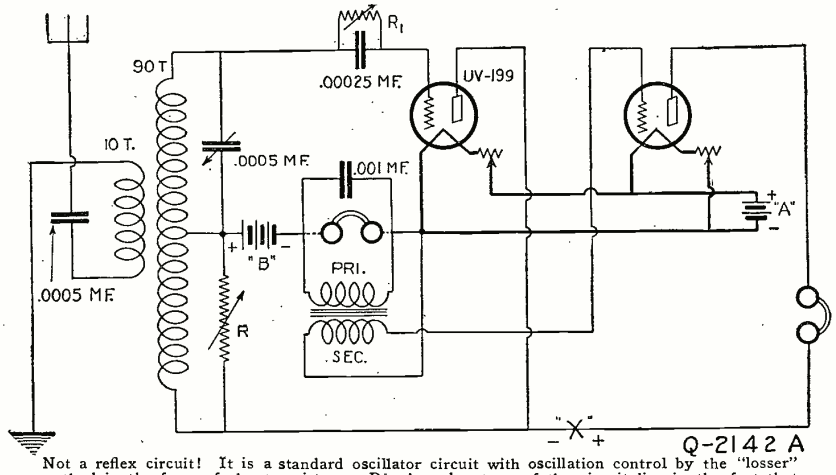
A. 3. While the Kompentrol radio set incorporates two stages of audio frequency amplification, we are showing the circuit without audio amplification, which is standard.

Any convenient coil construction may be followed. You may wind a 3-inch coil to the number of turns shown, with No. 22 D.C.C. wire. The primary may be alongside, or over, one end.

If you wish to use variable condensers of .0005 mf. capacity, reduce the number of grid coil turns to 45 or 50.

For best results it is necessary, as in practically all tuned radio frequency receivers, to have the lowest possible stray field coupling. This is secured by paying close attention to the coil angles and to the wiring and placement of the equipment.

The 200-ohm resistance may be a potentiometer. Greater quality and less sensitivity will result by connecting the detector grid return lead to "A" minus instead of "A" plus.



Not a reflex circuit! It is a standard oscillator circuit with oscillation control by the "losser" method in the form of shunt resistance, R. An advantage of the circuit lies in the fact that there are no movable coils. There are only two main controls and only one of these, the variable condenser, has any effect on the wave-length.

Q. 4. Please state some general points to be observed in the construction of what would be classed as a "good receiver."

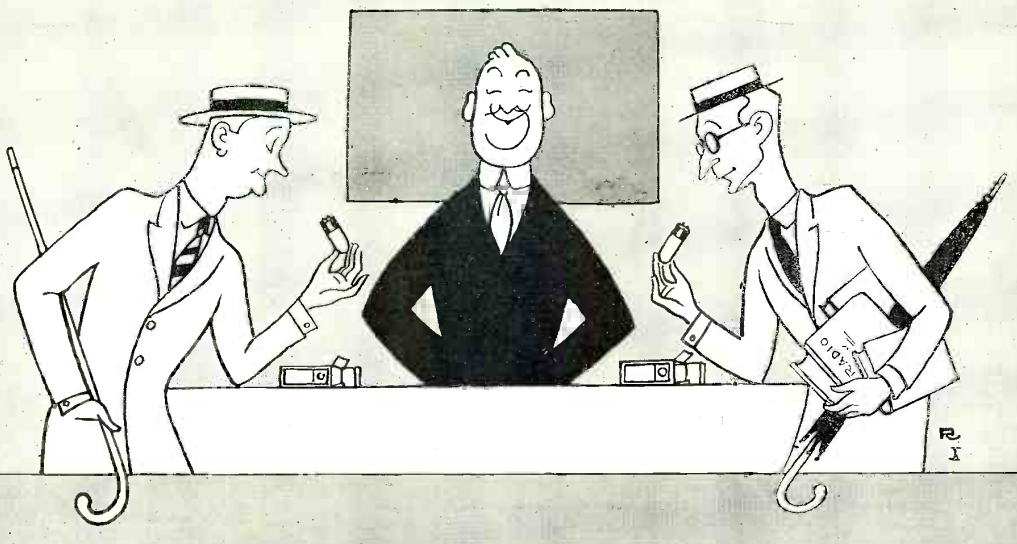
A. 4. Your last question was of such importance we decided to answer it in this issue.

Some constructors use a blow-torch for soldering connections. A blow-torch should be used only under special conditions. There are few set builders capable of using the tool properly. It should never be used for making soldered joints close to coils. Charred insulation between two turns is almost as bad as having two bare turns touching one another. Two turns with charred insulation between can undo all attempts towards a low-loss receiver design. A blow-torch is of most use where relatively large metals must be kept at a high soldering temperature.

Soldering flux should be used in the smallest quantities possible. Most jacks have highly absorbent insulating material and flux is quickly drawn into it by capillary attraction, causing a partial leakage that results in reduced volume, noisy operation or both. Resin flux is always safe to use, from the standpoint of leakage by absorption. However, too much resin flux will cause a poor joint. It may look perfect, but a little strain breaks the connection.

Design the receiver in such a way that all connections will be short. This short distance proposition is controlled to a considerable extent, in the radio frequency stages, by the minimum distance permissable for the coil spacing.

All the battery leads may be bunched. High frequency leads should be kept well away from the direct current supply leads, and from one another. Spaghetti insulation should be used on high frequency leads, only where there is danger of connections touching. Bus bar bent at a right angle looks good and does not cause any appreciable loss. Bending wire sharply is to be avoided. Tighten binding post connections with pliers.



It isn't a *genuine* UV-199 unless it's a *Radiotron*

The familiar names WD-11, WD-12, UV-199, UV-200 and UV-201-A rightfully belong to *Radiotrons* only. To be sure of *quality*, it is important to look carefully at the base of every tube you buy, to see that it carries the name Radiotron and the RCA mark as proof that it is a *genuine* Radiotron.

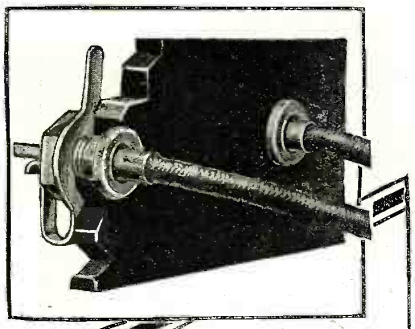


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Home-Built Set Contest

(*Continued from page 305*)

placed between the plates to prevent short-circuiting.

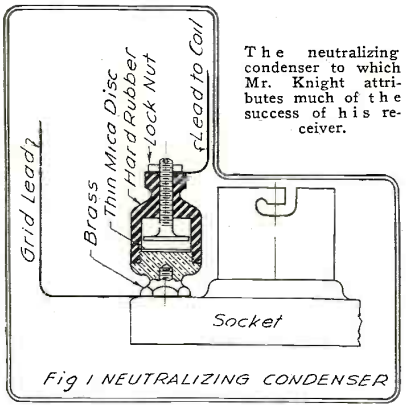
THE COILS

The neutroformer coils are home-made. The present proportions were decided upon after experimenting for a period of about



W. A. Knight, of Columbus, Ohio, who won fifth prize in the Home-Built Set Contest.

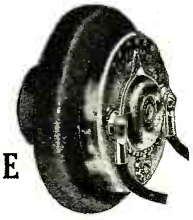
three months with different coils, including basket-weave, space-wound and other low-loss types. Specifications for the coils are as follows: Secondaries wound with No. 22 D.S.C. on bakelite tubing 2¾ inches outside diameter, 57 turns on antenna coil, 62 turns on each of the others—all close-wound. Tap-off for neutralizing condenser taken from 15th turn. There are 10 turns of wire on each of the primaries, wound on 2½-inch tubing. The antenna coil is wound singly with No. 22 D.S.C. On the other two primaries there are two strands of No. 24 wire laid side by side but spaced about



The neutralizing condenser to which Mr. Knight attributes much of the success of his receiver.

Fig 1 NEUTRALIZING CONDENSER

1/16 of an inch from adjacent turns. This is an important feature of the coils, as is also the *dielectric between primary and secondary*. Identical coils were made in which more than 66 per cent. of the tube was drilled out with staggered holes. The measured resistance of coils on drilled tube was 17 per cent. less at 270 meters and 13 per cent. less at 400 meters. Notwithstanding this, they were extremely poor in a receiving set. Every effort was made to cause them to function properly, by changing the size of wire (20 to 28, inclusive), space and close winding, changing position and kind of winding on primary, degree of coupling, etc. However, they were finally given up as



TYPE B PRICE $6

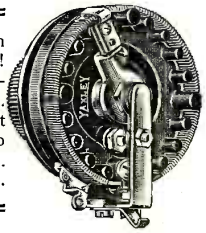
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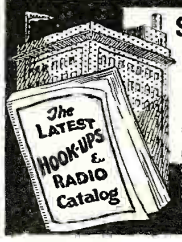


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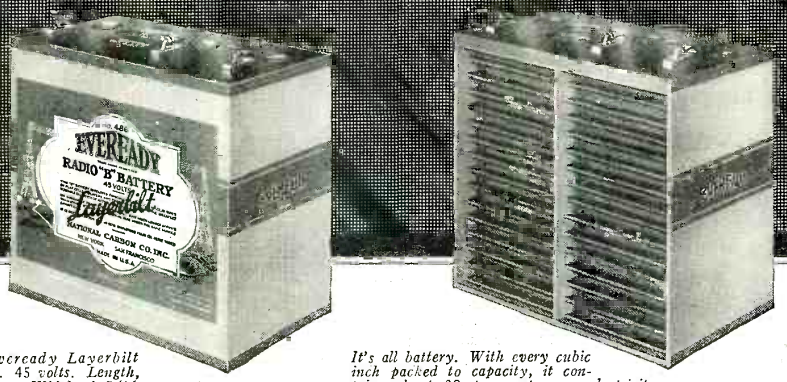
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No. 486 Eveready Layerbilt "B" Battery. 45 volts. Length, 8 3/16 inches. Width, 4 7/16 inches. Height, 7 3/16 inches. Weight, 14¼ pounds. Price, $5.50.

It's all battery. With every cubic inch packed to capacity, it contains about 30 per cent more electricity-producing material. All chance of loose or broken connections avoided by contact of full area of carbon plate against zinc plate. The scientifically correct construction.

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ABSOLUTELY new in construction—perfected through years of research, the new Eveready Layerbilt "B" Battery is as superior to the old type "B" Battery as a tube set is to a crystal.

Heretofore, all dry "B" Batteries have been made up of cylindrical cells—no one knew how to make them any other way. The new Eveready Layerbilt is made of *flat* layers of current-producing elements compressed one against another, so that every cubic inch inside the battery case is completely filled with electricity-producing material. Layer-building heightens efficiency by increasing the area of zinc plate and the quantity of active chemicals to which the plate is exposed.

After the most rigid laboratory tests, more than 30,000 of these new Eveready Layerbilt "B" Batteries were manufactured and tested by use under actual home-receiving conditions. These tests proved that this new battery is far superior to the famous Eveready Heavy-duty Battery No. 770, which up to now we have ranked as the longest lived "B" Battery obtainable.

On 4-tube sets, 16 mil drain, it lasts 35% longer.
On 5-tube sets, 20 mil drain, it lasts 38% longer.
On 6-tube sets, 24 mil drain, it lasts 41% longer.
On 8-tube sets, 30 mil drain, it lasts 52% longer.

The new Layerbilt principle is such an enormous stride forward in radio battery economy that we will bring out new sizes and numbers in this Layerbilt form as fast as new machinery is installed. For the present, only the extra-large 45-volt size will be available.

Buy this new Eveready Layerbilt No. 486 for heavy drain service. It far exceeds the performance for which Eveready Radio Batteries always have been famous and is, we believe, by far the most economical source of "B" current obtainable.

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.....

a bad proposition. The secondary of the antenna coil is shunted by a 19-plate condenser, the other two by 17-plate condensers.

Three stages of audio amplification are used, the first of which is transformer, the other two resistance-coupled.

The coupling resistances are home-made, or may be purchased. Resistances were adjusted to give the desired tonal qualities, rather than for maximum amplification.

The Interflex Circuit

(Continued from page 300)

ment side of the inductance. This increases the power of the set somewhat. It is also better for DX.

The crystal detector may be any good crystal, and the better the crystal the better will be the results. But here the writer wishes to make a few remarks: If the crystal detector is too sensitive, and if it takes too much time to adjust, the writer recommends that it be not used. Static and strong signals will invariably knock out its sensitivity and render the whole set useless. So many reflex set users have found, to their sorrow, that the crystal detector is usually the rock upon which the whole set founders.

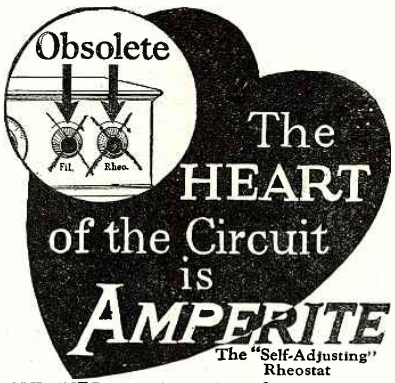
PARTS NEEDED FOR THE CONSTRUCTION OF THE INTERFLEX-4 CIRCUIT

1 Panel and baseboard, 7 inches by 18 inches.
1 .0005 variable condenser, straight-line frequency type.
1 Tuning inductance, tube, 3 inches in dia.; wound with 50 turns of No. 20 D.C.C. wire. Antenna inductance, six to ten turns of the same wire.
1 Radio frequency transformer, 220 to 550 meters.
4 Standard 201-A type sockets.
4 Amperite resistances.
1 Fixed crystal detector with mounting.
1 Double-circuit jack.
1 Filament control jack.
2 Audio frequency transformers.
1 Potentiometer, 400 ohms.
1 Fixed condenser, .002 mfd.
1 Vernier dial.
Binding posts, bus wire, screws, nuts, etc.

If galena, which is the most satisfactory in some respects, is employed, use only the so-called "million-point" mineral, which has a granular surface. This is the "argentiferous galena." And if possible get away from the adjustable feature, because when laymen have to use a set it should be so built that it cannot be tampered with.

There are several good fixed detectors on the market now which, if made by reliable concerns, can be trusted to work out satisfactorily. The writer must be specific here and wishes to say that he uses, and has been using for months, a carborundum fixed crystal detector which, while not perhaps as sensitive as galena, is certainly the most stable thing he ever came across, and he has worked with all of them. He has used a single detector for many months now, and has had the set operating during the worst static of the summer, when lightning could be seen, and when tremendous static crashes came out of the horn. Nevertheless, in no case has this crystal refused to work, nor has its usefulness been impaired. Its stability, therefore, is its one saving grace, and one reason why the Interflex-Four has been such an outstanding success with the writer.

The fixed crystal, as will be noted, is



AMPERITE controls the flow of current through the tubes automatically just as the heart controls the flow of blood through the body. Does away with hand rheostats and filament meters. Eliminates guessing and all tube worry. Prolongs tube life. Lowers set cost. Proved and adopted by more than 50 set manufacturers. For perfect filament control you must use AMPERITE. $1.10 everywhere.

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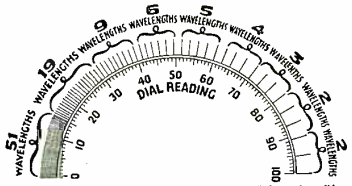
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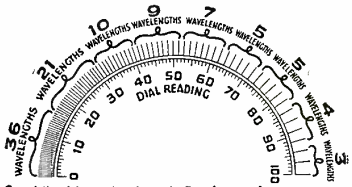
St. and No.....R. F. D.....Box.....

Town.....State.....



Ordinary Condenser Arrangement of Wavelengths

Ordinary straight capacity condensers crowd 70 of the 100 wavelengths into the first 30 points of the dial.



Straight Line Wavelength Condenser Arrangement

With straight-line-wavelength condensers 57 of the 100 wavelengths are crowded into the first 30 points of the dial.

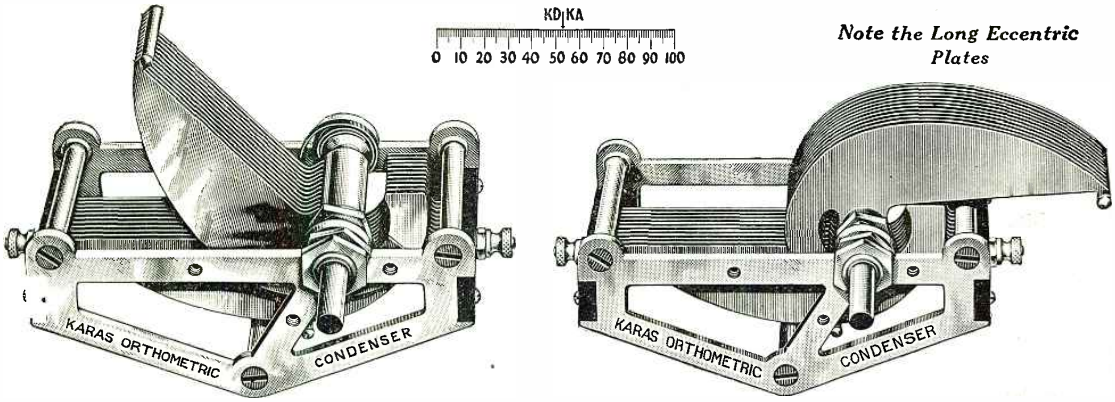


KARAS ORTHOMETRIC CONDENSER Arrangement of Wavelengths on Dial

The New, Scientific Karas Orthometric Condensers insure absolutely equal separation on the dial, of all wavelengths throughout the entire broadcasting range.

Tuning Marvelously Simplified With Karas Orthometric Condensers

The condenser that brings in KDKA where it belongs—at 53 on the dial. Remember, 52 of the 100 allotted wave-lengths must come in below KDKA.



Spread Stations Evenly Over the Dial—*No Crowding Whatever!*

The Karas Orthometric Condenser positively separates all adjoining wavelengths by EQUAL distances on the dial, giving you the full benefit of the 10 Kilocycle frequency separation fixed by the Government.

Ordinary condensers jam 70 of the 100 Government allotted wavelengths into the first 30 points of the dial—even straight-line-wavelength condensers crowd 57 of them below 30.

With Karas Orthometrics, each point on the dial corresponds exactly to one of the 100 allotted wavelengths. The result is marvelous simplicity in tuning—better, clearer reception—you get all the side bands without interference.

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The Karas Orthometric is a "job" that will delight the eye of the mechanical critic. It is made entirely of brass—frame and plates all die stamped—plates, patent leveled and solidly bridged to insure permanent rigidity and alignment. Every joint throughout is soldered. Grounded frame and rotor, with stator plates supported on hard rubber insulation. Tapered adjustable cone bearings, spring copper pigtail connection, automatic stops — in short, a condenser that is both theoretically and mechanically perfect.

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We are supplying Jobbers and Dealers as fast as the output of our factory permits. If your dealer is not yet supplied, order direct on the coupon. You need send no money with your order. Condensers will be delivered C.O.D., and you receive them subject to our unconditional guarantee of satisfaction. Why run the risk of delay? Order NOW!

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11 plate, .00025 Mfd. 6.50

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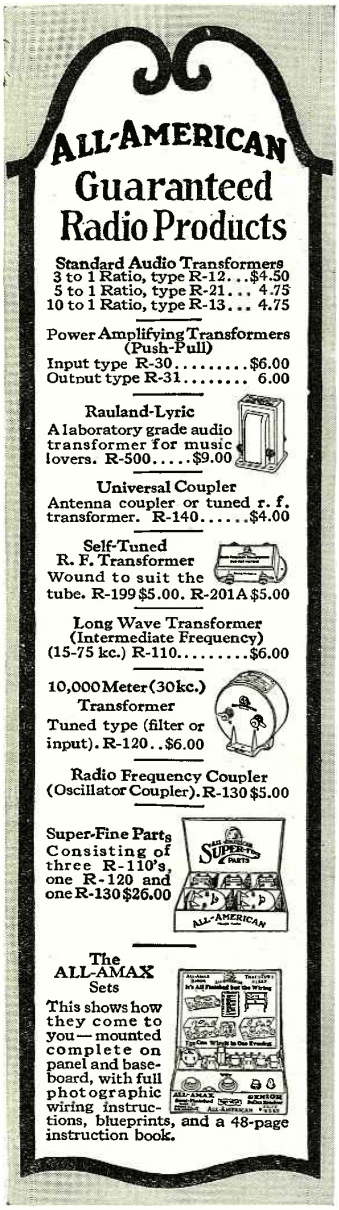
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For
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and
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ALL-AMERICAN RADIO CORP.
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Largest Selling Transformers in the World

mounted between brackets and looks somewhat like a fuse, when mounted. It is put in this position and never changed. With this particular crystal, as with many others, it was noted that it must be used in one direction only. Reversing it would greatly reduce the signal's strength.

The coils marked "RF" comprise a standard radio frequency transformer, such as may be purchased at any radio shop. Not all radio frequency transformers work satisfactorily in this set, and it may be necessary to try several before the right one is discovered. The writer has tried both the air-core and the iron-core, and while several of the iron-core type worked well, in many cases, the air-core type was found to work better.

On the audio frequency side two standard transformers, ratio 3 to 1 are used. A good transformer should be used here in order to increase the signal strength. If the set has a tendency to howl or whistle, it is probably the fault of one of the transformers. In that case, it is suggested that you use a small fixed condenser, C-2, as indicated. This may be of .00025 capacity.

If the set has been completed according to the instructions given here and in the layout, it should be noted that the second tube voltage should, with a good tube, be not more than 22½. While some tubes may require 45 volts, the writer does not recommend it. Nothing is gained by it but a waste of current, and distortion of the signals. The total "B" battery voltage is 90 volts for all the other tubes. The writer has used 201-A and 301-A tubes, although any other tube may be used.

WHAT THIS SET CAN DO

The writer has given a log of stations pulled in on a single evening. All of these were on the loud speaker and it should be noted that all of them were received while the locals were going. It should be noted also that such stations as KDKA, operating on 306 meters, and WGBS, operating on 316, could be separated nicely without interference from each other. Also station KDKA, 306 meters, and WPG, Atlantic City, 300 meters, could be tuned in easily without interference from each other.

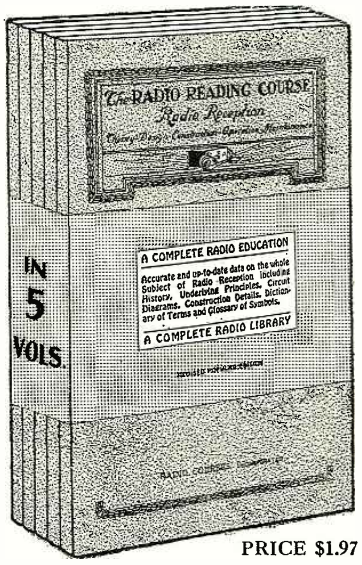
The writer is well aware of the fact that these are not records by any means, and that a super-heterodyne or a good 5-tube radio frequency set may tune more closely and more sharply, but the writer maintains that for a single-dial control, with very little fussing with the potentiometer, the results are not easily duplicated with other sets.

Furthermore, this set tunes from 550 meters down to about 200. This is not a theory, but actual fact. Most sets that claim this range find it impossible to tune down even to WRNY, on 258 meters.

On local stations the potentiometer setting is not critical, while on DX work it needs more or less attention. The writer recommends that this set be used with aerials of a total length of not more than 75 feet. This includes the length of aerial plus lead-in. A long aerial makes for more interference. A good indoor aerial may be used if absolutely necessary, although the writer does not recommend it.

It will be noted that this set is entirely automatic, as the telephone plug or loud speaker plug automatically lights the bulbs. No switch of any kind is used.

The policy of RADIO NEWS is such that it is impossible to recommend certain parts that go into the making of any set. The writer will, however, be glad upon receipt of a stamped addressed envelope, to forward a list of the particular parts used in the set described here. The writer will also be glad to give his attention to correspondence from those readers who have constructed the Interflex-Four, or who wish to have further particulars about it.



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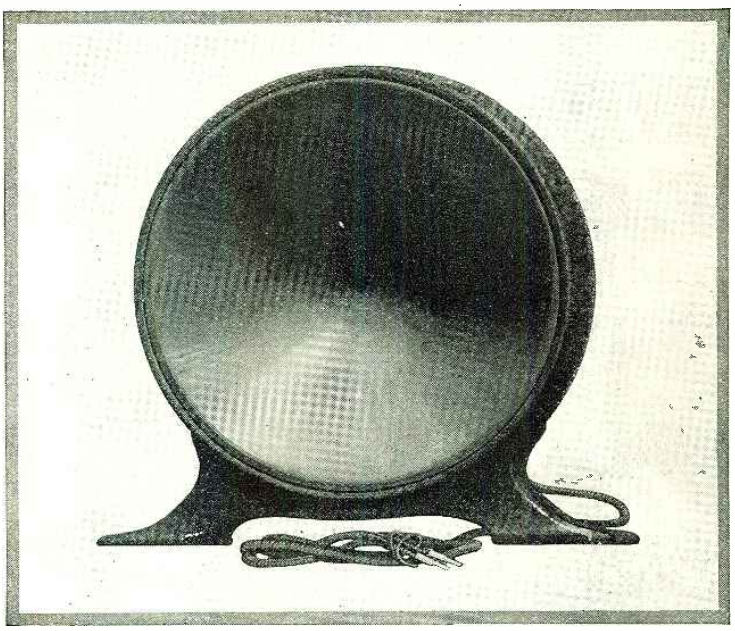
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Section of the New Acme *Free-Edge Cone* Loud Speaker, showing the two *free-edge cones.*



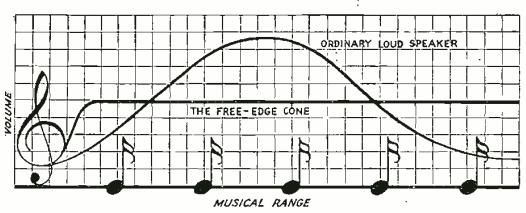
After 5 years and 256 experimental models

Acme is proud to put its name on this Loud Speaker

HERE in our laboratories at Cambridge, our radio engineers and sound experts have been at work, ever since broadcasting started, striving to perfect an ideal type loud speaker.

Two years ago, after having made, studied and tested 203 models, we obtained a very good horn type loud speaker. But our radio and sound engineers determined to go *even further.* After 23 months more of experimenting; making and testing 53 additional loud speaker models they at last developed the ACME *Free-Edge Cone* Loud Speaker.

As far as it is humanly possible to judge we feel certain that we have the finest loud speaker ever produced. This new type loud speaker does away with inherent resonance common in other types. Because of this improvement the new Acme now brings out the low notes and soft overtones never before obtainable in any loud speaker.



NOTE the equal volume over the musical range with the *free-edge cone* in contrast to the ordinary loud speaker.

The latest development in radio reproduction is the cone type loud speaker but the double *free-edge cone* is a further advancement because resonance is eliminated and faithful reproduction obtained over the whole musical range.

Clarence Hawkins

President, Acme Apparatus Company

SEND for the new edition of our famous book "Amplification without Distortion" telling the why and the how of perfect radio reception.

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The New

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Tunes All Wavelengths



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BAV	Brussels	1100 Meters
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PRG	Prague	1800 Meters
OKP	Kbely	1150 Meters
DENMARK		
OXE	Lungby	2400 Meters
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FL	Eiffel Tower	2600 Meters
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LP	Berlin	2370 Meters
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(*Continued from page 317*)

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SPANISH: smyy.
NETHERLAND: onl.
MISCELLANEOUS: kdka, 1ah, 66, wjs, ws, nkf, wiz, keg, kel, and pox, 26 mts.

RADIO 9EAN, C. ROSER, POTOSI, WIS.

1aer, 1af, 1agg, 1ajx, 1alw, 1am, 1avf, 1bbu, 1btr, 1bwx, 1cde, 1ckp, 1cqi, 1er, 1ii, 1ikb, 1jr, 1mr, 1oli, 1tt, 1vc, 2ad, 2adb, 2brb, 2le, 2wr, 3as, 3auv, 3avg, 3bur, 3buy, 3bwt, 3cgc, 3cj, 3fr, 3ir, 3kp, 3kw, 3op, 3ot, 3ov, 3qw, 3qy, 3tr, 4af, 4ai, 4az, 4bg, 4cs, 4ae, 4gh, 4io, 4it, 4jd, 4jw, 4mi, 4nx, 4oa, 4ow, 4qw, 4tx, 5abd, 5ac, 5ad, 5ads, 5aef, 5aeq, 5agd, 5agn, 5agq, 5ags, 5air, 5aiu, 5aiy, 5aj, 5alv, 5amg, 5amu, 5amz, 5aq, 5aqf, 5cd, 5ck, 5cn, 5cs, 5eg, 5ek, 5er, 5es, 5ew, 5fv, 5gn, 5he, 5hi, 5ic, 5ims, 5jl, 5jz, 5ka, 5kb, 5la, 5mb, 5mi, 5mo, 5mr, 5na, 5nj, 5nt, 5ny, 5pa, 5qh, 5qk, 5qs, 5rg, 5ru, 5sd, 5sy, 5ua, 5vc, 5vm, 5vv, 6aam, 6agc, 6age, 6vo, 7ajt, 7co, 7hw, 7pj, 7qd, 8aap, 8ahu, 8aby, 8acu, 8adb, 8adk, 8aeg, 8afn, 8aee, 8agc, 8ahm, 8ai, 8aje, 8ajf, 8ak, 8akk, 8al, 8aln, 8ami, 8amm, 8anb, 8anh, 8alz, 8apn, 8apu, 8apw, 8aro, 8arz, 8aqs, 8as, 8atc, 8atz, 8au, 8aue, 8aus, 8awa, 8an, 8axn, 8azm, 8ayl, 8bed, 8bee, 8bit, 8bju, 8bjv, 8bmb, 8bmv, 8bn, 8bnc, 8bnh, 8bno, 8boe, 8boo, 8bm, 8boy, 8bpl, 8bqa, 8bqi, 8brc, 8brt, 8bul, 8bzc, 8bzf, 8bzk, 8cab, 8cap, 8cci, 8ccr, 8cdg, 8cow, 8cdi, 8ced, 8cej, 8cfm, 8cgs, 8ceu, 8ckp, 8ckw, 8cif, 8cki, 8cmd, 8cmu, 8cni, 8co, 8cpz, 8cqh, 8cog, 8cng, 8crc, 8crv, 8cse, 8ct, 8cui, 8cv, 8cwl, 8cwr, 8cww, 8cxi, 8czy, 8czz, 8da, 8dac, 8daq, 8dar, 8dat, 8dbf, 8ddc, 8ddt, 8ddw, 8de, 8ded, 8dg, 8dgn, 8dgp, 8dgr, 8dhs, 8dgl, 8dil, 8dln, 8dlx, 8dnf, 8dnx, 8doi, 8dpk, 8dpo, 8dpx, 8dqb, 8dqe, 8drc, 8drm, 8du, 8eb, 8er, 8hn, 8hew, 8hv, 8kc, 8kg, 8lr, 8nb, 8nm, 8pl, 9pu, 8rj, 8rm, 8rn, 8rv, 8ta, 8tj, 8un, 8sam, 8wl, 8wz, 8yz, 9's too numerous to mention.

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U. S.: 1aa, 1asy, 1er, 1om, 1ox, 1rg, 1sd, 1sh, 1sp, 1vn, 1we, 1xaa, 1zac, 1zz, 2acv, 2agx, 2alw, 2ak, 2akm, 2amz, 2brb, 2czd, 2dac, 2wd, 2ze, 3ac, 3ace, 3adw, 3bpq, 3cdo, 3ceq, 3cgp, 3cka, 3mo, 3nf, 4ap, 4ax, 4by, 4fo, 4fu, 4ph, 4xb, 4zz, 5anw, 5bgp, 5bkf, 5bsk, 5lo, 5rd, 5xbf, 6aas, 6abi, 6ard, 6awp, 6bex, 6cwy, 6das, 6ed, 6kt, 6lo, 6xk, 7act, 7ahy, 7av, 7dm, 7do, 7qm, 7rh, 8dtg, 8ot, 8ov, 8ug, 8um, 8vt, 8wg, 9's too numerous.
All were hrd on 1 tube hi loss.
CANADIAN: 1ar, 1de, 1eg, 1ek, 2at, 2cg.
MEXICO: 1a, 1m, 1x, bx.
PORTO RICO: 4ge.
Crd from ani above wil be appreciated and qsled promptly.

8ZE-8GX, E. W. THATCHER, OBERLIN COLLEGE, OHIO

(40 Meter Band)

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FOREIGN AND SPECIAL: a2bk, (a2ds), ((a2cm)), a2ay, a2ij, a2yi, a3bq, c1ar, c1dq, c4cr, c4gt, (c5gt), g2kf, g6ym, m1aa, (m1x), P. R. (u4sa), (u4je), z2ac, ((z2xa)), z4aa, z4ag, z4ak, z4ar.
NAVAL: nmp, npg, (nrrl), Hawaii. 5gos, (qra?).

In connection with experimental work on the lower bands 8ZE is maintaining a relay transmitter on 41.5 meters. It is through this channel that communications regarding tests, etc., are made. Communications from men interested in taking part in a series of special tests on twenty and five meters, and reports on the character of the signals from 8ZE will be greatly appreciated. All cards will be QSLed.—"GX."

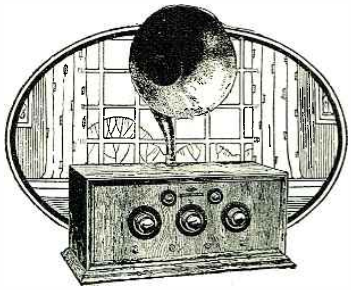
ENOUGH!

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Judge—Case dismissed!

—*Contributed by Jack Bront.*



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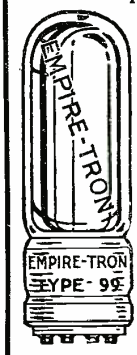
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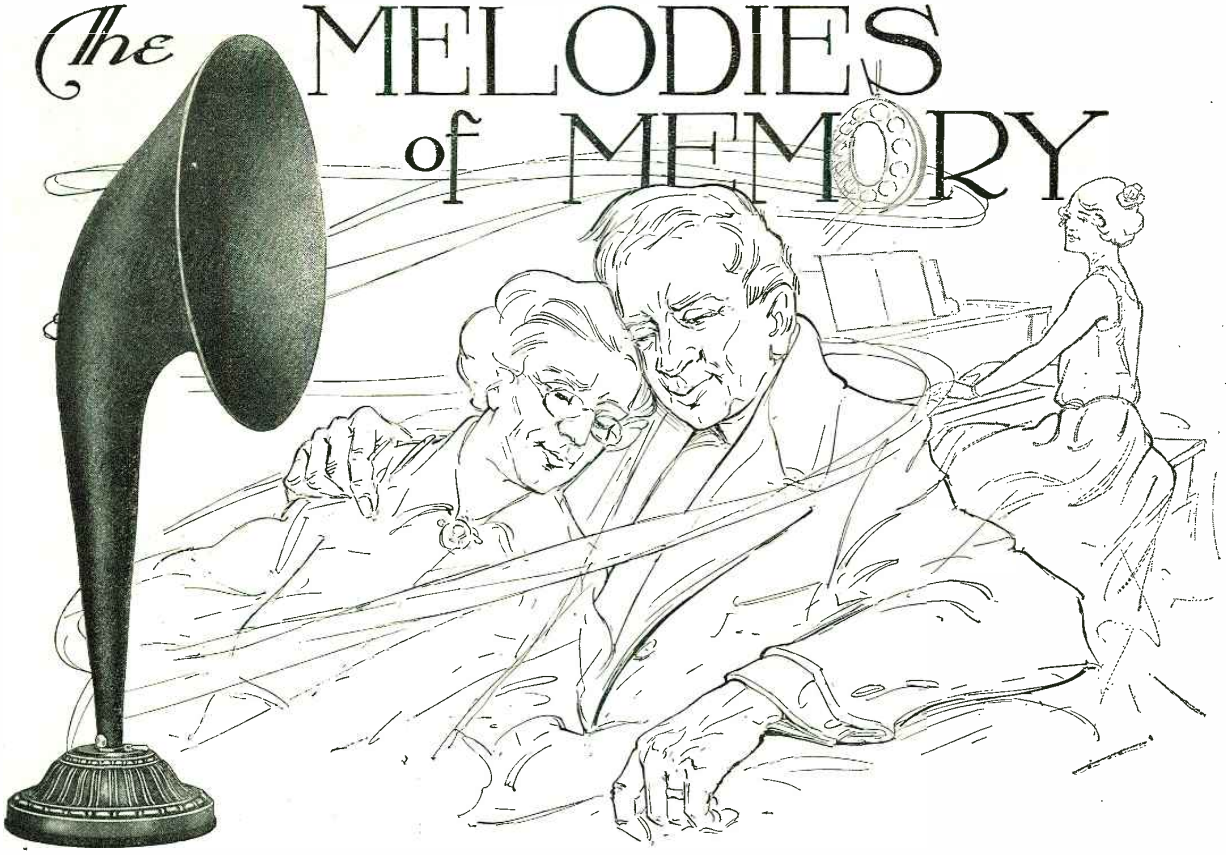
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The Bristol Line includes four models priced from $15.00 to $30.00. If not at your dealer's, write for Bulletin 3025-S.

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BRISTOL AUDIOPHONE Loud Speaker

TRADE MARK REG. U.S. PAT. OFFICE

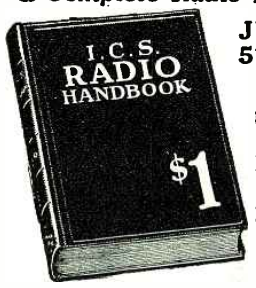
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Single-Tube Circuits

(*Continued from page 311*)

very noticeable. This prevents the log of the set from being particularly accurate. Furthermore, the condenser C1 will show capacity effect to the body due to the locating of the potential from a to b on the condenser frame. However, such capacity effect is minimized by not grounding the "A" battery positive or negative, as is usual. Complete elimination of capacity effect at C1 can be accomplished only by shielding. The choke coil is not entirely necessary on a set using this circuit without audio amplification, but with the addition of audio amplification it cannot be satisfactorily omitted.

THE ULTRA-AUDION

The circuit shown in Fig. 10 possesses the same quality as that shown in Fig. 8. It is possible to use with it a tuned primary circuit and have at the same time a two-control receiver. This is again because the tube circuit used is a steady oscillator. The secondary circuit is the well-known ultra-audion. The main disadvantage in comparison with the circuit shown in Fig. 8 lies in the fact that the strength of oscillation is not controllable (remember that the turns in the plate coil of Fig. 8 allow such control) without complication of tuning. This means that the primary must be coupled, generally, too close to the secondary to allow good selectivity. Of course, in the reception of C.W., oscillation need not be stopped, so that the coupling need not be close enough to destroy the selectivity; but broadcast reception is dependent on the stoppage of oscillation and the regeneration obtained just before the beginning of that stage, so the "selectivity" statement can only hold true in this latter use. Control of the oscillation strength is possible with the use of a variable grid condenser, but that means the addition of a control.

THE COCKADAY CIRCUIT

In Fig. 11 is shown a variation of the circuit in Fig. 10. The same ultra-audion circuit is used, but a closely coupled trap circuit is used to control oscillation, L1-C1. This makes Fig. 11 a duplicate of Fig. 10 in action, for the trap circuit acts as the antenna circuit does in Fig. 10. It will be recognized as the well-known Cockaday circuit. It is used with fixed or semi-fixed antenna tuning so that it will make up a two-control receiver. Cockaday recommends a single turn of direct antenna coupling coil and a nearby antenna loading coil mounted at right angles to S, the secondary. The antenna loading coil is an excellent addition to any fixed coupling coil arrangement, but the writer does not believe that a single-turn primary coupling coil is sufficient for the wave-lengths above 200 meters. The single turn is plenty for the shorter wave-lengths, however, and the loading coil is *not* needed. Because, as was mentioned in relation to Fig. 10, the ultra-audion is an excessively persistent oscillator, close coupling of the trap circuit—the so-called fourth circuit—is required; this makes its adjustments directly affect the secondary tuning. Yet, because the U-a is a strong oscillator, most settings are repeatable and the set's log will have fair dependability. This circuit, as well as the circuit in Fig. 10, could readily be used with plug-in coils to cover many wave-lengths.

The plate-tuned circuit arrives with Fig. 12. The same circuit is used with variometers in either the grid or plate circuits or both. With 201A tubes it is an effective circuit on any wave-length, but with the smaller tubes trouble is often experienced in making it dependable on wave-lengths as



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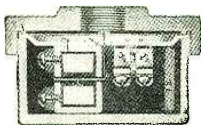
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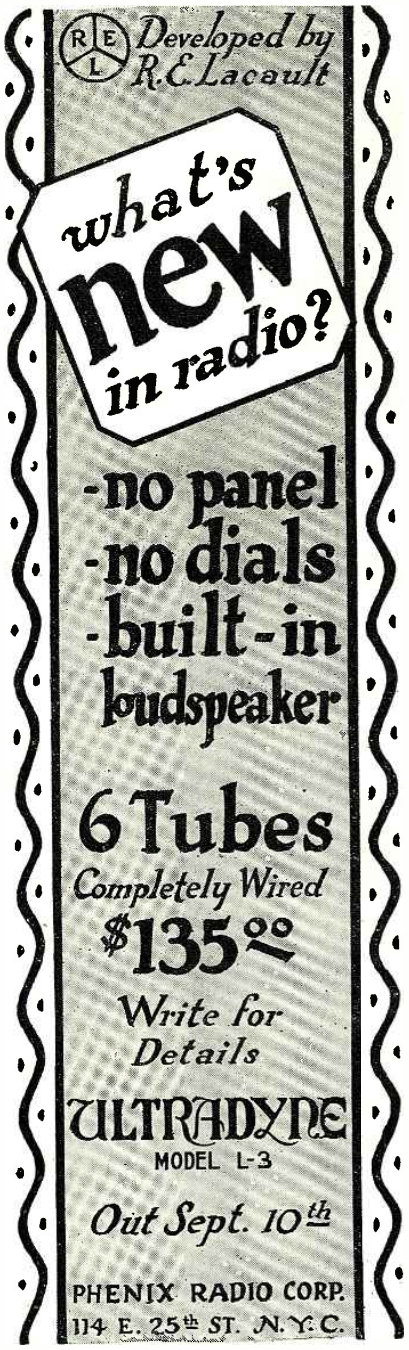
low as 300 meters. This is because the capacity of the vacuum tube is depended upon to furnish the feed-back coupling necessary to oscillation and regeneration. The smaller tubes do not have the capacity to provide this for the higher wave-lengths, although they will work well on the short ones. This failure to function presents itself in the form of spotty oscillation, or none at all. Fig. 12 has two advantages: the plate coil is independent of polarity unless it is inductively coupled to the secondary, which is not supposed to be the case; the second advantage is the fact that a plug-in coil system can be used to cover a great range of wave-lengths. The circuit has had, and still has, a large following on account of its sensitivity and selectivity, but it will do nothing that the others illustrated and described in the article will not. With this circuit, the plate tuning, the regeneration-oscillation control, directly affects the tuning of the secondary. This makes the log of the set only fairly dependable, and this is an unrectifiable defect.

Finally, in Fig. 14, we come back to one of the fundamental circuits with a completion of the phone circuits. The antenna circuit is coupled by one of the usual methods. The two variable condensers control the tuning and the oscillation. Because they control the tuning, the use of each separately is hardly satisfactory, so the best construction makes them a unit with both rotary plates controlled by a single knob. Then regeneration can be controlled at the by-pass condenser—it being made variable—or at a variable grid condenser; the variable by-pass is preferable. In general, the circuit is not very effective on wave-lengths below 600 meters, mainly because its control is not as smooth as that of the other circuits described. Furthermore, it is difficult to gain stability of control on the shorter waves. It has a bit of mechanical convenience in requiring but one coil in the tube circuit, which could easily be made into a plug-in proposition.

CONSTANTS FOR COILS AND CONDENSERS

The man who likes to try things will want constants for the various coils and condensers used in the circuits, so they are given herewith. The short-wave constants are given for coils to cover only the 75-85 meter wave-band and vicinity, about 60 to 120 meters. The larger sizes of coils are for the broadcast band of wave-lengths, or approximately 200 to 600 meters.

In all cases of coil marked S, there are 16 turns between filament and grid shunted by a .00015 microfarad condenser, C. These 16 turns can be basket-weave or spider-web of double-cotton-covered wire or white annunciator wire, No. 18. Or they may be wound on hard rubber or skeleton frame tubing. They should be spaced, if straight wound, about one-sixteenth of an inch, but the spacing need not be uniform. Tickler, 8 turns of any size wire. The L end of a tapped coil should have 8 turns and be a continuation of the coil, of course. A rotating or fixed tickler, not part of S, should be mounted at the filament end of S, as should the primary also. Reinartz type of primaries, Fig. 6, consists of three turns extra on the secondary, tapped every turn to a three-point switch. The secondary in Fig. 6 is tapped 4 turns from either end. C1, in every case a regeneration control, is a .00025 microfarad variable. Primaries, type a, are three turns, well removed from the secondary; type b are a single-turn, set closer, and the coupling capacity c is half-by half-inch plates about an eight of an inch apart. Ck, the R.F. choke. is 150 turns of wire finer than 28 on tubing one inch in diameter. C4 should be a fixed condenser of .001. C2 and C in Fig. 13 can best be a double .00025 microfarad unit. Tuned antenna circuits are more troublesome than





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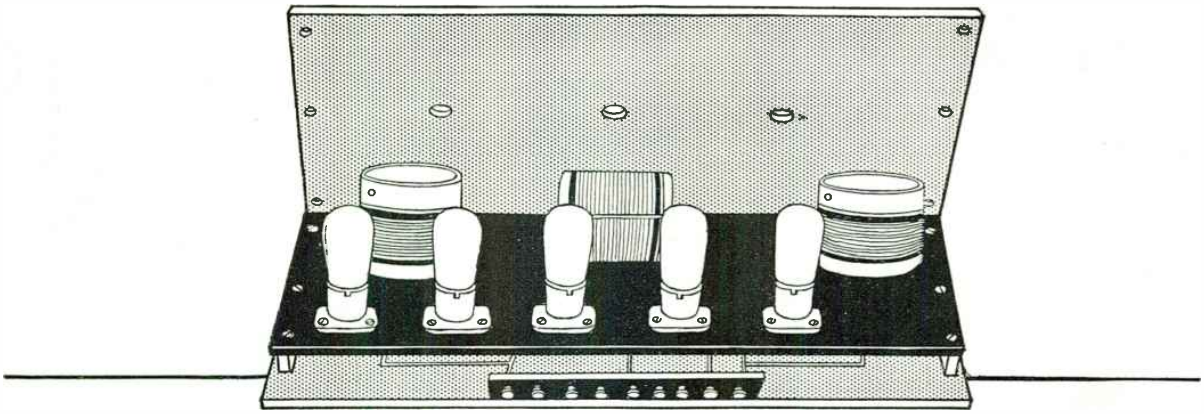
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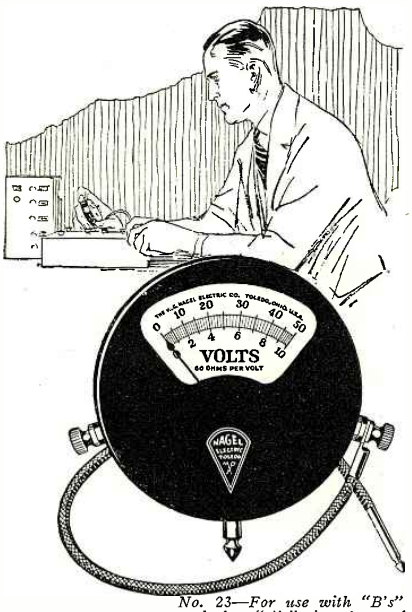
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useful in the amateur game, so are not considered.

FOR BROADCAST RECEIVERS

Jumping to data for the broadcast band: S, as mentioned above, is in this case 45 turns of No. 22 D.S.C. on a 3½-inch diameter tubing. It is shunted by a .0005 microfarad variable. The tickler is 25 turns of smaller wire on a form half the diameter of the secondary. The L end of a tapped coil has 20 turns and is part of the coil, of course. The rotating or fixed types of ticklers should be mounted at the filament end of the secondary, as should the primary coil. Reinartz type of primaries consists of ten turns tapped every two turns. The secondary in Fig. 6 is tapped 10 turns from either end. C1 is always .0005 microfarad or .001, as either is satisfactory. Primaries, type a, are 15 turns spaced one-half an inch from the secondary on the same tubing; type b are single-turn, wound in the center and two to four turns if necessary, while the coupling condenser system c is not satisfactory. Ck consists of 250 turns of wire wound in a lump on a wood spool or something small; No. 30 wire or smaller is O.K. C4 is a fixed condenser of .002 capacity. C2 and C in Fig. 13 are a double .0005 microfarad unit and S1 is 70 turns on the 3½-inch tubing. Primaries P1 are 70 turns of No. 22 D.S.C. wire tapped every ten turns with a series antenna condenser C5, of .001 or greater capacity.

The grid condenser in every case will be .00025 fixed with a grid leak between 3 and 7 megohms if 201A tubes are used. The grid leak does not hold to these limits with other tubes.

Directional Reception Reduces Interference

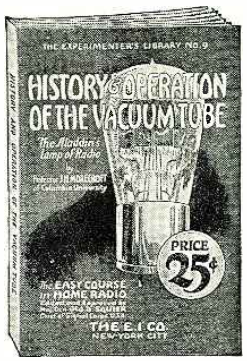
(*Continued from page 291*)

cm. apart. Experimental directional characteristics have been made through this system and agree very closely with the theoretical directional characteristics indicated in Fig. 3.

TUNING OF THE SYSTEM

The tuning of the system to a desired signal is quite simple. First, one of the loops is short-circuited and the other loop tuned and the beating oscillator frequency adjusted as for an ordinary double-detection receiver. The beating oscillator circuits are then tuned and finally the short-circuited loop is tuned. The set is now ready for the final adjustments of the beating oscillator currents in the two loops to give a minimum of interference. This will require adjustments of the variable input transformer and also of the phase-shifting imput transformer. On long wave-lengths it is quite convenient to tune the set on a local oscillator whose frequency is adjusted to the frequency of the desired signal. The short-wave system described above was tested during the summer months of 1924 at Cliffwood, New Jersey, and found to verify all conclusions derived from its characteristics.

On many occasions it is possible to reduce the summer. static interference so much that talk from some broadcasting station, which was absolutely unintelligible when received from one loop alone was made clearly intelligible by the two-loop system. It may here again be pointed out that static interference at broadcasting frequencies in the summer is due mainly to local thunder storms, but the direction is quite arbitrary. A gain in the reduction of station interference cannot, therefore, also be expected, as the static may come from the same direction as the signal wave. At



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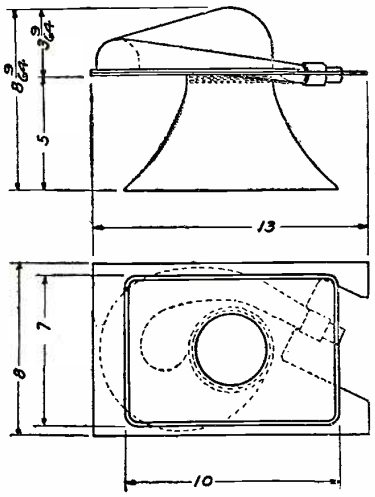
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long waves the direction from which static waves arrive is generally southwest, so that a considerable reduction in static may be expected when receiving signals from Europe.

THE LONG-WAVE, TWO-LOOP SYSTEM

A receiving system suitable for reception of single side-band speech signals of 5,000 to 6,000 meters wave-lengths was constructed and tested also during the fall of 1924 at Cliffwood, New Jersey. The locations of the receiving set and the two loops were permanent, as it is obviously not practicable to rotate a system 240 meters long, like a turntable. However, this limitation is not so important because long-wave receivers are generally used to receive signals from one direction only. The loops were installed in wood houses 10 by 10 feet, in order to make the system independent of weather conditions. The total weight of the house and loop is less than 2,000 pounds, so that a team of horses can easily move the loop to any desired location. Each loop is 8 feet square and has forty turns of No. 14 bare copper wire, spaced ¾ of an inch apart. Ordinary weather-proof, bare, twisted wires, lying on the ground, were used for the 225-meter connection between the loop and the receiving set. The long-wave, two-loop system is still in its experimental stages.

ADVANTAGES OF THE FRIIS SYSTEM OF DIRECTIONAL RECEPTION

The main advantages of this type of directional system of reception may be summarized as follows:

(1) Large reduction in static interference.

(2) Simple adjustments for signal interference reduction.

(3) Dimensions of not more than one-twelfth of a wave-length (for, by the use of the two-loop systems, only comparatively small areas are required).

(4) High efficiency antenna circuits so that excessive amplifications are not required.

(5) Plenty of power available in the beating current circuit, which simplifies the construction of the phase- and amplitude-controlling apparatus.

(6) The system can be made independent of local weather conditions.

An Invalid Experimenter

(*Continued from page 271*)

signed off. My log showed a dozen and a half stations scattered pretty well all over the country. Not bad for a novice. It must be remembered that at that time all the stations, some three hundred odd, were alleged to be transmitting on only two wave-lengths, 360 and 400 meters. Although the set wasn't very selective, almost a dozen stations could be separated, which gives some idea of how inaccurately those stations were tuned.

After the set had been in use a few weeks, I tore it up and proceeded to change the hook-up. This rather surprised the rest of the family who couldn't see any sense in tearing the set up when it was working well. Since then my set, or rather sets, have been in a chronic state of partial dismemberment. The first panel got so full of holes that it looked suspiciously like a colander gone bad and had to be replaced by another one before room could be found to drill any more holes. This time it was a larger panel to hold a three-tube set, as I had been getting the parts for a two-step amplifier a piece at a time.

During all this time no attempt had been made to use a crystal set. One of the local

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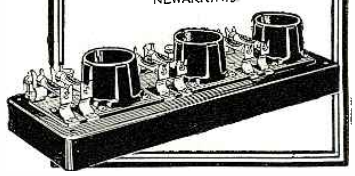
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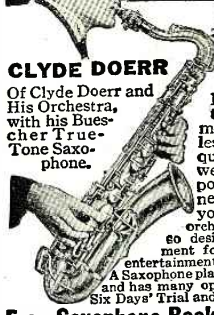
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permanently hold their color and finish. Write for Booklet 24.

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Sylvania

The Answer to the Question—"HOW GOOD CAN A RADIO TUBE REALLY BE MADE?"



SYLVANIA tubes are not made simply to sell but, first of all, to perform. If you have had experience with tubes of questionable quality, this simple statement of a fact will go far in accounting to you for the big difference in quality of tone, sensitivity and volume that you will notice immediately you install Sylvanias in your receiving set.

The fundamental reason for the extra measure of performance that Sylvania tubes deliver is easily understood when you consider the attitude of the makers to their product. They know beyond any question of doubt that the future of radio depends on how good its equipment is made—not how cheap.

Sylvania tubes are made by a close knit organization that has been identified with the manufacture of superior quality electrical products for many years. You are invited to investigate its responsibility through any of the commercial agencies.

To demonstrate to yourself how good a radio tube really can be made, compare Sylvania performance with that of any other tube you may hold in high esteem. Both the manufacturers and the dealers guarantee of complete satisfaction is an obligation that will be upheld under any and all conditions.

We Invite Dealers

—who recognize the relationship of quality to profits to ask us about the Sylvania franchise and the better business building plan. It will be worth your while to investigate regardless of your present connections.

Types: S 01-A, S 99 Large Base, S 99 Small Base

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SHARPER tuning—clear, true reception—increased selectivity—greater distance—perfect rectification.

No need to search around for a sensitive spot—no adjustments.

The Carborundum Detector is fixed, permanent, laboratory-tested. It can't burn out.

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You must have rheostats of correct ohmage. Insist on the genuine
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Made by pioneer makers of the vernier. FREE.—Send for valuable Rheostat Chart and information on the care and operation of vacuum tubes. Mention dealer's name.
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crystal users claimed to have heard a station several hundred miles away regularly. I was inclined to class him with the fans who are always hearing Honk Honk, China, on a one-tube set or to attribute his results to radiation. Finally curiosity got the best of me and I built a simple crystal set. To my surprise, I heard twice as far as the fan previously mentioned, and it was his turn to class me with the Honk Honk fans. Once or twice, under favorable conditions, a station nine hundred miles away was heard and no radiation could have been responsible for my results, for no one had a radio set of any kind within a quarter of a mile of me. The crystal set was discarded after a few days, because the signals were too weak, and it was not selective enough. Also the much-heralded tonal superiority failed to materialize.

About this time static began to give me much trouble. As there are no local stations, I had to depend on stations seventy miles or more away and static made results poor in the summer. Many fool schemes to eliminate static were printed from time to time and I played the "fall guy" and bit on them all. Most of them were advertised in the winter, possibly because static is easiest to eliminate when none is present.

I started out with wave traps and succeeded in trapping everything but the static. Then outdoor aerials, indoor aerials, and no aerial at all, counterpoise, loop, filters, on down to resonance wave coils, all were tried. In fact, nearly every fool contraption that the army of bright and half-bright fans could concoct and hornswoggle the editors into printing. None of them was worth a darn. Those that did eliminate the static weren't satisfied to stop there, but went merrily ahead and eliminated the signals, too.

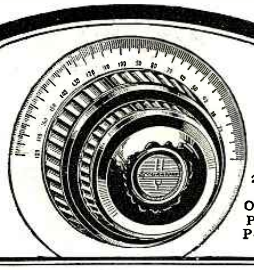
Of course, I fell for the numerous "dynes" and "plexes" in an effort to find an ideal set—I haven't found it yet. For instance, when the Superdyne made its appearance in hook-up form, I fell for it hard. I was all enthusiastic, the theory sounded good and the boosting it received led me to believe that it was *the* set. I was using WD11 tubes at that time and the directions said that they wouldn't work. Well, they didn't. My Superdyne didn't "supe" for some reason or other; UV-199 tubes gave no better results. (Dry cell tubes are used in all my experiments.)

The Superdyne circuit had furnished me plenty of trouble, I had thought, but it was hardly a drop in the bucket compared to what the reflex circuits did. My hat is off to the ones that worked out those circuits in the first place—providing they got them to *work*. All is well and good so long as the directions are followed, even to the makes of parts specified, but woe unto him who would roll his own!

Finally I succeeded in taming a few of the circuits, getting fair to middlin' results. While fooling with the reflex circuits I made some synthetic crystals by fusing lead and sulphur together. These proved fully as sensitive as any natural crystal that I ever tested and much cheaper.

When the short-wave broadcasting first swept the country by storm, I was one of the victims. It's funny, but all the reports wildly boosted it and, somehow or other, enthusiasts neglected to mention that it had any drawbacks whatsoever. Consequently, I was misled into believing that it was very nearly perfect. It didn't take long to disillusion me—all I had to do was to build a short-wave set and listen in a few weeks.

I couldn't find any dope on short-wave sets so the first two or three were built by guess-work. Distortion and swinging bothered me a good deal, although the signal strength was good. In fact, it was just about equal on one stage of audio to the longer waves from the same station on the second stage. This was only in the sum-



Pat Apr. 21-25
Other Pat's Pend'g

Geared 80 to 1

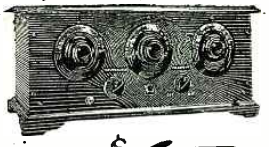
Adaptable to coarse or fine tuning, the infinite precision of the Accuratune brings in all stations within the scope of your set clearly, strongly, and with little effort on your part. Easily substituted in a few minutes for ordinary dials without alteration of your set. An essential accessory.

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A five-tube, tuned radio frequency set equalized on all wave lengths to give great power, distance and volume. Consider its performance, its appearance and its price. No wonder it is making radio history wherever it is demonstrated.

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UNIPOWER—*the latest sensation* in Radio!



The new Unipower—for all types of Multi-tube sets. Fits comfortably inside most set cabinets.

You can now have continuous unfailing "A" power . . in a single compact unit . . that automatically replenishes itself!

No longer is it necessary for you to put up with the cost and inconvenience of operating your set on dry cells—or the bother of charging a storage battery every week or so!

You can now equip your set with Unipower and have the thrill of *continuous unfailing* "A" power always of the highest quality and refinement, always at full voltage.

What Unipower is

Unipower is a single compact "A" power unit that fits *inside* most radio cabinets. It takes the place of dry "A" batteries or of separate storage battery and charging units. It is equipped with a Balkite charger of special design.

Unipower comes to you completely wired and assembled—just connect two wires to your set and plug in on your house current.

Attached to Unipower, in a neatly designed box, is a Master-control switch that governs the operation of your entire set. When the switch is *ON*, Unipower feeds your set rich, quiet power that gives ideal reception, with neither hum nor noise. When the switch is *OFF*, Unipower *automatically* replenishes itself on a low trickle charge with absolute quietness.

A new experience for you

Until you use Unipower, you will never know how easily, perfectly and economically your set can be operated. Never again will you go back to dry cells—or storage batteries.

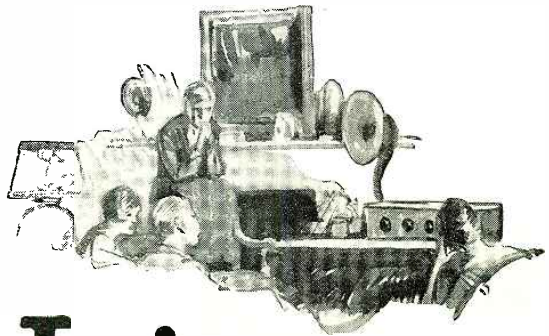
The nearest radio dealer can supply you with Unipower—or will get it for you.

GOULD STORAGE BATTERY COMPANY, INC.
250 Park Avenue ‘ ‘ ‘ New York

The first cost is the last!

Unipower's initial cost is moderate—and the first cost is the last. Unipower has no tubes or working parts that require frequent or expensive replacement. Compared with dry cell operation, Unipower pays for itself over and over again, and, in addition, gives you continuous unfailing "A" power of the highest quality, and always at full voltage.

Unipower oper tes from alternating current, 110-125 V-60 cycle. It is supplied in two types. The 4 Volt type is for sets using U V 199 tubes or equivalent and retails for $35.00. The 6 Volt type is for sets using U V 201-A tubes or equivalent and retails for $40.00. West of the Rockies, prices are slightly higher.



Unipower

Off when its on ~ On when its off

OUR SEAL!

Jefferson Radio Transformers would be just as good without a seal upon them—but it would be harder for you to know it. So we affix our seal as an instantly-recognized sign of superlative radio tone reproduction, as well as the highest possible amplification. We have been transformer specialists for 20 years. We are today the largest manufacturers of small transformers in the world. So the Jefferson seal is really a safeguard for your guidance in purchasing quality products.

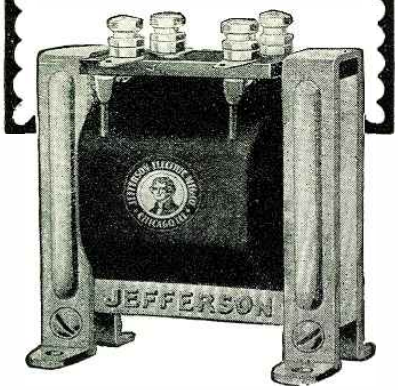
You'll say we deserve it when you install Jeffersons in set.

JEFFERSON ELECTRIC MFG. CO.

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One of the Jefferson Line of Radio Transformers.



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Thorough courses. Expert instructors. Dormitories—Restaurants — Club Privileges. Employment Service.

Write for booklet "Opportunities in Radio"

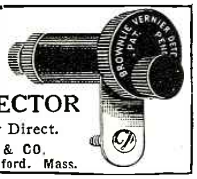
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YOU CAN GET

Greater reflex or crystal set reception if you use the

BROWNLIE VERNIER DETECTOR



$2.00 At your dealer or Direct.

ROLAND BROWNLIE & CO.
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mer when the longer waves were coming in poorly. In the winter there didn't seem to be so much difference, except that there was less static on the shorter waves. Distortion was hardly noticeable in the winter.

One thing that surprised me was the fact that it made practically no difference whether the aerial was connected to the set or not. The aerial was a large one, about 150 feet long, and of course operated aperiodically. With a ground connection of eight to twenty feet the signals seemed unchanged when the aerial was disconnected, except for a slight detuning and much less static. Because of peculiarities in their propagation, extremely short waves are unsuited for general broadcasting at this time. Waves below ten meters and upward to twenty meters or more may never come into general broadcasting use, except for strictly local and extremely long-distance work, the bulk of the broadcasting probably being done above forty meters.

Radio furnishes many thrills and much amusement, entertainment, and instruction for anyone who can't "navigate." I'll never forget the thrill that I got the first time I heard "Pee Dooblyvay Eckez, Habana, Cooba" (PWX Havana, Cuba). It ran a close second to hearing my first station.

One very amusing experiment is duplex reception. Two sets are hooked up to the same aerial, tuned to different stations and then one receiver from each set put in one headband. This gives you a different station in each ear, and it is possible to get some very funny combinations of programs in this way. Although the sets that I used were both regenerative, no trouble was experienced until both sets were tuned to the same station when neither would work. Incidentally this furnishes a handy means of observing fading and static on different wave-lengths. It will be found that fading does not occur on all wave-lengths simultaneously. In fact, even on two stations from the same city it often shows a big difference.

Radio has enabled me to hear many noted men that I could not have heard otherwise. Among them were Presidents Harding and Coolidge and ex-President Wilson and so many senators, governors, mayors, professors and other big bugs of assorted titles and achievements that I can't remember but a small fraction of them.

The experiments given here are only a sample of the many that can be done in bed—mine were not confined entirely to radio.

KDKA Rebroadcast in Germany

(*Continued from page* 273)

Cease from all discord Your cousins in far America give you this council. Midnight darkness now rests over German lands, but after the longest night comes sunrise. The ravens of Barbarossa flutter still around about the old Kyffhaeuser. Germany will again awake to greatness if you but hold out until the glow of dawn. Believe in yourselves! Build on your honor! Be united, united, united! And so will your childrens' children celebrate with our childrens' children the golden jubilee of a new age! Over the wide ocean we citizens of an old republic reach out the hand to you citizens of a young republic in token of brotherly bond."

A thrill went through the German lis-

There's A Reason!



The fine, clear tone and volume of the Kellogg Symphony Reproducer is due to the Kellogg unit with the magnetic diaphragm control.

This exclusive Kellogg principle has produced wonders in the accurate reproduction of voice and music; piano music is unusually fine, the lowest tones of the saxophone to the highest of the violin are as clear as a bell, the soprano voice can really be admired.

Observe the rigid construction of this unit, the exactness of every detail, the size of the magnets. The *unit* is *the* reason.

See one at your dealers today.

Kellogg Switchboard & Supply Co.

1066 W. Adams St, Chicago, Ill.

With every Kellogg radio part, Use—Is the Test



$3.50 COD

RADIO Storage "B" Battery

12 Cells 24 Volts ***Lasts Indefinitely—Pays for Itself***

Economy and performance unheard of before. Recharged at a negligible cost. Approved and listed as Standard by leading Radio Authorities, including Pop. Radio Laboratories, Pop. Sci. Inst. Standards, Radio News Lab., Lefax, Inc. and other important institutions. Equipped with *Solid Rubber Case*, an insurance against acid and leakage. Extra heavy glass jars. Heavy rugged plates. Order yours **today!**

SEND NO MONEY Just state number of batteries wanted and we will ship day order is received. **Extra Offer:** 4 batteries in series (96 volts), $15. Pay expressman after examining batteries. 5 per cent discount for cash with order. Mail your order **now!**

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1219 So. Wabash Ave., Dept. 75, Chicago, Ill.

Makers of the Famous World Radio "A" Storage Battery

Prices: 6-7, 100 Amp. $11.25; 120 Amp. $13.25; 140 Amp. $14.00. All equipped with Solid Rubber Case.

World FOR RADIO STORAGE BATTERIES

KDKA ≠ WEAF ≠ WGN ≠ WJS ≠ KHJ ≠ KGO ≠ KFAF ≠ WJY ≠ KOP

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We are franchising dealers for territorial rights under Sidson A. C. Receiver, the new Super-Hetro Magnetic, tuning from 5 meters to 1500, and the Harold Belevedere Receiver. Give us full details when requesting catalogue.

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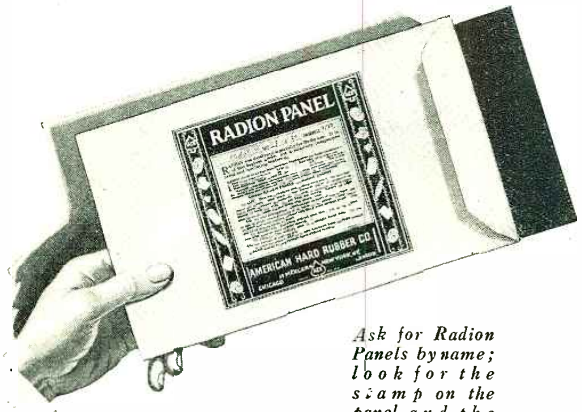
Radio Receiving Set

ANDREWS RADIO CO.

Tribune Tower Chicago

This special insulation made to order for radio

—now built into a line of low loss parts



Ask for Radion Panels by name; look for the stamp on the panel and the name on the envelope.

IN the early days of radio, our engineers discovered that insulation intended for other purposes would not meet the requirements of radio reception. So they developed a special insulation, *Radion*—a perfect insulating material which practically reduces losses in reception to the minimum.

Radion panels, made of this insulating material built to order for radio, immediately became the first choice of thousands of amateurs.

Now, we announce new developments in radio parts built out of Radion. These parts have the wonderful Radion finish, smooth and high-polished. This finish eliminates those losses caused by moisture gathering on the surface of ordinary insulation, causing leakage paths. The high-resistant characteristics found only in Radion Panels also mark these new parts.

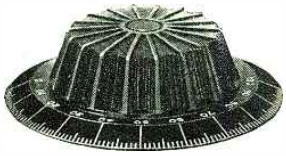
Radion Panels, made in Black and Mahoganite come cut in standard sizes for whatever set you wish to build. And, in addition, you can now get Radion Sockets, Radion Dials, the new Radion Loud Speaker Horn, Radion Tubing, Radion Binding Post Strips, Insulators, etc.



Radion Built-in Horn takes up small space in the cabinet.

Radion Built-in Horn

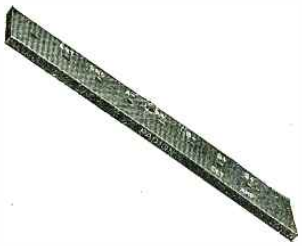
DURING the past summer, thousands who built portable sets put in them the Radion Horn. They did it because of its convenience. But they also discovered that Radion is the supreme material for loud speaker use. In any set you build, you may put in a Radion Horn which takes up small space, gives clear rounded tones, and eliminates the bother of an unsightly awkward horn outside the set. Price $3.00 including cap to fit most makes of headphones or loud speaker unit.



This is the new No. 10, 4-inch Radion Close-Tuning Dial, built to conform to the fingers.

New Radion Close-Tuning Dial No. 10

FOR the coming season we have produced a new 4-inch Radion Dial, built to conform to the fingers, helping you to get close tuning. It has the further advantage that it may be used for single mounting condensers. We believe it is the most beautiful dial yet designed. It is covered by design patent issued to us. Ask your radio dealer to show you the new Number 10 Radion Dial. There are nine other styles of Radion Dials, in several sizes to meet your requirements.



Radion Binding Post Strips enable you to group your terminals in one place.

New developments in sockets

WE will shortly announce a complete line of sockets to meet all requirements, including the new developments in tubes as well as all old-style tubes. Specific information on new sockets will be gladly furnished on request.

Radion Tubing and Insulators

RADION tubing is manufactured in all sizes to meet both the manufacturer's and the amateur's requirements. This includes ribbed tubing for low-loss coils.

You will find Radion insulators ideal to work with in putting up your antenna.

Radion Binding Post Strips

ASK your radio dealer to show you the drilled and lettered Radion Binding Post Strips. They are a great help in constructing your set. Look at one in any store and you will see how it helps to simplify construction.

Send for booklet "Building Your Own Set"

MANY set builders have written us that our booklet, "Building Your Own Set" is the most practical and helpful they have seen. It gives wiring diagrams, front and rear views, shows new set with slanting panel, sets with the Radion Built-in Horn, list of parts and directions for building popular circuits. Mailed for 10c. Send the coupon today.

AMERICAN HARD RUBBER COMPANY, Dept. A9, 11 Mercer Street, New York City.

RADION

The Supreme Insulation

Made to order for radio purposes exclusively

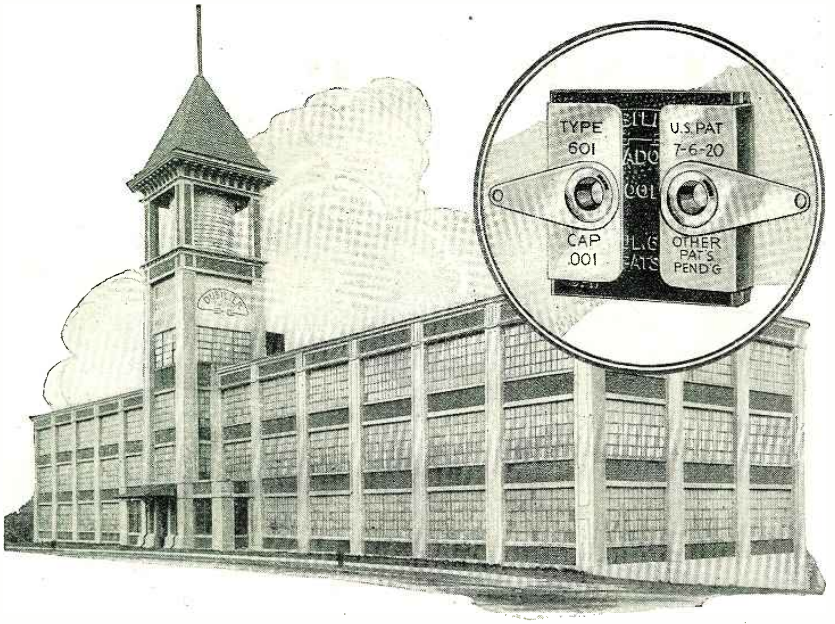
AMERICAN HARD RUBBER COMPANY,
Dept. A9, 11 Mercer Street,
New York City.

Please send me your new booklet, "Building Your Own Set," for which I enclose 10c (stamps).

Name .....

Address .....

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The factory back of Micadons

Little Micadons—made with keenest care in a great factory. Made so accurately, and with such permanent capacity that they are accepted as standard all over the world and are found in 90 per cent. of all radio sets.

It was the universal popularity of Micadons that demanded this great new factory. There they will continue to be made with ever-constant vigilance—always accurate, always efficient.

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THE MIDGET LOUD SPEAKER WITH THE GIANT VOICE

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Only 5 Inches High—$8.00

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A Year Ahead

The set with the air telephone directory

The Dayton Fan & Motor Company

DAYTON, OHIO

"RICO" HEADSETS AND RUBBER CUSHIONS—MELOTONE LOUD SPEAKER—TROPAFORMERS (TUNABLE FOR LONG WAVE CIRCUITS)—AND THE FAMOUS RICO-DYNE FIVE TUBE SET—AT THE BETTER DEALER'S SHOP, OR WRITE DIRECT.

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RADIO INDUSTRIES CORP.

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BODINE BASKET-WEAVE LOOP AERIAL

Gives winter reception with no reduction in distance. Folding Loop. Ask your dealer.

BODINE ELECTRIC CO.

2250 West Ohio Street Chicago, Ill.

Insure your copy reaching you each month. Subscribe to Radio News—$2.50 a year Experimenter Publishing Co., 53 Park Place, N. Y. C.

teners as they heard this greeting broadcast to them in their own tongue from far distant America. It brought the promise of a new bond between the continents. It is here that radio finds its highest mission, in bringing about contact and better understading between the nations of the world. The contact of travel is reserved for the very few, but radio is in a position to bring the masses of the people of the world together. A few hundred years ago people were divided into hundreds of petty groups which warred against each other. Improved means of communication have cemented these peoples into a few great nations. Now for world-wide radio remains, perhaps, the task of helping to cement these nations into one great world brotherhood. Short-wave broadcasting is showing the way. Let all who are developing the radio art be mindful of this goal!

Underground Radio

(*Continued from page* 303)

increased; in fact, to such an extent that it was possible to read ships from 100 to 400 miles off the Mississippi River bar.

The occasional jolts of very weak audibilities were picked up by the leads from the coils to the receiver, also by the connections and coils in the receiving circuit proper. This was proven when the same amount of strays was noticeable when the leads were disconnected from the receiving apparatus. *The leads of the coils, as well as the receiving apparatus and the operator, should be screened and grounded to totally eliminate the static.*

These coils were spaced fifteen feet apart on the river bed, twelve feet below the waterline, but *by increasing this distance to thirty feet, the signal strength was practically doubled.*

At 7:30 P. M. tests again were under way and it was fully demonstrated that this type of antenna was highly practical and more efficient than the overhead antenna, for at 7:45 P. M. Swan Island was sending to NJK, the New Orleans station, repeating English three times and coded message four times; while he (the operator at NJK), due to the very heavy static, had difficulty in copying even with so much repetition, I copied this station easily on the typewriter.

While Swan Island was transmitting, the coils were changed from fifteen feet apart to approximately two feet, and Swan Island's signals were reduced to a minimum (just audible); then the coils were moved so as to be separated fifty feet, at which position Swan Island signals were almost doubled in strength. This was the greatest distance possible, under the circumstances, that the coils could be spaced, but arrangements were made in order to ascertain whether spacing them further apart would have any noticeable effect on the strength of signals received and the results proved that *increasing this distance did not materially increase the received signal strength.*

TESTING AT NJK

Next the coils and receiving apparatus were removed to the New Orleans station grounds (NJK) where the coils were buried at a depth of four feet, having encountered water three feet below ground. They were placed thirty feet apart, as this distance was found best by experiments carried out at the Naval building where the coils were placed in the river, where it was an easy matter to change their position.

In order to have this circuit function properly, the apparatus in the receiving room of the station proper was discon-



ZENITH
TRADE MARK REG
→LONG DISTANCE←
TRADE MARK REG
RADIO

MacMillan Knew

When Commander MacMillan chose Zenith radio for his latest North Polar Expedition, he knew from personal experience what Zenith would do—

MacMillan knew that Zenith—even one of the earlier models—would enable him to tune in stations all over the United States and Europe—even far-off Honolulu.

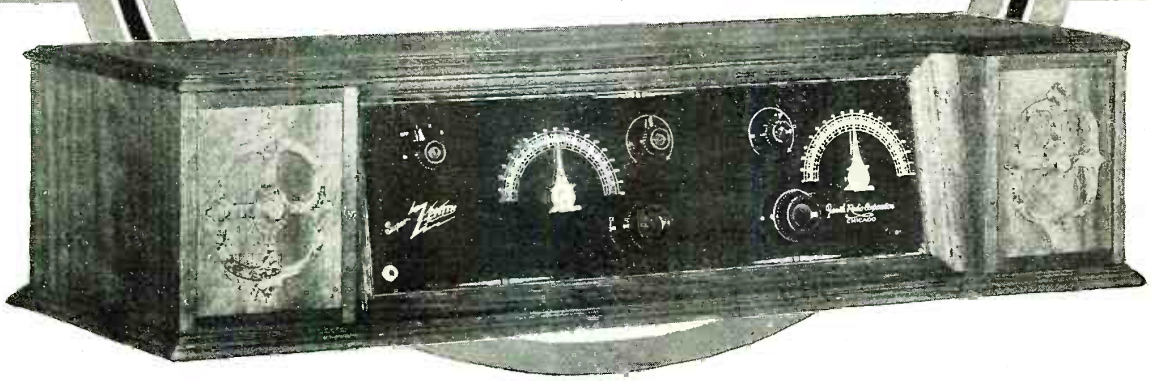
MacMillan knew that no other radio equipment would give him such extraordinary performance, such unfailing service.

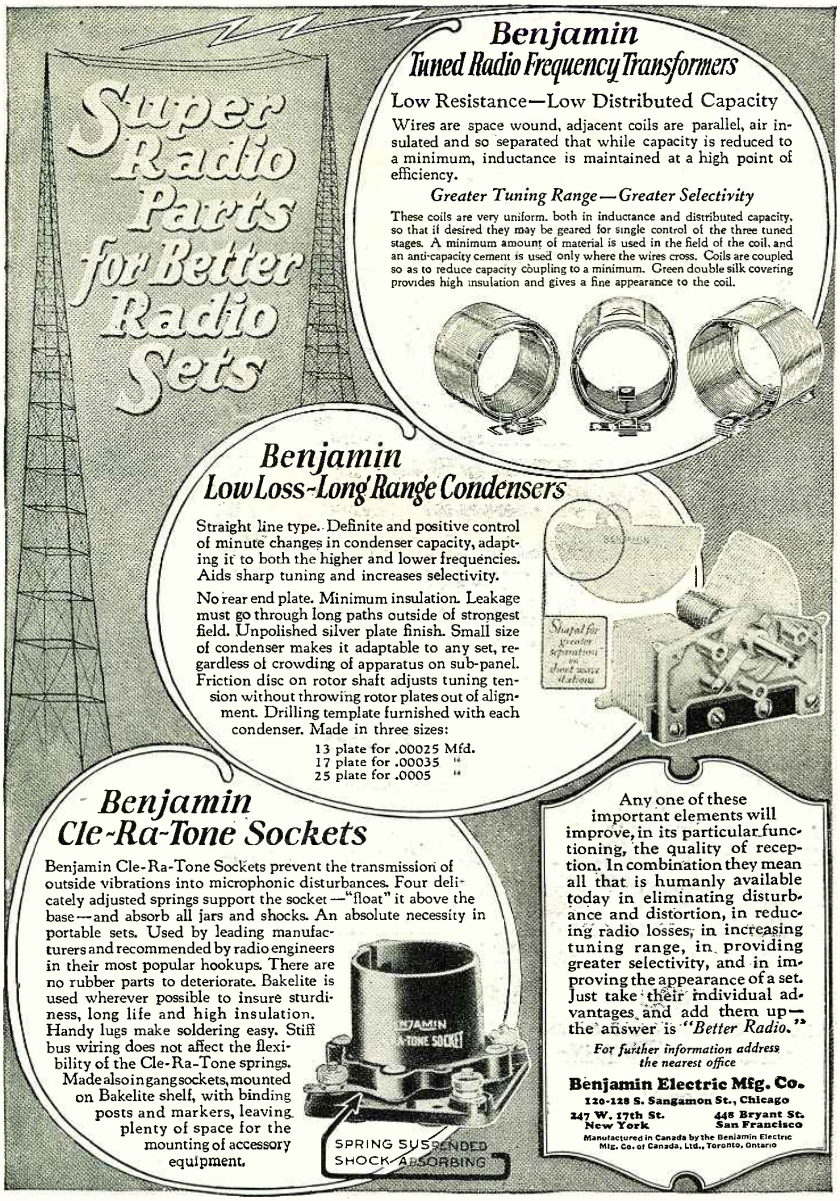
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nected and notations were supplied from our log, because whenever both of us were on the same setting, say 600 meters, the distance between the two receiving rooms being approximately 125 feet, any change in my apparatus cut him out, and vice versa. Also his tube, when setting on the same wave-length as mine, was easily picked up and hindered reception on that wave-length. The same effect was noticeable at his apparatus.

With these coils buried as outlined, signals were received which compared favorably with those picked up on the overhead antenna. This increase in signal strength as recorded here was brought about by the improvement noticed in diagram Fig. 5, where the 1-mfd. condenser C was connected between the ground and the RE lead, as shown.

In order to get some idea of the fundamental wave-length and capacity of the coils, measurements were taken and the results were quite surprising.

	Capacity	Fundamental Wave-length
Coil No. 1	.035 mfd.	1150 meters
Coil No. 2	.037 mfd.	1250 meters

These coils were both free-ended and are of the dimensions given previously (200 *feet of Packard cable, four-foot diameter, approximately fourteen turns*).

FREE-ENDED coils are used throughout and can be pointed out as the invention itself, since it is absolutely necessary that such coils be used in this work. It has been found through experiment that a buried CLOSED LOOP will not function, while the open, concentrated coil will give the same results as a length of wire stretched underground.

Naturally, it is necessary to employ a two-step amplifier, for signals will not be audible up to any considerable distance without this essential piece of apparatus, which reached a very efficient stage during the war.

CONCLUSIONS

The foregoing experiments proved beyond a doubt the value of such concentrated antennae for underground reception, and the following summary can be drawn:

1. The length of wire, which causes serious and detrimental effects when longer than 2,000 feet, can in this manner be concentrated and will furnish the same results, if not better, in respect to signal-static ratio. Since the coils need not occupy more than a reasonable amount of space, at any rate for long waves, 1/100 of the space necessary when employing the wires stretched to their full length, as in the Rogers system, is sufficient.

2. Practically the same signal strength is received in these tests as was obtained with the use of outstretched wires and, in addition, the static is reduced.

3. In this short space of time the foregoing experiments were the only ones that could be performed, but it is needless to say that they are only the beginnings of a new type of antenna in connection with underground reception, which will undoubtedly save thousands of dollars at each initial installation.

4. The coils themselves, being so small, could be easily encased in some form of insulating tube and finally set in a concrete casing which would undoubtedly increase the life of the coils.

5. The coils could be immersed on the surface of the earth, in large tanks which in turn must be grounded to act as shields. In this manner it would be possible to construct large coils which could be rotated at any angle desired and thereby cause maximum reception from various directions. The coils could be rotated by motors at the will of the receiving operator, or they could be

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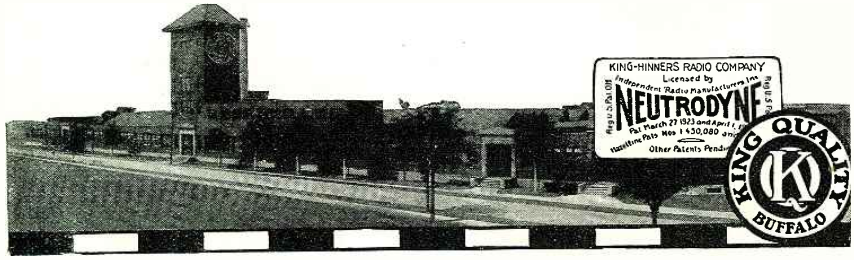
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buried and caused to rotate in the manner described above. In this case they would have to be installed in a concrete cellar, built under the ground.

Some further experiments along the same lines were tried later. The coils employed in this series of tests are shown in the photograph with the author and inventor standing between them.

With these coils laid in the earth or in the water very good results were obtained; pointing the coils toward or away from any given transmitter did not change the strength of its signal to any noticeable extent. However, it is believed that were the coils constructed at greater lengths, directional effects would be present.

These coils were laid in holes dug in the ground, into which water was pumped by means of a hose. This maintained the coils under the water at all times and permitted such tests as were necessary to ascertain whether or not they possessed directional properties. However, no directional effects were present, so the coils were then discontinued and square-framed coils used instead.

Experiments were carried out with large square-framed coils (two hundred feet to the turn, or fifty feet to each side of the square) laid upon the ground. These were tried for long-wave, undamped reception and exceptional results were obtained when the ground was wet, immediately after a good rain, for then the wires were practically buried. However, when the ground dried out, the signals vanished and were not received with a readable audibility. It was only necessary to have these coils buried in moist earth to obtain excellent results. *Receiving short wave-lengths with long outstretched wires underground demands a critical length of wire. However, on a loop or concentrated, open-ended coil such as mine, the length does not materially affect such reception until it exceeds* 500 *feet to the coil.*

Now all ye amateurs get busy and dig those four-foot holes until *permanent* moist earth is assured and place your little coils some fifty feet apart, hook her up, and there you are! Underground reception is at last within reach of the average experimenter and amateurs at large.

The amateurs not only have my permission to use this system but are encouraged to do so. Any further information will be given upon receipt of query.

Life and Work of Lee De Forest

(*Continued from page* 288)

of the visit. Finally Mr. Myers admitted that he was very interested in Dr. DeForest's device—rather that he had a client who was willing to pay well for its use. DeForest informed him that the American Telephone & Telegraph had the patent under consideration and were very favorably impressed with its operation. He left Mr. Myers with the impression that the Radio Telephone Company, to whom the patent was assigned, might listen to reason—if the reason were written with a sufficient number of zeros after it.

Mr. Myers replied that his client was not able to pay over a certain amount. He must stay within the appropriation.

DeForest was struck with Mr. Myers' attitude. The interview was rather uncanny and Mr. Myers, the doctor thought, was a bit too reticent about his client and not quite sincere enough in his price talk.

Mr. DeForest asked Mr. Myers point-blank if he represented the Telephone Company.

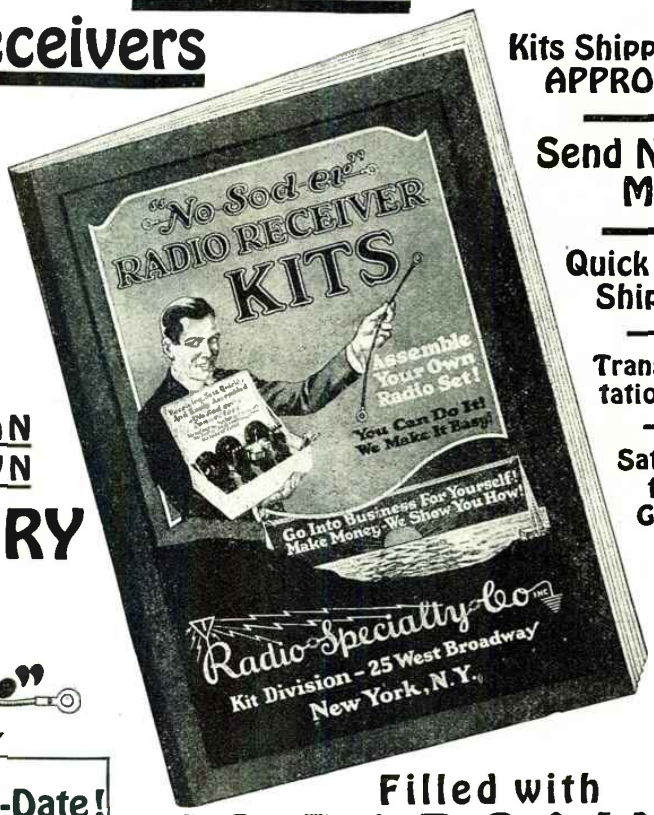
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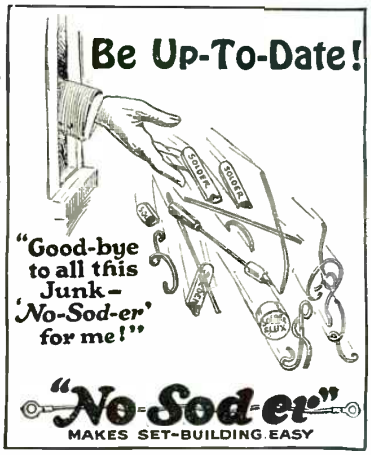
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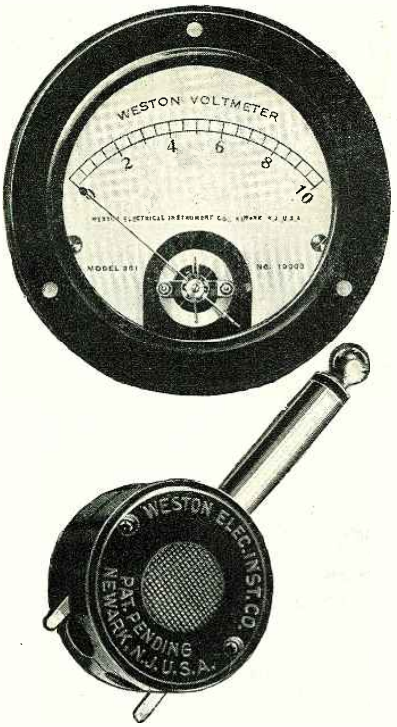
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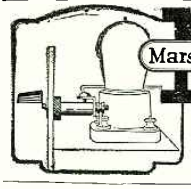
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Mr. Myers gave Dr. DeForest the impression that he had no connection whatever with the Telephone Company.

The interview continued, Mr. Myers saying that he could not offer Mr. DeForest more than $50,000 for the patent rights. He was extremely sorry, but the point had been thoroughly argued out with his client before he had entered the market. His client was in the business of expanding and could not spare a bit more than the amount named without jeopardizing future operations.

DeForest needed money and needed it badly. It would serve the Telephone Company right to lose the license rights, for the new purchaser required an exclusive use license and, in addition, control of further granting of licenses. They wanted, Mr. Myers said, merely to protect their own interests. Dr. DeForest had been in competitive business and could, of course, see this point as quite obvious.

The doctor did some swift calculation. The $50,000 was undoubtedly better than nothing. He *had* to have money and he must deposit it to his account post haste, or he would have no account to which he could deposit it. Further, he must eat and he must have a roof. And—if he were to continue his development and make a place for himself and the fortune he had been seeking these many years he must get back to his own.

Lord, if he could only wait for the telephone company! He'd make them pay! But here was something for the present.

The interview was at an end. Mr. Myers had an option on the patent rights for the sum of $50,000 to be paid to DeForest upon his executing the license to Mr. Myers. DeForest, of course, and the Radio Telephone Company were to retain full and equal rights under the new assignment.

DeForest rushed to an attorney and the deal was completed. The old laboratory was fitted up. The $50,000 was taken to the bank. The Radio Telephone Company was again a live organization. Logwood, DeForest's old assistant in the Federal, was called to New York immediately to take up experimental work with DeForest. The world was rosy again.

But while DeForest was so happy in his new field there was being enacted another little drama in the United States Patent Office. A bored clerk was writing: "Transferred this day from Sidney Myers, attorney, to the American Telephone & Telegraph Company, a corporation of New York, Borough of Manhattan, New York——"

And the wizened accountant handling the private books of the American Telephone & Telegraph Company was turning $450,000 back to the general account from the "Audion Amplifier Fund," which was voted for the purpose of purchasing the patent rights of Lee DeForest on the Audion Amplifier.

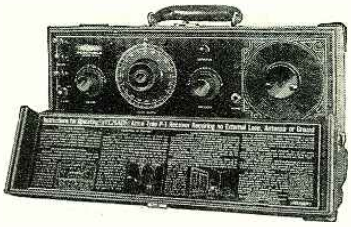
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History of Radio Inventions

(*Continued from page 297*)

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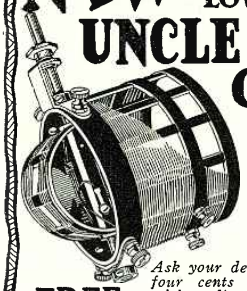
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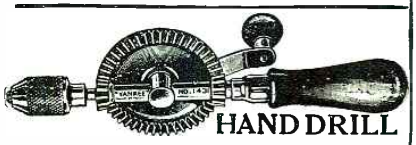
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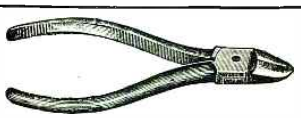


HAND DRILL

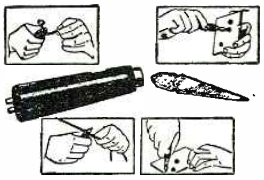
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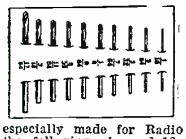
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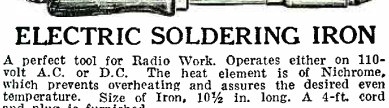
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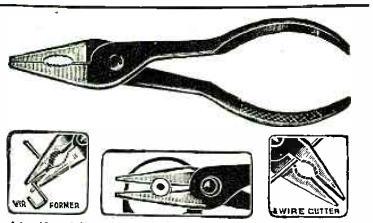
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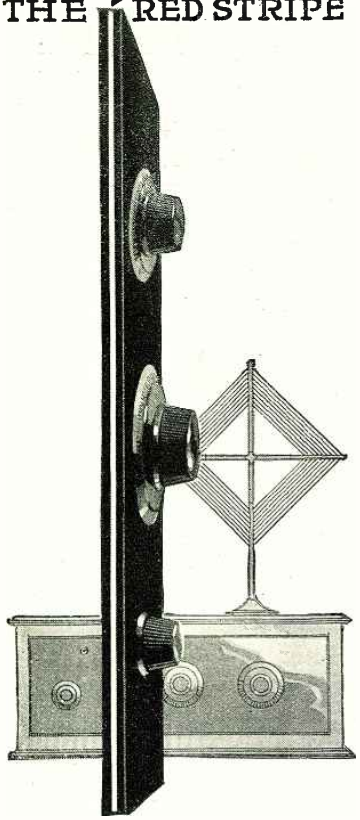
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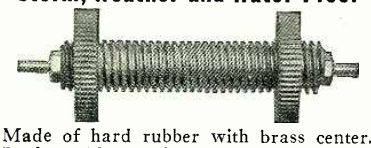
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long ago as 1867; moreover, in 1892, Sir William Crookes foretold the use of longer —but still short—electro-magnetic waves in focused radio-telegraphy. Therefore, it appears to be reasonable to hope that, at last, the radio beam is to emerge from the stock prospectus into the field of practical telegraphy.

SOME PATENT SPECIFICATIONS RELATING TO BEAM RADIO-TELEGRAPHY

BRITISH

1896	12039	G. Marconi.
1899	14449	S. G. Brown.
1900	1555	E. G. Foresio.
	14558	G. F. R. Blochmann (use of lenses).
1901	11003	G. F. R. Blochmann and C. E. Bichel (use of lenses).
	19170	A. N. Hovland.
1903	15569	H. W. Ladd.
1906	19878	DeForest.
1912	18632	H. Heinicke and M. Jasper.
1916	105909	G. Marconi (void), (reflector).
1917	128665	C. S. Franklin and others (reflector).
	128673	C. S. Franklin and others (reception of short waves).
	128983	C. S. Franklin and others (generation of short waves).
	130064	E. F. W. Alexanderson (directional radiator).
1918	134246	E. F. W. Alexanderson (reception of short waves).

AMERICAN

744897	F. Braun (reflector).
748597	DeForest (reflector).
1360167	E. F. W. Alexanderson (directional aerial)

CHAPTER IX.

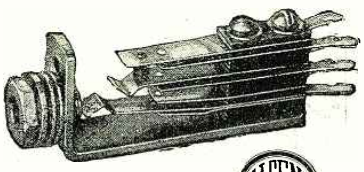
CONCLUSION

A consideration of the cases of Hughes in 1879 and Marconi in 1896 inevitably reminds one that "A prophet is not without honor, save in his own country." The appropriateness of the axiom is not affected by the fact that Marconi achieved fame in Italy; he had already become famous in England.

It is to be regretted that someone did not give to Hughes the encouragement and facilities for practical experiment which, nearly twenty years later, the late Sir William Preece gave to Marconi; but it must not be overlooked that the need of a wireless telegraph system was probably not so urgently felt in 1879 as in 1896.

Prior to 1896, Preece had in operation a system of inductive wireless telegraphy, and it was just when he was smarting under the failure of this system to provide communication with the East Goodwin Lightship that Marconi came to him with a letter of introduction from Mr. A. A. Campbell-Swinton. Both Lodge and Rutherford had already shown that wireless telegraphy was practicable, and by the same essential method that was used by Marconi; but apparently they did not see or were not interested in its commercial potentialities, or were too much engrossed in other activities to endeavor to exploit them. This circumstance has, no doubt, contributed to the fact that today the layman regards "Marconi" and "Wireless" (or "Radio") as interchangeable terms, while the credit that is due to Hughes, Lodge, Popoff, Braun, Fessenden and others is in danger of being forgotten except by technicians.

There may be much to be said in favor of a monopoly of a public utility; but if experience of radio teaches anything, it is that there should be no private monopoly of a public utility, which is based upon an undeveloped art. In other words, it is obviously undesirable that a monopoly should be so constituted that it might be concerned to defeat or delay the adoption of any in-



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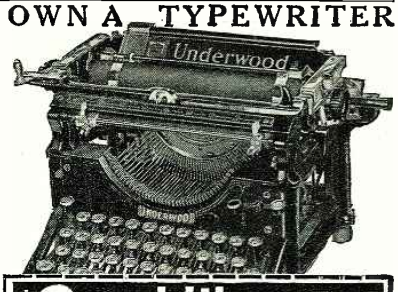
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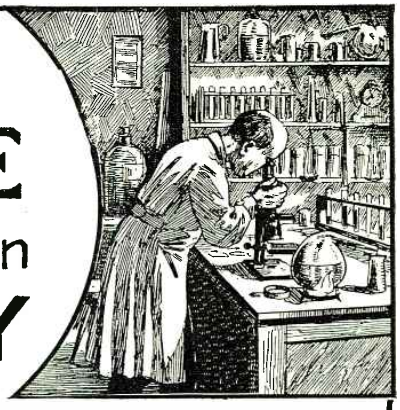
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R.N., Sept.'25

What becomes of the bass notes in *your* radio Set?

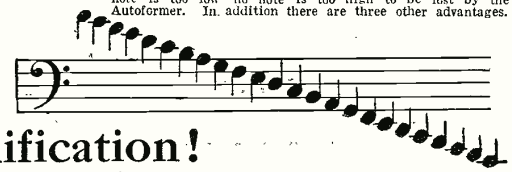


While the better transformers amplify quite evenly over the entire upper and middle registers of the musical scale, from about 60 cycles downward there is a pronounced loss of amplification, as indicated above. Poorer transformers begin to drop off in amplification even higher on the scale with the result that lowest notes disappear entirely.

The "Lost Octave"

The deep, low notes of the grand organ, bass viol, tuba, English horn and other instruments are practically "lost" in ordinary amplification.

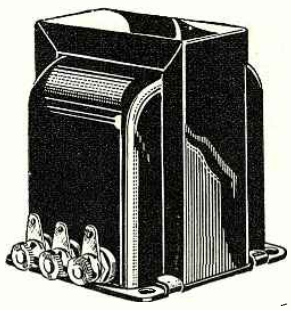
There is no variation in amplification over the entire range of musical frequencies with Thordarson Autoformers. No note is too low—no note is too high to be lost by the Autoformer. In addition there are three other advantages.



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Full amplification of those *bass* notes hitherto largely "lost"! Greater clarity on *all* signals! Improved reception of *distant* programs! Better volume *control!*

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Autoformer amplification is for those who seek the finest reproduction of programs to be had. It may be used with any set in place of the regular audio transformer hook-up. Full directions, with diagrams, for building a Thordarson Autoformer Amplifier are supplied with each instrument. Or

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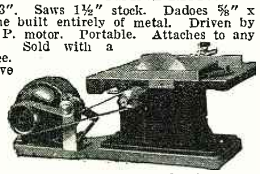
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vention of merit. This fact emerges most strongly from British experience, and even the late Sir William Preece was concerned about it. In 1907, when asked whether he thought that the practical development of wireless telegraphy had been due to the Marconi Company, he replied: "Not so very much, sir. I think myself if the Marconi Company, or Mr. Marconi himself, had never appeared upon the scene we should have had wireless telegraphy now." On the same occasion he also gave it as his opinion that "the whole effect of the operations of the Marconi Company has been to check and really stop the growth of wireless telegraphy as a convenience to navigators as well as a commercial undertaking."

IN AMERICA

The American story is somewhat different. Despite the circus psychology and cavalier financing of its promoters, the United Wireless Telegraph Company (owning the De-Forest patents) built up a very big business and applied radio to the public service to an extent yet unheard-of in Europe; but in 1912 a situation had been created which enabled the British Marconi interests to purchase the assets of the company for $700,000—a condition of the purchase being that the United Wireless Telegraph Company should admit the validity of certain Marconi patents, which they did.

The assets of the United Wireless Telegraph Company—in so far as they related to the American Company's territory—and the American patents of Sir Oliver Lodge, were later sold to the American Marconi Company for $1,848,800 in stock of the latter company at par.

In November, 1919, the American Marconi Company was absorbed into the Radio Corporation of America, which also acquired certain radio properties and rights from The General Electric Company, The Western Electric Company, The American Telephone & Telegraph Company, The Westinghouse Electric & Manufacturing Company, The International Radio Telegraph Company, The United Fruit Company and the Wireless Specialty Apparatus Company.

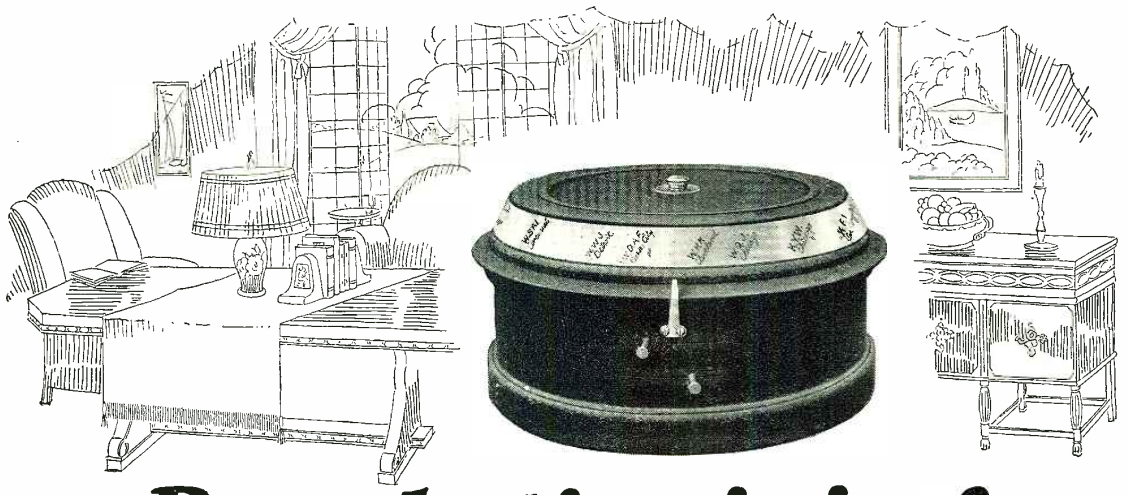
Since its inception as a public utility, there have been two, and only two, distinct waves of technical progress in radio. The first came with the development of the uses of the triode, and the Great War, when the art was relieved of the incubus of private monopoly; and the second came with the regular broadcasting of entertainment, which started in the United States in 1920, and led to the placing of the development and manufacture of radio equipment on a more competitive footing.

Obviously, there is a need of some legal machinery or organization which, regardless of vested interests, will facilitate the adoption of inventions of merit and public utility, and insure a fair reward to their authors.

In 1922 an "Australian Inventions Encouragement Board" was formed, "to stimulate and encourage the Inventive Spirit of the Nation." If such a Board were created in every country, and each affiliated with a common central Board, we might enjoy a wave of inventive progress such as characterized the years 1914 to 1918, without having to wait for another Armageddon.

The story of radio points yet another moral, and it is that, regardless of prefix or suffix, telephony is telephony, and telegraphy is telegraphy.

Radio is already in service as supplementary and auxiliary to other forms of telephony, and its applications are extending. On the other hand—and with the exception of the British Post Office Telegraphs—the big telegraph organizations appear still to regard radio as a sort of poor and suspected relation, and to be content to leave its exploitation to others. This attitude is, no doubt, nourished by the absurd claims of the



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The NO-DIAL brings in stations far and near by merely rotating the cover. Each station comes in at a certain point. As stations are received they are recorded right on the cover (Fig. 1) and thereafter they will always come in at the same point. Thus you have a *permanent* and *visible* station record which is positive and unfailing.



Visible Station Record

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The tonal qualities of the NO-DIAL will please everyone, due to the fact that they are directly caused by our latest combination in resistance coupled amplification. The tonal qualities are so sweet, so clear, so mellow! Harshness and interfering noises are absorbed and never reach the ear. Volume is regulated with a control lever. Far distant stations come in almost as distinctly as local. Results are positive and instantaneous.

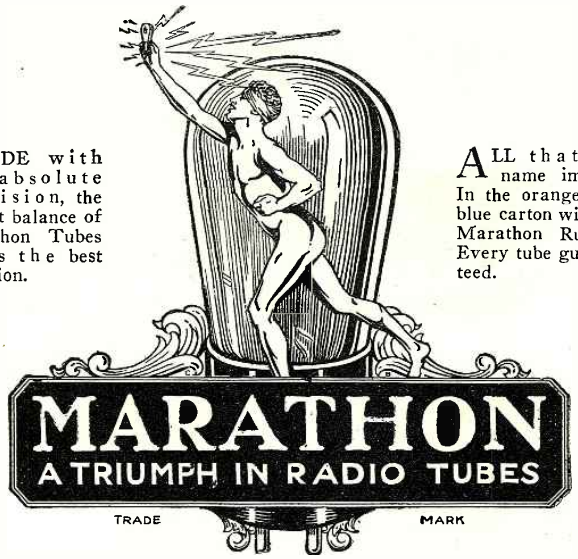
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Tube for tube, the NO-DIAL recognizes no superior, and on test it has out performed many higher priced receivers. The NO-DIAL will do everything any other single control set will do, and more, as regards fine volume, clarity of tone, selectivity and long range.

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stock manipulators and their "ballyhoos," who have beset radio from its birth; but in view of the great progress made in the last few years, its continuance is likely to prove unprofitable, if not contrary to the public interest.

A New Neon-Filled Rectifier Tube

(*Continued from page* 293)

the current varies from zero to about two milliamperes and back again, as the positive charge on the plate is changed from 138 up to 240 and back again to 135. Fig. 3 shows how the current changes from 0 to 200 milliamperes and back when the negative potential of the cylinder is changed from 135 up to about 150 and back again.

Consideration of these figures shows at once that this device will rectify alternating current. When the tube is connected to the terminals of an alternating current supply, the cylinder will become alternately positive and negative with reference to the central electrode. If the supply is a 220-volt 60-cycle circuit, the cylinder will rise from zero to 312 volts positive, fall to zero and then rise to 312 volts negative and return to zero sixty times in each second. The "effective" voltage as indicated by an ordinary A.C. voltmeter will be 220 volts. The peak voltages reached on the positive and negative surges will be about 312 volts, but the instruments do not read "peak volts." The instrument voltage is called "effective" because an A.C. voltage so specified (220, in this case) will produce the same heating effect in a straight conductor as a D.C. voltage of the same value (220) applied to the same conductor. The voltage fluctuation in a 60-cycle A.C. circuit of 220 effective volts is shown in Fig. 4.

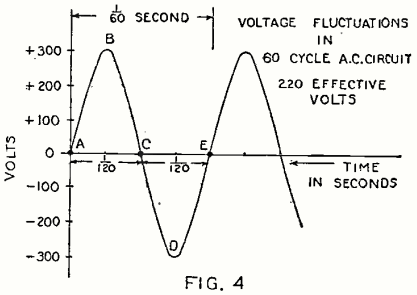


FIG. 4

During the negative half of the cycle a heavy flow of space current occurs in the tube.

Comparison of Fig. 4 with Figs. 2 and 3 shows that while the cylinder is on the positive half-cycle (from A to B to C), a relatively small current will flow through the tube, from 0 to 2 milliamperes as stated above, but when the cylinder is on the negative half-cycle (from C to D to E), a large current of one to two-tenths of an ampere will flow. The current passing through the tube during a number of successive cycles is shown to scale in Fig. 5, the currents to the cylinder while positive being exaggerated to render them visible. The current curves will have the exact shape shown in the figure only when some fairly heavy inductance or choke coil is in series with the lamp, but in "B" battery eliminators such coils are always present in the input transformer. Sixty of the current impulses, as shown, pass through the tube in each second, so that a pulsating, unidirectional current passes through any simple circuit connected to the tube. These humps can be smoothed out by introducing the set of capacities and inductances which form the second part of eliminators.

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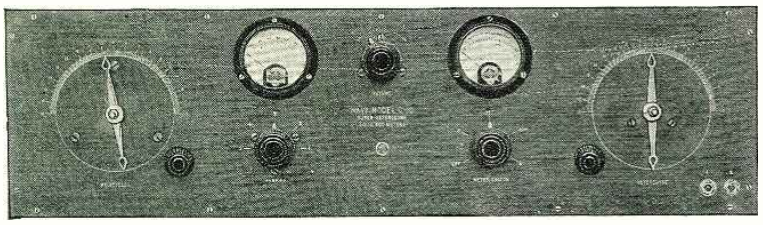
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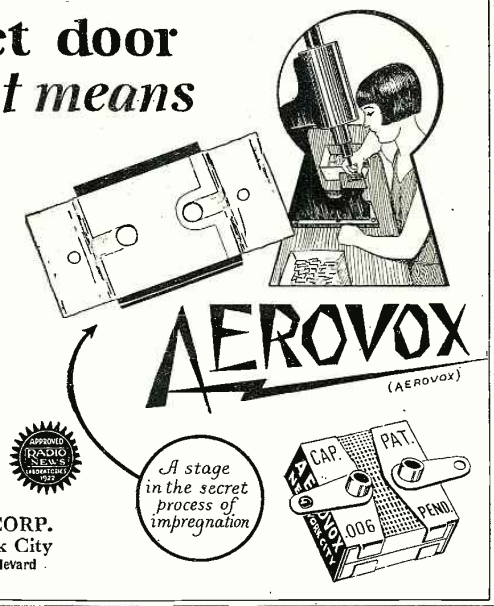
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drops in the external resistance and in the rectifying tube are allowed for there will be enough voltage left to operate some particular radio set. The transformer secondary, for example, may deliver 290 volts—the drop across the rectifier tube is about 150 volts and, if the voltage drops in the other series resistances are not too large, 90 to 100 volts D.C. will then be available for the radio set.

WHY THE TUBE WORKS

Why this gas-filled tube acts in the way described above is well and clearly explained by the established theories of the conduction of electricity through gases. We do not have space at present to enter into this explanation, but it should be understood that there is nothing fundamentally new and nothing mysterious in the device described. It represents a clever application of principles well known to physicists. It promises to be valuable in its present form, and it is certainly capable of important developments in the future.

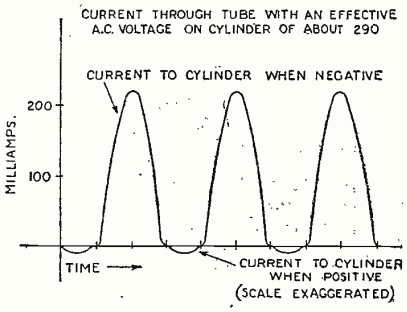


FIG. 5

Fig. 5 shows the variation of the current flowing between the rod and plate of the tube.

OTHER NEON LAMPS

Neon-filled lamps like the one here described have been manufactured for several years past by various English, Dutch and German firms. The Hydra-Werke of Berlin have been making a rectifier apparently identical with the one described above. The Osram Lamp Company of England has also had on the market for some years a neon lamp called the "Osglim," which is essentially the same, although not generally used as a rectifier. In this lamp the "cylinder" is frequently made in the form of letters of the alphabet. It is extensively used in advertising signs. Such lamps, when properly connected up, will automatically flash on and off with any desired frequency from once in two seconds to 60,000 times a second. In this country the long tubular lamp called the "Moore Light" is well known. One of these lamps may be 200 feet or more long and bent into any shape. Such a lamp was used to light the lobby of the Madison Square Garden and has there been observed by many New Yorkers. This Moore Light, although not the same as the neon lamps referred to above, nevertheless works on the same general principle.

POSSIBILITIES OF THE NEON LAMP

In concluding, we may say that the neon tube, whether used as a night light, as an advertising specialty or as a rectifier, has most interesting properties, some of which have been observed only very recently. It is, for instance, in some forms peculiarly sensitive to light falling on it—which in itself gives it a wide field of application in new inventions. Also, the fact that the glow from neon concentrates the great bulk of its energy in the colors which affect the eye brings it nearer to producing "cold light" than any other practical source. It is, consequently, potentially the most economical artificial light known.

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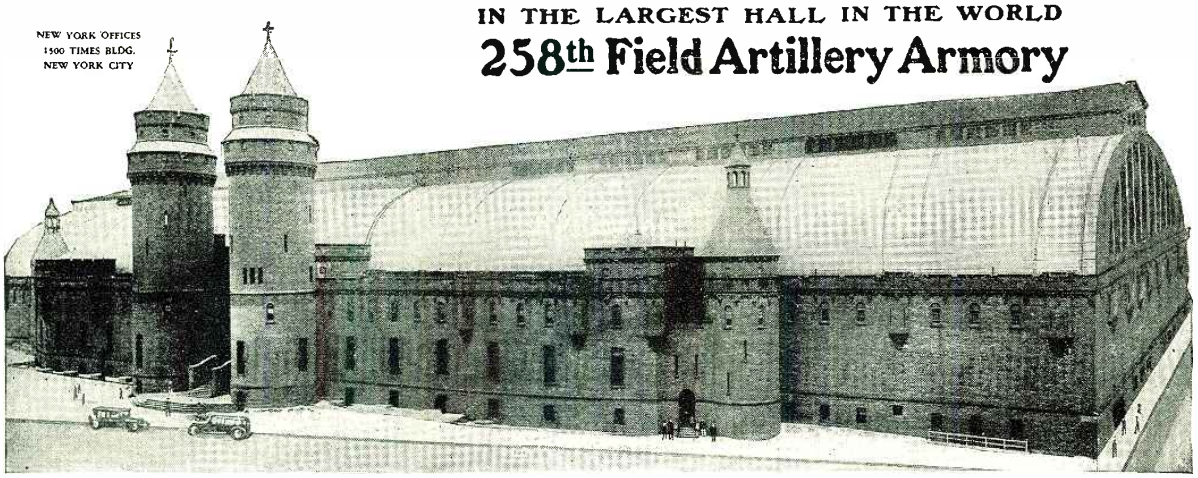
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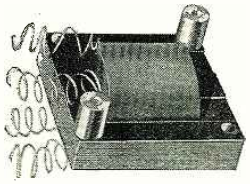
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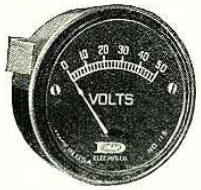
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Ride and Seek

(*Continued from page* 289)

Doc Maxwell looks up, surprised. "Why, how can you tell?" he asks. "They haven't signed off."

"I can tell to some extent by the characteristics of the station, but for the greater part by my directometer."

"Directometer?"

Jerry shows us a double-dial apparatus, the upper part of which is laid out like a compass, the lower dial having an indicating needle moving over a numbered chart. By looking at the compass-dial and finding the direction of the transmitted waves, all that's necessary is to look at the lower register and see how far away it is. Thus both direction and distance can be recorded, the latter within *three miles.*

"Do you mean to say that with this you can tell where any station is?" exclaims Doc, surprised.

"Within limits, yes. In a crowded city I have to use a much finer adjustment, with a very limited range. With that I can distinguish between houses in a block, on certain occasions. However, with this particular instrument a three-mile range must be allowed. In rural districts that is no serious handicap."

Doc is skeptical. "I don't believe it," he declares.

The Master is pained. "Why, Doctor, I can prove it," he states, and sure enough, the station signs off WEAF.

"Odd," says Doc, still unbelieving.

Jerry makes half a dozen tests, all coming out correct except one, but Doc Maxwell ain't convinced.

"I don't get it," he says. "There's a trick to it."

"None at all," assures Jerry. "Doctor, I'm surprised at you."

But Doc is insistent. "Do you mean to tell me you could find a station, for instance, my portable one, no matter where I was?"

"Within a radius of five hundred miles, yes," replies The Master. "I've not experimented beyond that distance."

Doc is an eminent authority on science, and no tyro at radio himself, having a nice laboratory of his own. I don't blame his skepticism, but in the face of facts I'm surprised.

"Why, Doc, it works," I argues. "Why the doubt?"

"Trick," mutters Doc, who can be as stubborn as static on a rainy night next door to a power plant. "A trick!"

Jerry's annoyed, but calm. "Haven't I proved it, Doctor?" he asks. "At present I can't explain to you just how it works, pending patent litigation."

"Not to my satisfaction," states Doc. "You'll have to find me first."

"Certainly," agrees Jerry.

"Do you mean that I can go anywhere, and you'll find me?"

"Precisely."

"Why, I'll take my portable set and travel for days, and you won't find where I've been."

I butts in. "Why not make a bet on it?"

"Absolutely," says Doc. "It'll take several days to get my portable set rigged up in the car, but I'll be back tomorrow night and we'll arrange details."

The next day I'm over at The Master's for information. I gets it.

"I noticed you didn't give Doc any facts last night," I remarks. "Just how does it work?"

Knowing I neither would nor can tell, The Master explains.

"The direction-finding is, as you know, ordinary enough, although I have made several improvements which greatly facilitate operation. The real difficulty was with the

distance gauge. After long experimentation, coupled with extensive mathematical calculations, I have devised this combination volt-ammeter, a special type which I have termed my ultra-intensifier. It merely records the strength of the incoming signals."

I grins. "Simple. But suppose, at twenty miles, a station uses forty watts, and at thirty miles, it uses a hundred watts. Won't the thirty-mile signals register stronger than the twenty, even though the twenty is closer?"

The Master bows to my wisdom. "Correct you are, Joe. However, I have dispensed with those difficulties. You see, my intensifier records the strength of the signals, not only as they are received, but also *as they are transmitted.* Calculations have proven that if ten watts at one mile deflected the needle eight points, then ten watts at ten miles would move the indicator one point. Thus an eight to one ratio is formed. If a station registers twenty watts at the station, and at the receiver the needle moves sixteen points, then that transmitter is twenty miles away. I have been forced to establish the three-mile variance, due to the fact that I cannot concentrate so many spaces on so small a dial. A larger dial would be cumbersome. Also there are atmospheric troubles. In operation, the upper dial shows the direction, and the lower dial, with two indicators, one for incipient wattage and the other for points, shows the distance, which is derived mathematically by allowing eight points to the mile for each ten watts in the transmitter. Is it clear?"

I admits it, lying a little. The Master asks me if I'm free for a few days, which I am. If you've met us before, our Q R M Club was padlocked after three weeks, but we came out financially well ahead, and on the top got so much free advertising we've been signed for a production engagement. Rehearsals are in two weeks, so I've a little more vacation left. Jerry's inventions are serious with him, and I wants to help him. Also, there's the sport of putting one over on Doc Maxwell.

That night, as the movie sub-titles cracks, we're all over at my place, except Jerry, who arrives late. Doc immediately begins to kid him.

"Well, Edison, how's the distance-finder?" he inquires, gay.

"Very well, thank you," replies The Master, grave. But Doc ain't to be quieted until the wager is down on paper. Doris is made stakeholder.

In a moment there's a thousand dollars on the table, five hundred from Doc and two-fifty each from Jerry and me. Then the rules is laid.

"I make no claims for my device beyond a five-hundred-mile limit," states Jerry. "You are to keep well within that range."

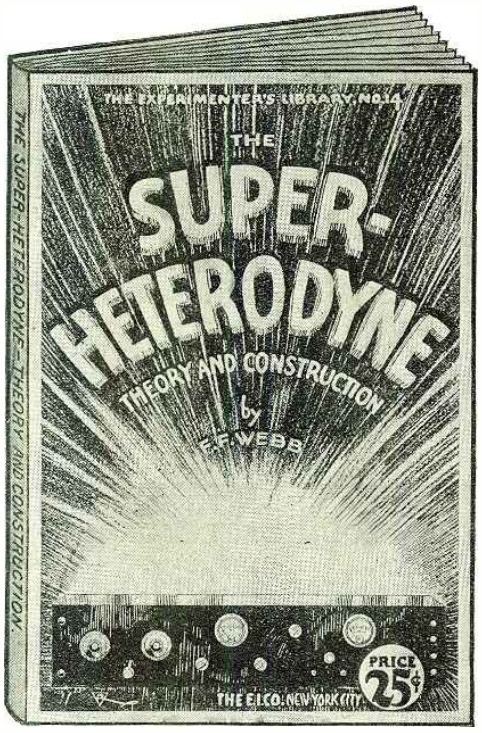
"Sure," agrees Doc.

"You are to transmit once every hour, on the hour, using eighty meters wave-length, which will cause no unnecessary interference with broadcasting. Call your name each time."

"Yeh."

The Master continues. "You will be given three days, during which time you may go as fast or as slow as you like, in any direction, as long as you stay within five hundred miles of Brightmere-on-the-Deep. You will start Monday afternoon at five, and be back Thursday morning at ten. You are always to use sufficient power to reach me, and I am to be allowed a winning average of 95 per cent. on the total, deducting 5 per cent. for errors due to atmospheric conditions. You are to transmit only from five in the afternoon until ten the following morning. During the day, when sending distances are restricted, you are to remain in the place where you signed off at ten, and

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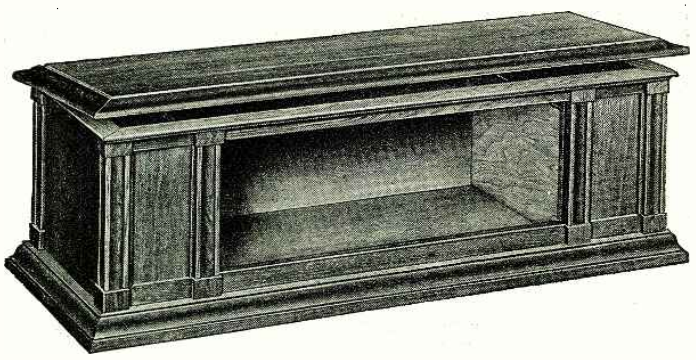
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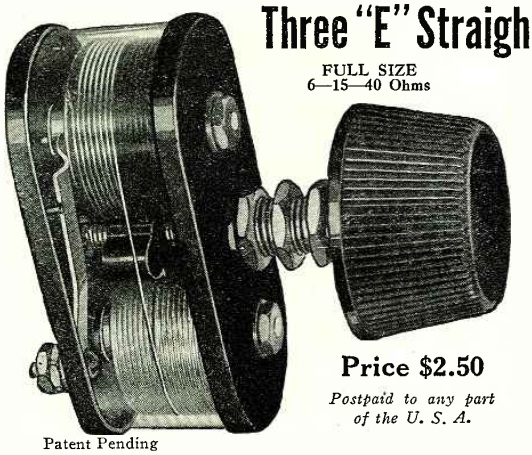
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before leaving there call at five. You are to travel all night. We shall make no attempt to trace you by any other means than radio direct from you. Is it agreed?"

"Sure," says Doc, the soul of amiability. "Anything else?"

"That will be all," says Jerry. "Are you prepared?"

Doc nods. "Be at our place Monday at five, and give us the grand send-off. It'll be your last laugh."

I wants to grin, but The Master's as solemn as a judge. "That remains to be seen," he says. "Monday at five, then?"

"O. K."

Well, the next day's Sunday, whereupon we ain't supposed to labor, but we does, Jerry and me making arrangements for the oncoming siege at the cans, while Doc Maxwell is busy getting his large portable transmitter ready. It's a great game.

Monday afternoon comes, and we're all over at Doc's. He's got his radio outfit in his sedan, he and Mrs. Maxwell occupying the front seat, intending to camp out along the way. Me and Jerry's got to stay at home. Somehow, I got a feeling Doc's getting the best of it, even if he loses.

"Well, so long," yells Doc, as his car jerks off. "You'll hear from me at six sharp."

We does. "Hello, you two," he calls. "How's the weather over there?"

We ain't to call him unless we don't get him, so we stays quiet.

"That first call was from lower New York City," says Jerry, marking it down on the map. "The Doctor is making good time."

"Rather," I grunts. "I hope he gets pinched."

"He's liable to, at this rate," admits Jerry. "However, that wouldn't help us."

At seven he's still in New York, on the upper island. Then he cuts loose, high, wide and thick. By the hour, it's Ossining at eight, then Matteawan, Kingston, Catskill, Albany, Schenectady, Johnstown, Littls Falls, Utica, Oneida, Syracuse, Auburn, Ithaca, Elmira and Oswego, where he signs off at ten A. M. Tuesday.

"Some traveler, that boy," I admits. "He must have all the traffic cops in the state after him."

The Master's wearing his horn rims and his puzzled look, and I'm getting a feeling that I'm gonna be two hundred and fifty dollars shy Thursday morning. We rests during the day, Jerry experimenting with the distance gauge, hardly saying a word until five o'clock, when we resumes our vigil.

Doc leaves Oswego at five, getting into Sayre, Pa., at six. The weather is ideal, both for autos and radios; Doc's just burning the gravel.

I'm curious. "Say, how come Doc can travel like that?" I inquires. "If I did I'd get nabbed once every constable."

The Master's musing. "Oh, Doctor Maxwell is a great motor enthusiast," he explains. "He's driven in nearly every country on the globe. He is quite familiar with the territory he's now in."

At seven it's Towanda, Pa., and then in order a place near Factoryville, Pa.; Scranton, Wilkes-Barre, a place near Freeland, Pottsville, Lebanon, Harrisburg, Carlisle, Chambersburg, Hagerstown, Md.; Harper's Ferry, W. Va.; Leesburg, Va.; Washington, D. C.; Laurel, Md., and Baltimore, where he hits the new-mown at ten A. M. Wednesday.

"That guy must have straight-eight glands in that bus," I grumbles. "How does he get away with it?"

"Largely night travel, you know, Joe," explains The Master, but I sees he ain't convinced. "Speed is easier and safer then."

Which is logical enough, but when I takes over the station at five o'clock Wednesday, Jerry's out on business. Doc leaves Baltimore at five, reaching Aberdeen, Md., at six. At seven, it's near Northeast, Md., and at

eight, Wilmington, Dela. Then Jerry comes in, his arms full of magazines. That grim look is on his map, and I knows when to stay shut. About eight-thirty, Jerry gets up and consults an atlas for a while. Then he smiles and turns to me.

"Doctor Maxwell will next sign at Philadelphia," he says.

"Easy," I replies. "That's almost in a straight line from Wilmington. Why?"

The Master shrugs his shoulders. "Oh, nothing," he says. "See if he doesn't."

Sure enough, at nine Doc hails us from the City of Brotherly Love.

"Ten o'clock will come from Camden, N. J., I believe," says Jerry.

It does, and I'm surprised.

"How'd you guess that?" I asks. "Why, Camden's only across the river. It oughtn't to take him that long."

"Remember, Joe, he doesn't necessarily have to race," reminds The Master. Then he lapses off into figures. About eleven he surmises that the next will be from Burlington, N. J. It is. Similarly, midnight finds Doc at Trenton, according to Jerry's prediction.

"One o'clock will find Doctor Maxwell either in Princeton or Jamesburg," states The Master, looking up from his magazines.

Jamesburg it is. My curiosity is only equalled by my admiration. I don't breathe a word.

"New Brunswick will be the two o'clock city," says Jerry. It is. Then The Master gets up, grins his conquering grin and takes command of the set. At three it's Rahway, then Elizabeth, Newark, Jersey City, New York for two hours, Brooklyn, and a little after ten we sees Doc's car chugging into his garage up the street.

"Hurray!" I yelps. "Come on, Jerry! We win!"

I shoots outa the door, but Jerry's at my heels and grabs me. "Just a moment, Joe," he requests. "I think I'd better tell him."

"Aw, please let me!" I begs. "I wanta see Doc's face when he hears——"

"You'll see his face, anyway," states Jerry. "If you talk, we'll lose."

Which sounds hay-wire to me, but I lets Jerry advance. Doc is nicely tanned up, and grins as we approaches.

"Well, did you trace us?" he inquires.

"Very nicely," admits Jerry. "A perfect score."

"Well, where were we?"

"First you went to New York——" I begins, excited. Jerry claps his hand over my mouth.

"Well, Doctor, did you have a nice time at your camp?"

Doc Maxwell's face registers the most complete expression of astonishment I've ever seen, and I guess my own map ain't placid.

"W-What do you m-mean?" stutters Doc, almost purple.

"Why, you spent the last three days very comfortably at your cottage across the island."

"Huh?" I puts in. "Why, Jerry, he came in from——"

"Never mind," says The Master, quick. "You were there, weren't you?"

Doc stutters some more, but admits it. "How'd you k-know?" he asks. "You followed us, huh?"

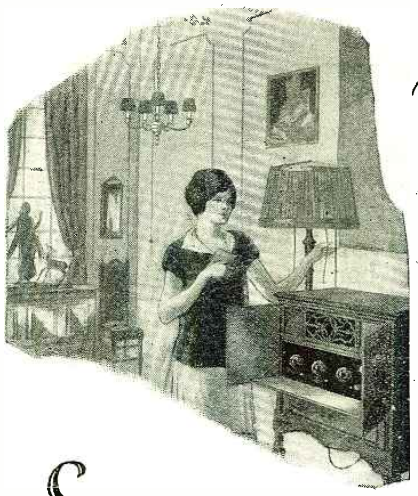
"Not at all, Doctor," smiles Jerry. "We didn't leave Brightmere, and scarcely left the laboratory."

"B-but—how'd you find out?" insists Doc.

The Master smiles some more. "As a matter of fact, I didn't, until I saw you just now with that coat of tan. I hastily surmised you'd been in the water and on the beach a good deal, and took a chance."

"B-But—how'd you know?" repeats Doc.

"The remarkable time you made some of



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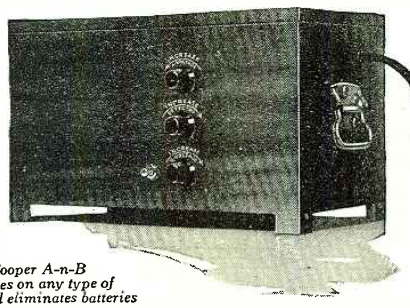
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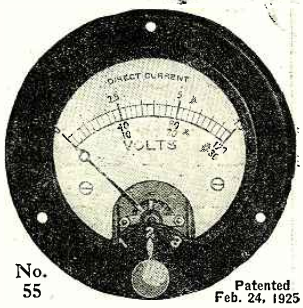


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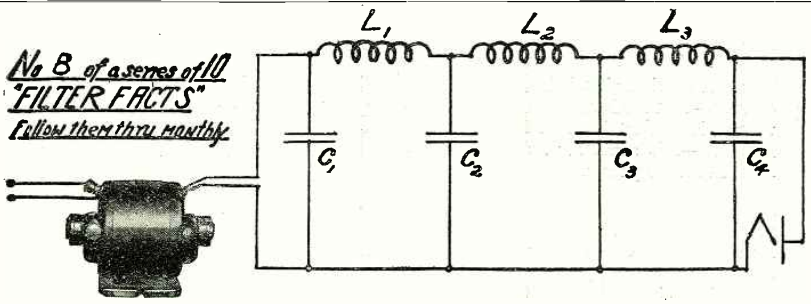
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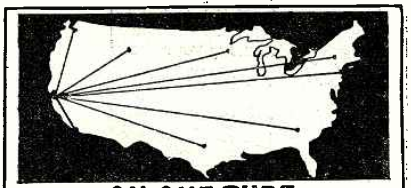
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those sixty- to eighty-mile jumps convinced me you weren't jumping at all. Doctor, you should have been more careful of your route. You evidently measured your distances as the crow flies, in a direct line, when you surely knew that some of those towns, while a short distance apart on the map, were nevertheless two or three times as far by road. You've traveled through that country often, Doctor; I really thought you'd be more careful."

"But—didn't my signals come in?"

Jerry laughs. "Perfectly, my dear Doctor. In fact, much too perfectly. You see, I also get the medical trade journals."

"W-what?" I starts, but The Master holds me back.

"One of the medical magazines has a small radio department, conducted for the most part as a sort of informal get-together medium on the part of physicians belonging to the association. Their names, locations and power were recorded. Doctor Maxwell, being a member of this organization as well as a traveler, knew a large number of these men personally. So he merely stayed at his cottage, and used fifty meters in transmitting to each of his friends in turn, who re-transmitted his speech on eighty meters. When I took over the station last night, Joe, I made tests with my duplex receiver, bringing in the fifty- and eighty-meter broadcasts simultaneously. Doctor Maxwell used only fifty meters in his work, which, I must admit, is in itself quite a feat. You must have used an immense wattage, Doctor. However, the directometer showed Doctor Maxwell to have been transmitting from a point across the island. I was puzzled for a while as to the exact location, there being no towns nearby. However, when I saw the Doctor just now, with his coat of tan, I recalled his having mentioned owning a cottage across the island. That settled matters."

"I'll say it did," remarks Doc, rueful. "Well, you win," he concedes, shaking hands.

The Master smiles. "But really, Doctor, why did you stay in one place?"

"H-huh?"

"If you'd only kept moving, for instance, in a route directly opposite to the order in which the stations came in, we'd have never known, at least not until I tried the low meter length. Why, you could have won easily by just driving within a single county."

Doc's silent. Then he speaks.

"Hell!"

To prove that the distance gauge works, we shows him the chart. It's perfect, and he admits the success of the apparatus.

On the way back to the laboratory The Master's in great spirits. He don't need the money, but it's the principle of the thing. He plans to blow his share of the wad into radios for some hospital. He asks me what I'm gonna do with mine.

"Nothing," I replies. "You forget Doris is stakeholder."

How Your Detector Tube Works

(*Continued from page* 315)

Now we see that there is always a current flowing through the tube whenever the filament is lighted. When the signal is impressed on the grid, it simply increases and decreases this current in amount exactly proportional to the signal. This is the reason that the diagram of the plate current in Fig. 3 is drawn above the wire line instead of on it, as is the case with the incoming signal.

It can be seen that the vibrations are just as fast in the case represented at Fig. 3 B in the plate circuit as they are in the grid circuit. This being the case, it is impossible to

hear the vibrations. The only effect which reaches the telephones is slow changes in the *average* current drawn from the "B"battery. Parenthetically, let us explain about the by-passing effect of the telephone cord. The resistance of the hundreds of feet of fine wire on the bobbins in the telephone magnets is almost infinite to the swiftly vibrating radio frequency, but the capacity—the condenser—formed by the very closely wrapped telephone leads is almost a short circuit for them. Therefore, the very swift changes take the easiest path and simply jump across the phone leads as they do in a condenser. They do not actually jump across electrically, but the effect may be explained that way, for the result is the same as if they did. It is simply a fact that must be taken for granted.

Now back again to the average current. If we could do away with all the rise and fall of the current on one side of the center line, it is obvious that the *average* current drawn from the "B" battery would change slowly—that is, would change in step with the voice intensity which controls the width of swing of the swiftly moving radio frequency oscillations and so would give us, in effect, the voice just as it was put into the transmitter. This is exactly what a crystal detector does; it cuts off half the radio frequency current and gives us a slowly rising and falling current. But in the vacuum tube we have to shift the way the oscillations pass to the grid in order to get the same effect. We might note here, too, that we are, by this expedient, not only able to detect with the tube, but also to amplify at the same time. This makes the tube much more valuable as a detector than the crystal.

Let us keep in mind that what we must do is to change the average current passing through the telephone receivers. Now let us look again at Fig. 4, which shows the characteristic curve of the vacuum tube. A little study will show that as long as the bias or polarity on the grid remains such that the incoming signal added to it will not carry it above or below the straight part of the curve between a and b, the situation will be that shown in Fig. 4 and in B of Fig. 3. In other words, we shall get amplification but no detection. That is, we shall increase the strength of the radio frequency oscillations—make them swing up and down further, still in step with the grid input—but we shall not change the average current or that part of it which affects the telephone receivers.

GRID BIAS

We mentioned grid bias. By this we mean simply the ordinary charge which would be on the grid when no signal is affecting the aerial or the receiving set. This bias is caused by the number of cells in the "A" battery which is attached to the filament circuit and the way the grid is connected to it. Sometimes we even insert a special battery to give the grid a certain bias. This is done often in amplifiers and is called the "C" battery. On the diagram at Fig. 4 the bias is represented by the point marked X, which is the center of the grid oscillations. The incoming signal adds its alternate positive and negative element to the bias, so causing more or less current to pass to the plate, as before explained.

Suppose we place a condenser in series with the tuning coil and the grid. The current still passes through the condenser to the grid. But—and here is where the detection action comes in—the electrons on their way from the filament to the plate are stopped when the grid is positive, as is the case when the radio frequency amplifications are on the plus side of the bias mark. The electrons gather on the grid as if it were a small plate when the positive potential is applied. Then after the radio frequency oscillation has shifted to the negative side

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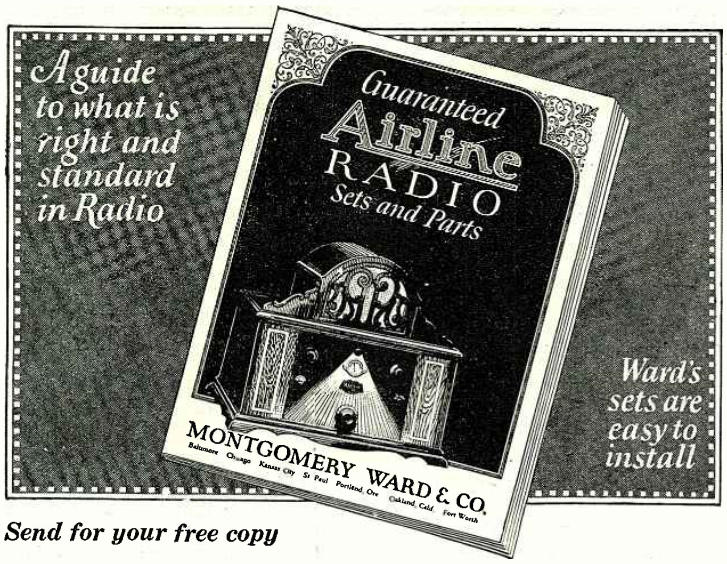
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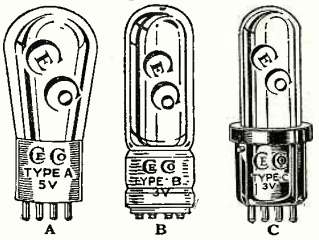
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again and back to the positive, the positive charge added by the radio frequency swing is not so great because the grid has a negative charge of its own, due to the electrons (which are negative) it collected on the previous swing. The condenser keeps them, the electrons, from flowing back to the filament through the wire, as they ordinarily would if the condenser were not present. So the grid becomes more and more negative, each swing adding to the last and following the voice envelope.

But if this process of adding electrons to the grid continued, it would soon collect such a charge that the tube would become paralyzed, since the changes in the signal would not affect the polarity of the grid. Therefore, we must provide some way for the electrons to escape after their natural fashion when we have finished using them for biasing of the grid and making the detector detect. Therefore, we place a very high resistance across the condenser for them to escape through. This is the grid leak. Its resistance is usually around one million ohms.

By selecting the proper capacity for the condenser and the proper value for the grid leak we can strike a balance so that the building up of the charge on the grid and the passage of the electrons back to the filament is proper to make the tube work well as a detector.

This is a very abstruse subject for the beginner, but we hope we have made it clear. If there are any questions, or points which are not clearly explained in this article, the writer will be glad to answer questions or refer the reader to simple treatises on the subject from which he may receive more details.

Correspondence from Readers

(*Continued from page 322*)

ness with inventors is given the awe-inspiring name of "executive shrewdness." Wonderful, isn't it? As for the inventors—well, some of them have to eat once in a while, and being thoroughly convinced that there is no money in ideas, they take a meal-producing course in "lawn-mowing" or some equally remunerative profession.

A. G. SAMUELSON,
Ribbing, Minn.

The Dunoyer-Toulon Experiments

(*Continued from page 275*)

Fig. 5 will, however, give us what is needed. This circuit ought to be unraveled easily by a radio fan. The secondary of the transformer delivers 220 volts A.C. across the non-inductive high resistance 1-3 (perhaps 1,200 ohms). When the sliding contact 2 is set at a definite point on this resistance, S will be kept constantly at a certain potential with reference to A throughout the potential variations of A. S will pass through the same cycle of variations at the same time as does A. It will be noted that the arrangement is such that S may be brought to the same potential as C (when the slider is resting at 2), or to a greater or less potential—the lamp itself being fed from one-half of the transformer only. It will be found that the lamp will light and remain lighted when the slider is between 1 and some point 4—and that the lamp goes out and stays out when the slider is below 4.

CONTINUOUS VARIATION OF CURRENT

When connected as shown in Fig. 4. the tube operates as a high-tension switch—the current either passing through it in full

strength or else being entirely cut off. These two adjustments, "on" and "off," are the only ones possible. The tube so used is really an *arc-relay*. Dunoyer and Toulon showed, however, that, in addition to this on-and-off action, it is possible *to cause the average volume of the rectified current passing through the arc to vary progressively by varying the phase retardation between the alternating potential, sheath to cathode, and the alternating feeding potential, anode to cathode.* This is a new and highly important point. In order to understand it we must see exactly what the term "phase retardation" means in this connection.

Suppose we have two alternating current lines in which the potentials rise to a plus maximum together, fall to a minus maximum together, and so on, always keeping step, as is shown graphically in Fig. 6, A and B. Such potentials are "in phase" with each other—the difference of phase is zero. Suppose, next, that we have two alternating potentials, one of which rises to its positive maximum at the same instant that the other rises to its negative maximum, as sketched at C and D, Fig. 6. These potentials are completely "out of phase"—their difference of phase is said to be ½ cycle. If, further, the time relation of potential variation in the two circuits is as shown at E and F, then the difference of phase is said to be ¼ cycle—the one is retarded in phase behind the other by ¼ cycle.

PHASE RETARDER

Now it is possible easily to shunt a circuit across the leads of an A.C. supply and to provide this shunt with variable resistances and inductances, so adjustable as to produce any desired phase difference between the potential taken off the middle of the shunt and that taken from the end. Such an arrangement is shown in Fig. 7, where R is a non-inductive high resistance, say 2.000 ohms, and L₁ is a variable inductance obtained from a small electric door-bell transformer by closing its primary through a variable sliding resistance K, of perhaps 10 ohms. Changing the value of K changes the effective inductance of L by changing the load on the bell transformer and thus delays, more or less, the time of arrival of the potential maximum at S after the time of arrival at A. The potential on S can thus be put out of phase with that of A by any desired fraction of a cycle.

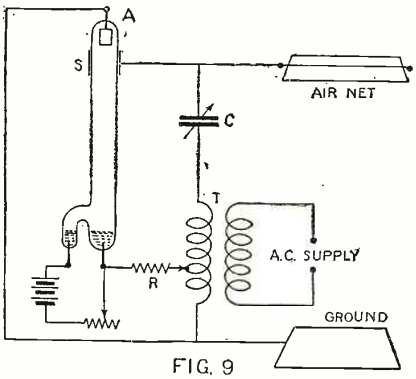


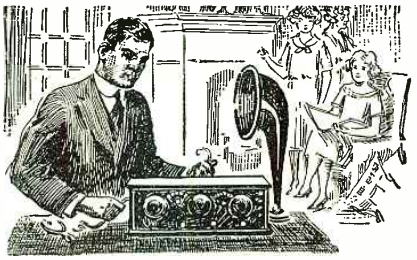
FIG. 9

This is the arrangement for utilizing the mercury vapor arc as a burglar alarm.

HOW IT WORKS

Let us next see how this arrangement enables us to vary progressively the average value of the rectified current through the main tube. How this is done is explained in the series of drawings in Fig. 8. Examine these drawings carefully. You will find them easier to understand than they look at first. The explanation depends on the fact, mentioned before, that a certain rather

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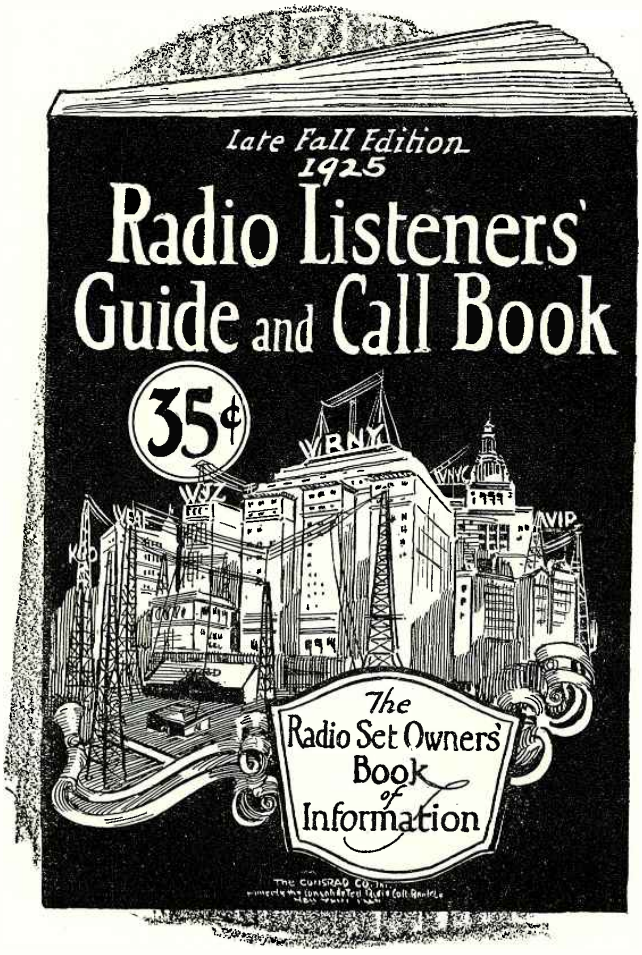
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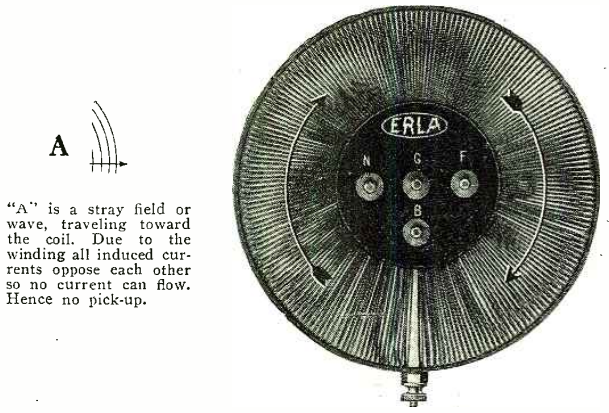
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low critical positive potential relative to the cathode must be reached by the sheath before the arc can strike and also on the fact that the arc, once lighted, will remain lighted until the supply potential traveling on its cycle falls below a certain other critical value near zero at the end of the positive half-cycle. Fig. 8-A represents the potential and current relations in the arc when the potential on the sheath relative to the cathode is "in phase" with the supply potential. The dotted line (line 1) shows how the supply potential varies and also how the potential sheath-cathode varies, since these two are in phase. When the supply potential reaches a value equal to the normal fall of potential in the arc the arc strikes, since, at this point, the potential of the sheath is already above its critical value. Then, due to the low resistance of the arc when burning, the potential across it remains practically constant, as shown by the heavy line, until very near the end of the half-cycle, when the potential becomes too small to maintain the arc longer and it goes out. The resistance of the tube then rises enormously, so that the potential across it follows that of the supply throughout the second half-cycle. Line 2 of the figure shows the corresponding current flow through the tube. This represents the maximum current that the tube can pass.

Consider now B of the same figure. Here the potential sheath-cathode is ⅛ cycle behind the applied potential. The curve in dots (line 1) shows the supply potential, that in dashes the potential sheath-cathode. The heavy line below (line 2) shows again the corresponding rectified current in the tube. The arc will not strike until the potential sheath-cathode rises to a positive value equal to the critical value, as is shown in the sketch. The current is then seen to start and continues until the applied potential is no longer capable of maintaining the arc toward the end of the first half cycle. The area of the current curve is here seen to be much less than in case A. This means that the average value of the rectified current passed by the tube is less. Next study the pair of curves at C, Fig. 8, where the potential sheath-cathode is represented as ⅜ of a cycle behind the supply potential. The explanation is the same as before, the amount of rectified current passed being still further reduced. Finally consider the fourth pair of curves where the retardation of phase, sheath-cathode, behind the phase of the supply potential is taken to be ½ cycle. Under these final conditions no current at all is passed by the tube. The facts represented by these sketches show us that by adjusting the phase retardation at the sheath by means of a device like that of Fig. 7 we can progressively alter the average value of the rectified current passed by the tube from maximum down to zero. The current flowing through the ammeter is obviously pulsating, having 60 bumps a second and the shapes of these bumps are, as shown in Fig. 8, very different at different adjustments, nevertheless, there results a progressive alteration in the average current obtained by adding up all of these bumps.

COMPARISON WITH TRIODE

We have now outlined the essential points of these significant experiments. Let us next try to estimate their importance. In the first place, in comparing this device with the ordinary 3-electrode tube, which it, in some respects, resembles, a vital difference must be pointed out. The plate current in the 3-electrode tube, properly used, faithfully follows the variations in the potential of the grid. Here, although the "plate current" (current from anode to cathode) depends on the "grid" (sheath) potential, there is, obviously from Fig. 8, no simple relation in the shapes of the representative curves. This is unavoidably the case since the arc,



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once struck, continues to burn until the end of the positive half cycle. The mercury arc relay cannot, therefore, be used to amplify signals in the same way as the 3-electrode tube.

AMPLIFYING POWER

If we define the voltage amplifying power of a tube as the relation of a voltage change on the grid to the corresponding voltage change on the plate developed by it, we see that, whereas the amplifying power of the ordinary wireless tube is about 6 or 7, the amplifying power of this mercury arc relay is of the order of 100. Further, if we define the current amplifying power as the relation of the current taken by the grid to the current thereby controlled in the plate circuit, the current amplifying power of the mercury arc relay is seen to approach the extraordinary value of 100 million. Since the power (product of applied voltage and amperes passed) handled by these tubes is enormous—300 kilowatts, for example—as compared with the 3-electrode tubes—1 kilowatt, or so—they could be most suitably used as a source of oscillating currents for radio transmission. However, up to the present time, no workable circuit connections for producing the necessary continuous oscillation through the mercury relay have been devised or, at any rate, published. This is an open problem which may or may not be possible of solution.

APPLICATION TO BURGLAR ALARM

In conclusion, let us look over certain applications of this device already made by Dunoyer and Toulon. First, an application involving merely the "on-and-off" relay action. Remember that the arc will light up only when the anode is positive with reference to the cathode and when the potential of the sheath is of the same sign as that of the anode at the same instant—that is, when anode and sheath are in phase. Let us set up one of the relays in the connections of Fig. 9, where T is the supply transformer. The large lower plate represents the earth and may be the floor of a room. Overhead is an insulated aerial line or network. The anode is connected to one end of the transformer and the sheath is connected to the other end, which will always be exactly opposite in phase to the first end, through a variable condenser C. Due to the coupling action of this condenser, the sheath will be charged by influence to a potential of the same sign as the anode itself and, if that condenser alone were considered, the arc would strike if the other conditions were proper for it. However, the system earth-aerial line acts also as a condenser, charging the sheath oppositely and tending to keep the arc from lighting. Now, if C be adjusted to such a value that the arc just does not strike and then the capacity of the

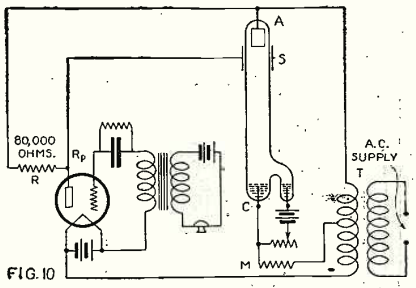
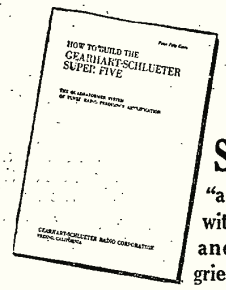


FIG. 10

The mercury arc used with a 3-electrode amplifier can control great amounts of power through weak impulses sent either by wire or by radio.

earth-aerial condenser is increased slightly, causing the potential on its plates to fall, the arc will instantly light. Such an increase in capacity of the earth-aerial system could be produced by a person walking under the wire. It is evident that this set-up could be



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made into a very efficient burglar alarm, since the entering of a person into the space not only would instantly cause a bright illumination, but also the resistance R could be replaced by the motor of a powerful alarm siren. The outdoor space in the store yards of industrial plants could be thus protected.

CONTROLLING MOTORS BY VOICE

Next consider the application of the arc relay in the circuit of Fig 10, which involves as well the ordinary 3-electrode tube. This set-up is designed to enable one to control a motor or other device, perhaps of several hundred horsepower, by the sound of the human voice, or through wireless waves received from a distance. The sheath of the mercury arc is seen to be connected on the one side to the one end of the supply transformer and to the anode through the high resistance R (perhaps 80,000 ohms), and on the other side to the other end of the transformer through the plate resistance (plate-filament gap) of the 3-electrode tube. This plate resistance, as is well known, depends on the potential of the grid of the tube being practically infinite when the grid is negative and falling to perhaps 10,000 ohms when the grid is slightly positive. It is evident from what we have already said that the arc will light when the sheath is of the same sign of potential as the anode. This will be the case when Rp is greater than R, *i. e.*, when the microphone is being talked into, since, under this condition, due to the use of the little condenser (.002 mf.) and of the high leak resistance (4 megohms) shown in the figure, the grid takes up a negative charge, just as in the ordinary radio detecting tube set up with grid condenser and leak. When, on the contrary, the microphone is silent, the tube resistance falls, the sheath takes on potential in the opposite phase and the arc goes out. In place of the microphone an ordinary aerial connection could be made to the telephone transformer, in which case the apparatus, whatever it might be, inserted at M could be started and stopped by wireless.

STREET CAR CONTROL

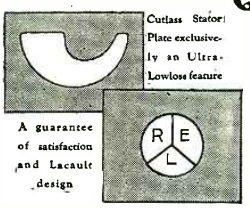
So much for the use of the tube as a switch or relay. As for applications involving the continuous variation of the strength of the rectified current by phase retardation adjustment, one suggestion has to do with a method for controlling the speed of electric street cars. At present, large and costly resistance switches (controllers) are employed for this purpose. It is suggested that A.C. be used to drive the cars and that this be rectified underneath the car by these mercury arc relays. The strength of the current fed to the motors could then be adjusted without loss or danger from zero to a maximum by a device as simple as the sliding contact on the 10-ohm resistance in Fig. 7. This is an attractive idea, but unquestionably requires development to make it entirely practical.

ELECTRO-OPTICAL APPLICATIONS

A whole group of applications can also be made by using the variations in intensity of the light developed from the arc. The fluctuations in the average light intensity apparently follow the changes in the sheath potential, even at high frequencies—certainly above 1,000 cycles per second. The most obvious of these applications is in what amounts to searchlight signaling—the light from the mercury lamp itself or from a searchlight controlled by it being projected in a beam to the receiving station. Morse code can be sent by connecting the sheath through a key so as to throw it into phase with or out of phase with the anode—thus sending a flash or cutting off. By using an automatic high-speed sending machine, the signals could be sent so fast that the light



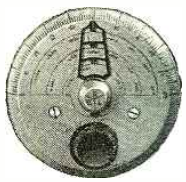
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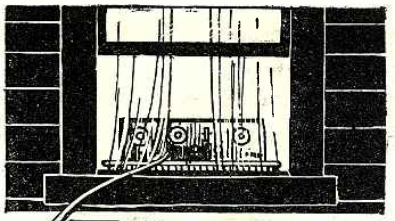
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beam would look quite as steady as in ordinary use—thus insuring secrecy. These rapid signals could readily be deciphered by receiving the light beam on a rapidly moving strip of photographic film.

Other applications, as to telephotography, to television, to the registration and reproduction of speech, and so on, have been suggested, most of them making use of the photo-electric cell. However, I shall leave the development of these additional applications to the ingenuity of the reader.

The Inventions of Reginald A. Fessenden

(*Continued from page 277*)

flammable insulation which should be as elastic as rubber. How the compounds were made non-inflammable, by chlorine substitution, has been told, and was not so difficult.

But the "as elastic as rubber" clause was "anything but." After studying over it a bit I concluded I did not know enough about the theory of elasticity, so got out Todhunter and Ibbotson's mathematical theory of elasticity from the Orange library and went carefully through it. The original memoirs referred to were all in the Edison library. Of course it was not possible to read them all through, but fortunately I had formed the habit of always translating into words all mathematical formulæ as I went along (a habit which cannot be too strongly recommended to all students of mathematical physics, as helping to visualize the processes and as a great safeguard against mistakes in limits of integration, series, etc.), and so was able to get all that was necessary to give a clear idea of the subject in a few months. It was then apparent that the mathematical theory was not sufficiently advanced to give a solution and, so far as the immediate problem was concerned, was on the wrong trail.

But what was the right one? The two great authorities on elasticity and cohesion were Kelvin and Sutherland, the latter of whom had made the subject peculiarly his own. Both of them, and all other physicists at that time, held that cohesion could not possibly be an electrical phenomenon because conductors such as copper and silver had cohesion, and electrical charges could not exist inside of conductors. Both of them were agreed that cohesion was a gravitational phenomenon; Sutherland had published a score of papers in the *Philosophical Magazine* to prove this, and Kelvin had published in the same journal a paper demonstrating that the elasticity of rubber and similar substances was due to the gravitational attraction between very long and attenuated forms of atoms.

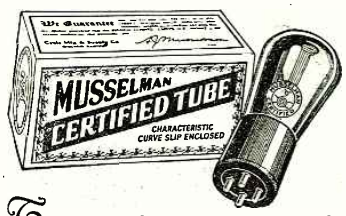
But I saw that the behavior of these substances would not fit in with any gravitational theory. For example, the fact that if one stretched rubber and then heated it it would contract, when according to the gravitational theory it should expand. By this time I was "indoctrinated" with the Edison methods, and decided that the thing to do was to get "more tumblers."

FIRST STEPS—BUILDING THE THEORY

So slips of paper, a lot of them, were taken, and the first filled out with the names of all the chemical elements in alphabetical order. On the second slip were the atomic weights, so that when the slips were laid side by side the atomic weights would be opposite the proper elements.

On the third the specific heats. On the fourth the electric conductivities. On the fifth the atomic diameters. On the sixth the atomic areas. On the seventh the atomic volumes. On the eighth the heats of fusion, etc., etc., until every known property of every known element was tabulated on those slips. Of course many of the slips con-

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tained very few entries, as the data were not known, and only a few were complete.

Then these slips were laid side by side, in all possible combinations, and compared to see if there were any relation detectable between say heat of fusion and electric conductivity. If there appeared to be any possibility of relationship, curves were drawn.

Finally it was found that there was definitely a relationship between the rigidity and the Young's modulus of the elements and the square of their atomic volume. Also between the tensile strength, *i. e.*, cohesion, and the atomic volume and the fusion point, and the following table was prepared.

The square law suggested either gravitation or electrical force. Gravitation was tried, but came out only a minute fraction of the observed value. Electrical attraction on the other hand gave a figure not so far out. So the force was probably electrical, but depended upon some configuration other than the simple attraction between positive and negative charges, located (mathematically) at the centers of the atoms.

It was finally found that if the atoms were considered as electrostatic doublets, with a positive charge at their centers and a negative charge on their surfaces, the cohesion, rigidity and Young's modulus came out just right. (Fig. 5.)

There was another vital condition which must be met. Clerk Maxwell had proved that any theory of cohesion must satisfy a certain fifth power law. The electrostatic doublet theory was tested by this and satisfied the law.

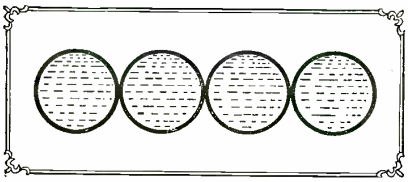


Fig. 9. A series of copper spheres filled with a liquid has very strange elastic properties. When the series is compressed 10 per cent. the copper envelope is strained only a fraction of 1 per cent.

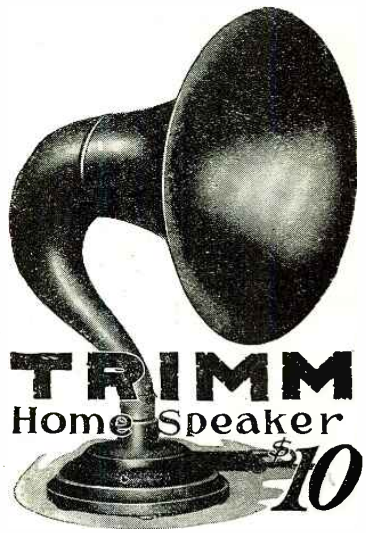
But this was all contrary to the accepted ideas of the distances between the atoms. They had to be substantially touching each other in order that the electrostatic doublet theory should give the correct values, and all the textbooks made them far apart, some even taking them as mathematical points, without any real size. Other theories made them variable in size. And there was one fact which seemed to prove definitely that they could not be touching, for if one took 45.5 cubic inches of potassium and added to it chlorine atoms equal in number to the potassium, the resultant potassium chloride occupied a space of only 37.4 cubic inches.

More tumblers. A long strip of a compound of asphalt and paraffin was cut up into 64 equal parts, such that when each part was rolled into a sphere, and they were all stacked together evenly in four layers, 16 to the layer, and 4 balls to the side, they occupied a space of 45.5 cubic inches. Then 64 smaller balls were made, so that when they were stacked evenly they occupied a space of 15 cubic inches. The former stack of balls (Fig. 6) represented potassium, the latter stack represented chlorine (Fig. 7). Then the balls from the two stacks were used to build up a new stack, one ball from one stack next a ball from the other stack.

This made a sloping stack, Fig. 8.

It was found that the new stack instead of occupying a volume of 60.5 cubic inches occupied only 37.4 cubic inches, owing to the smaller balls fitting to some extent into the vacant spaces between the larger balls.

It was also found that the angle of slope of the new stack was very closely that of



The Trimm Home Speaker is the biggest value in radio today. It out-performs other speakers costing twice as much. Model No. 25 has large Volconite horn, 18 inches high with a 12 inch bell and prevents tinny, scratchy noises giving a full, well rounded tone.

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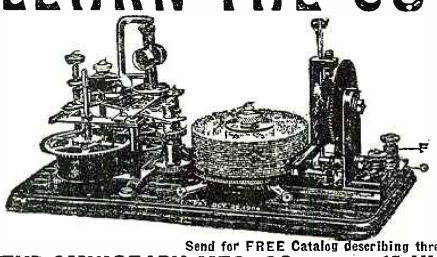
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the crystals of the chemical compounds formed.

Other combinations of elements were tried and the results showed conclusively that the atoms in the solid state were close together, almost touching, and therefore the electrostatic doublet theory was probably true.

The theory was then applied to many other phenomena, to correct Van der Waal's formula for gases; to substitute for the then authoritative theory of osmotic pressure a new concept, that of osmotic suction; to show that electric conductivity was a function of the velocity of sound through metals, etc., etc. (*Electrical World,* August 8 and 22, 1891 *Science,* July 22, 1892, and March 3, 1893; *Electrical Review,* London, November 27, 1891.)

THE DISCOVERY—ELASTICITY OF INDIA RUBBER

This explained the elasticity and cohesion of the elements. But no elements are nearly as elastic as India rubber. So the elasticity of rubber must be due to some other cause. It could not be a direct effect of electrostatic doublets. Therefore, it must be due to some configuration.

More tumblers. First rubber was examined very carefully under the microscope, and found to consist of two or even three differently appearing substances. Tested by solvents, it was found that some solvents would dissolve it all, but others would dissolve only one part, swelling up the rest but not dissolving it. The configuration giving rubber its great elasticity must probably be one, then, depending upon the mechanical mixture of two or more substances.

A simple type of double configuration was examined, that of a three-walled sphere of copper, filled with water, as shown in Fig. 9. Such a body, when compressed between two flat surfaces until it was shortened, say, 10 per cent., was found to have elastically strained the copper envelope only a fraction of 1 per cent. and the volume of the water had been changed still less. In other words, a body made up in this type of configuration, irrespective of the size of the elementary particles, for example a car bumper spring made of a large number of such water-filled copper balls, soldered at their points of contact, would compress or lengthen as a whole very greatly and with only a minute lengthening of any of its constituent parts so resembling rubber.

It would also resemble rubber in other ways. The metals follow Poisson's law, *i. e.,* a rod of copper increases in volume when stretched and diminishes in volume when its ends are compressed, to a quite large amount. But rubber does not, nor would a rod made of water-filled copper balls.

Rubber heats when stretched, instead of cooling, and so would the rod of water-filled copper balls, because the water in the balls is really compressed when the rod is stretched. Also if a stretched rod of rubber is heated it contracts instead of expanding as a rod of copper would. And so would the rod of water-filled copper balls, because the water would, in expanding, try to make the balls return to their original round shape.

So all the different peculiar actions of India rubber were gone through, one by one, and all found to be explainable as due to a configuration in which an A type of substance, such as the water, is contained in or is surrounded by a B type of substance such as the copper sphere; like for example, a skein of silk embedded in gelatine, and when a rod of the compound is stretched the A substance is compressed and the B substance is stretched.

Artificially elastic substances were made up from various soaps, which behaved ex-



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actly like rubber, even as to light polarization, but which could be squeezed in the hand to expel the A substance and then behaved like the metals.

Having found out, in this way, why rubber is elastic, it was a simple job to make the compound, already non-inflammable, also elastic.

As will be seen later, this discovery resulted in a number of inventions. For example the question at once suggested itself: If tensile strength and rigidity are a function of the atomic volume, may there not be some other metals which are better mechanically than steel and better electrical conductors than copper or silver? It was found that there should be such a metal, beryllium or as it is sometimes called, glucinum. (*Electrical World,* July 16, 1892.)

Radio Wrinkles

(*Continued from page 321*)

One of these strips of tin foil is placed at Y. (in the diagram) and clamped down by the springs; the fuse now is ready for use. *Contributed by Dana Miller.*

RADIO BANQUET

Probably the most important "get-together" of the radio industry to be held this year will be the second annual banquet of the Radio Industries which will be held in the Grand Ball Room of the Commodore Hotel in New York City on the evening of Sept. 17. This meeting is being sponsored by nineteen of the largest and most influential radio organizations throughout the country —all branches of the trade will be represented.

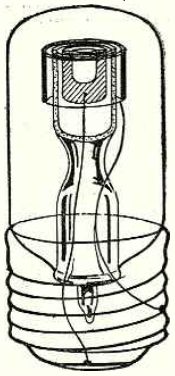
The speakers will be chosen from the men of importance. The entertainment will be in style with the remainder of the plans for the meeting.

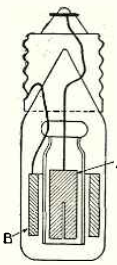
Not the least important feature of the banquet will be the broadcasting of the speeches and the entire entertainment through WEAF and its allied stations and WJZ, with the Radio Corporation net which covers the country.

See with Your Radio

(*Continued from page 278*)

and ease. The lenses—there are forty-eight of them—are focussed so that they draw a fine line across the face of the picture. Each of them would follow the same path were it not for the prismatic disc. The forty-eight of them cover a picture about four inches long. That is, each one covers approximately one-twelfth of an inch of the picture.





Two types of the Moore television light.

The prismatic disc moves these lines struck out by the lenses from the top to the bottom of the picture, giving the complete break-up process.

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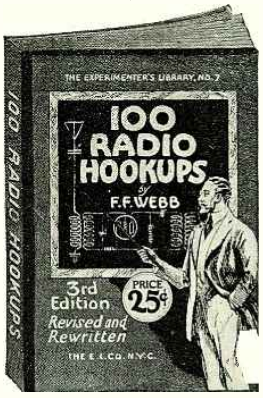
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Thus we have the breaking of the picture into its component parts. The superiority of the present machine lies mostly in this process, which is made possible by the Moore light. The picture, instead of being broken up into dots, as has been done before, is broken into *lines*. Each of the lenses sweep out a line across the photograph. As was explained, each of the lines is just beneath the previous one. The Moore lamp makes this possible by its characteristic, as explained above.

A more detailed description of this little instrument might not be amiss. It uses the conductivity of the gas and the heating of the atoms by the passage of current. When a difference of potential is established across the two terminals—the outside sheath is the negative while the inside one is the positive—the gas becomes luminescent, giving off light. Immediately the current is cut off, the light stops. "Immediately" is used advisedly.

The construction of the light is such that the illumination is all from the point in the center of the center electrode. This allows perfect focussing and the better use of the lenses.

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CONTENTS FOR SEPTEMBER ISSUE

Touring and Camping. By W. J. Bernett.
Fun in the Finger Lakes. By Emma Gary Wallace.
What a Woman Should Know About Her Car. By F. L. Allen.
Iowa and Its Motor Camps. By J. D. Long.
Carlsbad Caverns. By Eric Howard.
Vacation Time. By Evelyn Bouchard.
Don't Tour with Tired Tires. By Maurice H. Decker.

Then there has always before been the question of keeping the transmitter and the receiver in sychronism. This problem has been solved with a degree of simplicity in keeping with the remainder of the apparatus. By employing synchronous motors to revolve the discs and lenses at the two stations, and using a hand adjustment to set the machines after they are started, the problem becomes simple. The synchronous motors *must* run in step, and the adjustment is so simple that a child might easily handle it. From the large manufacturers of alternating current generators comes the word that in all their large installations they can guarantee that the difference in frequency between any two plants is less than one-half of one per cent. This guarantees the perfect operation of the machines in any localities where alternating current is available.

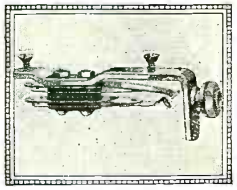
The actual transmission of the impulses from the transmitter to the receiver is a very simple problem. When it is to be by radio, the impulses from the photo-electric cell are amplified, just as they come from it, led to a radio transmitter similar to that used in a broadcast station or by amateurs, where the picture current modulates the carrier wave just as the voice of the artist usually does. At the receiving station it is picked

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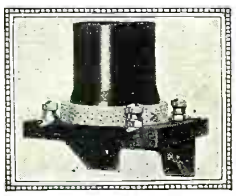


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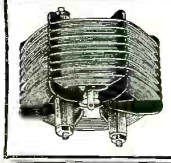
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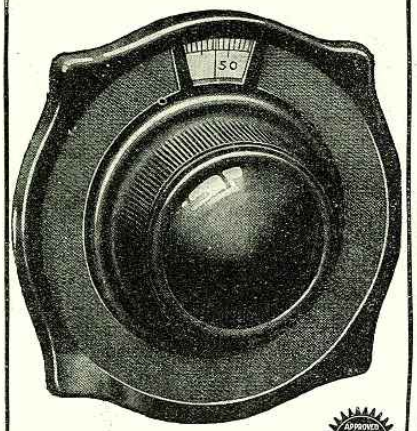
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up and detected in the usual manner, and sent to the Moore light after amplification. On account of the great simplicity in the remainder of the apparatus, only the light current is transmitted through space.

In the absence of atmospheric disturbances, in fact, any typical winter evening, there should not be the slightest difficulty in hooking the ordinary receiver of sufficient power to a power amplifier, such as the Western Electric type, and then to one of these machines, and picking up experimental pictures being transmitted from the Jenkins laboratory.

Some adjustment might have to be made in the intensity of amplification, but this would be a simple matter. Once it was set, no further adjustment would be necessary.

One of the most important points in connection with the use of the set is that it may at the same time be used for the transmission of voice. Just this was done in the demonstration in Washington. In Bellevue, the operator would change the position of the electric fan which was used as the motive power for the toy wind-mill, and while doing it speak into the microphone of the transmitter, telling the listeners at the laboratory in Washington that he was making the change. The voice would be heard from the loud speaker and immediately a change of the speed of the silhouette on the screen would be noted.

The Experimenter

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LIST OF INTERESTING ARTICLES TO APPEAR IN SEPTEMBER ISSUE OF THE EXPERIMENTER

An Ultra-Short Wave Oscillator, By Leon L. Adelman.

High Capacity Chromic Acid Battery, By C. A. Oldroyd, Barrow-in-Furness, England.

Recent Developments in Talking Motion Pictures, By Dr. Bechhold, Frankfort-a/M., Germany.

Bombardment of Atoms.

A Successful Three-Stage Amplifier.

How to Make a Toroidal Coil.

Alternating Current Motors on Direct Current, By Winfield Secor.

As to the origin and design of the machine, a few details might be interesting. Mr. Moore, as far back as 1899, had been granted patents covering certain elementary principles of television design. Since that time, he has been constantly thinking about the solution of the problem. Mr. Jenkins' connection with this line of research is of long standing. It was he who deduced the idea of the prismatic ring. One of the peculiar things is that the lens disc used in the present design is incorporated in one of the old Moore patents. Of course, use of it is no longer protected because the time limit on the patent has expired.

In reconnoitre. We have all been hearing so much about the solution of this problem that we are hardly impressed by the appearance of one article more or less on the subject. If the general public reads this carefully and considers it with some degree of sincerity, realizing that the thing has been

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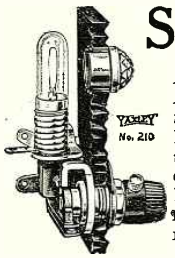
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done, the purpose of this article will be fulfilled. What we must believe is that we are well on the way to a practical and possibly a commercial adaptation of a new art to radio. Within six months, Mr. Jenkins hopes to complete the transmission of a perfectly legible picture between his laboratory in Anacostia and Philadelphia. Let us watch radio history being made.

The Poor Fish

(*Continued from page 282*)

men in the United States. Just think what it would mean to the radio trade in general if every one of these fishermen were to buy a complete radio outfit with loud speaker! Mind you, Your August Highness, not mere crystal sets, but real honest-to-goodness fivetubedynes with real loud speaker growlers."

The Anointed One was all ears immediately, which I noticed by the way he was flapping them. His forehead frowned and laid itself in a number of radio wrinkles, which, from many years of observation, I knew to mean concentrated interest—at six per cent. per year.

The Grand Duke then murmured some indistinguishable words, which I understood to mean a 75c. raise should the scheme be adopted. Thus encouraged by this magniferocious magnamosity, I threw myself at his feet again and thanked him in appropriated language for his confidence in me. I then proceeded:

"You see, Grand Chief, every fisherman likes to catch fish. This, I may say —while it sounds fishy—is an axiom well understood by the piscatory tribe. The trouble with the process is that the fish have other ideas about the subject and do not always care to nibble at the bait —albeit they are hungry."

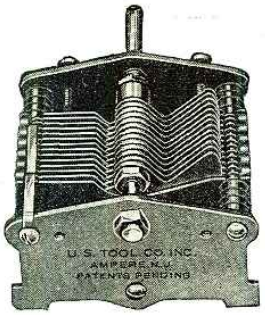
At this, the Emperor made a quick gesture as if to throw something at me, but he bethought himself after looking at the thermometer, and I continued:

"Last year, while I was away on my vacation in Maine, thanks to the magnavoxity of Your Honor, I rigged up a little scheme which did wonders, and here is where the great, big, beautiful idea comes in. I took a metal horn loud speaker and inverted it into the waters of the lake. I connected the loud speaker part to my portable 8-tube Superflexneutrooscilloregenocrystodyne. I quickly turned on the switch, and immediately the sound slipped out of the horn right into the lake.

"From where I was sitting, not much sound seemed to emanate, of course, because most of the music stayed right in the lake. I satisfied myself that this was the correct theory by diving into the lake myself and listening to the music under water, which I could hear almost half a mile away.

"In my glorious modesty I claim no revolutionary principle for this. It is well-known to scientists, near-scientists, as well as radio engineers (?)—if there be such—that sound in water travels much better and further than through the air. As a matter of fact, although I am aware that you, my dear Sultan, know it already, sound travels through air at the rate of 1,088 feet per second, while in water it travels 4,700 feet per second. One of your star radio performers, Reggie Fessenden, used this principle of submarine sound-signaling during the war, when he listened to the naughty German submarines and caught the flip of their very propellers' tails as they did their naughty little stunts.

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U.S.TOOL CONDENSERS



THE new models U. S. Tool Condensers embody the latest refinements made possible by the combined skill of our large staff of engineers.

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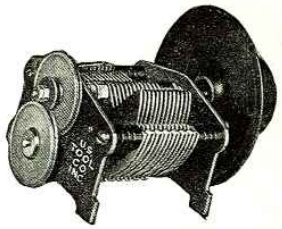
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	Max. .00035,	Min. .0000086.....	2.95
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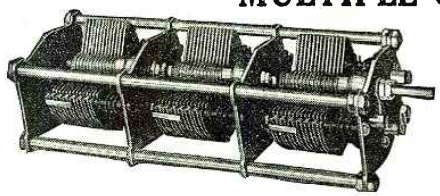
Model 9

Same as Model 8, but with Vernier and Kurz-Kasch Dial.

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	Max. .00035,	Min. .0000086,	4.10
	Max. .00050,	Min. .000011,	4.75



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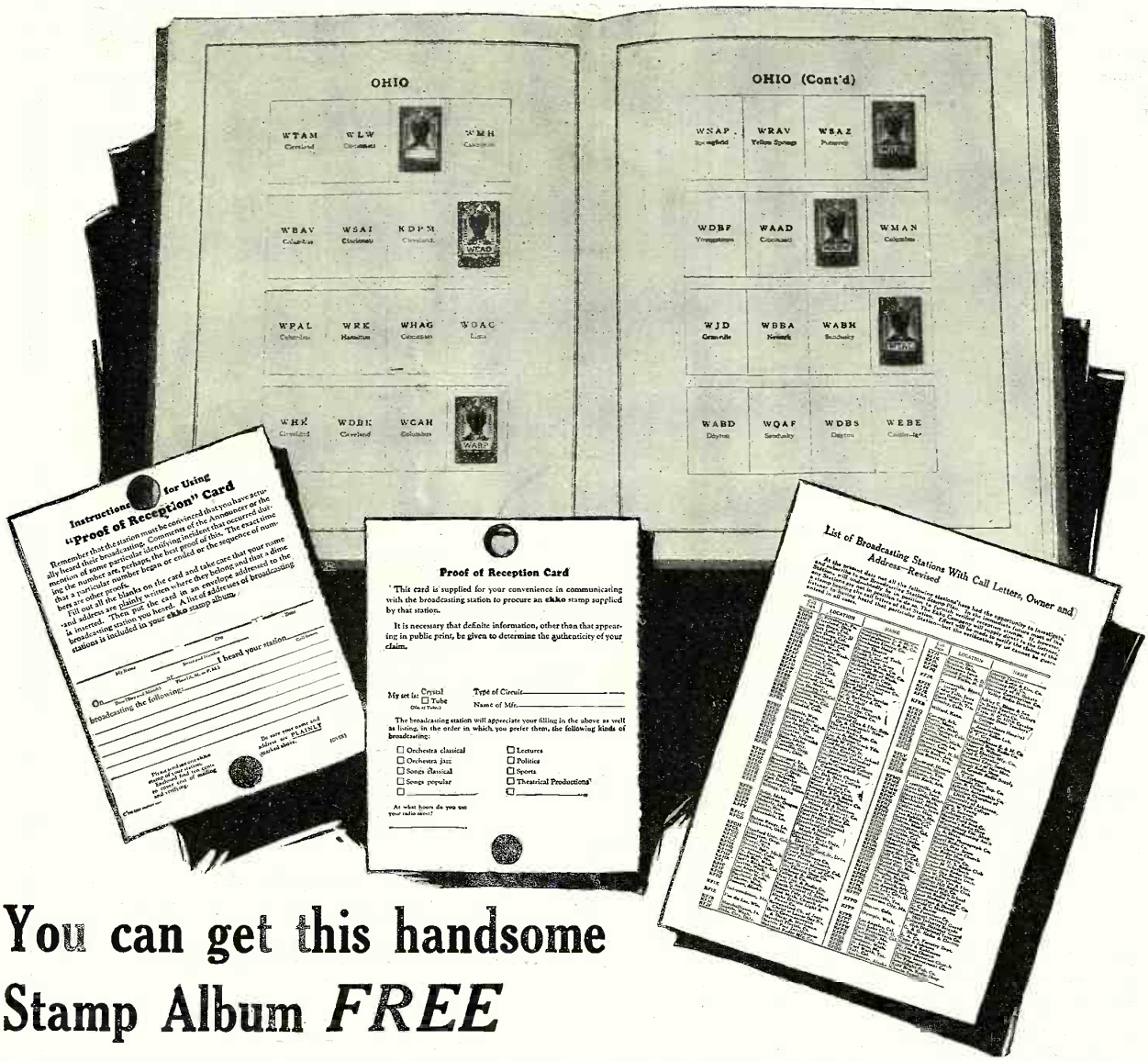
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The New Radio Stamp Fad

Here is the DX Radio Stamp Album just like the ones we owned in our youth, in which were placed the rare stamps of the countries of the world. Some were hard to get, some couldn't be purchased for love or money; but the fun of the hobby was the seeking of rare stamps and the eventual possession. So it will be with the DX Radio Stamp Album. There will probably be some stamps you will never be able to own, but there will be many you will be proud to have and be able to show to other radio enthusiasts. It's an interesting game. Below the Album is shown the "Proof of Reception Cards" of which a generous supply is furnished with each Album. A dime placed in the hole in the card and sent to the station you heard brings back a stamp for your Album.



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This beautiful EKKO Stamp Album, illustrated above, will be given away absolutely free with a subscription to any one of our four magazines: *"Radio News," "Science and Invention," "The Experimenter," "Motor Camper and Tourist."*

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With the Album is furnished a large Crams comprehensive radio map of the United States and Canada; a supply of "Proof of Reception Cards" and also some stickers. The Album contains a list of broadcast stations of the United States and Canada with wave-lengths and columns for recording dial setting, a table of stations arranged according to wave-lengths and a section for log records.

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DON'T FAIL TO USE THIS COUPON

"Now I have often observed that fish are very curious. They are attracted by the least little sound, and are always looking for excitement, novelty and the latest scientific doings. They get the hook only in forgetfulness or when they are too hungry to think—most of our human fish being ditto.

"To come back to my main story in Maine: Well, noble Emir, as soon as the loud speaker was turned on under the water, a surprising thing happened. A jazz band was jazzing away at its best jazz-time. Immediately fish from all over the neighborhood, attracted by the weird and unaccustomed sounds, drew near. Evidently they liked the music, because I could see lots of them wiggle their tails in complete harmony with the discord of the jazz. I may say that several pairs of fish, although I may be mistaken in this, actually got together and seemed to do some sort of weird fish dance. I also noted that some of the fish grabbed at some of the notes as they came out of the horn and seemed to swallow them whole.

"At any event, they seemed to like the music and came in flocks. I had no trouble in catching them, and was kept busy pulling out the fish that were so numerous around the horn. I also noticed that when there was a talk going on, they seemed to become frightened, particularly when the talk was monotonous and of too technical a nature. But they adored all kinds of variegated and assorted sopranos—the poor fish! They seemed to grow fat on them. They did not care so much about the tenors, because these seemed to them too noisy. In music made a tremendous hit and had respectful attention to every ... As a matter of fact, you could ... strain their ears, or whatever ... use, to catch the faintest ... solos were not greatly ... these seemed to frighten ... when the *piano* was pianissi... to hold some interest.

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List of Radio Articles Appearing in the September Issue of "Science and Invention"

Circus Broadcast by Relayed Radio.

A Suitcase Portable Super-Heterodyne. By Sydney E. Finkelstein, Assoc. I. R. E.

A One-Tube Portable Set of Merit. By Herbert E. Hayden.

The Radio Constructor—Complete Details for the Construction of a Browning-Drake Two-Tube Receiver. By A. P. Peck, Assoc. I. R. E.

All About "B" Battery Eliminators. A Complete Collection of Material Gleaned from Authoritative Sources.

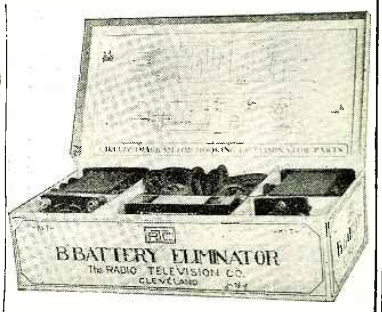
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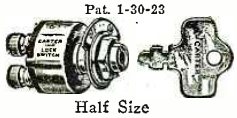
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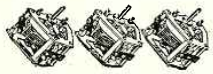


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"As it got tiresome for me to catch so many fish, I invented an automatic fishing reel, which I will now explain to you. Herewith are the plans, from which you will see that "1" is a steel stake driven into a solid spot, "2" is a sort of hinge, "3" is a fishing rod, while "4" is a fishing line. Normally the entire rinktum is in a horizontal position, but the minute a fish nibbles, a pawl "5" is pulled by the line, which disengages the spring "6." This immediately, with a jerk, fires weight "7" onto gong "8." This does a number of things. First, the entire fishing rod "3" is jerked from its horizontal position into an angular one, which jerks the fish from the water; if the sleeping fisherman is in the correct position the fish will hit him smack in the face, thereby waking him up. This is the signal for the fisherman to rebait the hook and go back to sleep once more. If the fish does not wake him up, the gong "8" does, so there is no chance of the fish being fried in the sunshine."

A thunder shower had come up during the last few minutes during which I was speaking to the Shah, and the temperature had become bearable again. The Mikado seemed to revive under the bracing air, which up to that minute I had not observed. With one vicious lunge he grabbed me by the lapel of my coat and was about to pull me over to him. I could see a dangerous light in the upper side of his northeastern eye, and I quickly slipped off my coat, which he retained as a souvenir. I made for the door, but before I went through it I couldn't help asking him: "Now, Boss, what is wrong?" at which he came back:

"You confounded little liar, don't you know that fish have no ears and cannot hear?"

I feel deeply hurt and aggrieved. There is always some one taking the joy out of life. You can not argue with these scientific people. They know everything. But whether fish have ears or not makes no difference to me. I stick to my version. Perhaps fish have a certain sense by which they can hear. At any rate, the ones up in Maine did. I am ready to swear it on a stack of super-heterodynes, and if you don't believe it, just try it!

As I have no means of vindicating myself before the Chief, will those of my readers who try the experiment let me know the results? I guarantee that I will get the Old Crab to print the results, if substantiated by you.

Concerning the Nature of Fading

(*Continued from page 270*)

everything is known about the mechanism of radio transmission in the upper air. Little is known about the actual electrical conditions up there and, in fact, radio experiment has now become the chief source of securing information about the electrical conditions up to a hundred miles above the earth's surface. Such information is by no means unimportant, aside from radio, because those electrical conditions have a vital influence on terrestrial magnetism and weather. Enough has been learned to give zest to the search for more complete knowledge of radio transmission phenomena. Work along these lines is in progress all over the world, and there is an organization, the International Union of Scientific Radio Telegraphy, for the promotion of such research.



KIC-O STORAGE "B" BATTERIES

"B" ELIMINATOR SIMPLICITY

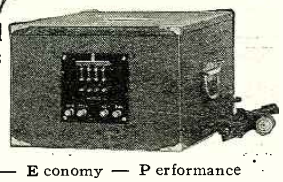
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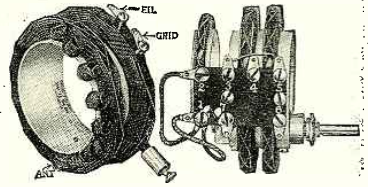
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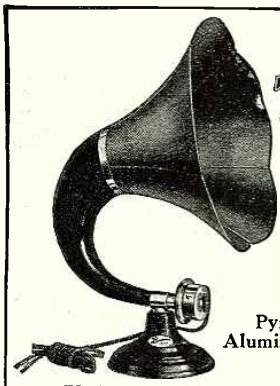
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Lonesome: Make friends everywhere through our Club. Write Eva Burchard, Box 75, Portland, Oregon, for particulars.

Printing Outfits and Supplies

Print your own cards, stationery, circulars, paper, etc. Complete outfits $8.85; Job Presses $12, $35; Rotary $150. Print for others, big profit. All easy, rules sent. Write for catalog presses, type, paper, etc. Press Company, A-13, Meriden, Conn.

Radio

Boys! Don't Overlook This. The "Rasco" Baby Detector. Greatest detector ever brought out with molded base. Fully adjustable. See former advertisements in this publication, or our catalog. Detector with Galena Crystal, complete 50c, the same detector with Radiocite Crystal, 75c prepaid. Send for yours today. Radio Specialty Company, 96-98 Park Place, New York City.

Radio (Continued)

Attention!—50 Vacuum tube hook-ups. The greatest collection of vacuum tube circuits ever brought under two covers at such insignificant cost. These diagrams will be found in the great "Rasco" catalog, which contains raw materials and parts in a greater profusion than any other catalog. 15c in stamps, or coin, will bring the catalog to you. Radio Specialty Co., 96-98 Park Place, New York City.

Edison Elements 5c per pair. Co-operative Merchandise Co., Chelsea, Mass.

McWilliams super-sensitive selenium cells are excellent for voice modulation and experiments with the amplification of Radio by light rays. Hook up for Radio furnished free with each cell. Electric Bean Grader Products Co., Ithaca, Michigan.

200,000 satisfied customers hear distant stations on Lambert Crystal Sets. Copyrighted plans $1.00. Complete kit and plans $5.00. Leon Lambert, 595, Wichita, Kansas.

At Last—New RCA UV-202, 5 Watt Tubes $6.00. 5 Watt transmitting sets complete, 3000 Mile Range $20. 3BOV—S. Strobel, 3923 N. 6th St., Philadelphia, Pa.

Cage Antenna—Used by all experts. Increases set's efficiency 50 per cent. 4 Hoops and Instructions for making cage $1.50. Acme Products, 903 P Broad St., Newark, N.J.

Salesmen Wanted

Clothing Sensation. New Line of men's clothes. All-wool suits and top-coats all at one low price of $23.50. Nothing higher. We pay biggest commissions cash with order, supply finest selling outfit and give powerful cooperation. Three to six orders a day gives you income of $60.00 to $125.00 a week. We have men who earn even more and can prove it. If you're looking for a real proposition and a money maker, write us. Clothing experience isn't necessary. If you're honest, earnest and willing to work, we'll train you. Write at once to Dept. 557, William C. Bartlett, Inc., 850 W. Adams St., Chicago.

Skat Sales Agents Wanted. All or Part Time for Skat Hand Soap, Metal Polish, etc. Strictly Commission. The Skat Company, Hartford, Conn.

A Salesman wanted in every town or city within 25 miles of a broadcasting station to sell Radiogem, the complete radio receiving set that retails for $2.50. With Radiogem there is nothing else to buy—the outfit includes the Radiogem receiving apparatus, 1,000 ohm phone, and aerial outfit. The cheapest radio outfit on the market—yet as practical as the most expensive. Big money to the right men. Send $2.00 for sample outfit. The Radiogem Corp., 66-R West Broadway, New York City.

The Clothing Industry is the second largest business in the country. Men have made fortunes in it. So can you if you go into it right. We'll put you into it right without one penny of expense to you, supply everything you need to get into the business and clear from $100.00 to $200.00 a week, right from the start. This is a wonderful opportunity for the right man—but he must be "right." He must be honest, dependable, able and willing to sell, and above all, he must be willing to work hard for success. If you are such a man, we want to hear from you. Let's get together. You start by addressing Dept. 760, Goodwear Chicago, Inc., 844 West Adams Street, Chicago.

Scenery to Rent

Settings for Opera, Plays, Minstrels. Plush Drops. Address Amelia Grain, Philadelphia.

Song Writers

Songwriters: Let me furnish the music for your songs, guaranteeing you absolute satisfaction. Copyrights secured. Submit your scripts for estimate and free advice. Walter W. Newcomer, 1674 Broadway, New York.

Telegraphy

Telegraphy—Both Morse and Wireless taught thoroughly. Big salaries. Wonderful opportunities. Expenses low; chance to earn part. School established fifty years. Catalog free. Dodge's Institute, Cour St., Valparaiso, Ind.

Wanted to Buy

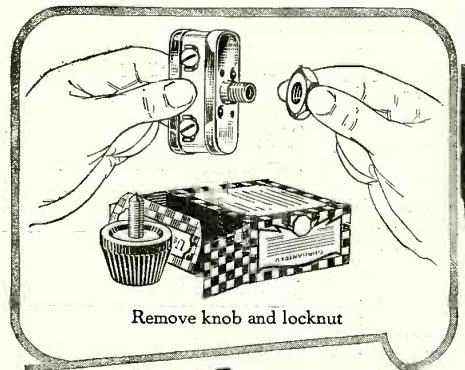
Full Value Paid for Old Gold, Jewelry, Watches, Diamonds, crowns, bridges, dental gold, silver, platinum, gold or silver ore; magneto points, old false teeth. Packages returned if our offer is not satisfactory. United States Smelting Works (The Old Reliable) 39 So. State St., Dept. 16, Chicago, Ill.

Bradleystat

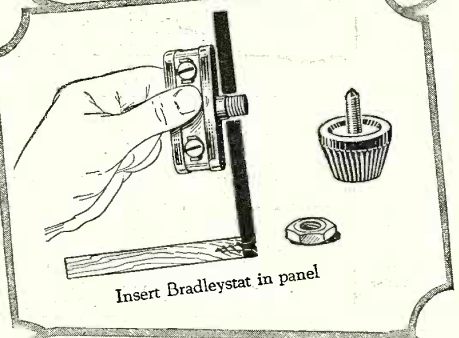
PERFECT FILAMENT CONTROL

for ALL Tubes

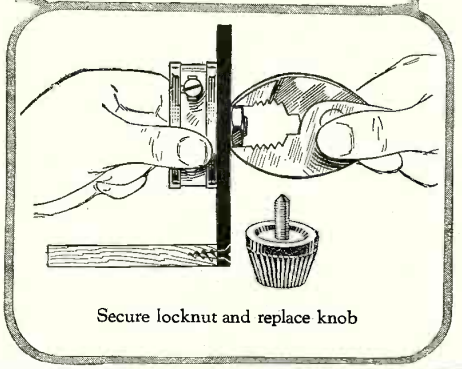
without change of connections



Remove knob and locknut



Insert Bradleystat in panel



Secure locknut and replace knob



Buy your Bradleystat from nearest dealer

Improve your Radio Set with noiseless filament control

THE present trend in radio receivers is toward greater refinement in tone quality, selectivity, and simplicity of control. This accounts for the growing popularity of the Bradleystat and other Allen-Bradley perfect radio devices. The graphite disc construction eliminates the scratchy, noisy operation obtained with wire rheostats, and it provides an unequaled range of control for all tubes.

The "one-hole mounting" and the small size of the Bradleystat permits quick and easy substitution for other rheostats.

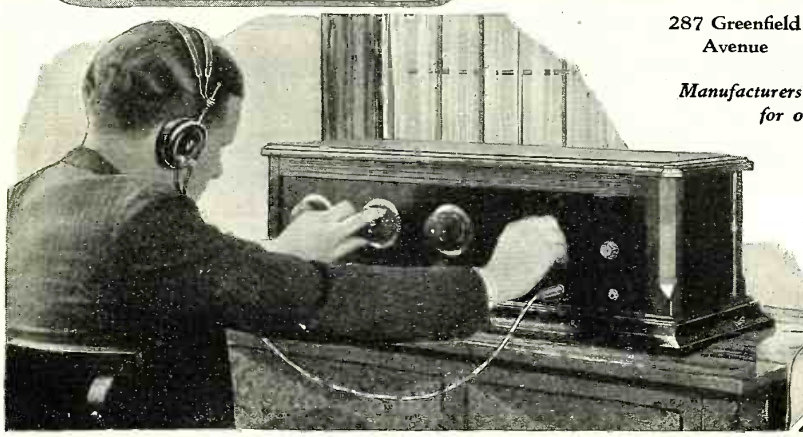
Try a Bradleystat, tonight, and enjoy the silent, perfect control that makes tuning a pleasure.

Allen-Bradley Co.

Electric Controlling Apparatus

287 Greenfield Avenue A-B Milwaukee, Wis.

Manufacturers of graphite disc rheostats for over twenty years



Allen-Bradley Co.
287 Greenfi... Ave...
Milwauke...

Please send ... latest literatur... Allen-Bradley ... radio devices.

Name.....

Address.....

.....

GILES PRINTING CO., LONG ISLAND CITY

Announcing
the Balkite Trickle Charger *at* $10
and the new Balkite "B" *at* $35

FOR THE "A" CIRCUIT



U. S. Patent May 27, 1924

The Balkite Trickle Charger

Charges both 4 and 6 volt radio "A" batteries at about .5 amperes. Usable in 3 ways: (1) As a regular charger with a low capacity storage battery for sets now using dry cells. (2) With storage battery sets of few tubes. Furnishes more current than used by 6 dry cell or 3 storage battery tubes, so that if used during operation it need be used at no other time. (3) As a "trickle" or continuous charger for storage battery sets of as many as 8 tubes. Sizes 5½ in. long, 2¾ in. wide, 5 in. high. Operates from 110-120 AC 60 cycle current.

Low capacity batteries especially adapted for use with this charger are being offered by practically all leading battery manufacturers this fall.

Reputable manufacturers are also offering this fall for use with this charger special switches which turn on Balkite "B" and turn off the charger when you turn on your set. This makes the current supply for both "A" and "B" circuits automatic in operation.

Price $10
West of Rockies, $10.50
Slightly higher in Canada



U. S. Patent May 27, 1924

The Balkite Battery Charger

The most popular battery charger on the market. It can be used while the radio set is in operation. If the battery should be low you merely turn on the charger and operate the set. Charging rate 2.5 amperes. Operates from 110-120 AC 60 cycle current. Special model for 50 cycles.

Price $19.50
West of Rockies, $20
Slightly higher in Canada

The Balkite Battery Charger is today the most popular charger on the market. It is the only charger commonly used while the set is in operation. Balkite "B" II is also well known. It replaces "B" batteries entirely and supplies plate current from the light socket. It was the outstanding development in radio last year.

We now announce the Balkite Trickle Charger at $10. This low-rate charger is especially adapted to use with sets of relatively low "A" current requirements—any dry cell set and storage battery sets having a small number of tubes. Owners of dry cell sets can now make a very compact and economical installation with a Balkite Trickle Charger and a low capacity storage battery of the type being offered by leading battery manufacturers this fall.

We also announce at this time the new Balkite "B" at $35. This new model is specially designed to serve sets of five tubes and less. It fits in your present "B" battery compartment.

Noiseless—No bulbs—Permanent

All Balkite Radio Power Units are based on the same principle. All are entirely noiseless in operation. They have no moving parts, no bulbs, and nothing to adjust, break or get out of order. They cannot deteriorate through use or disuse—each is a permanent piece of equipment with nothing to replace. They require no other attention than the infrequent addition of water. They do not interfere with your set or your neighbor's. Their current consumption is remarkably low. They require no changes or additions to your set. They constitute the most advanced power equipment on the market, one that is economical, unfailing in operation, and eliminates the possibility of run-down batteries.

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

FANSTEEL
Balkite
Radio Power Units

FOR THE "B" CIRCUIT



U. S. Patent May 27, 1924

Balkite "B"

Eliminates "B" batteries. Supplies plate current from the light socket. Operates with either storage battery or dry cell tubes. Keeps "B" circuit always operating at maximum efficiency, for with its use the plate current supply is never low. Requires no changes or additions to your set. No bulbs—nothing to replace. Requires no attention other than adding water about once a year.

A new model, designed to serve any set of 5 tubes or less. Size 8¼" long, 8" high, 3¾" wide. Occupies about same space as 45 volt dry "B" battery. Operates from 110-120 AC 60 cycle current.

Price $35
Slightly higher in Canada



U. S. Patent May 27, 1924

Balkite "B" II

The most outstanding development in Radio last season. Same as the new Balkite "B" but will fit any set including those of 10 tubes or more. Current capacity 40 milliamperes at 90 volts. Size 9" high, 6¼" wide, 7½" deep. Operates from 110-120 AC 60 cycle current. Special model for 50 cycles.

Price $55
Slightly higher in Canada

The Unipower, manufactured by the Gould Storage Battery Company, is equipped with a special Balkite Radio Power Unit.

BALKITE BATTERY CHARGER • BALKITE TRICKLE CHARGER • BALKITE "B" • BALKITE "B" II

Now! C-H Quality at a New Low Price

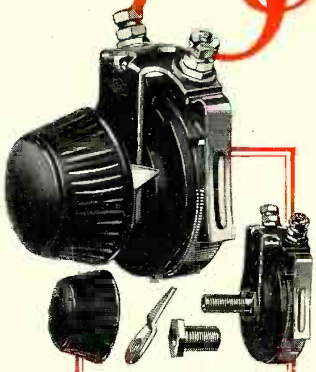
75¢

The Perfected C-H Rheostat

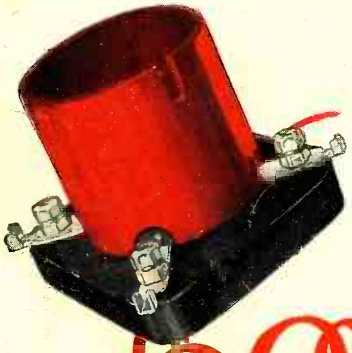
Designed to radio engineers' specifications. Revolving drum type with one hole mounting. All spring tensions adjusted at factory and undisturbed by mounting. Instrument cannot turn on panel. Very small size—less than ¾ inch back of panel and narrower than standard socket. Operation smooth and quiet. 6 ohms, 15 ohms, and 30 ohms—perfect control for all tubes and their combinations.

C-H Radio Potentiometer

Similar in construction to the perfected rheostat. 400 ohms and only a little larger than a silver dollar. Perfect, smooth operation—no back lash or sticking. Price $1.00.



Operating parts built as unit—the C-H Perfected Rheostat is not dismantled for mounting on panel. Rheostat is locked in place and knob positioned without a single set screw.



60¢

The C-H Low Loss Socket

The revolutionary socket design that created a sensation everywhere. Thin ORANGE Bakelite shell. Base of heatproof Thermoplax—terminals cannot loosen under heat of soldering iron. Contacts grip both sides of each tube prong and are SILVER plated to prevent corrosion losses. Preferred by careful builders at 90c—now 60c because of huge production savings

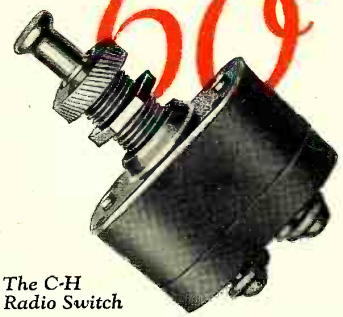


60¢

C-H Radio Toggle Switch

The newest idea in panel switches. ON or OFF with a flip of the finger. Beautiful appearance and simple one hole mounting—neat etched plate for panel provides definite indication. Quiet, easy operating switch mechanism.

60¢



The C-H Radio Switch

The original radio switch. Millions in use. One hole mounting—high capacity mechanism. The only radio switch approved for 110 volt circuits by the Underwriters Laboratories. Ideal for batteryless sets or higher voltage circuits. Many switches now have buttons to look like the C-H but the patented mechanism cannot be duplicated. Demand the orange and blue box for satisfaction.



60¢

The C-H Radioloc

The radio switch that locks with a key. Just the thing for the home with children—for the protection of tubes and batteries. One hole mounting—quiet operation. Like all C-H radio parts, packed in orange and blue boxes. Look for them—and the C-H trade mark.

The name Cutler-Hammer has held an enviable position in radio. Consistently from the earliest days has the C-H trade mark been synonymous with proper design and unequalled precision. Radio builders everywhere justly had faith in these foremost engineers and millions of their radio parts in the orange and blue boxes have helped build receiving sets of quality.

Better Sets at Lower Cost

These millions of sales have brought down manufacturing costs and today this quality carries no premium. Demanding the C-H trade mark now not only insures satisfaction, but provides a saving. Dealers everywhere are ready to serve you. If yours has not yet stocked any C-H part you desire, send us his name and we will see that you are supplied.

THE CUTLER-HAMMER MFG. CO.

Member Radio Section, Associated Manufacturers of Electrical Supplies

MILWAUKEE AND NEW YORK

CUTLER-HAMMER

Buy Your Radio Parts by Name