RADIO BROADCAST

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England's Venture into Broadcasting

The British Listener-In and Amateur—What the "Broadcatcher" Gives and What He Receives—Nine Hearts That Often Beat as One—Problems of Radiation and Other Interference—The Cost and Quality of British Apparatus—Some General Observations

By WILLIAM H. CARY, Jr.

LONDON.

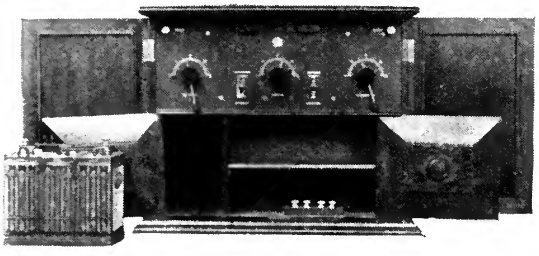
ON THE whole, the radio bearings are well oiled, here in England. This, at least, is the impression one is likely to receive after talking with B. C. L.'s, amateurs, radio editors, engineers, and others, and after listening, from various points in and near London, to the signals that pass in the night. And why not? Considering the caution with which Great Britain entered the broadcasting game—her profiting by the example of the "Yanks", her establishment of a British Broadcasting Company to control the nine stations (only nine, not five hundred and seventy-five), and her foresight in technical and administrative matters—good results are naturally to be expected. The advantage of having all transmission under a single control was brought home to me the first night I listened-in. 2LO was on, and it was a few minutes before an opera was due to fill the air.

"You will find on page——of your *Radio Times* for January——," came the announcer's voice, "a summary of the opera and some comments on the music and its composer." This happened to be an "S. B. (Simultaneous Broadcast) to all stations," so that from Aberdeen to Bournemouth, from Cardiff to London, subscribers to this official weekly of the B.B.C., and those who had planked down their tuppence for a copy at a newsstand could post themselves on the forthcoming music.

According to Post Office figures, about 600,000 broadcast listeners have so far taken out licenses. In November alone, between 40,000 and 50,000 new licenses were issued. There undoubtedly exist some low wretches who make their own sets and listen-in for nothing, leaving the financing of the programs to honest folk. But the general opinion seems to be that evaders are few, and that the 10 or 15 shilling charge* (depending upon the kind of license wanted) does little to prevent people from buying or making receivers. One experimenter—one, by the way, who had heard America during the Transatlantic Broadcasting Tests in November—thought that people who paid out their shillings for a receiving license might very likely invest rather heavily in a set or in parts, so as to be sure and get their money's worth during the twelvemonth. This recalls the old absurdity of the Irishman who stuffed a five-dollar bill down a crack in a boardwalk, in order to make it worth while to rip up the walk and recover a nickel that he had lost there.

*Equivalent to about $2.20 and $3.30.

At any rate, in England there is a lively interest in broadcasting. Across the street from a fifteenth-century church in a quiet little village in Hertfordshire (and sandwiched in between a shop displaying tripe and flounder and one exhibiting Scotch whiskey, brandies, etc.), I came upon a store devoted exclusively to the sale of the latest receiving apparatus. In backyards visible from trains passing



A COMPACT SET

The cabinet contains everything necessary except a loud-speaker The closed cabinet is shown on the next page

through the outskirts of London, the number of antennas is reminiscent of the view from a N. Y., N. H. & H. train up beyond 125th Street, New York. Or even worse. I counted ten parallel antennas in ten adjoining backyards. In town, on every hand there are radio stores, and electrical shops selling radio as a sideline. Enthusiasts who are not inside ardently "talking shop" gaze silently with covetous eyes at the window displays as we do at home. Magazine stands are full of radio periodicals and the periodicals are full of both good and not-so-good stuff, with a fairly healthy proportion of "ads."

Some of the non-technical schools are teaching radio theory and construction to the younger boys; notably the London County Council Schools. I am told that red-cheeked twelve-year-olders are making one shilling do the work of two by strategic shopping around for grid leaks, coils, and whatnot.

WHAT THE PROGRAMS ARE LIKE

THE quality of the B.B.C.'s transmissions seems to be excellent. If there is any kick coming—and of course there is: 600,000 listeners cannot be expected always to chant the same refrain—it is due to the fact that some thousands of the audience may want jazz while other thousands may prefer news or opera. And, unlike the listener-in in America, who can often choose any one of twenty programs, the Englishman must, during the frequent periods of "S.B. to all stations," take what's offered—unless he can tune-in something made in France. As a matter of fact, the S.B.'s are generally well worth listening to—the dance orchestra from the Savoy Hotel, for instance.

One of the most popular programs staged by the British Broadcasting Company is music from "The Old Vic," a sort of secondary national opera house. It is situated about a mile from Marconi House—where are the transmitting plant and antenna—on the south side of the Thames. A land line was used at first to bridge the gap, but it was both inconvenient and noisy. Finally, Captain A. G. D. West, Assistant Chief Engineer of the B. B. C., installed apparatus in The Old Vic for transmitting on low power and low wavelength; these transmissions were picked up by 2LO and put on the air on 365 meters.

Since the November transatlantic tests, by the way, new wavelengths have been assigned to most of the original eight* British stations. As follows:

Station	Location	Wavelength During Tests	Wavelength at Present
2LO	London	363	365
2BD	Aberdeen	495	495
5IT	Birmingham	423	475
6BM	Bournemouth	385	385
5WA	Cardiff	353	350
5SC	Glasgow	415	420
2ZY	Manchester	370	400
5NO	Newcastle	400	435

Here is a complete program from station 2LO, chosen at random:

Monday, Jan. 7, 1924

3.30-4.30.—Concert: The Wireless Trio and Frank Poulton (Bass-Baritone).
5.00.—WOMEN'S HOUR: Ariel's Society Gossip. A Newspaper Story from "Whirligigs," by O. Henry.
5.30.—CHILDREN'S STORIES: Songs by Uncle Rex. "Jack Hardy," Chap. 16, Part I., by Herbert Strang.
6.15.—Boys' Brigade News.
6.25-7.00.—Interval.
7.00.—TIME SIGNAL AND 1ST GENERAL NEWS BULLETIN. *S. B. to all stations.*
JOHN STRACHEY (the B.B.C. Literary Critic): "Weekly Book Talk." *S.B. to all stations.*
Talk by the Radio Association. *S.B. to all Stations.*
Local News and Weather Forecast.
7.35.—THE LONDON 8 CONCERT PARTY.
S.B. to all Stations
Introducing each other.
Quartette, "Come to the Fair" (*Eastbope Martin*) . . . .
COLTON, TARRI, VIRGO, COPELAND

*To these should be added a ninth station, Sheffield, which now not only transmits "S. B.'s" from London, but offers programs originating in its own studio. Its wavelength at present is 300 meters. It has not yet been assigned a call

Instrumental Trio, "Extase" (*Louis Ganne*)
JOAN DUFF, DOROTHY ALWYNNE, WALTER NUNN
Song, Devon Dialect Song
STANLEY HAYSMAN
Bag-pipes Song and Story
TOM COPELAND
Violin Solo, "Gypsy Airs" (*Sarasate*)
DOROTHY ALWYNNE
Humorous Trio, "Willie Brewed a Peck o' Malt" (*Burns*)
. . . . VIRGO, HAYSMAN, COPELAND.
Humorous Imitations on "Coal Black Mammy" (*Suzette Tarri*) . . . . SUZETTE TARRI
Song, "On With the Motley" (*Leoncavallo*)
WILFRID VIRGO
'Cello Solo . . . . . WALTER NUNN
Anglo-Scottish Interlude TOM COPELAND AND SUZETTE TARRI
Song, "Love's a Merchant" . . . EVA COLTON
Piano Solo, Waltz Chromatic (*Godard*) JOAN DUFF
Final Medley, Old Songs (*arr. Suzette Tarri*) THE 8
9.15.—MR. H. GERMAN (President of the National Farmers' Union) on "The Farmers' Position To-day." *S.B. to all Stations.*
9.30.—TIME SIGNAL AND 2ND GENERAL NEWS BULLETIN. *S.B. to all Stations.*
Local News and Weather Forecast.
9.45.—"THE MEISTERSINGERS," Act III. (*Wagner*), relayed from The Opera House, Covent Garden. *S.B. to all Stations.*
11.15.—Close down.
Announcer: R. F. Palmer.

It is evident that the engineers and executives of the B. B. C. are doing their very best, and their best is pretty good. One listener recently wrote to the editor of the *Radio Times*.

DEAR SIR:
Will you please have one rotten program at least once a week, so that I may have an opportunity of having a night out occasionally without regrets?
Yours faithfully,
J. F., London, W.

The *Wireless Review*, a weekly, commenting on a discussion that had been stirred up in one of the daily papers on the subject of the programs, says, "It was noted that most of the contributors to the discussion were in favor of programs being at least as serious as at present. There were some who wanted all jazz, but they were comparatively few. . . . It is gratifying to know that as far as the correspondence went, it was a distinct endorsement of the present policy of the B. B. C."

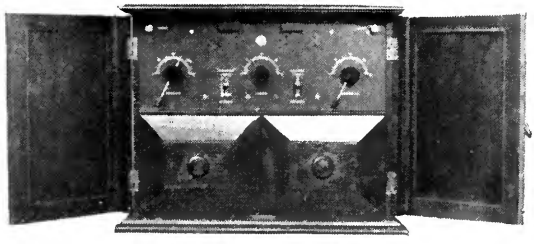
ADVERTISING NOT ALLOWED—ALOUD

AS WITH our stations in America, it is all well enough to broadcast "Yes, We Have No Bananas," but *not* to add that so-and-so's store, at such-and-such an address, expects a consignment of the yellow fruit next week and will sell it at so-much a bunch. In fact, an attempt is made to drown all direct advertising before its eyes are open. Manuscripts are always censored before they are allowed to be read into immortality. I am told that when a talk on modern novels, for instance, is given, the publisher's name is not mentioned; and that when phonograph records are used (as in tests or for certain children's programs), the name of the piece is given, but not the make of the record.

English people seem inclined to think that direct advertising by radio in America is more flagrant than is really the case. Some of them have also the impression that the air with us resembles a delirious person's dream about bee-hives. I have assured them that only on exceptionally clear evenings and on exceptional receivers do all 575 of our stations bombard that receiver at one time.

TROUBLE FROM RECEIVERS THAT RADIATE

THE situation regarding interference from oscillation is a peculiar one in Great Britain. When the British Broadcasting Company first started in, under the supervision of the Post Office, there was considerable fear that tube sets would cause trouble. Officials thought of the storm of whistles and squeaks in America, and turned up their mental coat-collars. Accordingly, the Post Office then undertook to test all sets which were to bear the official stamp of the B. B. C., to make sure



A POPULAR RECEIVER
With the British listener-in. He is just as avid as his American cousin, reports Mr. Cary

that they would not radiate sufficiently to cause interference; and it was made illegal to sell for broadcast reception any complete set not bearing the official stamp. Later on, however, many people who had little technical knowledge wanted to build their own apparatus.

A special license was provided, allowing them to do so, and knowledge of the proper operation of receivers was spread as widely as possible.

But one good squeak deserved another, so it seemed, and recently there has been a marked increase in the amount of interference from bloopers. B. B. C. officials were—and still are—alarmed; listeners-in were likewise personally affected. The blame was placed principally upon those holding Experimental Licenses and those holding the more recently established Constructor's Licenses. But the Post Office no longer tests receivers for oscillation, but only for wavelength range. Mr. Hugh S. Pocock, Editor of the *Wireless World*, says in a recent number of his magazine:

> Exactly what circumstances have brought about such a complete reversion of policy on the part of the Post Office is difficult to follow. Probably it is out of consideration for the manufacturers who were naturally very seriously handicapped in the design of receivers when they had to make them pass the test of non-radiation. In fact, it is exceedingly difficult to design a truly efficient receiver which will pass such a test.
>
> Is it surprising that interference from oscillation should be so much on the increase, remembering that these sets go usually to complete novices who hold broadcasting licenses? If it has been found that official broadcast receivers cannot be satisfactorily designed for non-radiation, then surely publicity should be given to the fact, in order that those using them shall be aware of the interference they may cause and learn how to operate their sets in order to avoid interference.

The law is laid down for holders of the Experimenter's License in these words:

"The apparatus shall not be used in such a manner as to cause interference with the working of other stations. In particular, reaction (regeneration) must not be used to such an extent as to energize any neighboring aerial."

Thus the man who "lives like a star and dwells apart" may obtain the advantages which a regenerative receiver will give, yet without disturbing any one; but the town-dweller must "watch his step"—(or as many "steps" as he is using).

The fact is, the single-circuit regenerative hook-up, not unknown on the west side of the Atlantic, is extensively used on this Island, although vocal and printed expression regarding it parallels what we have become used to at home. To avoid interference from oscillation, various other circuits have been brought forward. Reflex sets have been much in vogue, and neutrodyne receivers are beginning to find considerable favor in the eyes of many enthusiasts. Super-heterodynes have been used by advanced amateurs for some time, but not generally; they are expensive, and, for the reception of any British broadcasting, unnecessary.

Interference from other sources does not seem to be particularly serious. Set-owners who live along the coast have occasion to think horrid things of the naval and commercial stations now and then; and sometimes amateurs invade forbidden wavelengths. The latter, working on 440 meters (the length allowable for C. W. and telephony only) have been requested to "pipe down" during what are known as the Main Broadcasting Hours—5 to 11 P. M. daily and at certain other hours on Sundays.

LICENSES AND WHAT THEY INVOLVE

AT PRESENT there are three classes of receiving licenses. The Broadcast License, which costs 10 shillings a year, allows the holder to listen-in to whatever he may be able to hear. He agrees that his "receiving set, and any valve, amplifier, head-telephone, or loud speaker used therewith, will bear the official trade-mark of the British Broadcasting Company."

The holder of a Constructor's License pays 15 shillings a year, and certifies as follows: "My receiving set will be made or put together by myself; and in its construction I will not knowingly use parts manufactured elsewhere than in Great Britain or Northern Ireland."

The third class is known as the Experimenter's License. It costs 10 shillings a year and permits the holder to use any kind of apparatus in his set, but "Applicants must satisfy the Postmaster General that they have in view some object of scientific value or general public utility and that they are competent to carry out experiments in wireless reception." On the application blank appears also this:

> Strike out (A) or (B):
>
> (A) I declare that the proposed installation will not be used for the reception of broadcast programs except for experimental purposes.
>
> (B) I desire also to use the proposed installation for the reception of broadcast programs for the purpose of entertainment and I agree on that account to pay a license fee of 15s. (instead of 10s.) per annum.

The holder of the first two classes of license

needs only to fill out a blank at his local Post Office, and pay over the stipulated ten or fifteen bob. The would-be experimenter, however, "shall produce evidence of British nationality and two written references as to character. A certificate of birth should be furnished if possible; but this will not be insisted on if the referees testify of their own knowledge that the applicant is of British nationality." His license is obtained through the General Post Office in London.

The regulations governing the British amateur transmitting license may be interesting to American "hams." The requirements regarding evidence of British nationality, references as to character, and birth certificate are the same as for the Experimenter's License just mentioned. Among other things, applicants must also "satisfy the Postmaster General that they have in view some definite object of scientific value or general public utility. If scientific research is intended, they should be certified as competent investigators by a Government Department or some recognized scientific body." By examination or otherwise the applicant must satisfy the Postmaster General that he has attained:

(a) A sufficient knowledge of the adjustment and operation of the apparatus which he wishes to work.

(b) An operating speed of at least 12 words (Morse)* a minute, sending and receiving. This qualification is necessary even when wireless telephony only is used, in order that the person in charge of the station may be in a position to act upon instructions in the Morse code issued by Government and commercial stations.

A fee of 5s. will be charged for the examination referred to above, when necessary.

The person in charge of a sending station must also make himself acquainted with the regulations of the International Convention in so far as they relate to the prevention of interference and impose certain duties on all wireless operators.

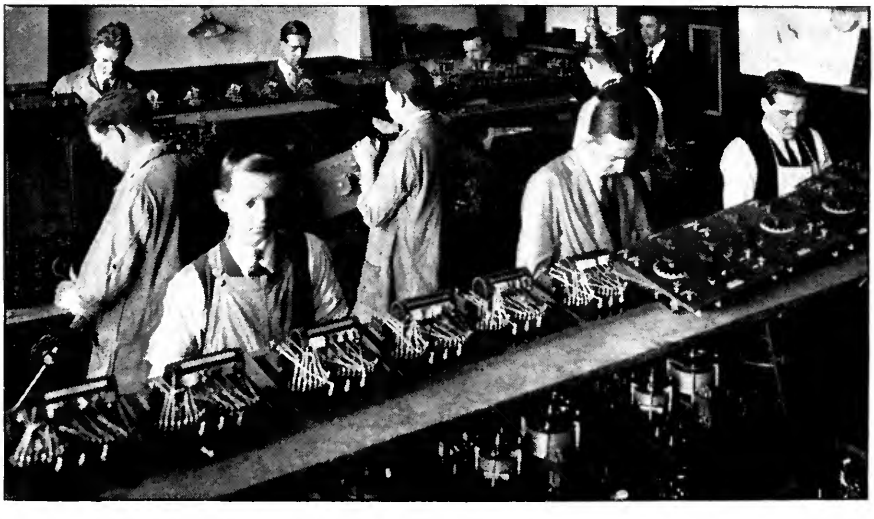
Also:

"For each station authorized to use power up to 10 watts, the charges, which will cover the use of receiving as well as sending apparatus will comprise an initial licensing fee of 10s. plus an annual fee of £1, payable in advance. . . . Higher fees will be charged for more powerful stations.

The combined height and length of the antenna must not exceed 100 feet. For spark, I. C. W., C. W., and telephony, the wavelength band from 150–200 meters is reserved for the British amateur. He may operate within this range during broadcasting hours (although not on the 440-meter wave, as mentioned above). In any case, the amateur may not transmit for periods amounting to more than two hours a day.

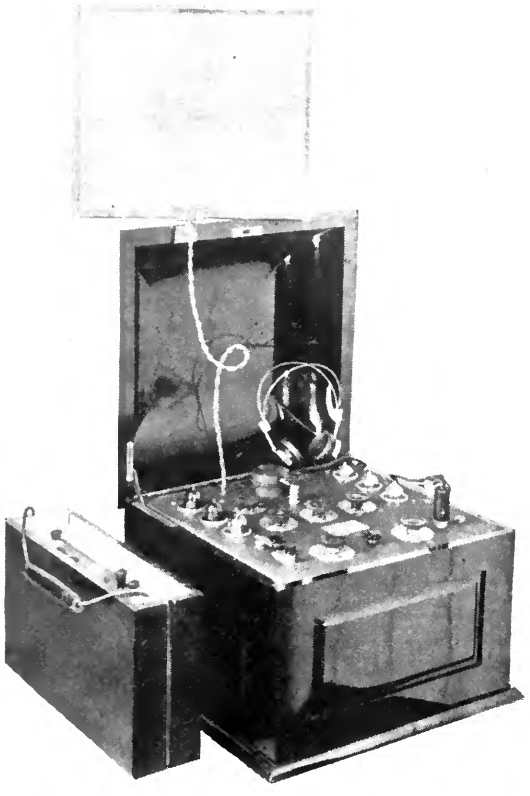
THE COST AND QUALITY OF RECEIVING APPARATUS

SEVERAL companies are clothing their broadcast receivers in extremely handsome cabinets, advertised for sale at approximately the same prices as equivalent American "furniture." Most of the less pretentious store sets, and also the separate parts, appear to be carefully and substantially made. Stores are full of apparatus for apparently every conceivable purpose, and, as at home, there are plenty of different kinds of instruments designed for the *same* purpose. The receiving apparatus of British amateurs, before the advent of broadcasting, was generally mounted



A CORNER IN AN ENGLISH RADIO FACTORY

*This of course, is not what we call "Morse"—our land-line code—but the "Continental" or "General Service" or "International Morse" code.



A SIX TUBE RECEIVER

Three radio, carborundum detector, and three stages of audio made by Metropolitan-Vickers Company, of Manchester. It retails in England for £91

on horizontal panels; this style still prevails in many cases, but slanting panels and vertical ones, similar to most of ours at home, have become much more popular during the last year. One or two manufacturers put out complete units in small square boxes, all the same size and each containing a condenser, or vario-coupler, or tube unit, or some other part. This arrangement is intended to appeal both to the person who wants to build up his set gradually, as his means allow, and to the novice-experimenter, and the restless and ubiquitous "circuit-hound" whose chief pleasure is the pursuit of new and more efficient hook-ups. The square blocks thus serve their purpose. One objection may be that a mess of external wiring results from connecting up six or eight of these units.

The cost of parts averages about the same as in the States, in spite of a considerable variation in many items. Of course, the British listener is admittedly paying for his broadcasting; and those who buy store sets pay also a certain tax for the B. B. C. stamp required on all manufactured receivers. This tax varies from about 1 to 4 per cent. of the selling price of the apparatus. In some cases, due to the incorporation of certain patented apparatus in the sets, there is in addition a Marconi tax to pay. Often, therefore, a B. C. L. pays his broadcasting license fee, the price of the set, the B. B. C. tax, *and* the Marconi tax, before turning his attention to such trifles as tubes, phones, and batteries.

Many manufacturers include the B. B. C. tax in their advertised selling price, and some prices are inclusive of everything but tubes—or everything but tubes and batteries, for instance. It will be seen that, as with us, it is with few exceptions impossible to buy a receiving set which may really be called complete—from A battery to antenna wire. British enthusiasts have been known to exercise their voices in well-modulated complaint of this latter condition.

Various makes of dry-cell tubes are now becoming popular. One type draws .06 of an ampere at 2.5 volts. These low filament consumption tubes are known as "dull emitters."

THE RADIO ENTHUSIAST—HABITAT: EVERYWHERE

I AM sure that there is no fundamental difference between members of the radio fraternity in America and in this, or any other

AN EIGHT TUBE OUTFIT

An excellent example of excellent English taste and workmanship in cabinet building. This set has five stages of tuned radio-frequency amplification, and two of audio

A GOOD ENGLISH AMATEUR RADIO INSTALLATION
Is this station 5CC at Bath

country. One meets here the same enthusiasm the same exaggerations, the same patter of station calls, apparatus, and circuits; the same praise, the same "kicks," the same "wise cracks." It is only the words which expresses all this that differ. And the vocabulary of the British listener (not to mention the old-time amateur) must at first seem very foreign to any one trained in the American idiom. "Dull emitter valves," "frames," "accumulators," "note magnifiers," and other "components" are discussed on all sides.

WHITHER?

"WHERE is it all going to lead?" is, of course, the question frequently asked. What will broadcasting be like in England five years from now—or even two years?" Nobody can do more than guess at the answer; but the outlook is promising—and mighty interesting.

People here are interested in what the "Yanks" are planting and reaping in the radio field, but they are far from dropping their tools to gawk at us; they have far too much to do tilling their own wavelengths. A number of British amateurs, engineers, and the "general public" are expressing their hope, even their conviction, that reliable rebroadcasting of international programs is the next big thing we have to look forward to.

And we can only express the same hope, and say to them (with double meaning): "More power to you!"

More power to all of us!

The Story of the Super-Heterodyne

Its Origin, Development and Some Recent Improvements—A Radio Club of America Paper

By EDWIN H. ARMSTRONG

Marcellus Hartley Research Laboratory, Columbia University, New York

THE purpose of this paper is to describe the development of the super-heterodyne receiver from a war-time invention, primarily intended for the exceedingly important radio telegraphic direction finding service in the Signal Corps of the American Expeditionary Force, into a type of household broadcasting receiver, which, with our present vision, appears likely to become standard.

The invention of the super-heterodyne dates back to the early part of 1918. The full technical details of this system were made public in the fall of 1919. Since that time it has been widely used in experimental work and is responsible for many of the recent accomplishments in long-distance reception from broadcasting stations. While the superiority of its performance over all other forms of receivers was unquestioned, very many difficulties rendered it unsuitable for use by the general public and confined it to the hands of engineers and skilled amateurs. Years of concentrated effort from many different sources have produced improvements in vacuum tubes, in transformer construction, and in the circuits of the super-heterodyne itself, with the result that early in the month of April there has been made available for the general public, a super-heterodyne receiver which meets the requirements of household use.

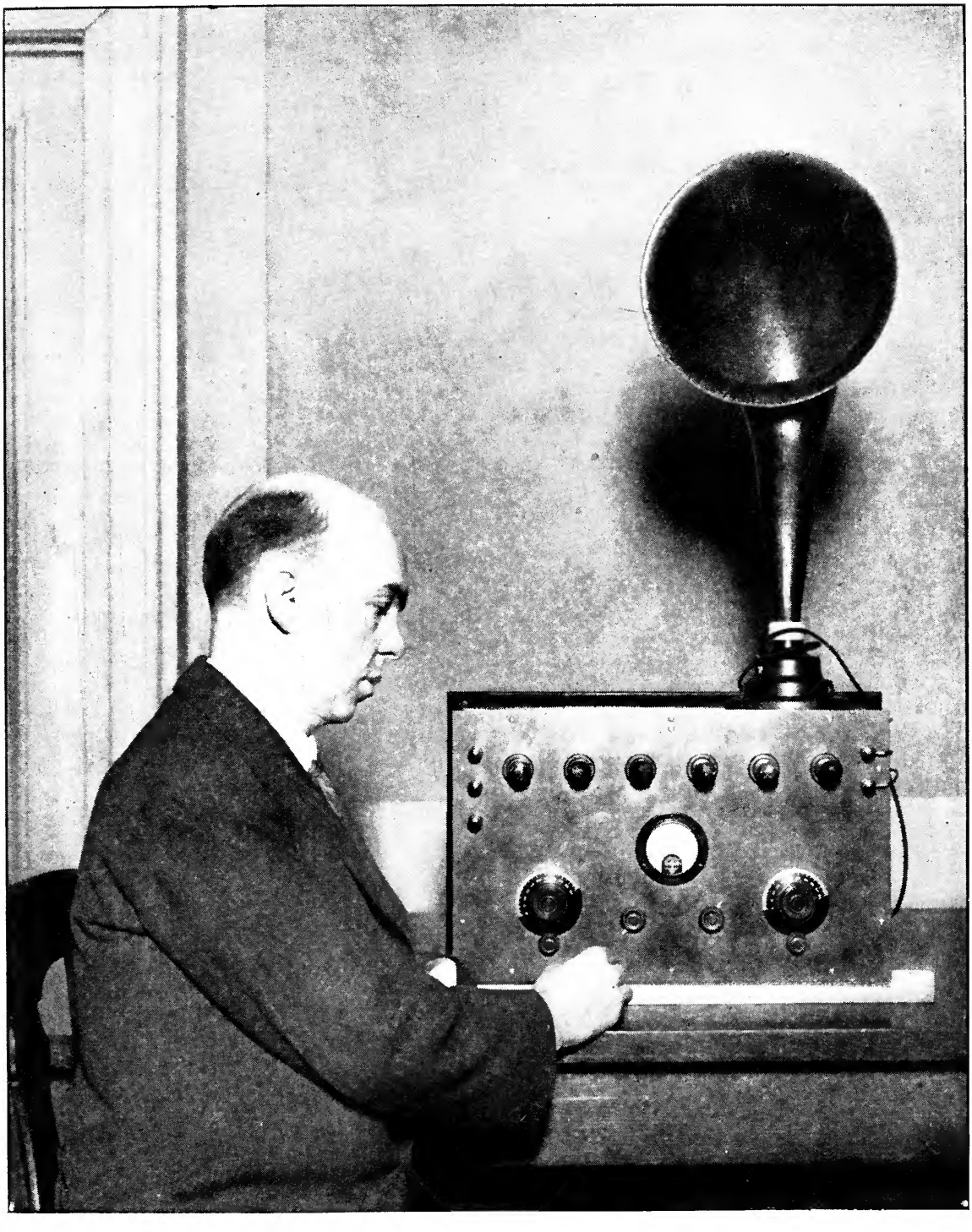
It is a peculiar circumstance that this invention was a direct outgrowth of the failure of the vacuum tubes constructed in the United States to meet a very important problem confronting the American Expeditionary Force. This problem was the reception of extremely weak spark signals of frequencies varying from about 500,000 cycles to 3,000,000 cycles, with an absolute minimum of adjustments to enable rapid change of wavelength. The technical difficulties of this problem are now so well known that it is not necessary to consider them. H. J. Round in England, and Latour in France, by some of the most brilliant technical radio work carried out during the war, had produced substantially aperiodic radio-frequency amplifiers covering the band from 500,000 to 1,200,000 cycles and though covering a much more limited band, amplifiers operating on 2,000,000 cycles had been constructed. These results had been accomplished by the use of vacuum tubes and transformers of a minimum capacity. As this apparatus was used in the highly important intelligence services, all information was carefully guarded. When the United States entered the war, the fact that it was necessary to produce extremely sensitive receivers for short wavelengths and that tube capacity would prove the bar to a straightforward solution of the problem was not known in this country. As a result, no attention was paid to the capacity in the type of vacuum tube which was adopted and while the tube met the

Truth and Poetry—Plus Romance

No reader who makes a practice of neatly avoiding the "technical articles" should miss any of these fascinating lines of Edwin Armstrong's straightforward story of the development of the super-heterodyne, which is quite decidedly romantic in spite of the simple and direct way in which it is told.

This article tells how the second harmonic super-heterodyne was developed after the pressure of war-time necessity had caused the practical invention of the receiver. Mr. Armstrong has some pertinent remarks to make on radiation, reradiation, and the future of broadcast reception in general.

Here is an article that no one genuinely interested in radio should fail to read. It is an article we are proud to publish.—THE EDITOR.



EDWIN H. ARMSTRONG

And an early model of the six tube regenoflex second harmonic super-heterodyne—one of the greatest achievements ever made in broadcast receivers. This young inventor at one time studied under Professor J. H. Morecroft at Columbia University, New York City. Much of his present radio experimental work is being done at the Marcellus Hartley Laboratory at Columbia

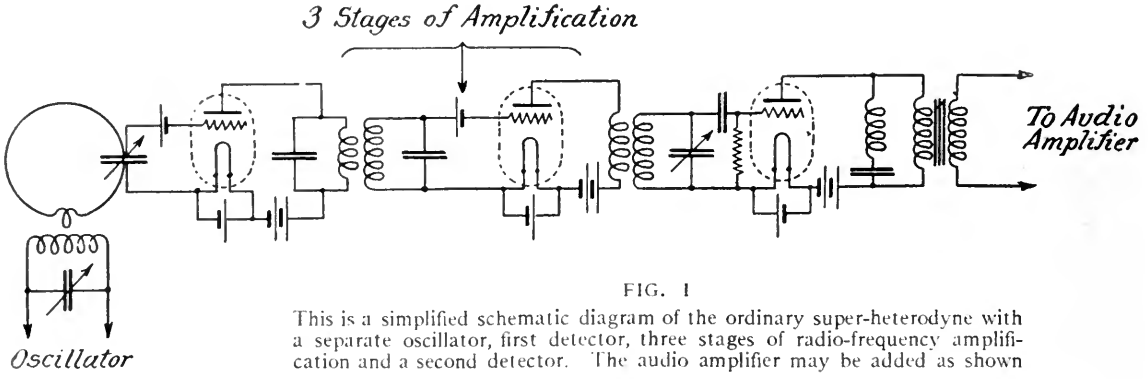


FIG. 1

This is a simplified schematic diagram of the ordinary super-heterodyne with a separate oscillator, first detector, three stages of radio-frequency amplification and a second detector. The audio amplifier may be added as shown

requirements of the lower frequencies admirably, it was impossible to use it effectively for the frequencies of importance in the direction finding service.

HOW THE SUPER-HETERODYNE ORIGINATED

DURING the early part of 1918, through the courtesy and energy of General Ferrié and his staff, the American Expeditionary Force was supplied with apparatus of French manufacture. It was quite apparent, however, that this source of supply could not be a permanent one and a solution of the problem became essential. During the early part of 1917, I had made a careful study of the heterodyne phenomena and their effect on the efficiency of rectification. With these experiments freshly in mind, the idea occurred to me to solve the problem by selecting some frequency which could be handled by the tubes available, building an effective amplifier for that frequency, and then transforming the incoming high frequency to this readily amplifiable value by some converting means which had no low limit; preferably the heterodyne and rectification. The principles and advantages of this method were explained in a paper presented before this Institute and are now so well known that no further explanation is required here.

After much experimental work, an eight-tube set was constructed consisting of a rectifier tube, a separate heterodyne oscillator, three intermediate-frequency amplifiers, a second rectifier or detector, and two audio-frequency stages. The intermediate-frequency stages were coupled by tuned air-core transformers set for a frequency of about 100,000 cycles, with an adjustment for controlling the regeneration. The amplification of voltage measured at the input of the second detector with the amplifier just below the oscillating point, was about equivalent to a radio-frequency amplification of 500.[1] The arrangement of its circuits in Fig. 1 gave satisfactory results except that the inclusion of a regenerative control on the intermediate-frequency amplifier made skilled handling necessary, as the adjustment of the frequency of the oscillator changed the plate current of the detector tube and this, in turn, varied the resistance which that tube introduced into the amplifier system and upset the regenerative adjustment.

The Armistice ended development at this point, but in the fall of 1919, for the purpose of determining the results which could be obtained by pushing the super-heterodyne method of reception to the limit, a resistance-coupled intermediate-frequency amplifier consisting of five high mu tubes was constructed. The voltage amplification of these five stages was probably between 5,000 and 10,000 fold. While greater amplification could have been obtained, the sensitiveness of a set composed of a two-tube frequency converter, a five-tube intermediate-frequency amplifier, a detector, and one-stage of audio, was such that on a three-foot (one-meter) loop, the sole criterion of reception was simply whether the signal was stronger than the atmospheric disturbances.

PAUL GODLEY USED A SUPER-HETERODYNE TO COPY AMERICAN AMATEURS IN SCOTLAND

THE sensitiveness of the super-heterodyne was demonstrated during the winter of 1919–1920 when the spark signals from amateur stations on the West coast and telephone signals from destroyers in Southern waters

[1] This amplification is based on the ratio of the voltage applied to the second detector to the voltage at the loop terminals. The intermediate frequency amplification is unknown.

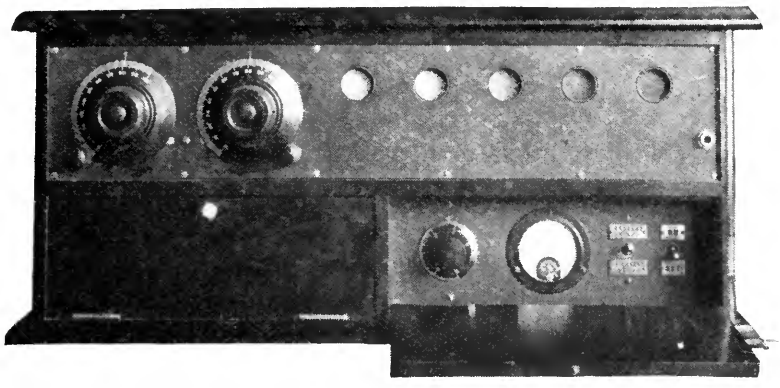


FIG. 2

This super-heterodyne is transformer-coupled and has been used by Major Armstrong in many demonstrations given under the auspices of the Radio Club of America

were received in the vicinity of New York on a three-foot (one-meter) loop. Probably the most striking demonstration of the capabilities of the method occurred in December, 1920, when Paul F. Godley, at Ardrossan, Scotland, received the signals of a large number of amateur stations located in the United States, many of them being spark stations. The super-heterodyne used by Godley consisted of a regenerative tube for the first rectifier, a separate oscillator, four stages of resistance-coupled intermediate-frequency amplification, a second rectifier, and two stages of audio. While it is difficult to state definitely the actual voltage amplification obtained, it appears to have been between 3,000 and 5,000 fold.[1]

With the coming of broadcasting and with the great increase in the number of stations and the consequent interference, the super-heterodyne began to take on a new importance—an importance which was based not on its superior sensitiveness nor on its selectivity, but on the great promise which the method offered in simplicity of operation. It was, and still is, the standard practice to furnish the public with receivers equipped with a variety of tuning adjustments for the purpose of amplifying the desired band of radio frequencies and excluding all others. As a matter of fact, many more adjustments are on receivers than should be used—more than could be placed in the hands of the average user. It would obviously be of the greatest importance if in some way these tuning adjustments could all be made in the laboratory by skilled engineers and sealed, leaving some relatively simple adjustment for the hands of the operator. The super-heterodyne offered the ideal solution. This solution lay in the construction of an intermediate-frequency amplifier which would amplify a given frequency and a band 5,000 cycles above and below it and which would cut off sharply on either side of this desired band. The adjustments necessary to accomplish this could all be made by skilled men, and the only operations left for the user would be the two adjustments necessary to change the incoming frequencies down to the band of the amplifier—adjustments which are not dependent on each other, which are of extreme simplicity, and which can be made equally well by the novice or the engineer. To determine just what could be accomplished along these lines, the writer, working in conjunction with Mr. Harry Houck constructed during the spring of 1922, a set designed for the maximum usable sensitiveness and selectivity.

THE FIRST MODEL

THE set-up consisted of one radio-frequency stage (non-tuned transformer) a rectifier tube, an oscillator tube (used as a separate heterodyne), a three-stage iron-core transform-

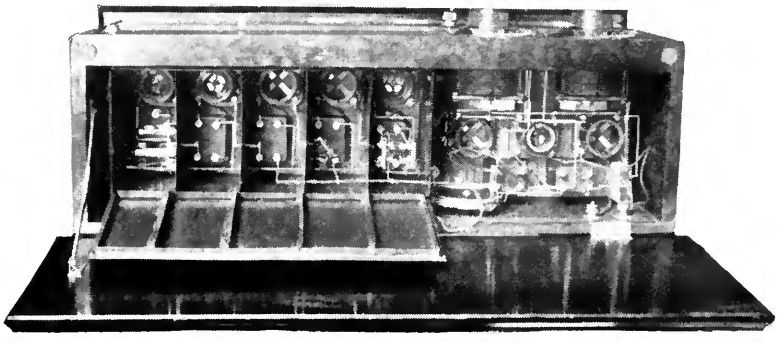


FIG. 3

This is the interior of the receiver pictured above

[1] Based on the standard previously described. This is without the second heterodyne which was used in receiving continuous waves.)

er-coupled intermediate-frequency amplifier designed to cover a band of 20,000 to 30,000 cycles, a second detector tube, and two stages of audio-frequency amplification. UV-201-A tubes

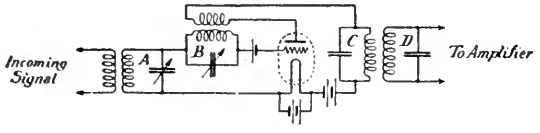


FIG. 5

The fundamental circuit of the second harmonic method of producing the oscillator frequency

were used. The set without the audio-frequency amplifiers is illustrated in Fig. 2 and Fig. 3. To prevent the intermediate-frequency amplifier from oscillating, each stage was shielded separately. The use of a radio-frequency stage ahead of the first detector possesses a number of advantages but the chief one is in eliminating the reaction between the loop circuit and the oscillator circuit. Experience with the original type had shown that when an oscillator of ordinary power was used, it was necessary to couple it rather

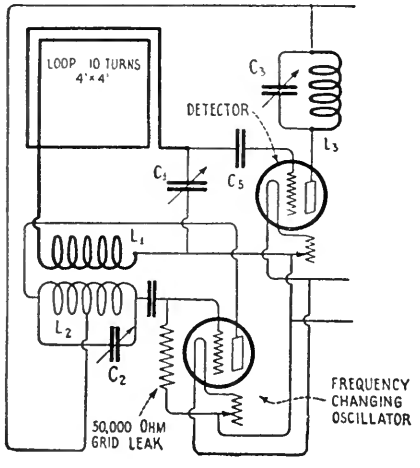


FIG. 4

The ordinary type of wave-changer for the super-heterodyne requires two tubes as shown here—the new method is shown in Fig. 5

closely with the loop circuit in order to insure a sufficiently strong heterodyning current. This close coupling affected the tuning of both circuits, an adjustment of one changing the setting of the other. To avoid this trouble and to produce a system wherein a station could always be tuned-in on exactly the same settings, a single stage of radio-frequency amplification (using a non-tuned transformer) was used, and the oscillator was coupled into this transformer. This arrangement eliminated the reaction, reduced the radiation to a minimum, and, in addition, removed the damping of the first rectifier from the loop circuit and improved its selectivity.

The results obtained with this set were about as expected. On a three-foot (one-meter) loop, the factor determining the reception of a station was solely whether the signal strength was above the level of the atmospherics. The selectivity was such that stations which had never been heard before on account of blanketing by local stations, were received without a trace of interference. While the performance of the set was much superior to any other receiver, it was apparent that the cost of construction and maintenance was prohibitive. The single item of a ten-ampere filament current will give some idea of the size of the storage battery and auxiliary apparatus required.

With the coming of the low filament consumption, or dry battery type of tube, the possibilities of producing a super-heterodyne for household use were tremendously improved. The set of Fig. 3 was remodelled for the WD-11 tube and its sensitiveness was brought to about the same value as obtained with the storage battery tubes. This was a long step forward but still its cost was prohibitive.

WHY THE SECOND HARMONIC PRINCIPLE WAS DEVELOPED

IT HAD been apparent ever since the question of the application of the super-heterodyne to broadcasting had been considered, that there were too many tubes performing a single function which were quite capable of perform-

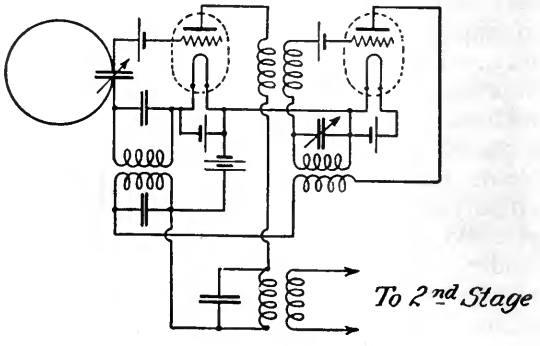


FIG. 6

This circuit makes it possible to reflex some of the intermediate amplifier tubes, using them for audio amplification as well. The result is more economical operation

ing a double one. The most outstanding case is that of the separate heterodyne oscillator. In view of our knowledge of the self-heterodyne, it appears quite obvious to perform the first rectification by means of a self-heterodyne oscillator and thereby save a tube. As a matter of fact, this was one of the very first things tried in France, but, except for very short wavelengths, it was never very successful when a high intermediate frequency was necessary. The reason was this. If a single tuned oscillating circuit was used, the detuning to produce the proper beat caused a loss of signal strength which offset the gain of a tube. If two tuned circuits were used on the oscillator, one tuned to the signaling frequency and the other arranged to oscillate at the heterodyning frequency, then on account of the relatively small percentage difference in frequency a change in the tuning of one circuit changed the tuning of the other. The solution of this problem was made by Houck, who proposed an arrangement so simple and so effective that it completely solved the problem. Houck proposed to connect two tuned circuits to the

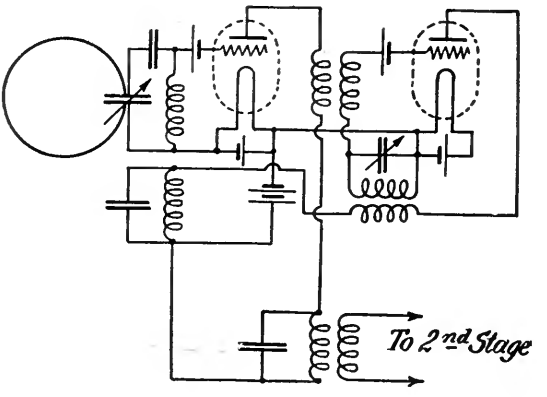
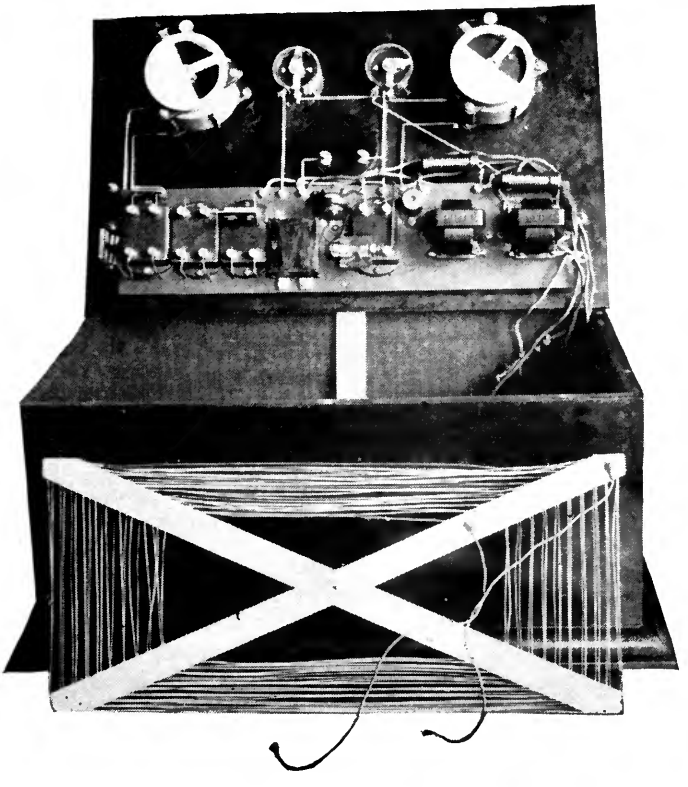


FIG. 7
A similar arrangement to that shown in Fig. 5 and explained in the text

oscillator, a simple circuit tuned to the frequency of the incoming signal and a regenerative circuit adjusted to oscillate at such a frequency that the second harmonic of this frequency beating with the incoming frequency produced the desired intermediate frequency. The general arrangement is illustrated by Fig. 5.

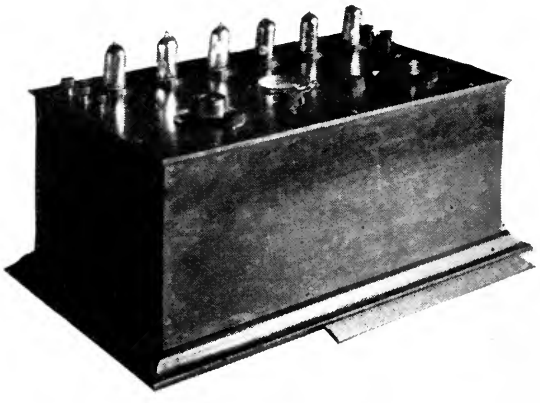
In this circuit A is tuned to the incoming signal, circuit B is tuned to one-half the incoming frequency plus or minus one-half the intermediate frequency, and the circuits C and D are both tuned to the intermediate frequency. The operation of the system is in line with ordinary self-heterodyne action. By reason of the asymetrical action of the tube, there are created in the circuits a variety of harmonics. The second harmonic combines to produce beats with the incoming signals of the desired intermediate frequency, the tube rectifies them to produce the desired intermediate frequency and, through C and D, the new frequency is supplied to the amplifier. On account of the fact that circuits A and B are tuned to frequencies differing by approximately 100 per cent., a change in the tuning of one has no appreciable effect on the tuning of the other. This arrangement solved the oscillator problem and, in addition, practically eliminated radiation.



This is the interior of the original receiver built on the second harmonic principle

The next step in the reduction of the number of tubes, was to make the radio-frequency amplifier perform the function of amplifying

intermediate-frequency as well. This can be done with none of the difficulties inherent in audio-frequency amplification, as the very small amplitudes of voltage handled by the first tube precludes the possibility of the grid becoming positive with respect to the filament. The general arrangement of circuits for carrying this out is illustrated by Fig. 6. In this arrangement the signals received by the loop are amplified at radio-frequency by the first tube and applied to the grid of a second harmonic oscillator by means of an untuned radio-frequency transformer. The combined signaling and heterodyning currents are then rectified by the second tube producing a current of the intermediate-frequency which is applied to the grid of the first tube, amplified therein and passed on to the second stage of the intermediate-frequency amplifier. A more practical method of carrying out this idea is illustrated in Fig. 7. In this arrangement, a secondary



One of the early models of the six-tube receiver. The receivers now sold employ a similar circuit

of the first intermediate-frequency transformer is connected to the grid of the first tube and in parallel with the loop circuit. Otherwise, the arrangements of Figs. 6 and 7 are identical. The parallel type of circuit arrangement eliminates a variety of reactions which would give rise to oscillations of various frequencies and in addition, prevents the reception of long-wave signals by the intermediate-frequency amplifier. When this development had been completed, improvements in the design of the intermediate-frequency transformers made it possible to obtain with two stages all the amplification which could be used.

On account of the high amplification, signals from local stations overload the second rectifier and introduce distortion. Control of the amount of intermediate-frequency amplification is essential. While there are numerous methods equally effective, the simplest one appears to be the control by means of the filament temperature of the second intermediate-frequency amplifier.[1]

The features just described were all incorporated in the receiver which is illustrated in Figs. 8 and 9. The set measured 16″ x 10″ x 10″ and was completely self-contained—the batteries, loop antenna, and speaker mechanism being enclosed in the box. The results were highly satisfactory and loud speaker signals (at night) in the vicinity of New York were obtained from stations in Chicago and Atlanta. It demonstrated that not only could a household receiver of the super-heterodyne

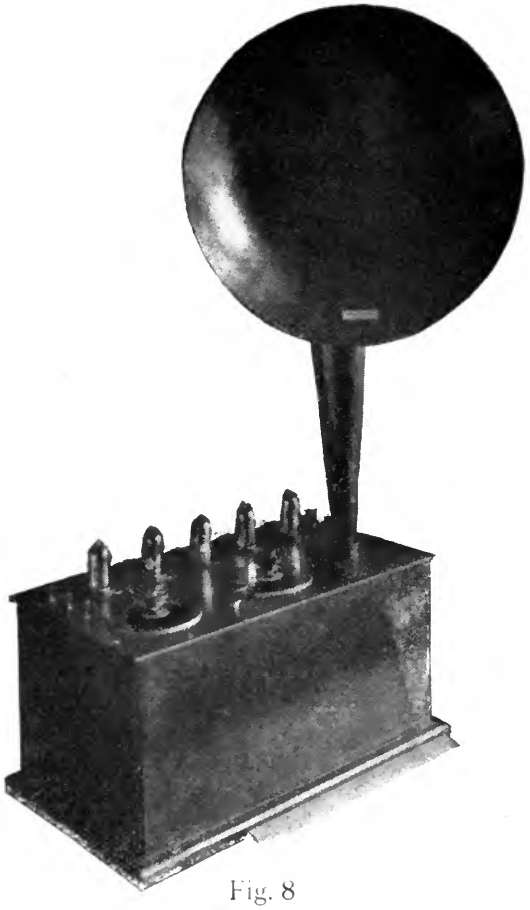


Fig. 8

In this five tube layout a loud speaker has been incorporated

[1]Although some form of potentiometer type of control of the voltage applied to the grid of one of the amplifier tubes would obviously be better, the simplicity of the filament control has many advantages in manufacture.

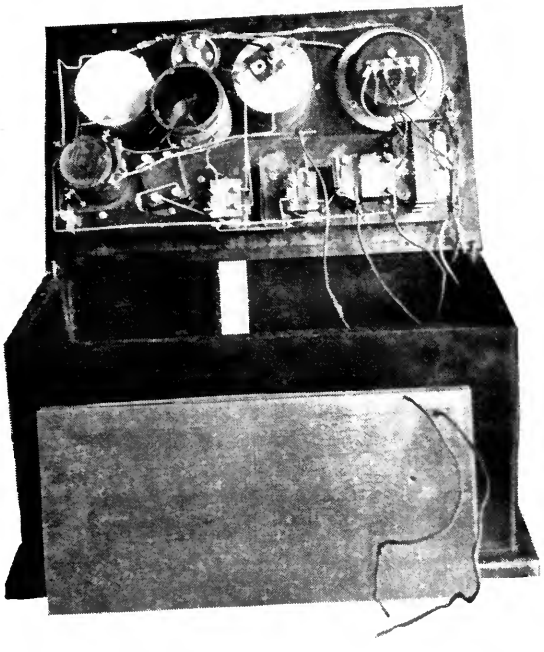


FIG. 9

Interior of the super-heterodyne portable with which an inexperienced woman heard 2LO during the tests run by RADIO BROADCAST and the *Wireless World* (London) last November

type be built, but that the first practical solution of the portable set was at hand.

FROM THE LABORATORY MODEL TO THE COMMERCIAL PRODUCT

IN THIS form, the capabilities of the set were brought to the attention of the Westinghouse Electric and Manufacturing Company and the Radio Corporation of America a little over a year ago. Its possibilities were instantly visualized by Mr. David Sarnoff, who immediately took steps to concentrate the resources of the research laboratories of the Radio Corporation of America, the Westinghouse Electric and Manufacturing Company and the General Electric Company on this new development. From that point on it passed into a new phase—that of placing an invention in a commercial form. In the limited time available, this was a most extraordinarily difficult proposition, and credit for its accomplishment is due to the untiring efforts on the part of the engineers of the above organizations. Many improvements and some radically new ideas of design have been introduced, but it is the privilege of those responsible for them to present these. In the final development of this receiver, an additional stage of audio-frequency amplification was added in order to insure operation within steel buildings, particularly those within the city limits where signals are relatively very weak compared to suburban locations. This makes a six-tube set but six tubes can be readily operated on dry batteries and the increase in sensitiveness is well worth the extra tube.

Some idea of the sensitiveness and the ease of operation of the set illustrated in Fig 9, may be gathered from an incident during the RADIO BROADCAST—*Wireless World* transatlantic broadcasting tests of November and December, 1923. On December 1st, two women, neither having any technical radio knowledge, received loud speaker signals from station 2LO, London, England. This was accomplished at Merrimac, Massachusetts, with the set and loop illustrated in Fig. 9 and perhaps constitutes a record for the first radiophone reception from Europe with a portable receiver. With the same set and a three-foot (one-meter) loop, loud speaker signals from broadcast stations on the Pacific Coast were received in the vicinity of New York on an average of three or four times a week. The sole criterion of reception was whether the signal strength was above the level of the atmospheric disturbances.

The type of super-heterodyne described herein is now available to the public in the two forms illustrated in Figs. 10 and 11. Each of

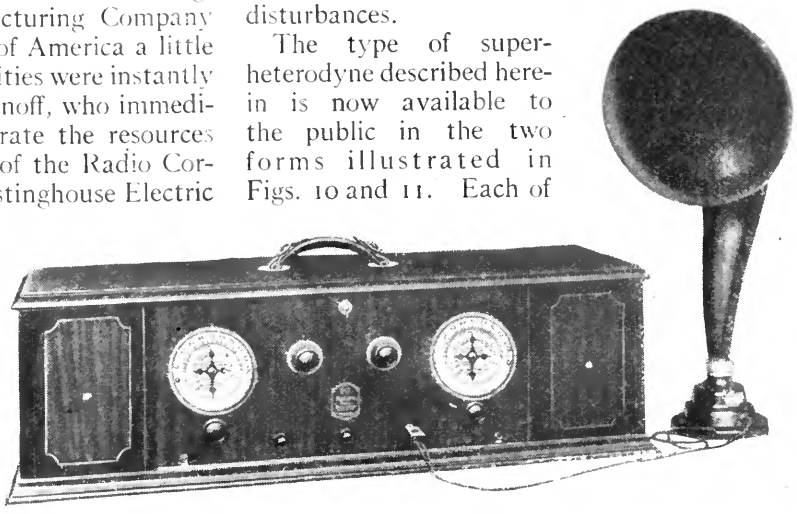


FIG. 10

The semi-portable six tube super-heterodyne now coming into great popularity. It is luxurious in appearance, simple to operate and produces excellent volume with marked clearness of tone

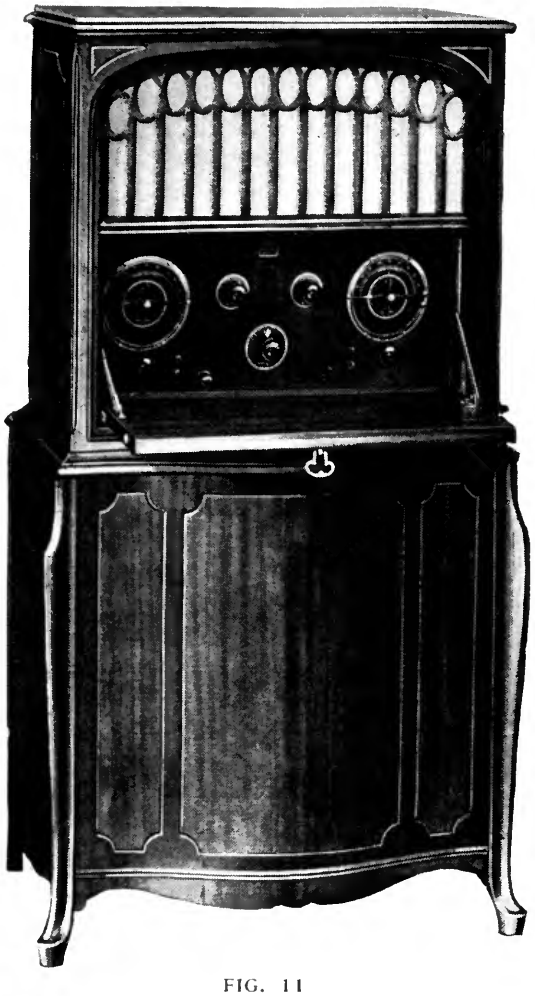


FIG. 11

The loud-speaker has been made a part of the receiver and a rotatable loop is provided in the case below. This receiver is one of the most luxurious ever placed on the market

these sets incorporate the arrangements herein described. Their sensitiveness is such that, with a two-foot loop and an unshielded location, the atmospheric disturbances are the criterion of reception. Here we reach a milestone in the development of broadcast receivers for no increase in the distance of reception can now be obtained by increase in the sensitiveness of the receiver. Unless the power of transmitting stations is increased we are about at the limit of the distance which can be covered. Future improvement of this receiver will lie along the line of increasing its selectivity and simplifying its construction. Aside from the development of the super-heterodyne but few recent radio receivers have improved in other than their mechanical arrangement and cabinet work.

APPENDIX

Some notes on the interaction between receiving sets.—Radiation—Coupling between antennas—Have broadcast stations enough power to go around?

PROBABLY the greatest outstanding problem in radio is the interaction between receiving sets. This interaction is due to several causes. The three main types may be classed under the heading "Radiation, Reradiation, and Coupling between Antennas."

At the present moment, much attention is focused upon the problem of radiating receivers. Much is being written about it under the misnomer "Reradiating receivers." Little has been written on the subject of reradiating receivers and still less about the problem resulting from the coupling between antennas. Doubtless this is due to the fact that the last two problems are at present masked by the first one. In my opinion, they are equally important, will cause increasing trouble and if radio proceeds along its present lines of development, will as seriously affect long distance reception as radiating receivers are affecting it at the present time.

To explain the above three types of interference, I will define each of them:—

RADIATION

THIS interference is produced by sets which, of their own volition, generate electrical oscillations of a frequency which is determined by the constants of their own circuits. The effect on neighboring receivers is the production of a beat note or whistle on wavelengths close to the frequency radiated by the oscillating receiver. This type of interference is commonly and improperly called "Reradiation." A radiating set may also produce interference by reradiation but this is a secondary matter and the primary cause of interference is radiation. The radiation is in the form of a continuous unmodulated wave.

RERADIATION

THIS type of interference results from an antenna picking up energy from an incoming wave and as the name implies, reradiating that energy into space. The reradiated

energy is not a continuous unmodulated wave as in the previous case but a wave which is modulated substantially in accordance with the modulations of the received signals and which exists only as long as the received wave exists. This type of interference is most pronounced in the case of regenerative receivers which are set just below the point of oscillation. It causes trouble in near-by receivers in two ways. One is that the energy reradiated is not in the form in which it was originally transmitted from the sending station but has some of the characteristics of the receiving set superimposed upon it. The other is that the reradiated energy, particularly in the case of a large antenna with regeneration, boosts the signals in adjacent antennae, producing a fictitious signal strength in the other receivers which disappears when the large antenna is tuned to another station.

At present, receivers which regenerate in the antenna are responsible for most of the trouble. Elimination of regeneration in the antenna would aid the situation greatly. It would not, however, be a permanent solution of the problem. The elimination of regeneration in the antenna would merely reduce the area over which the effect of reradiation would be felt. If the number of antennae increase at the present rate, it will not be long before practically every antenna in a city will be within the reradiating range of a dozen others, each of which will make its influence felt. If regeneration is eliminated from all the antennae, then the question of whether the signal will be strengthened or weakened in any individual antenna on account of the proximity of the others, will depend largely upon their relative size, resistance and position. In general, a small antenna in the proximity of a large one will have its signals strengthened when the large antenna is tuned to the same wave, although this rule is not invariable.

COUPLING BETWEEN ANTENNAE

THIS type of interference is perhaps the most annoying of all. It occurs where two or more antennae are located so close together that each affects the tuning of the other. Where several antennae are associated together and produce this effect (for example, when they are all on the same roof) the difficulties of the operator in keeping his set in tune with a particular station can well be imagined.

At the present time in congested localities, all three of these types of interference occur and the solution of the radiation problem, while it is technically and economically possible of solution, will but serve to concentrate attention upon two other problems which are not technically capable of solution. In addition to these specific problems, we have in cities the much broader one of whether there is going to be enough energy to go around. It is perfectly apparent at the present time that the tuning of a large number of receivers in a congested area to the same signal results in a weakened signal for practically everybody. If every housetop were fitted with several antennae, the question arises as to how much energy the man in the center of the city would find left if everyone ahead of him had absorbed as much from the wave as possible by using as high and efficient an antenna as he could erect. The sole solution to this and all the other troubles is the use of an antenna of the loop type whose effect on near by receiving stations is negligible.

Of course, this necessitates more sensitive receivers with an increase in amplifying power commensurate with the relative receptive powers of an antenna versus a loop. At first sight, it might appear that the cost of this change would be prohibitive but with our present rate of development, I believe that it is going to be possible to build loop sets as sensitive as our present type antenna sets with but relatively little increase in cost. At the same time, the situation can be improved from another angle. The power of transmitting sets will gradually increase both because of the fact that there is no way to eliminate the effects of atmospheric disturbances, elevator induction, X-ray machines and all the other types of interference which exist in a large city except to ride over them with high power and because of the fact that from the program standpoint, it is economically better to concentrate talent at one point.

All these factors point to the elimination of the present type of antenna which will disappear in the same manner as the overhead telegraph, telephone, electric light and trolley wires have disappeared in the last twenty years.

Radio Talent Is Not Localized

AMONG the many advantages made possible through radio, an outstanding feature is the opportunity it affords each section of the country to gain an understanding of the local musical talent in all the other sections. Even to those of us who, through much travel to various music centers while carrying on our professional activities, have felt that we were well in touch with the musical life of the country. the radio brings constant revelation, as surprising as it is agreeable.

Before the days of broadcasting we would one and all have said that the best local musical talent would be found in those localities where music, as a profession, had the greatest following. But that uncanny medium of communication, the microphone, is apt to prove this conclusion more often wrong than right. Some of the best singing and piano playing the present writer has heard over the radio goes to the credit of such stations as WOC at Davenport, and WHAA, Iowa City, Iowa; KFKX, at Hastings and WOAW at Omaha, Nebraska; WMAB, Oklahoma; WCAL, Northfield, Minnesota, to name but a few. This does not mean that you will always get satisfactory musical programs through these stations; but if you tune them in often enough you will at one time or another hear some of the most gratifying performances the radio has to offer.

Why is this? Perhaps some of our readers can enlighten us. It is a case where many opinions are worth more than one. As for a single opinion, the answer to the question seems two-fold, First, that in such towns as these, and many others as well, good health pervades the musical life. Good health in that the bitterness of unrelenting competition has not eaten to the heart of that life and made it a struggle for existence against almost superhuman odds. And another reason may be that many women who once expected to pursue music as a profession and studied under noted teachers to this end, gave up the fight, married, settled in these communities and are now using their music as a by-product instead of making it the main interest of their lives. Also among the men may be some who might have become professional singers, but who at the crucial moment decided to make their lives financially sure by becoming established in business and who now use their vocal accomplishments as church singers and through concert appearances in near-by localities.

The colleges scattered through these sections also contribute their share toward the musicians who are heard on these programs, and an occasional station may be found that is directly associated with a college. But even in such cases the programs are not confined to the students or the faculty.

Long before such a thing as broadcasting was dreamed of, many of these towns now sending out at times such excellent radio programs were known among musical managers as lucrative fields for concert artists. But patronizing a dozen concerts or so during a season has little effect on the musical culture of a community as compared with the residence in that community of well trained musicians.

BETTY COMPTON

—In "Vogues." What has become of the inventor who said he would make it possible to see a broadcast performance as well as hear it? Doesn't this picture prove that his invention was badly needed when WJZ broadcast the musical revue, "Vogues," from start to finish direct from the Schubert Theatre?

The fact that many such musicians live in the localities distant from the so-called music centers can be proved time and again by one who uses a receiving set.

And just as this was being written came a letter from a friend who was long a resident of New York City where she continually heard the best that that city had to offer in music, and who is now in a South Dakota town so small you cannot find it on the map. She writes:

"I have heard some really good music here. It is interesting to find real gifts and talent tucked away in such secluded places as this."

Doesn't this comment prove that if this little town had a broadcasting station some music worth the hearing could be programmed?

While the towns previously mentioned are by no means secluded places, but on the contrary are known far and wide, it has taken the radio to bring their musicians into public knowledge. If the announcers at these stations would be somewhat more particular in giving the names of the various persons heard quite a list of those who have been enjoyed could be set down here. One does not, for instance, want to write Pauley for Crosby, in case the name of the woman pianist who recently played so well in Hastings, Nebraska, should be Crosby although it sounded like Pauley. . . . So let the list remain unwritten.

After all, every disadvantage has its companion advantage. We have all considered it a disadvantage that money was not available for the payment of radio music so that the regular concert artists might be heard by every listener, and this must in time come to pass. But had such a custom prevailed from the beginning of broadcasting, we should never have known what fine local talent is to be found in many towns.

RUTH EDWARDS

—Pianist. Miss Edwards has been heard a number of times over the radio as pianist of the Cleveland Institute of Music Trio. These players, also the String Quartet from the same school, have provided one of the most artistic features associated with station WTAM

Talented Youth Is Broadcasting

THE monthly concert given by the Rensselaer Polytechnic Institute Students Symphony Orchestra at Troy, N. Y., Station WHAZ, always has something good to offer, and, apart from this, is interesting in that it is a means of making known what good work some of our young people are doing along musical lines.

One would expect these students to play popular music well, as it is an expression of youth's spirit. But for them to give a good performance of such a work as a Ballet Suite by Delibes is a test of genuine musical understanding; for it takes something more than mere love of music to bring out with any degree of satisfaction the fascinating grace and polish of this French composer. They generally include a movement from some classic symphony in their programs, on one occasion giving the first movement from Haydn's "Military Symphony." And they will even play for you a Strauss waltz in a way that would do credit to a more pretentious organization. The conductor, A. Olin Niles, must be a man of ideals as well as ability. May he long keep up his good work!

Another student organization, quite famous in its own locality, the Lincoln High School orchestra of Jersey City, was recently heard through Station WEAF under the baton of C. W. Barget. These players, forty-one boys—and four girls, range in age from ten to fifteen years. Probably the reason there are so few girls in the personnel is because ninety-nine girls out of a hundred who study music study the piano.

This High School orchestra is an organization of which Jersey City may well be proud, both because of the talent of the players and the

way that talent has been drilled by Mr. Barget. But it is open to the criticism that applies to all of our public school orchestras, a preponderance of strings and the lack of certain instruments imperative to the right performance of orchestral music. If fewer boys would study the violin and more would study wood wind instruments, or the French horn, the tuba, the double bass, our school orchestras would be improved, and the boys themselves would be benefited because they would stand a better chance of using their musical education for financial returns if they so desired. For you can find hundreds of good violin players these days to one man who can play, let us say, the bassoon, the oboe, the French or English horn.

And while on the subject of young people, those boys from the North East Y. M. C. A. Minstrel Troupe who took part in a program broadcast from station WTAM, Cleveland, gave their listeners a jolly good time with their lively choruses and solos. Whoever drilled them did his work well. A program of this kind is a relief from the monotony of jazz when something popular is the object of the program maker. Jazz is all right—some of it—but there are other forms of popular entertainment the public enjoys as much if not more.

As for jazz, it comes in fifty-nine varieties via radio. If you have in times past tuned-in WEAF Thursday or Saturday evenings at eleven o'clock and heard Vincent Lopez and his orchestra playing in the Hotel Pennsylvania Grill, unless you had the soul of a sluggard you did not tune out until the last note of the hour's program was sounded. And this is said by one to whom ordinary jazz is an abomination. Fundamentally, jazz is an interesting musical medium, but, like all musical mediums, it must be handled with intelligence and finesse. Vincent Lopez brings both of these factors to the direction of his orchestra. Their playing showed that their guiding spirit was an artist.

Yes, Mr. Lopez, we say this even though you do drop into the commonplace sometimes. Why jazz portions of the ballet and the grand march from "Aïda"? We heard those travesties hundreds of miles distant from New York the other night.

EDWARD GERMAN'S "Three Dances from the Music to Henry VIII," heard from nine different stations in one evening, shows that good music can be popular music.

The St. Louis Symphony Afield

WHEN listening to the program of a public concert that is broadcast, the reaction of the audience is about as interesting a feature of the entertainment as is the performance itself. When the St. Louis Symphony orchestra, conducted by Rudolph Ganz, gave a concert in Jefferson City, Missouri, during a recent tour, it was broadcast through WOS. The response of the audience to every number showed that orchestral music does not go unappreciated in that rather small city. There was something like pandemonium after the "Tannhäuser" overture, and another Wagner number, "Dich Theure Halle," given by the soloist, came in for the same sort of reception. When the announcer gave out the information that Mr. Ganz would play a request number at the close of the program there was some curiosity on the part of one listener as to just what sort of music would be requested. It proved to be "The Blue Danube." Not a bad choice, by any means.

The management of the St. Louis orchestra evidently has no fear of a broadcast perfor-

HENRY HADLEY

—Composer, Conductor. Some of the lighter orchestral works of this foremost among American composers are heard now and then over the radio from broadcast orchestras that make it a point to present programs of genuine musical value. While giving the major portion of his time to composing, Mr. Hadley is also well known as an orchestra director, having for some years been assistant conductor of the New York Philharmonc

mance injuring the patronage of the organization. On this tour the orchestra played in many Missouri towns that could listen in to that Jefferson City concert. They no doubt did listen, and then, early the next morning, bought seats for the coming concert in their town. That is what radio is going to do for the patronage of music, all over the country, just as soon as some of the musical managers get over their scare about it.

Handel and Mendelssohn Are Still Popular

AFTER the Madrigal Choir from the Oratorio Society of New York had sung choruses from "The Messiah" and "Elijah" through station WEAF, the announcer asked those who had been listening to send in word if the program was enjoyed so that it might be known whether or not such programs would be acceptable in the future.

He could have found the answer to his question in any musical dictionary. Handel, who wrote "The Messiah," died in 1759. Mendelssohn, who wrote "Elijah," died in 1847. Why have their works survived so long after their death? Because of the public's interest in them.

CAPTAIN HERMANN WEBEL, U. S. A.
Bandmaster. The 17th U. S. Infantry. His band has been heard from WOAW, and is very highly regarded

VICTOR KOLAR
—Assistant Conductor of The Detroit Symphony Orchestra. Mr. Kolar conducted the series of concerts for children given in Orchestra Hall, Detroit, during the past music season and broadcast from station WWJ. Thousands of children and grown-ups as well, far distant from Detroit, listened in to these concerts. Mr. Kolar in addition to being a conductor of conspicuous merit, is a composer whose works have attracted wide attention

And so, Mr. Announcer at WEAF, the surety goes without asking, that many listeners were grateful to your station for giving them an opportunity to hear excerpts from these works.

Flying Fists and the Microphone

HAVING commented a number of times in this department on the programs of old-time American songs which are so deservedly popular with radio audiences, WBZ was tuned-in a while ago for the express purpose of hearing such a program which had been previously advertised. Immediately the dials were adjusted came a deafening roar of shouts accompanied by the stamping of feet. Then a voice:

"If this broadcast is a flop you may know it's because I'm new to the job and there are seventeen people hanging on my back."

The astonished listener-in examined the dials carefully. Surely there was a mistake. This could not be the Springfield station, always so correct and courteous. Then came

another voice, the cultured sort that is ever in evidence from WBZ.

"This is station WBZ broadcasting from Boston the fight at the Boston arena for the heavyweight championship of New England."

The microphone was then turned over to the first voice, and from that moment until the end of the fight in the seventh round when Jack Shawkey knocked out Eddy Somebody (the listener was too excited to get his full name), radio music was forgotten by the one whose business it is to listen to it, for she has always had a secret longing to attend a prize fight. Round by round that fight was followed with many a chuckle over the drawling witticisms of the man at the microphone. If a galaxy of the greatest musical artists in the world had been broadcasting a program while that fight was in progress the dials would still have been kept at WBZ. Woman-like, the listener was rooting for Eddy Somebody from the moment it became evident that he was getting the worst of it. And there was exultation that it took seven rounds for the challenged champion to retain his title.

When it was all over and the two combatants, according to the man at the microphone, were "going home to mother," the WBZ cultured voice conveyed the information:

"We will now resume our musical program from the Hotel Brunswick Studio, Boston."

But, not being in a musical mood, with one's mind still bearing that graphic picture of the prize fight, it was not until some evenings later that a connection was made with the Hotel Brunswick Studio, Boston, where a program by the Tschaikowsky String Quartet of the Weltman Conservatory of Music, Malden, Mass., was the attraction. The advance notice of this program had spoken of the quartet as being comprised of four men "who have heard, studied and played the greatest music under the greatest conductors and with the greatest players, and who follow music as an art and not as a trade."

This seemed, like many press notices, too good to be true. But the work of the quartet that evening did much toward justifying the preliminary praise. Even in the most brilliant numbers there was the poise that comes only after one has so thoroughly mastered the classics that something of their equable spirit will tincture the performance of the most modern works, just as it is the technical foundation of these works. Mr. Leon Weltman, with Edward Garmant at the piano, played a group of violin solos in a manner in keeping with the general high standard of the program which was one that did credit to station WBZ. All who heard this program must have elt grateful for the opportunity to enjoy such music so well presented. The entire program came through the air to the present writer's studio in Toledo as clearly as if it were heard in Boston.

And—it is frankly acknowledged—we are glad that the prize fight came through just as clearly, but the thrill of hearing such an event involves considerable mental strain.

MARY ELLIS

—Soprano. After being a member of the Metropolitan Opera Company for a number of seasons, Miss Ellis has joined the ranks of operetta. Station WJZ has presented this young singer in a series of recitals of songs by Rudolph Friml with the composer as accompanist

Among Other Things

Some of the other events that deserve being remembered, and one or two that should be forgotten are——

MRS. H. H. A. BEACH, America's foremost woman composer, in a short piano recital, Station WRC, Washington, D. C. An attractive group of numbers very charmingly played.

MR. MORRIS A. SCOTT singing a group of songs, station WTAM, Cleveland, along about 1.40, A. M. He deserves special mention because he kept the tempo of every song up to the mark, and also because his phrasing was intelligent, his tone unforced, and his interpretations as a whole in good taste.

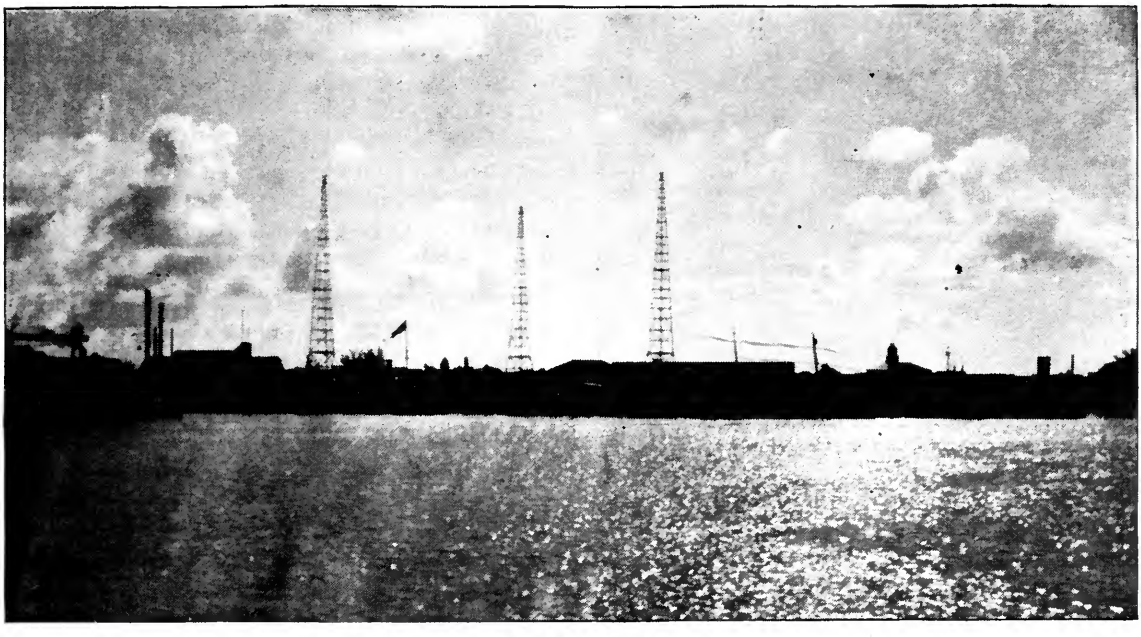
THE 17th U. S. Infantry Band, stationed at Fort Creek, Nebraska, and frequently heard through station WOAW at Omaha. One of the finest bands in the country, judging from these radio performances. The playing of the men shows the broad musical education of the bandmaster, Hermann Webel, graduate of the Paris Conservatory, and later a student in musical history, theory, and composition, under leading New York teachers including W. S. Pratt and Henry E. Krehbiel.

THE program of old hymns—the good ones—sung Sunday evenings at station WHAA. Enjoyed perhaps by more people than the directors of this station realize. A custom that should be indefinitely continued.

THE orchestra of the Hotel Statler, Cleveland, in a dinner hour program each evening, broadcast by station WTAM. One of the finest hotel orchestras so far heard over the radio. The director gives his audience credit for enough good taste to enjoy something other than jazz. His orchestra plays the lighter classics beautifully

VINCENT LOPEZ

And his well-known and well-liked orchestra playing at the Hotel Pennsylvania, New York, have been heard from WEAF



RADIO—FARTHEST SOUTH IN THE UNITED STATES
Lazy Gulf of Mexico clouds and the tall towers of the Navy's high power radio station, NAR, at Key West, Florida

THE MARCH OF RADIO

J. H. Morecroft
President, Institute of Radio Engineers

Names—And Still More Names

WAS there ever an art which called forth as many unpronounceable and unintelligible names as has radio? This failing for coining names, sometimes simple and sometimes complex, for tubes and circuits originated at a certain laboratory in Schenectady about twelve years ago according to our recollection. These Graeco-Schenectady names, as Doctor DeForest aptly characterized them at the time, were not as bad as they first sounded because they were at least coined by men who knew some philology. The names of sets and circuits which descend to-day on a startled world, surpass one's powers of pronunciation and analysis alike. One firm kindly condescends to translate its names into ordinary English for us, so we at least know what the names are intended to convey but many others remain outside our vocabulary and in despair we have decided not to attempt to keep up longer with the word coiners.

That prefix "super" has suffered rare punishment since radio came into its stride—overworked so much that nowadays unless a set is super something or other no one pays any attention to it. And the situation has its serious side, as well as comic; many times lately we have been asked by enthusiastic newcomers in the radio field about the relative merits of the super-diddle-daddle and the super-daddle-diddle and have had to confess that we didn't even know what they were. Wherewith our reputation has straightway fallen to less than nothing! "He knows the theory," say our in-

CAPTAIN O. P. JACKSON, U. S. N.

New director of Naval Communications. "I consider," says Captain Jackson, "that the greatest progress in the efficiency in our battle fleet will come about through the development of radio communication"

quirers, "but he doesn't know how it is applied." Won't the word coiners take a few days off?

Pot Shots at the Goose, Golden Egg, *et al.*

WHY can't some dealers see past the end of their noses? Several times in these columns we have noted the disagreeable effect produced by a raucous blast of what passes for music bellowed forth from a poor loud speaker, being pushed much past its working limit by excessive amplification. On our way to the ferry almost every evening we have to witness this misdirected effort of small dealers to get customers. A hole cut through the transom permits the loud speaker to pour forth its strident tones on the stream of commuters on their way home. The dealer evidently expects to attract customers by this display of the wonders of radio. Killing the goose that lays the golden egg is a sound economic policy compared to this disagreeable form of advertising because at least the goose might be despatched noiselessly without bothering the neighbors.

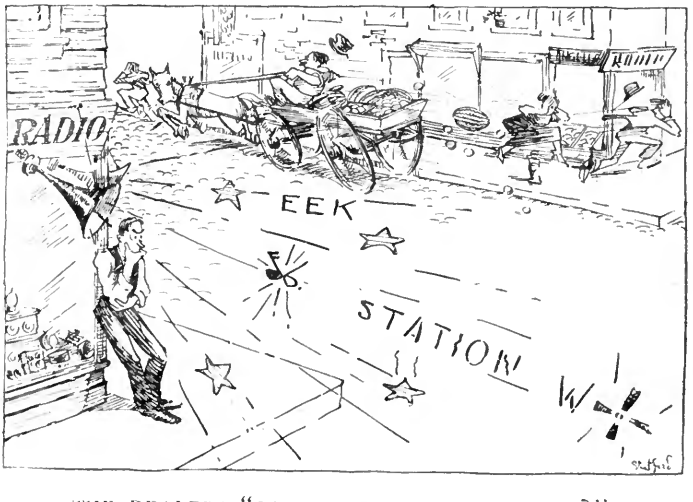
The average loud speaker is none too good even when treated gently, but when it is forced to compete with honking automobiles, and horse-drawn trucks on cobble-stone pavements, the effect is painful indeed. When will these dealers come to their senses and try to get good reproduction inside their stores, instead of making themselves a public nuisance and killing their trade at the same time?

Something the Senate Can't Investigate

RECENTLY the Senate considered a bill having to do with the conditions under which a broadcasting license could be held. This bill contains the declaration that "The ether and the use thereof within the territorial jurisdiction of the United States is hereby re-affirmed to be the inalienable possession of the people of the United States and their Government."

Some of the Senators actually became curious as to the meaning of the bill they were acting upon and called upon the framer of the bill, Senator Howell of Nebraska, for a definition and explanation of the "ether." To this very pertiment inquiry (for surely our Senators wouldn't legislate on matters they didn't understand) Senator Howell confessed—"We don't know much about the ether. We haven't been able to investigate it."

Senator Bruce expressed the opinion that it was not seemly to assert ownership of something which could not be defined or caught hold of, but the Senate disagreed with him and accepted the dictum of the bill that the people of the United States own the ether, inalienably.



THE DEALER: "WHY IS BUSINESS SO POOR?"

It is perhaps a good thing that Mr. Doheny can't extract oil from the ether or the people probably wouldn't own it very long, in spite of the Senate's declaration to the contrary.

An "R. E." is a Prophet Without Honor

LATELY we have received several letters from men in the radio business on stationery burdened with such a name and title as John Smith, R. E., the R. E. evidently standing for Radio Engineer. As such a designation undoubtedly gives prestige among people not acquainted with college degrees and their significance, it seems worth while to point out the status of such a degree.

To the best of our knowledge none of the good technical schools in this country confer such a degree, and it does not seem likely that it will be officially recognized by any such school. The really technical phases of radio are electrical. Perhaps we had better not say simple because the theory of radio is as advanced as any other branch of electrical science. What we mean is that any one who wants to become a radio engineer must be first an electrical engineer, and a good one.

The degree E. E.—standing for electrical engineer—is given by many engineering schools. None of them, however, have thought it wise to give such degrees as P. E. (Power Engineer) or T. E. (Telephone Engineer) both of which branches of the electrical art absorb many more men and have much greater invested capital than radio. Such degrees would be of no service at all to the men using them because those with whom they associate would know enough immediately to appraise the standing of the user. The man using the title R. E. however, generally moves among people who may be unduly impressed with its importance. The title R. E. has no standing, and it is not difficult to make the same assumption for those who affect it.

There Are No "Inaudible" Radio Waves

NEW ideas and developments in radio are coming to the front in such profusion that many times a writer finds himself without suitable language to express his thoughts. There are, of course, innumerable new words coined in the name of radio to designate new sets and circuits, or catch-words originated by enthusiastic advertisers to get the purchaser's attention, but to these we do not refer.

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WALLACE IRWIN

—The creator of Hashimura Togo, who makes that delightfully ingenuous, yet observing character say (in *More Letters of a Japanese Schoolboy*):

"On Table befront of him sat one black suitcase all covered with nickel plated science. It cantained a window with electric bulbs doing so inside. It cantained silver pushers, pullers, arrows and Kodak supplies. It cantained so many Wires that I was sure it was connected with Edison somewhere. It had a Horn with its mouth wide open as if to speak. It had one of these switchboards which enable Hon. Telephone Operatress to get your number wrong 13 times out of 11. Taken altogether, this was a Radio."

In a recent interview dealing with the remarkable scheme of radio repeating which the Westinghouse engineers are developing, one of them referred to their high frequency wave as "inaudible." "Pittsburgh," said he, "sends out the ordinary wave to which KDKA's listeners are accustomed and another inaudible wave which is used for repeating to Hastings and London." Several inquiries came to us regarding this inaudible wave—how did it differ from the ordinary one?

The use of "inaudible" in this sense is rather unfortunate because it expresses more and less than it should. It seems to say that the longer

MISS AGNES MILLER

Of New York, who wrote the play "A Million Casks of Pronto" which won the $500 prize offered by station WGY, Schenectady, in its recent contest

wave is audible whereas the short one is not. Now what was meant was simply this—using an ordinary receiving set the high-frequency wave to Pittsburgh is of so high a frequency that it is generally impossible to tune-in on it. This is because the distributed capacity of the coils, tubes, and connections, is sufficiently great that the 94-meter wave cannot be tuned-in and in this sense it is inaudible.

If about two-thirds of the turns are taken off the various coils used then this inaudible wave may become audible, provided it is rectified and amplified just as the regular wave is. No engineer or person in authority who uses a new word, or uses an old one in a new sense, can escape the responsibility of making his meaning perfectly clear.

Distance Records During the Past Winter

RECORD transmissions were recorded for several stations during the past winter season, some of which are probably freak transmissions but long-distance records will become more and more common with every improvement in receiving and transmitting sets. WOR reports reaching Japan, over 9,000 miles; WJAZ sent to Samoa, 7,000 miles; WLAG got through Soviet Russia to Batum, 6,680 miles, and WGY and WEAF both have been heard several times in South Africa, a distance of 7,880 miles. The real record is apparently held by WHAZ of Troy which on four successive mornings was heard in Invercargill, New Zealand, a distance of 9,577 miles from Troy.

There Are None Too Proud to Study

THERE are few who will deny that radio has done more to interest the general public in experiment and study than any other development in any age. The automobile caused many a man to wonder about the evaporation of gasoline when his carburetor did not work, and the elementary laws of the electric circuit came for their share of his interest when his ignition or lights failed. But the study excited by the automobile's misbehaviour is nothing compared to that in which the general BCL is indulging to-day.

In the subway we see staid business men devouring a serious article on radio and it is surely true that many a youth who previously spent his evenings in a corner pool room is now engaged in trying to beat his pal in establishing long-distance receiving records. A well known scientist expressed the idea not long ago that "radio is becoming vulgarized," but it seems that such a thought deserves but little sympathy. Possibly it would be more satisfying to one's vanity to feel that the branch of science in which he spent his investigations was far beyond the ken of the average human mind, but wouldn't it be more satisfying to know that his branch of knowledge was of such importance to the human race that everyone was striving to gain its portals—that any contribution he might make would be an immediate and universal good?

It probably had been a source of some embarrassment to the scientist we have in mind that some of his friends bitten by the radio bug had become so inoculated that their thirst for knowledge had prompted the questions which outreached his grasp of the subject. For it is perfectly easy to pose as an authority in a branch of knowledge which interests no one else, but it takes an able man indeed to hold a reputation for knowledge in such a subject as radio into which nearly every intelligent man seems to be delving so earnestly.

A well known radio worker, when asked why he put wax in his sets and why he refused to make public the constants of the circuits said something to the effect that it wouldn't do any good anyway. He had to build twenty

sets before he could make one work, so therefore it was a foregone conclusion that the general public would find it impossible to build one successfully even if the constants were published.

Well, from our acquaintance with the radio amateurs of to-day, we wouldn't put much money on his opinion. Many of the "radio proletariat" are evolving a rather fair grasp of the technique of radio and their knowledge is growing every day. The subject has ensnared men from all walks of life. In the colleges, students from every branch of engineering feel that they must know radio at least whatever else they learn. Graduates of all kinds are striving to master its secrets. The publishers of the more theoretical books on radio can vouch for this fact.

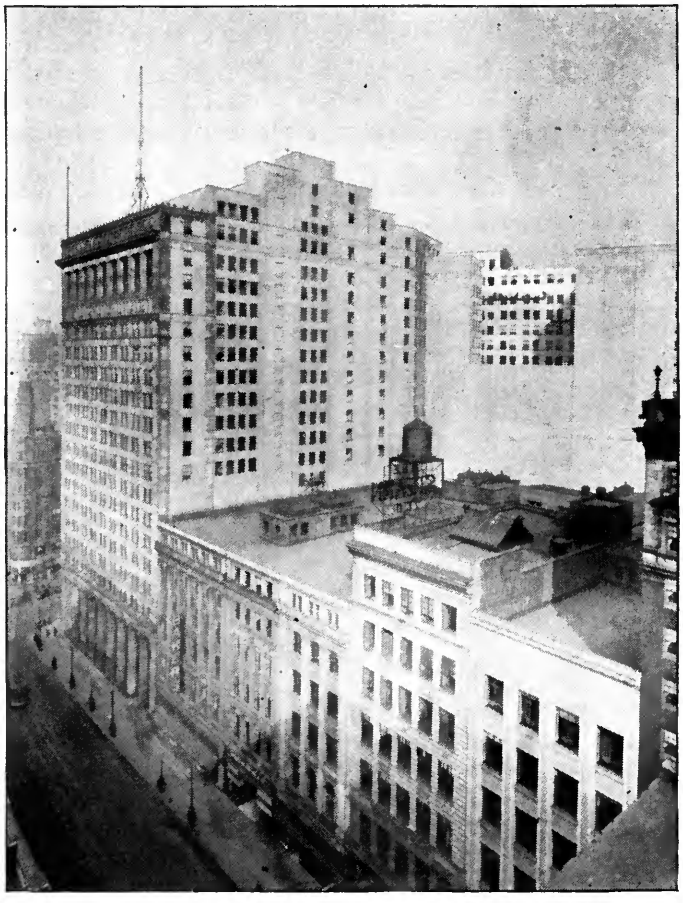
We happen to know the president of a large electrical company who is "taking time off" to study radio seriously. He spends long hours in study and performs all kinds of laboratory experiments to expand his grasp of the subject. A successful bank executive is working assiduously with a college instructor for tutor, to gain such technique and knowledge of the theoretical side of radio that he "can help his friends" to understand their sets. A professor of chemistry is spending his evening hours, not in evolving more elaborate chemical formulae to puzzle his students (as perhaps he should) but in studying the action of loud speakers.

Radio Antennae Are Safe

AN ABANDONED antenna wire had been carelessly strung over some 2,400-volt power wires in Montclair, N. J. and when some firemen were fighting a grass fire they came in contact with the dangling antenna which connected them to the high-voltage wire and gave two of them a fatal shock. This antenna was strung in a careless and dangerous manner but the accident, while lamentable, does not mean that danger lurks in antennae and that country-wide investigations should be started. No one but a fool would think of putting up a wire across high voltage lines even if for no other reason than the possibility of being shocked while putting it up. It is not at all impossible that the wire was one thrown over the power wires by some mischievous lad, and was not an antenna at all.

More Electrodes in New Radio Tubes

THE ubiquitous triode, with its filament to boil off electrons, its plate to pull them across the vacuum, and the grid to control their flow, performs such wonderful feats that it seems as though more than three electrodes in a tube would be superfluous. Such is not the case however; years ago a four-electrode tube from Schenectady, christened the plio-dynatron, was described and now we have the five-electrode tube making its appearance. This will undoubtedly perform modula-



STATION WJAX

Of the Union Trust Company, Cleveland, Ohio, which has just been moved to this location atop their new building at the corner of Euclid avenue and East Ninth street—Cleveland's Forty-Second and Broadway

tion, oscillation, rectification, amplification, and a few other functions. Powerful an instrument as the triode is, it will probably soon be supplanted by the quadrode or other tube even more liberally endowed with electrodes and what these multi-electrode tubes will do is quite beyond conception. It is probably a conservative statement to make that a present five-tube set may be equalled in the future by only one of the newer tubes.

Don't Do It by Radio Unless Other Methods Fail

IN OUR last number there was described a new radio beacon, consisting of two large transmitting coils placed at about 135 degrees to each other; it had been designed for the Air Service, to make the navigation of planes easier and more reliable.

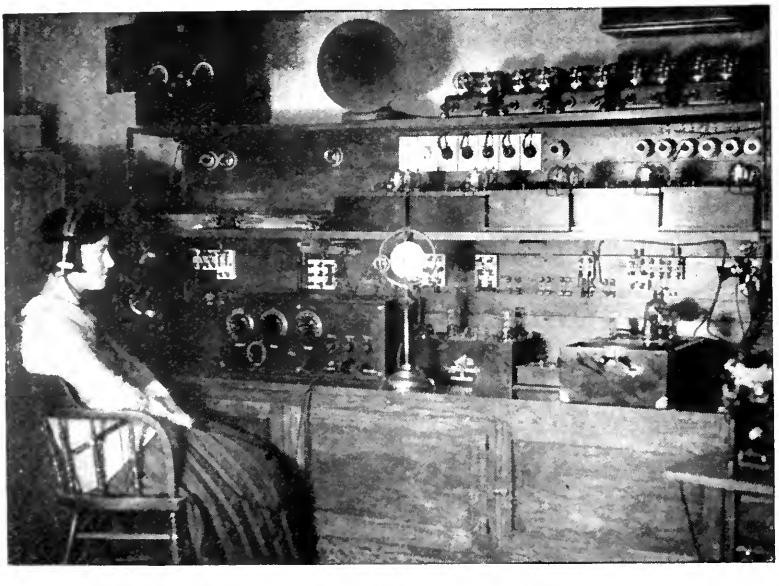
This same type of beacon is to be installed at San Francisco, we learn, to guide the ferry boats across the bay in case of fog; it seems that even in the land of "sun-kissed" oranges the sun does sometimes hide its face so that shipping has to depend upon other than visual navigation.

If we accept the claims that have been made for the submerged channel cable, the kind that was installed in New York harbor, it seems that such might have solved the foggy harbor problem as well as or better than a radio beacon. Such a cable, carrying 500 cycle current, enabled a ship equipped with suitable listening coils to come into harbor through a narrow channel, without ever seeing a channel buoy. Because of the ever-increasing density of radio traffic the popular slogan should be, not "Do it by radio" but rather "Don't do it by radio unless other methods fail."

Voluntary Contributions for Radio Programs

STATION WHB, at the Sweeney Auto School in Kansas City, is apparently endeavoring to win our $500 prize for the solution of the "Who is going to pay" problem by direct experimental methods. Its listeners have been asked to send in voluntary contributions as their share in the upkeep cost of the "invisible theater." This station manager, in common with many others, has concluded that the advertising received by the school was not sufficient to warrant the expenditure for musicians, artists, royalties, and other necessary items of upkeep.

"We believe it is only fair," says their announcement, "for those sharing the pleasure to pay a portion of the expense." We agree with this idea heartily and are glad to note that at the latest report $3,100 had been contributed by the invisible audience. Of course that amount won't go far towards keeping a broadcast station running, but the audience is indeed showing an appreciative spirit.



RADIO PROGRAMS ARE DISPENSED WHOLESALE

Through this arrangement of apparatus by the telephone company at Fredonia, Kansas. Subscribers who purchase loud speakers for their homes through the telephone company are given the radio service free from this receiving station. This service is in its second year and more than 200 loud speakers are in use

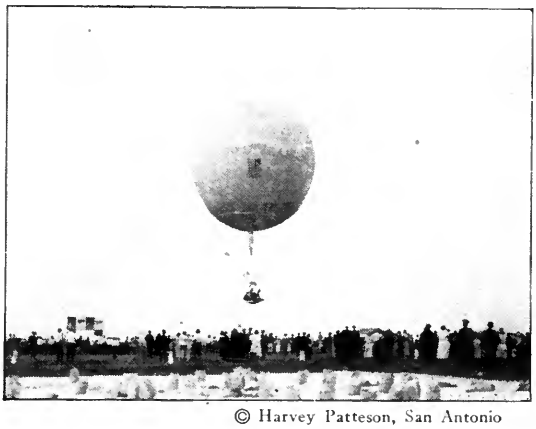
The Radio Corporation View

IN A recent speech at Chicago, David Sarnoff, vice-president and general manager of the R. C. A., expressed his views on the probable and reasonable source of revenue for the support of radio broadcasting. After expressing the view that broadcasting would, in the future, be car-

ried out by a few superpower stations (R. C. A. stations we presume) he ventured the guess as to the proper source for the money to meet the ever increasing cost of maintaining a station.

"Broadcasting, in my judgment," said he, "will be primarily supported by the radio industry itself and from the returns on the sale of radio apparatus. A fair method of determining the amount to be paid by each member, or portion of the industry, will be worked out and this will be based on a percentage of the sale price of the radio devices."

Naturally, to the business man, this seems the logical solution. It is probably the simplest solution of the problem and possibly it will be the final one. A reasonable percentage on the sales profits in tubes, batteries, accessories, etc., will maintain a good many stations, even after the sale of new sets begin to fall off, and this falling off, by the way, is still a long way in the future.



© Harvey Patteson, San Antonio

RADIO AIDED THE GOODYEAR III TO WIN

The recent national balloon race. Pilot Ward T. Van Orman carried a four tube reflex set which he built himself. The photograph shows the start of the race at San Antonio, Texas. During the winning flight of the Goodyear III to Rochester, Minnesota, where the balloon landed stations at Los Angeles, Cleveland, Davenport, Springfield (Mass.), Troy, and Schenectady were among those heard. The Goodyear Radio Club of Akron, Ohio, arranged with 16 broadcasting stations to send out regular meteorological information which proved of great value in navigating the balloon

Holy Communion by Radio

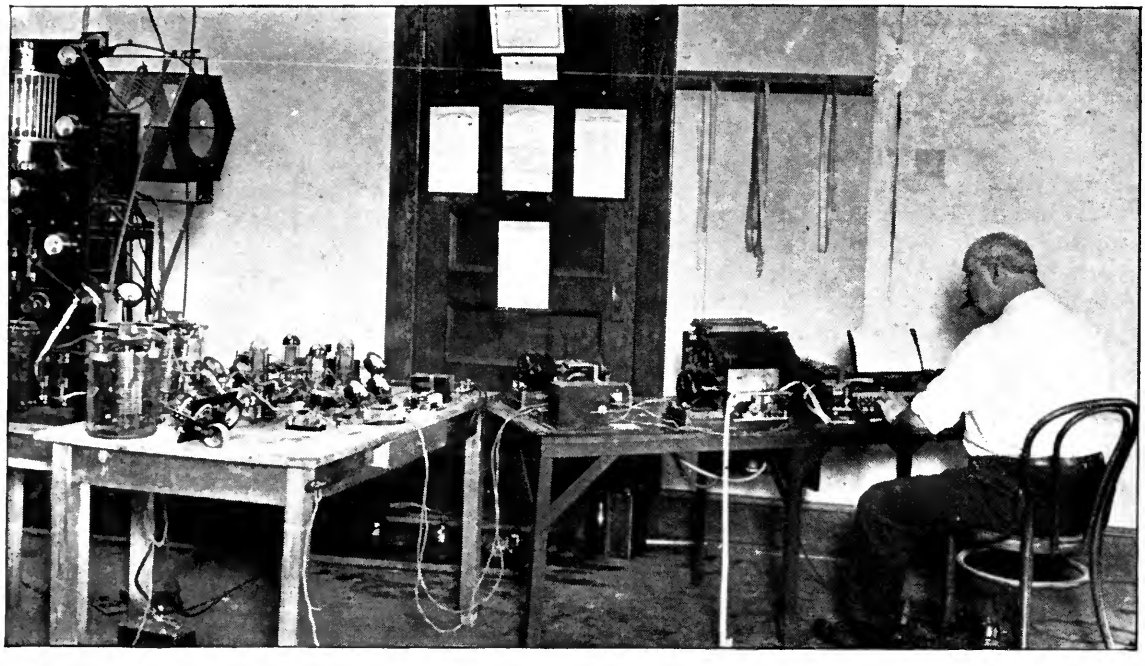
ALTHOUGH it must be confessed that nowadays we seldom enter into the Church's most solemn service, feeling that perhaps God is as much present in our flower garden (where Sunday morning is spent with the cultivator) as he is at the fiery debates of Modernist versus Fundamentalist, still we are just human enough to be unable to throw off the idea that the celebration of the Holy Communion is really a solemn rite, not to be entered into lightly and not to be used for Church advertising.

Perhaps that feeling is a little old fashioned and squeamish. It did jolt us to hear coming in over WJZ's radio channel recently "Jesus took bread and blessed it and gave it to his disciples and said, Take, eat, this is my body." It was the communion service being broadcast from the West End Presbyterian Church of New York, the Rev. Dr. Edwin Keigwin officiating. We happened to listen-in just as the solemn words were being pronounced, and the effect was anything but religious and sacred. One has naturally to compose his thoughts to be in a mood to appreciate this, the most solemn of the Church's ceremonies. Whether or not we believe in the Transubstantiation, whether we are religiously inclined or not, we cannot help but feel that this service is one which should not be participated in by those who have not come to it voluntarily, such as church attendance indicates.

Of course the minister who thus uses radio broadcasting may feel that he is accomplishing good in that a few of his parishioners may be bedridden, yet in

SECRETARY WILBUR

Of the Navy, inspecting the central naval radio control office in Washington where the high power stations at Arlington, Annapolis, Sayville and others are controlled



THE RADIO PRINTER

Designed and developed by William H. G. Finch, radio editor of the New York *American*, for the International News Service. The system uses a radio transmitter of 200 watts power and a wavelength from 60 to 150 meters. This is the transmitting sending typewriter and instrument panel

this manner be permitted in the communion service. This number is however comparatively few and the minister could just as well, or better, visit them in their homes, there to commune with them in the quietness such service demands. At the risk of being called old fashioned and out of date we venture the opinion that this minister did the Church a dis-service, by distributing his communion service, his most precious possession, in places where it wasn't welcome.

New Edition of Circular No. 74

EVERY technical and semi-technical radio enthusiast desires to have available reliable and workable tables and data on radio circuits and apparatus. One of the very best of the books giving such information is published from the Bureau of Standards under the title of Radio Instruments, Circular No. 74. The first edition of the circular met with great favor so that the Bureau staff has found it worth while to revise it thoroughly and bring it up to date. The new edition of this circular is now ready and can be obtained for $.60 from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Good "Radio" Voices Are Rare

WHEN we ventured to criticize the attempted French accent of one of the well known announcers some time ago his "boss" replied that it was not easy to get "a good radio voice." One would think that any body could talk intelligibly over the radio but such is not the fact. A prominent minister who has broadcast many sermons has a lamentably poor voice with which to actuate a microphone. The explosive voice, which throws quick, staccato, accents at the listeners is poorly adapted to the microphone. The violent emphasis on one or two words paralyzes the microphone. The listener gets the effect of a series of grunts. A cough, which is not especially unpleasant when occasionally heard from the lecture platform, sounds like a hippopotamus sneeze over the radio. A cough should never be permitted at a radio studio until the microphone has been short circuited.

We had a treat a short time ago listening to a series of oddly modulated voices. The modulation was actually so poor that the event was extremely amusing. The menagerie of a circus was "put on the air" for half an hour, and the microphone went through all sorts of contor-

tions trying to follow the gentle accents of the elephants, lions, and the like. And didn't the sea lion enjoy broadcasting! She (it must have been a she) seemed to feel there were several listeners being charmed by her dulcet tones and she did her best. Even after her turn was over we could hear her triumphal squeals, penetrating through the hyena's laugh. Few of the listeners had probably heard the hyena laugh before since he is generally a quiet kind of a beast.

Following this interesting bit of Nature broadcasting we hear that 2LO intends to sneak a microphone out into the dells where the nightingale holds forth and thus give to this far-famed songster an audience of the size he really deserves. And Paris, not to be outdone, is going to put on similar Nature programs.

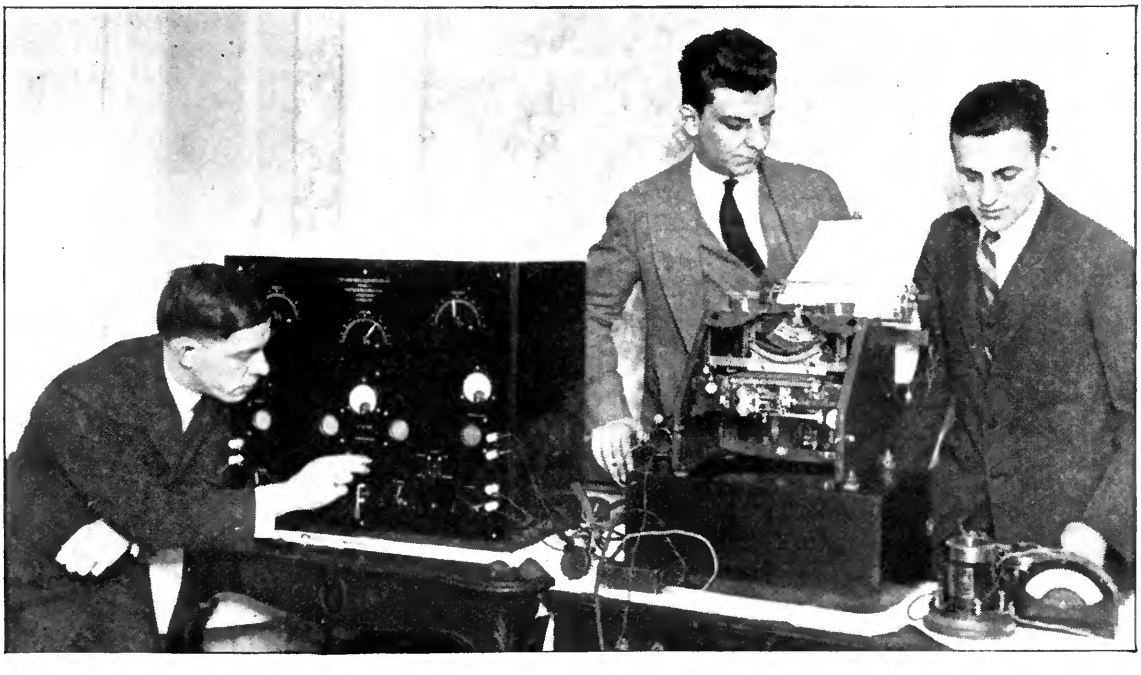
If this type of broadcasting increases in popularity it will be necessary to adopt some new scheme of modulation or else to train the elephants and lions to be more gentle.

How Radio Saved U. S. Troops from the U Boats

AT A recent meeting of the Federal Club at the Bureau of Standards, one of the speakers, Commander D. C. Bingham, of the Naval Communications Division, gave a short but illuminating talk on the part radio played in the successful transportation of American troops through the submarine-infested waters around the British and French coasts. The radio direction finder, according to Commander Bingham, was largely responsible for the ineffectiveness of the German U boats in preventing the movement of our troops to France. The submarines had radio, and of course, they used it, perhaps not more than they had to, but still enough to give themselves away. Allied shore stations, equipped with direction finders, could locate them and follow them through their journeys. The approximate location of the boats being known, the troop ships on their way across were routed in such a way that they missed the waiting submarines.

In case a submarine kept quiet for a day or two, ever-widening circles were drawn around the point where she was last heard from, thus indicating the territory in which she must be, because of her known cruising speed and the time elapsed. The troop ships were, in so far as possible, kept outside these circles.

We well remember one troop ship thus being kept outside an imaginary circle and the circle got so big that it seemed we nearly hit Iceland before instructions were received by radio to turn towards port.



THE RECEIVING RADIO TYPEWRITER

And its inventor, W. H. G. Finch (right). An accuracy of 99½ per cent. at 65 words a minute was attained at its first public trial at the Waldorf Hotel, New York, during a recent convention of newspaper publishers

Come With Me 'Neath the Family Tree

Read the Story of the Radio Detector's Best Booster, the Ever-present Help in Time of Trouble—Radio-frequency Amplification. Applying Family Tree Methods to the Hundred-and-one Trade Names for this Form of Amplification

By JULIAN KAY

This is the second of a series of avowedly breezy explanatory articles designed to put the non-technical reader at his ease when staggering radio terms and phrases and circuits are conversationally hurled at him. The reader will find in the "Family Tree" an orderly and unusual grouping of radio names and circuits which he will do well to preserve. The first article—which classified radio receivers and circuits—appeared in June.—The Editor.

EVERYONE who has a radio has a detector in some one of its many forms. This is the essential part of any receiving equipment about which all the other apparatus is grouped. In the first article of this series, something was said of the function of a detector likening it to our ears as the organ that "hears" the radio signals.

Now, given a detector, what can we do to increase its value?

The thing that naturally comes to mind is to use amplifiers, and since everyone is talking "radio-frequency" amplification, we shall apply our previous Family Tree methods to it. So much is claimed for this method of amplification that one almost considers it as a general palliative for all modern radio ills. If your radio is weak and pale, unable to go great distances, liable to get nervous and confused if two stations are transmitting at the same time, if, in short, it is in a state of general debility, what can be done?

Do You Know—

—The difference between radio- and audio-frequency amplification?
—When radio amplification is better for a given result than audio?
—What part transformers, variometers, and resistances play in a radio-frequency circuit?
—Why transformers are better for inter-stage coupling than other coupling devices?
—How radio-frequency amplification compares with regeneration for sensitivity?
—What impedance-coupling means?
—Why "heterodyning" is advantageous?
—What "tube capacity" is and what difficulty it causes in receivers, and how this difficulty is commonly obviated?
—What a "losser" is and what receivers use them?
—What the $57\frac{1}{2}^\circ$ angle is?
—What to do for a "pale and weak radio"?

The answer is radio-frequency, for it will do the following things to your present set:

1. Add selectivity.
2. Increase the receiving range.
3. Add volume to the final signals.
4. Help to overcome static.

For instance, with one stage of radio-frequency amplification before a regenerative detector and two steps of low-frequency amplification—four UV-199 tubes in all—it is possible to hear Chicago stations in a New York city apartment when five local stations are transmitting.

Without the radio-frequency stage, local stations can be separated only when the detector tube is oscillating and making the neighbors swear, and distant stations are not heard clearly until after midnight.

For the city dweller, this type of amplification to help the detector do its tricks is a great boon; for the fortunate country home it makes many of the magazine advertisements come true.

The methods of adding a stage of radio-frequency amplification have been previously described in RADIO BROADCAST, and those who have made it work already know its value. If it does not work to suit the builder, one of two things must be wrong, either it is not properly constructed and operated, or perhaps the builder expected too much.

If one should suddenly see Niagara Falls without having heard of this natural wonder, he should be amazed and awed at its grandeur, but having been brought up from childhood in the belief that it is unsurpassed, we are only awed and amazed when seeing it for the first time that we believed all the wonderful things said about it. The statistics are interesting—the fall is 168 feet high and not a mile, and one million several hundred thousand newly-weds gaze at it each spring—but—

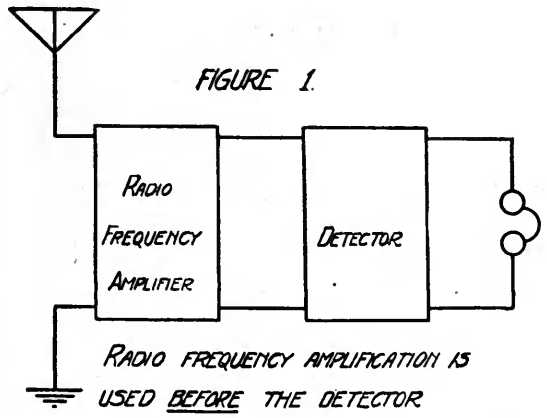
The trouble is that we expect too much.

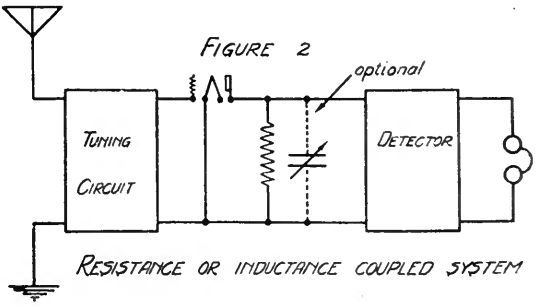
HOW R. F. AMPLIFICATION WORKS

DETECTORS are peculiar devices. They do not follow the "straight and narrow" but go off on a tangent and act according to what is known as a "square law." Their function is to distort the inaudible energy coming down the antenna in such a fashion that the ear, with the aid of accessory apparatus, hears audible sounds.

The square law comes in the picture in the following manner. If twice the voltage is applied to the detector in one case as in another, the detector output will be multiplied by four instead of two. Here is where radio-frequency amplification, which takes place before the detector, gets in its good licks.

If an amplifier boosts the incoming energy three times and then delivers it to the grid of a detector, the latter in turn will deliver nine





times as much voltage as it would without the previous amplification.

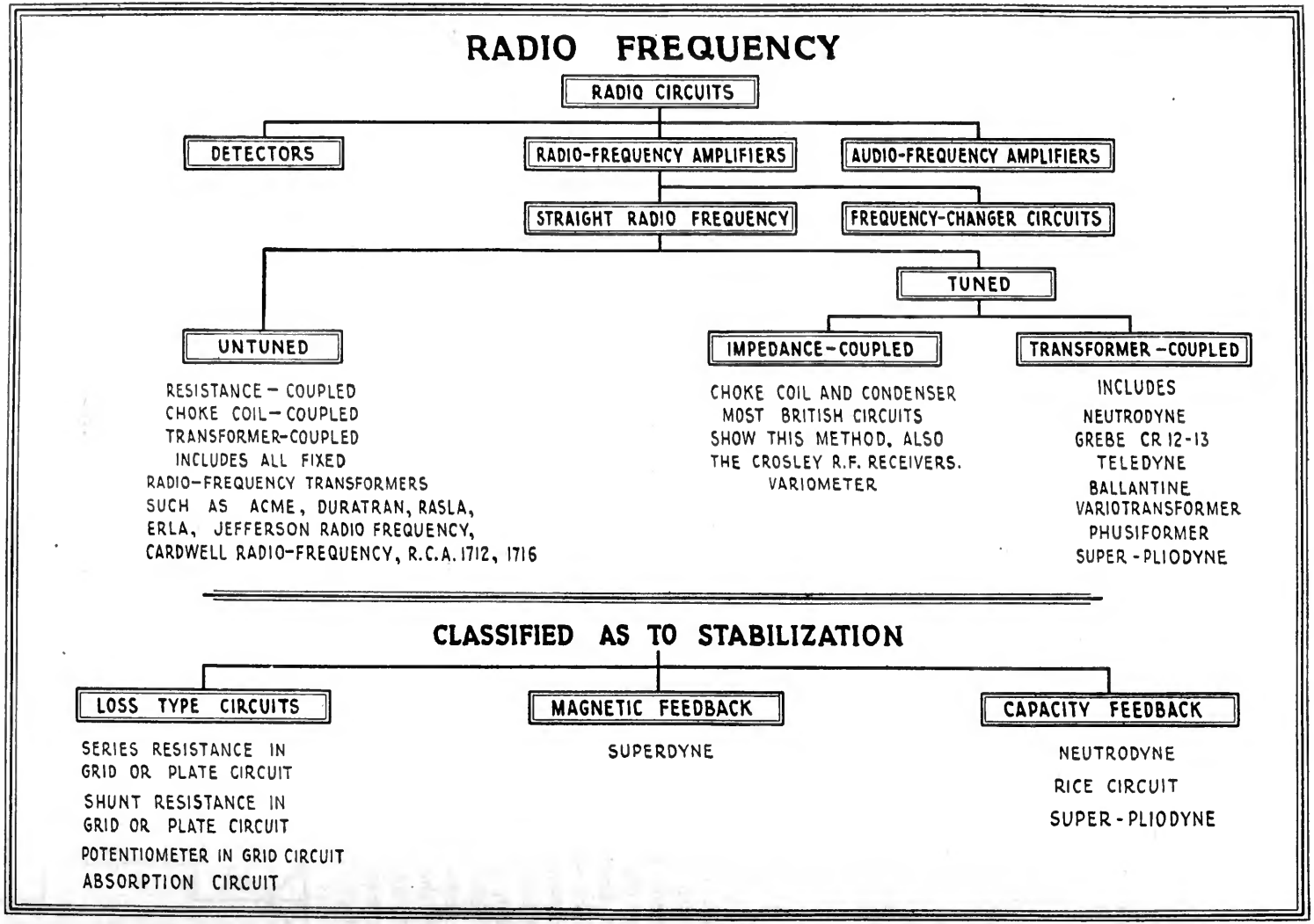
Of course we shall not hear nine times as much sound, for the ears have some idiosyncrasies of their own—but you can see what radio-frequency amplification does to a weak and debilitated detector.

There is another advantage in amplifying before detecting. The currents after the detector tube are all of low frequency, since it is these that we actually hear. For this reason any noises in the circuit itself—say, bad B batteries, loose connections, microphonic "bongs"—all will be audible and increased in strength by the low-frequency amplifiers, but are not so likely to cause trouble in a high-(radio) frequency amplifier. Still another advantage lies in the difficulty of making distortionless audio amplifiers.

THE R. F. FAMILY TREE

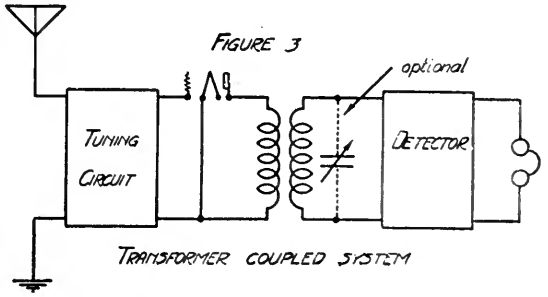
THE principle of radio-frequency amplification is simple. The input or grid is tuned to the incoming signal which is amplified by the tube and then passed on to the next amplifier or detector. The many types and names arise from the many methods of coupling the various stages together, and the methods of keeping the amplifiers from oscillating.

The Family Tree shows the two general methods of coupling: resistance and inductance. The first is not used for radio frequencies because of the short circuiting effect of the tube capacity (grid to plate). Inductance-coupling can be of two types, either a single coil known as impedance-coupling, or a two-winding transformer. Naturally, either of these methods can be tuned to the wavelength desired with added selectivity and amplification. If the coils are merely used to couple the tubes together, say by using an Acme or Duratran or any of the transformers mentioned on the Family Tree, one tuning control is eliminated.



THE FAMILY TREE FOR RADIO FREQUENCY

A single stage of untuned radio-frequency amplification is not as good as a single regenerative detector, but by tuning this one stage, remarkable results can be had. The transformer has two advantages over the single coil such as a variometer, that of greater



tuning range and the fact that such amplifiers are easier to reflex. The greater amplification resulting from pure inductance tuning—variometer—may be offset by using a "step-up" in the transformer. On the other hand the losses are greater in two windings of a transformer than in the one winding of a single coil.

It should be noted that when a single winding or a variometer is used, a condenser must be inserted before the grid of the next tube to keep the B battery voltage from that grid.

The Teledyne receiver described in RADIO BROADCAST for May uses one stage of tuned transformer-coupled radio-frequency amplification. Other receivers now on the market using this general method of attaining distance and selectivity are the Atwater Kent five- and six-tube receivers. All Neutrodynes, some Superdynes, and the Grebe CR-12 use this method and are explained in detail in following paragraphs.

Reflex methods usually use untuned transformers, but the loss by such methods is made up by passing the energy through each amplifier two or more times. These receivers are simple to operate, for there are at most two tuning controls, and with efficient radio- and audio-frequency transformers they should give good results over the entire broadcast range. The Acme Triflex, the Grimes Inverse Duplex, the Sleeper Monotrol, and the DeForest Reflex, are good examples of commercial receivers employing this method of amplification.

RADIO-FREQUENCY DIFFICULTIES

LIKE most good things on this earth, radio-frequency amplification is fine—except for one small difficulty. This trouble arises from an inherent defect in our present vacuum tubes, the fact that there is a small electrostatic capacity existing between the grid and plate. This provides a path for the alternating plate current to get back to the grid circuit where it is again amplified and passed to the plate. This process keeps up until the circuit oscillates. The result is that a large oscillating current passes around from grid to plate and back again so that the minute antenna currents are lost in the shuffle. All we hear is a shriek and groan and neighbors probably say,

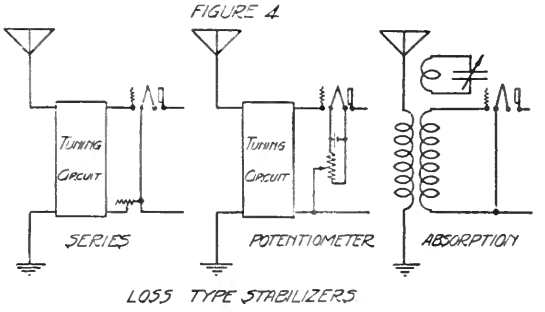
"By golly, there's that single circuit hound again."

At the present time there are three methods of attacking this problem of feed-back currents:

1. "Losser" methods.
2. Reversed feed-back (Superdyne).
3. Balancing methods. (Neutrodyne).

The first of these three is an old scheme and is usually disguised under the general term of "stabilizers." It is used on receivers built by manufacturers who are not licensed to use the more modern and efficient methods disclosed by Rice and Hazeltine.

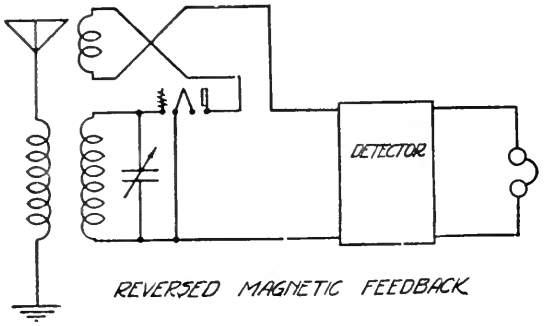
Fig. 4 shows the "losser" methods. Here enough resistance is added to the circuit, either in series or shunt to cut down the amplification to a point where oscillations do not occur. The other method is that of placing a potentiometer across the A battery with the variable arm connected to the grid return end of the input tuning coil. When the circuit starts to oscillate the operator shifts this variable



arm until the grid becomes slightly positive thereby stopping the oscillatory currents.

Both of these methods involve adding losses to the amplifier, in other words, decreasing the amplification. This of course is inefficient although simple to operate.

FIGURE 5



REVERSED MAGNETIC FEEDBACK

The second method, the reversed tickler, is used in the Superdyne and does not introduce losses into the circuit except for what voltage is lost in the tickler coil. The scheme resembles the "tickler" feed-back detector except that the tickler coil is reversed in direction so that instead of forcing the circuit to oscillate, it prevents oscillation. If the circuit should break into oscillation no signals can be received and the operator will at once be aware that his amplifier is in trouble.

Both of these two methods have the disadvantage that they require adjustment—one more dial to turn. In the Superdyne receiver this is not such a bother, since the circuit can be adjusted for each wavelength and brought as near actual oscillation as is desired.

THE NEUTRODYNE RECEIVERS

THE balancing methods, of which the Neutrodyne is the typical example, are perhaps the best for eliminating the bad effects caused by grid-to-plate tube capacity. The advantages of the Rice and Hazeltine circuits over other schemes are apparent when one considers the following:

1. Once adjusted for a particular tube, the balancing need not be changed.
2. There are no added controls, no more dials to juggle.
3. No losses are introduced, that is, the full gain of the amplifier may be utilized.
4. Many stages of amplification can be worked if each is properly neutralized.
5. The balancing is practically independent of wavelength.

The Neutrodyne principle is one of balancing the small feed back current by another capacity current of an exactly equal strength but fed into the circuit in opposite direction—the result being that no current actually flows. This method isolates the grid and plate circuits so that they may be sharply tuned to the same wavelength without sensible interaction. The grid of the tube can be kept negative by C batteries, and large values of B battery voltage used thereby getting the maximum benefit from the amplifier tubes.

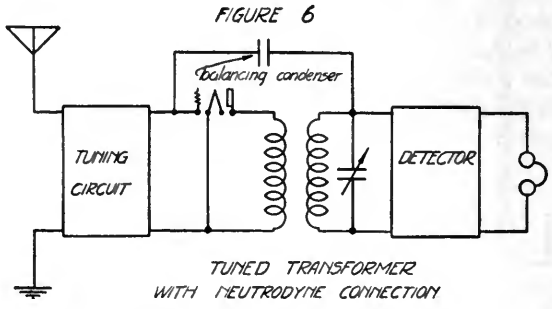
The Hazeltine method is shown in outline Fig. 6. The neutralizing condenser, commonly called a "neutrodon" is connected to the following tube in such a manner that the proper magnitude and phase of the balancing current is maintained. The actual method of adjusting these small capacities has been described in RADIO BROADCAST. It is quite important that the exact point of balance be found, for over-neutralizing is just as bad as no neutralizing at all.

The Rice circuit has a slight advantage over the usual scheme in that the balancing capacity is kept in the circuit of the tube being neutralized. Thus any type of output can be used. Care must be taken here that the neutralizing condenser does not short or the B battery will be on the amplifier filaments.

The usual "five-tube receiver" is a Neutrodyne in which two tubes act as radio-frequency amplifiers, one as a detector, and two as audio-frequency amplifiers. It is possible to use small tubes, say UV–199, for the first three, but larger capacity tubes such as the UV–201—A should be used in the last stages to handle the output without overloading. The two radio tubes can be reflexed, that is—the audio-frequency currents delivered by the detector can be sent back through the first two tubes, but in general there is little to be gained in such a method. The four-tube sets are of one of two types; either they have but one stage of radio amplification, or but one of the radio tubes is reflexed. The Fada "160" and the Garod are examples of the latter.

Some confusion seems to exist about the need for neutralization or for stabilizers. The rule of whether to use some one of these oscil-

FIGURE 6

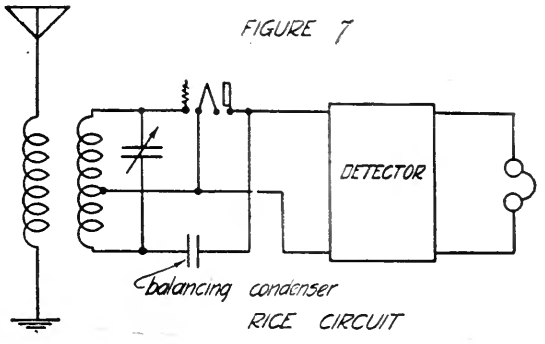


TUNED TRANSFORMER WITH NEUTRODYNE CONNECTION

lation preventing methods or not is simple; if the radio-frequency circuit oscillates at the lower wavelengths, neutralize or stabilize it. If the circuit does not oscillate, there is no necessity of complicating it. Sometimes the disposition of coils and leads is such that neutralization is automatically affected without further trouble—*but*, if the tube does not oscillate, it is usually a sign that it is not in an efficient circuit.

For example, let us take the Hazeltine (Neutrodyne) circuit. If the primary winding of the radio-frequency transformers has but few turns, it is probable that the circuit will not oscillate, but the full gain of the tube will not be realized. The remedy is to increase the number of primary turns until oscillations actually occur on the longer wavelengths, then neutralize the tube. Those who use the Rice circuit can do the same thing by removing the filament tap from the center of the coil and bringing it nearer the bottom or plate end of the coil. This increases the voltage across the input, and a point will be reached where the circuit actually oscillates. There is no need to neutralize before this point is reached.

In all neutralizing schemes, it is important to have no electromagnetic coupling between the various coils. This can be accomplished by placing the coils at right angles to each other and far apart, or by assuming the well known "$57\frac{1}{2}$" degree angle of the coils.



A well-made receiver employing two stages of radio-frequency amplification—or one stage plus detector regeneration—should be able to cover the entire United States broadcasting area. Where one wants strong signals and great distances, the 201-A tubes are unexcelled; for less powerful signals the 199's are extremely economical and efficient.

Radio has been referred to as the magic carpet on which we may ride to the ends of the land. This is theoretically possible—radio-frequency amplification makes a pleasant theory into practicality.

In the next article, the super-heterodyne, another and very well-known radio-frequency receiver, will be described.

SOME of the prize-winning receivers and stations in our "How Far Have You Heard" distance contest will be described in the August number of RADIO BROADCAST.

How to Charge Your Storage B Battery from an A Battery Rectifier

A Few Feet of Lamp Cord, a Socket, a Hundred-Watt Lamp, and an Ammeter are the Simple Essentials Required to Convert any A Battery Rectifier into a B Battery Charger

BY ZEH BOUCK

In this article, Mr. Bouck tells how the various types of A battery chargers now on the market can be made to charge storage B batteries without expensive auxiliary equipment. He also touches on the theoretical operation of the rectifiers he describes so the reader may more perfectly comprehend the principles with which he is experimenting. Many enthusiasts are no longer satisfied merely to "read" radio. Instead, they study it. It is only by understanding both the theoretical and practical aspects of an electrical problem that the experimenter can obtain the highest efficiency from his apparatus.—THE EDITOR

RECTIFICATION, as most of us know, means the changing of an alternating current, which in commercial frequencies reverses its direction of flow from twenty-five to sixty times a second, to a direct current that, though it may be pulsating, maintains its periodic push in one direction. Rectification is most simply accomplished by smothering or cutting off one half of the A. C. alternation so that (say sixty times a second) we shall get very decided unidirectional electrical impulses.

Several electrical processes, such as the

FIG. 1
A typical lead-plate acid storage B battery

charging of storage batteries, require direct current, and where A. C. is the only convenient power source, rectification is the most simple and logical method of supplying this one-direction current. Due to certain advantages in alternating current distribution, a majority of homes are electrified with A. C. in preference to D. C. Most of our readers are therefore familiar with the principle of rectification

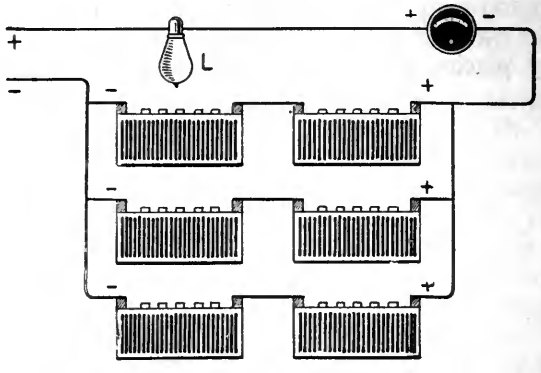


FIG. 2
Charging a B battery from direct current lighting mains. Note the series-parallel connection

through the common use of rectifiers for charging storage A batteries, which, until the advent of the dry-cell tube, was the only practical way of lighting the tube filament.

The popularity of the multi-tube receiver, and more particularly special cases as the superheterodyne and resistance-coupled amplifiers, has bespoken the very pronounced advantages of the storage B battery, and again presents the problem of rectification which the dry-cell A battery had perhaps tended to eliminate.

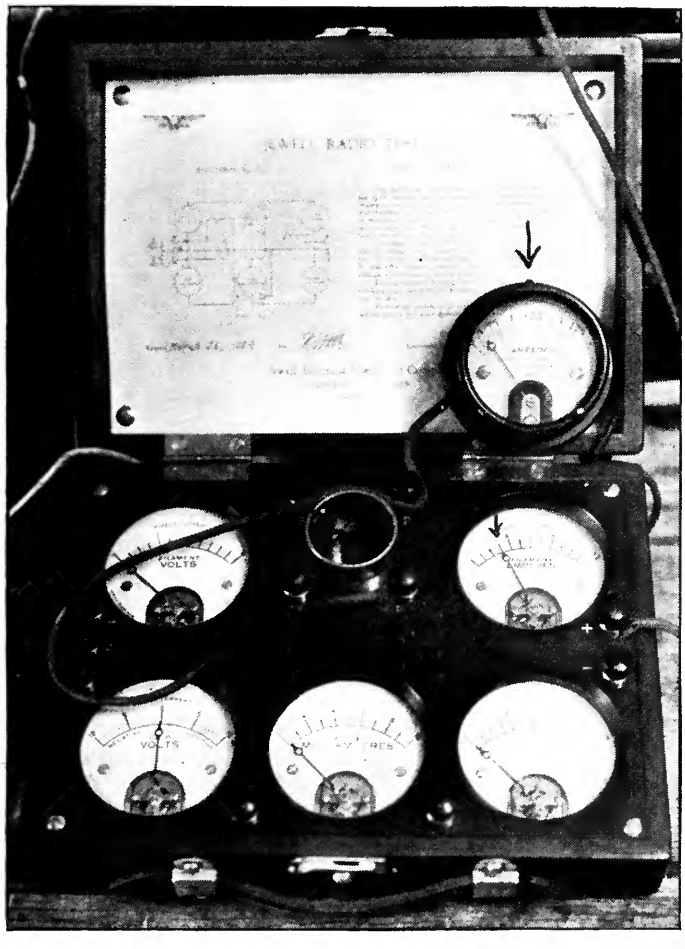


FIG. 3
The two meters in the upper right illustrate the inaccuracy of the standard D. C. meter on a pulsating current. The upper meter is correct

Storage B batteries are obtainable in two electrical types, generally recognizable by certain consistent mechanical characteristics—the lead-plate-acid cells and the Edison nickel-iron battery. The lead plate cell, a battery of which is shown in Fig. 1, is a minature A battery in both appearance and construction. These batteries are generally manufactured in 24-volt blocks, two or more sections being connected in series for high amplifying potentials, and in parallel for charging.

The Edison cells are usually built up in a test-tube rack, such as the battery shown undergoing charge in Fig. 7. Sizes of these are obtainable in tapped voltages up to one hundred and forty volts. Switches are provided which break up the battery into smaller units and connect them in parallel for charge.

The characteristics of each type of battery will have a different appeal to individual experimenters, and to an extent will affect their adaptability to taking a charge from various A battery rectifiers. The lead battery probably holds its charge longer or more consistently, will give greater current, and suffers less from voltage drop during a normal discharge. The Edison cell, on the other hand, is cheaper when high voltages are desired, and, as it is apparently immune from abuse, has a longer life. It goes without saying that the maintenance of these batteries differs with their differing electrical characteristics, and the instructions of the individual manufacturers should be studied and observed in every case, occasionally modifying the charging instructions with the suggestions given in this article.

CHARGING THE BATTERY

IF THE reader is one of the fortunate minority whose home is lighted by direct current, (D. C.), he may of course charge his battery without the aid of a rectifier. Fig. 2 shows how this may be done, and also illustrates the principle of series-parallel connection. Six 24-volt batteries giving a series potential of 144-volts, have been broken up into

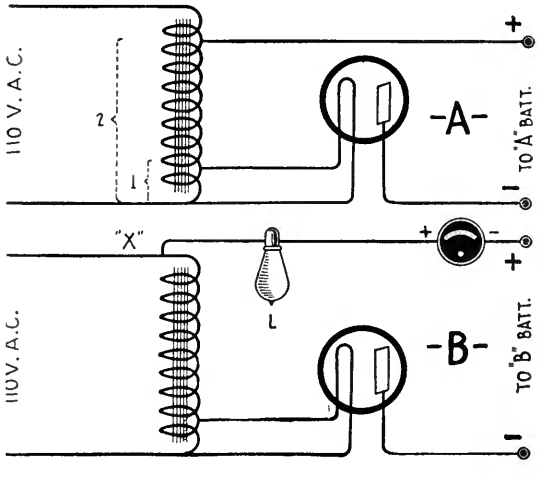


FIG. 4
Converting the Tungar type A battery charger

48-volt units and connected in parallel. L is a 75- or 100-watt lamp which passes a charging current of about .4 ampere. The meter is not necessary but it is very desirable as both a polarity indicator and an indication of the charging rate.

In charging from alternating current, a rectifier is needed in addition to a 100-watt lamp and the meter. The meter should read from zero to one ampere, but in the case of a rectified current it is an indication of polarity rather than a reliable reading of the charging current. As before mentioned, the rectified current is pulsating, rising from zero to maximum and falling to zero again. Due to the reactance in the winding of the direct current meter, a quality which, as we have had occasion to explain before, opposes any current change, only a small amount of the available current is permitted to actuate the meter. The meter indicates only about two thirds of the total *direct current* passing through the circuit. Fig. 3, showing a hot-wire meter connected in series with a magnetic meter, illustrates this discrepancy, the former meter registering the true current. The D. C. instrument is emphatically unreliable in the case of chemical rectifiers, where the alternating current inadvertently passed through the cells has no effect whatever on the needle but will register a very definite deflection on the hot-wire meter. The D. C. meter, however, is preferable in all cases, for the one third allowance is easily made, and the needle is a reliable indication of the direction of current, which is most important.

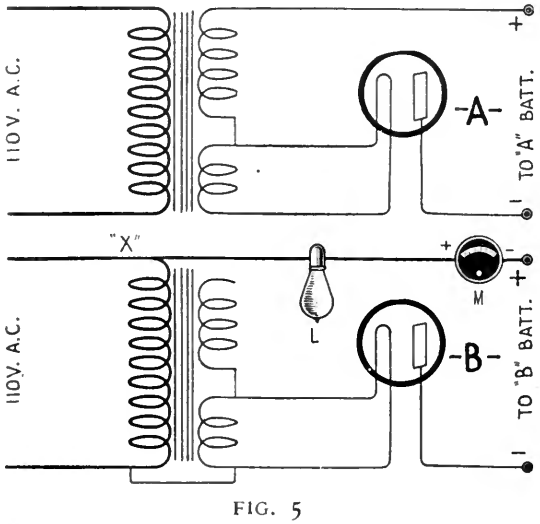


FIG. 5

Doing the same with the separate winding transformer

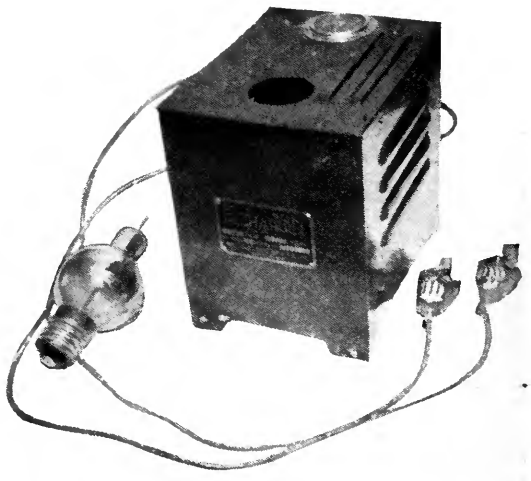


FIG. 6

A typical bulb rectifier designed for charging storage A batteries. This article tells how to charge B batteries with it

THE RECTIFIER

THE rectifiers we shall discuss in this article are those originally designed for charging storage A batteries. These arrange themselves into three classes, designating the principles upon which they function. The first, and probably the most popular, is the bulb rectifier, such as the Tungar, Rectigon, and King. The next most common is the mechanical, or vibrating rectifier, good examples of which are found in the Leich, Valley, Apco, Handy Charger, Unitron, Homcharger and La France. Last in place, but by no means so in merit, is the efficient chemical rectifier such as the Fansteel Balkite.

The manufacturers of one or two of these chargers, anticipating the demand that is following the widespread appreciation of the storage B battery, have designed attachments which adapt their chargers to higher voltage batteries. These attachments, however, are generally superficial additions of which the experimenter can easily avail himself without further expense. A few feet of lamp cord, a socket, a 100-watt lamp and the meter are all that is necessary to convert any A battery rectifier into a B battery charger.

CONVERTING THE BULB RECTIFIER

MOST enthusiasts who are at all familiar with the action of the three-element vacuum tube comprehend the principle upon which the two-element valve, such as the Tungar, functions. When the positive half of

the cycle is applied to the plate of the tube, electrons are drawn over from the filament, and current passes through the bulb and the battery, which is included in the plate circuit. On the negative half of the cycle the plate charge is reversed, the "like charge" repels the electrons thrown off by the filament, and no current passes.

There are two types of bulb rectifiers in use for battery charging, one employing the auto-transformer (Fig. 4A) and the other using the conventional transformer with separate primary and secondary windings (Fig. 5A). In the auto-transformer diagrammed in Fig. 4A, the entire winding functions as the 110-volt primary. The turns braced by 1 act as the filament lighting secondary, while the section braced at 2 furnishes the higher potential for charging the battery. The Tungar rectifier is of this type, and is quite easily converted into a B battery charger.

As is shown in the diagram, one side of the A. C. line connects to the filament. It is first necessary to determine which side of the line this is. Disconnect the connection to the plate of the rectifying tube by slipping off the Fahnestock clip, and plug the rectifier into a lamp socket. Now take an electric light bulb and connect one side of it to the filament of the rectifier. The free end of the connections leading to this bulb is touched first to one side of the alternating current line and then to the other. The side on which the 110-volt lamp lights to its full brilliancy is quite evidently the side *not* connected to the filament. A tag or other means of identification should be affixed to it to designate this wire as "X" of Fig. 4B. The remaining connections are

FIG. 8

An A battery charger of the vibrating type

followed accordingly. "X" runs to the lamp; from the lamp to the meter; from the meter to the plus of the storage B battery, and from the minus of the battery to the plate of the tube.

A charger of the separate-winding type is illustrated in photograph Fig. 6. If the experimenter is in doubt as to the connections of his charger, the test suggested in the preceding paragraph for locating side "X", will determine the type of transformer used. If the test lamp does not light on either adjustment, it is evident that there is no connection between the primary of the charger and the filament lighting secondary, i, e., the circuit of the charger is that shown in Fig. 5A. In converting a charger of this type, one side of the 110-volts is connected deliberately to the rectifier filament, while the remaining side, "X" again, is connected to the lamp and meter in the same way as with the Tungar machine. Fig. 5B shows the separate-winding rectifier arranged for charging storage B batteries.

L, in both Figs. 4 and 5, is the 100-watt lamp, and M is the direct current meter already described. If more convenient, an electric soldering iron may be substituted for the lamp. Fig. 6 shows the A battery

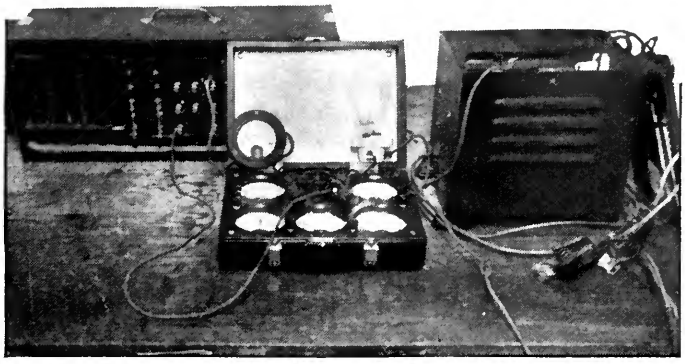


FIG. 7

Charging a forty-volt B battery (three sections in parallel) from a converted A battery charger. On discharge this battery gives more than 120 volts

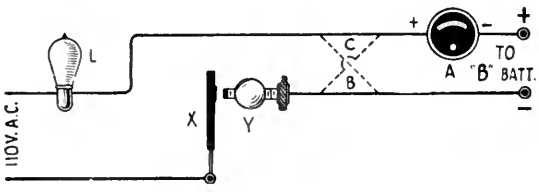


FIG. 9

How to connect the vibrating charger for charging a forty-volt B battery. The vibrating mechanism is connected to the 110 volt line as usual

charger made by the King Electric Company charging an Edison storage B battery.

THE VIBRATING OR MECHANICAL RECTIFIER

THE mechanical rectifier is nothing more than an automatic switch for connecting the battery to the charging potential when the current is in one direction, and breaking the circuit on the other half of the cycle. This is most simply accomplished magnetically, through a combination of permanent- and electro-magnets, the winding of the latter being placed over the former as a core. When an alternating current is passed through the coils, the core is given a magnetizing impulse first in one direction and then in the other (the polarity of an electro-magnet is of course determined by the direction of the current responsible for its magnetism.) Thus on one half of a cycle, the magnetic attraction of the permanent magnet for a near-by armature will be augmented by the electro-magnetic effect while on the other half, due to the opposing magnetic fields, there will exist little or no attraction. The armature will therefore be pulled to the magnet sixty times a second, and, if suitable contacts are provided, mechanical rectification becomes an obvious and simple matter. Other types of magnetic rectifiers utilize a polarized armature, but the principle of opposing and coöperative magnetic fields remains the same. Fig. 7 is a photograph of one of the most efficient rectifiers of this type, and upon which the experiments described in the following paragraph were made.

In converting magnetic A battery rectifiers for charging higher voltages, the various rectifying circuits—and they are several—need not be considered individually. The actual original circuit may be partially ignored, and the reader's attention concentrated on running two free leads, one to the vibrating arm (X in Fig. 8) and the other to a stationary contact (Y). On most rectifiers, two contacts will be found placed on opposite sides of the vibrating armature. It occasionally happens that only one stationary contact is connected to the A battery charging circuit, which makes the free contact particularly adaptable to our purpose. However, either contact may be used.

It is next necessary to determine if the armature and *both* stationary contacts are isolated from the 110-volts. A test lamp is best employed, after the manner described for tracing the bulb rectifier circuits. One terminal is connected first to the contacts, one at a time, and then to the armature, the remaining terminal being touched to each side of the 110-volts. The test is, of course, made when the rectifier is plugged into the lighting circuit. Negative results indicate the desired isolation. As separate winding transformers are used in the majority of magnetic rectifiers, this will probably be the case. If, however, the tests show a circuit complexity, it will be necessary to break the undesired connections, leaving the stationary contact points free from direct connection with the 110-volt line.

The armature and contact point are then wired as shown in Fig. 8. L and A are the lamp and meter already described. It is a fifty-fifty chance that it will be necessary to reverse the leads at BC as suggested by the dotted lines. Fig. 9 shows the ensemble in action.

THE CHEMICAL RECTIFIER

THE chemical rectifier is one of the oldest known means of converting alternating current into direct current. The improvements which have made it a very efficient and convenient system to-day, have not altered the principle of its functioning. On half of the alternating current cycle, one of the two electrodes is enveloped in bubbles, forming a gaseous and insulating film which breaks the circuit until they are dissipated by the reversal of the alternating current.

The Fansteel Balkite is the best and perhaps the only representative of this type of rectifier available to the broadcast enthusiast for the charging of storage A batteries. This rectifier may also be used for charging a 24-volt unit of storage B battery without any alterations whatever, half of a 24-volt battery merely being clipped into the circuit in place of the usual six-volt accumulator. The higher potential of the B battery reduces the potential difference between the output of the

rectifier and the battery undergoing charge, with a corresponding reduction in the charging rate which drops to about .3 ampere. The manufacturers of this rectifier will send to interested readers corroborative data on this particular method of charging.

A 24-volt battery may also be charged as a single unit, by leading the 110-volts directly to the rectifying cell, and from there to the battery as shown in Fig. 10. Again it may be necessary to reverse the leads at BC. Fig. 11 shows this arrangement charging 24-volts of B battery, and the reader may observe the connections soldered to the rectifying cell terminals. The Balkite rectifier, fed from 110-volts, A. C., does not charge satisfactorily when the normal battery voltage is over thirty. In using the Fansteel charger for B batteries, it is suggested that they be connected in parallel units not exceeding this voltage.

While this system of rectification works well on all batteries, it is more satisfactory on the lead plate cells, due to the efficiency with which such batteries accumulate a charge at very low rates. The Edison cell takes a charge best at a comparatively high amperage. For this reason, when charging the latter type, particular care must be observed to maintain the electrolyte at the proper height in the Balkite cell, or, more technically, at the proper specific gravity. It is at this strength that the solution offers the least resistance to the current, and therefore passes the highest amperage. Needless to say, the efficient operator will maintain the desired specific gravity at all times, regardless of the type of battery being charged. Very few of us are efficient operators.

CONCLUSION

EXCEPT where the voltage is specifically stated in the foregoing paragraphs, it has been assumed that the battery will be

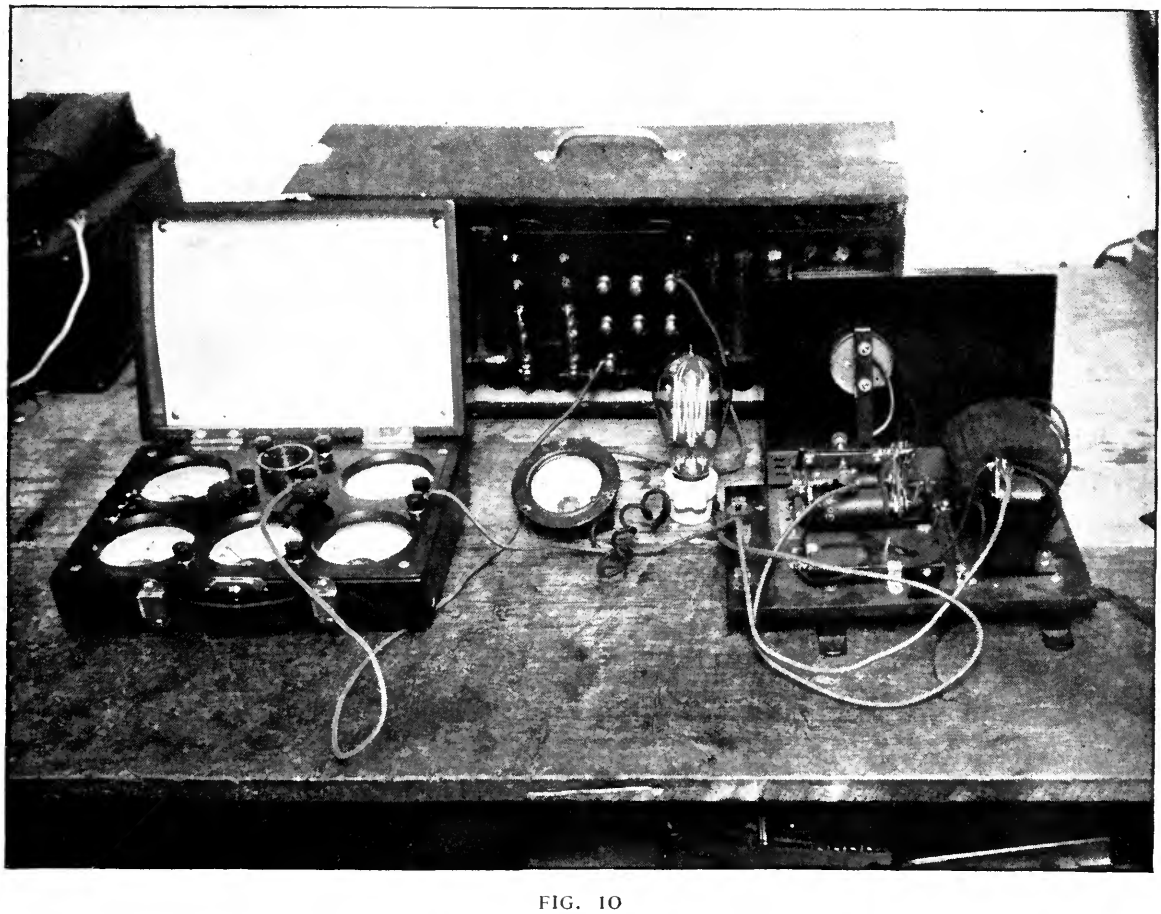


FIG. 10

Charging the B battery with the vibrating rectifier. An electric soldering iron may be plugged in, adding the needed resistance in place of the electric light bulb

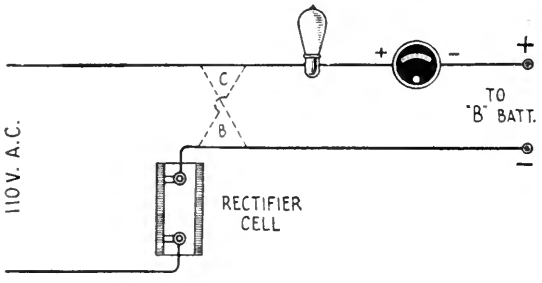


FIG. 11

How to connect the 110 volts directly to the Balkite rectifying cell for charging a B battery as a twenty-two-volt unit

charged as a 48-volt unit. It is difficult to charge a higher voltage than this without recourse to a step-up transformer. The experimenter, however, may charge his cells as a 24-volt battery. This is particularly convenient in the case of a 72-volt battery built up of three 24-volt blocks. No change in the charging apparatus is necessary to compensate for the current, which automatically adjusts itself by flowing through more parallel units.

The B battery should be disconnected from the receiver while undergoing charge, and the possibility of a grounded connection should be assiduously avoided. Do not attempt to charge A and B batteries simultaneously from the same rectifier, unless you are sure, very sure, of your circuit. It can of course be done, the author does it, but he has discovered that in doing so it is a good idea to supplement one's genius with a supply of fuses.

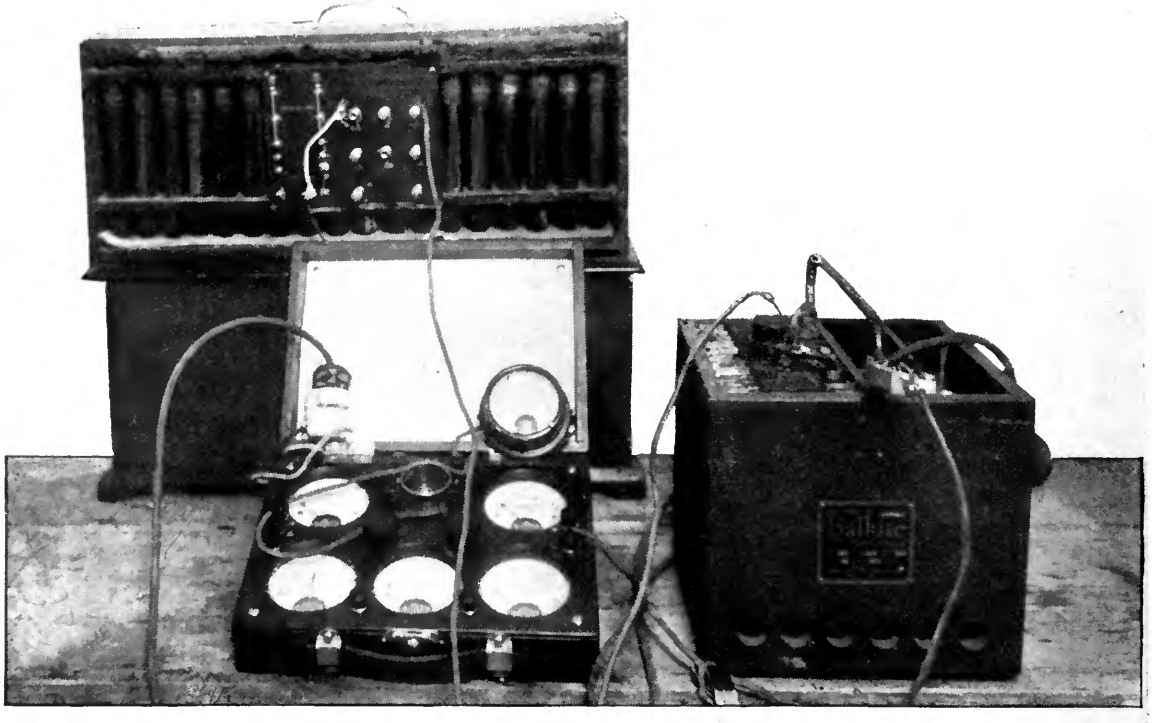


FIG. 12

The Balkite B battery arrangement in action. The transformer of the rectifier has been substituted for the usual electric light bulb

HOW an amateur can make a receiver for very short waves will be the subject of the next of Mr. Bouck's how-to-build-it articles, appearing in August. A very sensitive and economical non-radiating circuit never before used for the reception of 100-meter waves is employed.

Man-Made Static

Showing That Some "Static" is Native to Poorly Built Receivers—How to Test a Suspected Set

By A. F. VAN DYCK
Engineer, Technical Division, Radio Corporation of America

PART III

TWO previous articles have described various causes of interference with radio reception originating in electric power circuits or devices, and methods of eliminating those disturbances. There are some general aspects of the subject, not covered in these previous articles, which should receive consideration by every broadcast listener who believes that interference which he experiences is due to such causes. Then the broadcast listener can find a solution for his particular problem, with minimum trouble to himself and to others.

As the number of broadcast receivers increases, the number of cases of interference reported grows also. The number of cases reported to radio and power companies has attained large proportions. This has given such agencies good opportunity to study such interference.

The most interesting and important discovery brought to light by these companies is that a large percentage of complaints of interference are not due to outside interference at all, *but are caused by defects in the complainant's receiver.* This has been found especially true of home-made receivers built by persons with little or no electrical experience. Bad contacts, poor soldering (or no soldering at all) broken wires, run-down B batteries, are sources of noises which are none too easy for the novice to find, so that he very often concludes that the noises he hears are due to "interference." He may blame the amateur, the commercial station, the power company, or any one else on whom his imagination may alight.

All That Scratches

Isn't static, as Mr. Van Dyck points out. Inexperienced enthusiasts can build a receiver fairly bristling with potential scratchings and howlings by being satisfied with little or no soldering, poor contacts—and careless workmanship in general.

Power companies aren't altogether to blame for the unearthly noises your set may vent—but when they are to blame, they are mighty willing to "shoot trouble." Here is some good advice to look carefully before you take a petulant radio leap and blame your "interference" on all and sundry.—THE EDITOR

HOW TO TEST FOR A FAULTY RECEIVER

THE first thing to do when noises are heard in a receiver is to make sure that they are not originating in the receiver itself. A first and informative test is to connect together the antenna and ground terminals of the receiver with a piece of wire. This prevents any voltages in the antenna from actuating the receiver, and if the noises are still heard it is absolutely certain that they are being caused within the receiver, and are not coming by way of the antenna. When such a connection is made on a receiver which is in good condition, perfect silence in the loud speaker (or headset) will be had.

The next general observation of importance made in study of large numbers of complaints to power companies, is that much trouble is caused by standard devices connected to power lines by individual owners, and therefore, over which the power companies have no control. Devices such as heating pads, violet-ray machines, elevator motors, etc., may cause interference—but through no fault of the power company whose responsibility is merely to supply power to the user. It is important to appreciate this, because it is useless to ask a power company to eliminate a source of interference over which it has no control.

GET THE FACTS BEFORE YOU COMPLAIN

THE second thing for a broadcast listener to do when he experiences interference of this sort, provided the first test has proved that the trouble is not in his receiver, is to determine the nature and general source of the disturbance, or if he can't carry out this work personally to engage the services of a radio expert to do so. The object of this second test is to determine whether the trouble is caused by any electrical device or circuit in the same house with the receiver, whether it comes into the house over the power lines which furnish power to the house (these questions can be studied by switching off all devices in the house and finally by opening the main switch, usually located near the meter, or removing the fuses—if the interference is actually coming in on the house power wires it will be affected by opening the switch, although not necessarily stopped) and whether the other receivers in the neighborhood experience the same interference. Intelligent execution of this second step is essential before anything else can be done and before any complaints can justly be made to any one. If the source of the trouble is located, it is then possible to complain to the proper party and thus obtain correction most quickly, and incidentally to avoid unwarranted complaint to other parties not responsible for the difficulty. If the test described above shows that the noise is coming in on the house power lines, the search can then be continued. The fact that it comes in over the lines does not mean necessarily that there is a fault on the power lines. It may be caused by some device connected to the lines at some point. Or it may be caused by the power lines acting merely as collector of a disturbance which originates on other wires near them at some point.

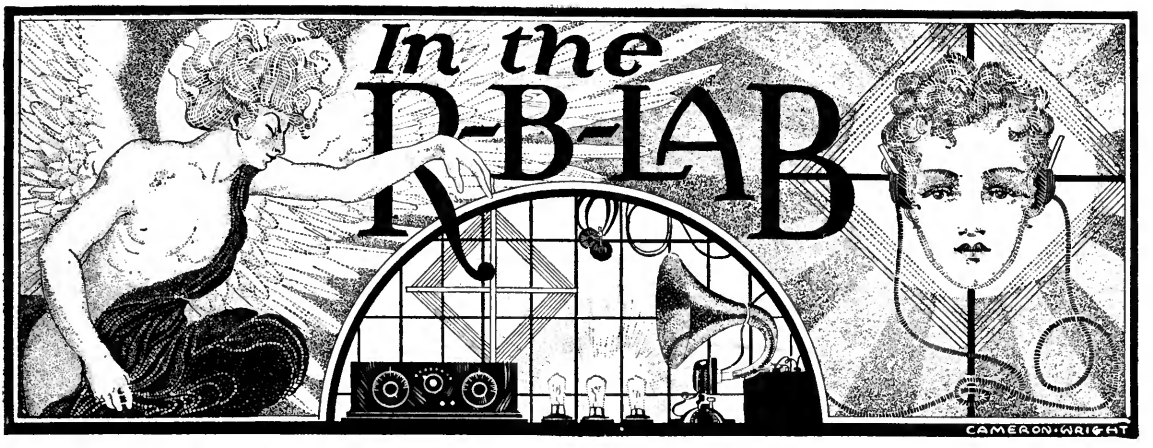
Power companies take care of the maintenance of the lines which supply and distribute electric power. Faults on lines themselves, which cause radio interference, occur sometimes, but such faults make only a small percentage of all sources of interference, as shown in the table below. Power companies try to maintain their lines in good condition, and most lines are regularly inspected, so that serious faults are likely to be discovered before they have existed very long.

The following table of classes of interference caused by electric circuits, is based upon approximately one hundred verified reports.

NATURE OF INTERFERENCE	PERCENTAGE OF TOTAL CASES
Telephone Bell Ringers	25%
Gas Engine Plants	21%
Miscellaneous Industrials (Trolleys, motors, rectifiers, signals etc.)	17%
Town lighting plants and street lighting	13%
Household Appliances	12%
Power Lines	10%
Electric Precipitators	2%

It should be appreciated by broadcast listeners that interference may be caused by some electrical devices which are in normal working order. Examples of such devices are heater pads (thermostatically controlled), violet-ray machines, trolley cars, store and factory motors, elevator machinery, etc. In many cases, operation of such apparatus can not be stopped for the sake of broadcast reception, and unless some of the remedies described in preceding articles (RADIO BROADCAST for April and May, 1924), can be applied, through cooperation of the broadcast listener and the owner of the apparatus, the broadcast listener should be satisfied with reception of signals which are strong enough to dominate the interference. Exceptional cases of this sort may arise, however, where such electrical apparatus operation affects the radio reception of a sufficiently large body of listeners to constitute a public nuisance, and in such cases, special remedies may be justified.

WIDE interest has been excited by the RADIO BROADCAST *$500 prize contest "Who Is to Pay for Broadcasting—and How?" Full particulars appeared in the magazine for May and June. All entries for the contest must be in the mails by July 20, 1924, addressed* RADIO BROADCAST *Who Is to Pay Contest, care American Radio Association, 50 Union Square, New York City.*



HOW TO BUILD A RADIO "TESTOMETER"

IT IS often exasperating, or worse, to await the opening of a local or particular broadcasting station in order to determine whether or not a new receiver is operating. The radio "Testometer" is a convenient name for a small buzzer transmitter that may be used to generate radio signals for the testing and comparison of receiving sets. The testometer enables the experimenter to test the sensitivity of any receiver by using this kind of portable standard, and to determine approximately its wavelength range, quite independent of S O S's and the caprices or operating hours of broadcasting stations.

Technically, the testometer is nothing more than a buzzer excited wavemeter—the accuracy of which would send the Bureau of Standards into convulsions. However, it is quite adequate for the purpose for which we recommend it, and it is so simple that it may be almost thrown together in a few minutes, if the experimenter does not care to construct the testometer as a permanent piece of laboratory equipment shown in Figs. 1, 2 and 3. The circuit is diagrammed in Fig. 4.

B is the buzzer, preferably of the radio type, with an adjustable contact, and vibrating very rapidly. C1 is a by-pass condenser around the buzzer coils. C2 is a tuning condenser, an active part of the oscillating system that eliminates the necessity for a many-turn coil at L. Both capacities are fixed Micadons. Using a .00025 mfd. condenser at C2, L is wound on a three-inch form with twenty turns of approximately No. 22 wire, tapped in the middle. A three-point switch is mounted under the buzzer, giving "off" to the left, and low and high wave on the respective points to the right. With the suggested values of capacity and inductance, the circuit will oscillate on the middle tap at approximately 1,111 kilocycles (270 meters) and at 667 kilocycles (450 meters) on the higher wave—giving a good idea of the ability of the receiver under test to cover the broadcast range.

Three dry cells, or a six-volt storage battery are used to actuate the testometer. In

What the Lab Offers You This Month

—How to build a "radio testometer"—a simply built adaptation of the wavemeter which indicates at once the wavelength range and state of sensitivity of your receiver.
—Illustration of commendable super-heterodyne construction from RADIO BROADCAST *articles.*
—How to build a self-supporting loop.
—An illustration of a neat three-tube RADIO BROADCAST *Knock-Out receiver built by a reader.*
—How an audio-frequency transformer may be connected, still to perform good service as an impedance-coupling for the last tube of your audio-frequency amplifier.
—How to build a very inexpensive and very stable crystal detector which should be valuable in a reflex receiver.
—Results of using the WD-11 and WD-12 tubes in the RADIO BROADCAST *one-tube Knock-Out receiver.*
—Suggestions for the growing laboratory.

merely testing a receiver, the wavemeter is placed on the operating table, alongside of the set, as shown in Fig. 3. The testometer is operated on either high or low wave, and the note tuned for in the receiver. The sound received is not the comparatively pleasing tone of the buzzer, but is a rather rasping note, sounding somewhat like a poorly adjusted spark coil transmitter or the raspings of a violet-ray machine.

The testometer should first be tried with a receiver of known excellence, and the contact of the buzzer adjusted until the signals are most steady and loud. No antenna is required for these tests. As a criterion for future comparisons, it is a good idea to note how far from the receiver the transmitted buzzer signals are audible. The testometer is removed from the operating table, and carried to other parts of the station or home until the signals can just be heard—i. e., at "threshold" audibility. During these tests, the buzzer and its inductance should be rotated for maximum intensity, as the directional effect of the miniature transmitter is quite noticeable.

It is now possible to compare the sensitivity of any other receiver with your standard set, by noting how far from receiver number two the buzzer signals can be heard at threshold strength.

A standard announcing buzzer may be used in the testometer if the experimenter cannot secure the high tone type.

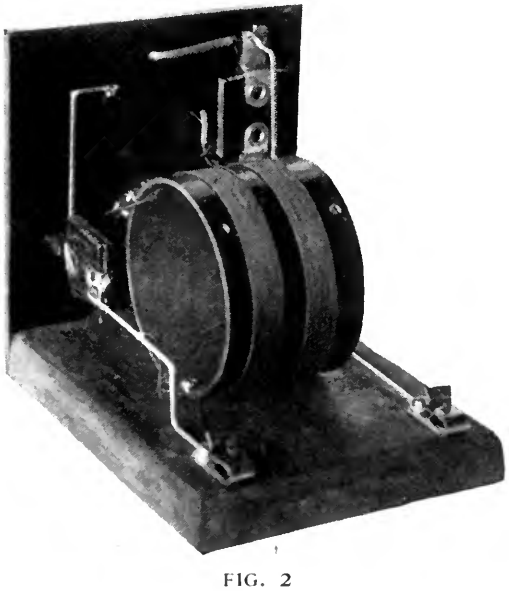


FIG. 2
Rear view of the Testometer

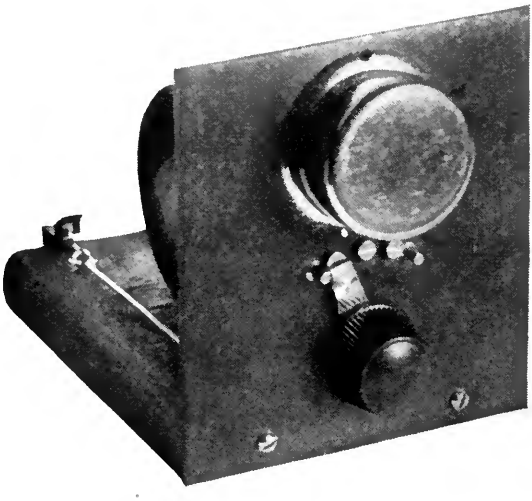


FIG. 1
Front view of the Radio "Testometer"

SOME EXCELLENT EXAMPLES OF SUPER-HETERODYNE AND REFLEX RECEIVER CONSTRUCTION

THE enthusiast does not truly begin to enjoy radio until he applies his own ingenuity to the problems that inevitably confront him. The pleasure derived from operating and displaying a set which reflects one's own mechanical or electrical ability far exceeds the merely passive pleasure of tuning a receiver that some one else has built and installed for you.

The photographs, Figs. 5, 6, 7, and 8 are expressions of original thought in the construction and mounting of receivers. Figs. 5 and 6 are views of the super-heterodyne built by E. F. Weber of Chicago, Ill., from data published in RADIO BROADCAST.

Mr. Weber is to be commended, not merely on the electrical details, such as individual meters, etc., which are evidences of deviation from Mr. Haynes' description of his super-heterodyne, but for the ensemble—the desk-cabinet which adequately provides for his entire equipment. The B battery is contained in the desk compartment, and can be seen in the photograph. The storage A battery is in the lower left hand cabinet, and just above it is the motor-generator charger.

Particular attention is called to the very original construction of the loop aerial. It is two feet on a side, and built entirely of rigid bus-bar wire. This eliminates the usual cross-bars and makes the loop self-supporting.

Three quarters of an inch spacing between turns is about right.

A shortened broom stick may be used for the central support. Toward the center of the loop, single lengths of bus bar wire will suffice for both horizontal and vertical wires but clipped pieces will be necessary for each of the four sides of the outer turns.

Figs. 7 and 8 show the very neat three-tube set built electrically from the description of "A Three Tube Knock-Out," published in the February RADIO BROADCAST, and mechanically from the imagination of the builder, F. W. Becker of Gloversville, New York.

The photographs are self-explanatory. The cabinet houses the receiver, B battery and loud speaker, the bell of which is directly behind the burlap screen in the upper right hand portion of the photograph.

The finished instrument is equally worthy of a place in a well appointed library, or in the radio laboratory.

AN EFFECTIVE WAY OF USING A BLOWN OUT AUDIO-FREQUENCY TRANSFORMER AS IMPEDANCE COUPLING

WHEN your last stage transformer succumbs to the strain of high voltages, and either the primary or secondary becomes "open," its usefulness is by no means exhausted. Utilizing the remaining winding as a coupling impedance, the last step circuit can be made over into a final stage of impedance-coupled amplification with very little trouble. Though this system may give slightly less volume than a transformer-coupled amplifier working with a step-up ratio, the resulting quality is better.

Most transformer difficulties in audio-frequency amplifiers can be traced to an open in the primary of the last stage. It is this winding that is subjected to the greatest strain. However, for the purpose of impedance-coupled

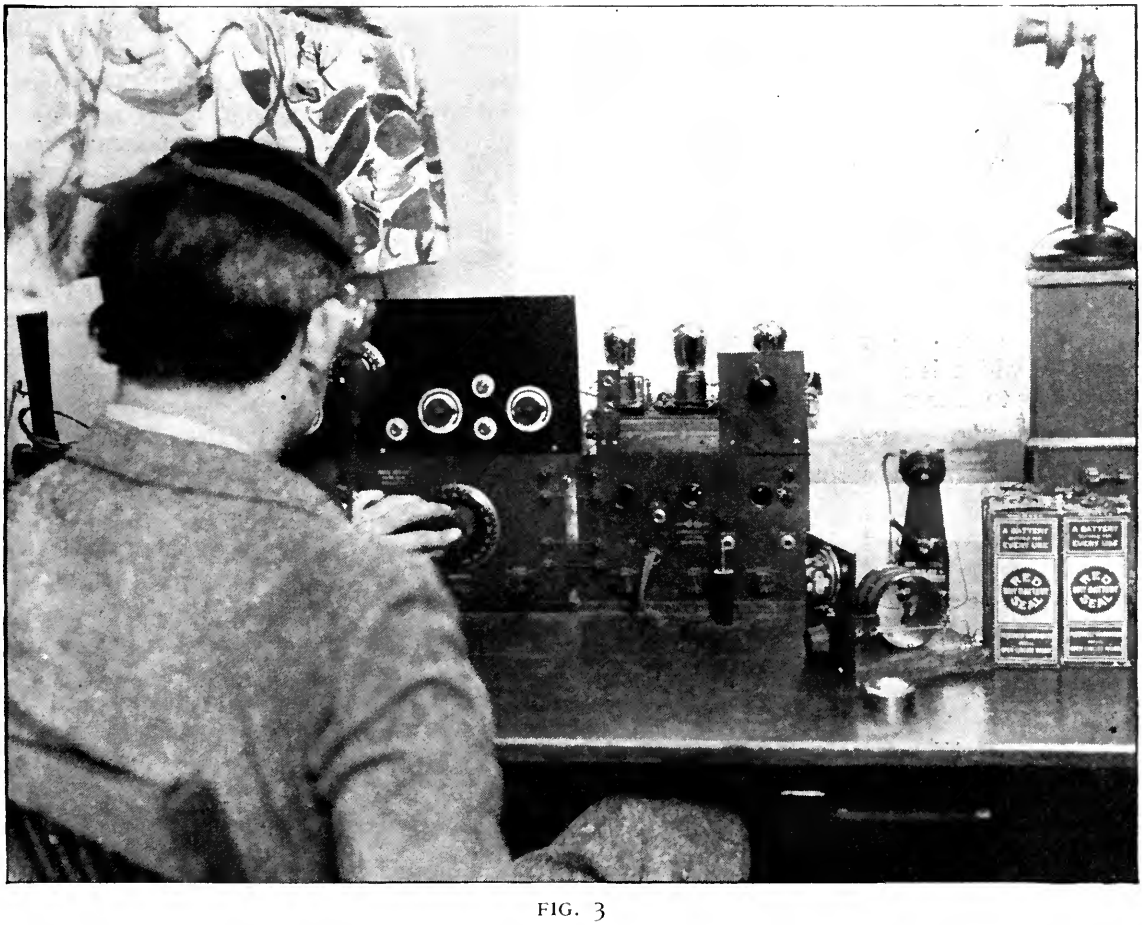


FIG. 3

Using the Testometer. It may be operated at a distance from the receiver in order to test it for sensitivity

amplification, it is immaterial which winding survives. If, as it is probable, a perfect secondary is at the disposal of the experimenter, the input efficiency of the last tube will be high. On the other hand, if a primary is employed as the impedance coupling, the output efficiency of the next to the last tube (or that tube in the plate circuit of which the impedance is placed) will be at par—so the effect is that of an average.

Fig. 9 is the diagram of a two-stage amplifier in which the second transformer has broken down, and the remaining winding "X" substituted for the separate primary and secondary. C is a combination isolating-coupling condenser such as used in resistance-coupled amplifiers. Its capacity is preferably .006 mfd., though .0025 mfd. will work very well. R is a grid leak, the resistance of which is best determined by experiment. One fifth megohm is, perhaps, the average value for R. The connection between the minus B battery and the filament lighting battery has been indicated only tentatively by dotted lines. This connection will probably be made in the tuning or detecting circuit where the polarity is often important. The amplifier will operate either way.

The theoretical functioning of the impedance-coupled intensifier is a cross between the action of a resistance-coupled amplifier (see the "Knock-Out Four Tube Receiver" in the June Radio Broadcast) and the operation of the transformer-coupled amplifier. There is, of course, a potential drop across X which is applied to the grid of the succeeding tube through condenser C as would be the case were X a pure resistance. There is also a self-induced potential, an auto-transformer action, caused by the rise and fall of the magnetic flux about the winding, that is similarly impressed on the grid of the last tube. Impedance amplification has the advantage over resistance coupling in that no higher plate voltages are required than are usually applied in the conventional amplifying system. The quality, as before mentioned, is superior to that of a transformer-coupled amplifier. This is partly because there is no step-up ratio which has the effect of magnifying distortions. Also, there are many less turns of highly inductive winding which have an inherent tendency to distort. Due to the perfect quality of output, impedance-coupled amplifiers are used in the Bell system for amplifying telephone speech.

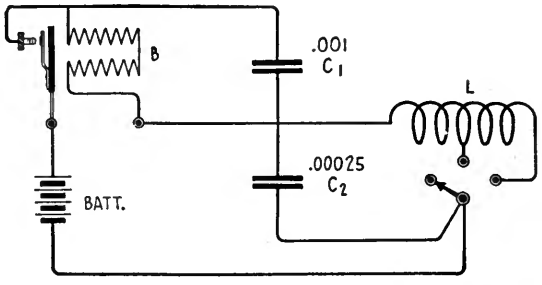


FIG. 4
The circuit of the Testometer. It is merely a wavemeter with two adjustments

The substitution of impedance for transformer-coupled amplification is not, of course, confined to the last stage. Three reasons, however, recommend it in the final stage. The probable transformer break-down in this position makes its substitution a particularly simple matter, and the impedance-coupled amplifier is much more effective when fed with the "kick" from the first stage of intensification. Also, the last step of amplification, where quality is especially impaired, is the logical position for a stage that amplifies with a minimum of distortion.

The secondary of a Ford spark coil or a telephone repeater coil makes an excellent coupling impedance and might quite well be used by the curious experimenter.

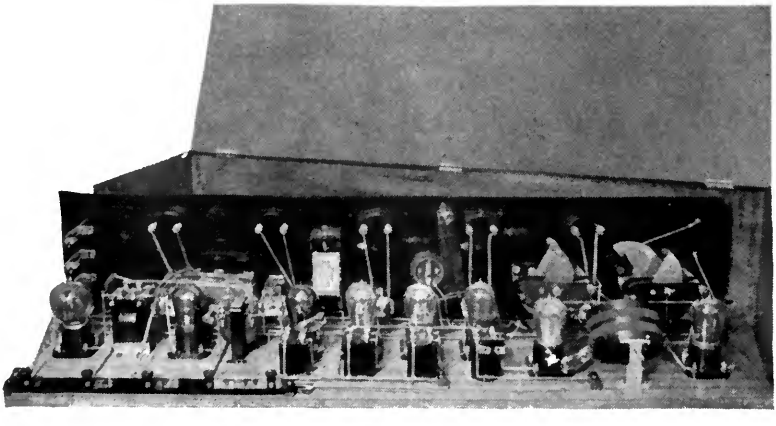


FIG. 5
Behind the scenes in a super-heterodyne built by one of our readers

HOW TO MAKE A VERY STABLE CRYSTAL DETECTOR

FIG. 10 is a photograph of a clever crystal arrangement devised by J M. Dockstader of Perth Amboy, New Jersey. It was designed for use with the single-tube reflex receiver as a compromise between the fixed crystal and the adjustable detector. Mr. Dockstader's little device possesses the stability of the fixed crystal, while permitting the desirable adjustment of the old-style detector. Used in this laboratory, it maintained its sensitive adjustment for two weeks, during which period it was moved about, from shelf to the operating table and back again several times.

Photograph 10 shows the crystal arrangement mounted on a small individual base made of Mahoganite panel material. It can, however, be mounted more conveniently on the panel or base of the receiving set proper. The photograph shows the construction very clearly. The size of the base is about two inches by two inches.

The prongs may be bent from any very stiff wire (they are not delicate cat-whiskers). The designer recommends No. 20 German silver. Two and three quarters inches of wire will be enough for each prong. Small loops are formed in one end, while the other end is flattened and cut with snips or pliers to a spear point. The prongs are then mounted in the position indicated by the photograph (most conveniently with wood screws on the base of the receiver) so that they meet the crystal at right angles to its surface, and with the contact points separated not more than $\frac{1}{4}$ inch. The closer the points are together, the more surface of the mineral there is available for exploration.

The crystal is silicon, *not galena*, and is mounted in a small slab of bakelite or hard rubber. An oblong hole is drilled and cut in the insulating strip to a depth that will flush mount the crystal, which should have a flat surface. A bit of sealing wax is melted into the hole and onto the reverse side of the crystal. While the wax is hot, the mineral is pressed into the hole. Two or more crystals may be mounted on the single strip as suggested in the photograph.

The tension on the two wires should be about equal, and sufficient to hold the crystal firmly against the base. The points should follow the crystal rather than glide over it when it is moved. In some cases it may be of advantage to blunt one of the wires.

The detector is adjusted by moving the crystal with the fingers or tapping with a lead-pencil.

THE WD-12 AND THE REFLEX SET

THE designer of the crystal detector described above, also sends us some operating data on using the dry cell tube in the one-

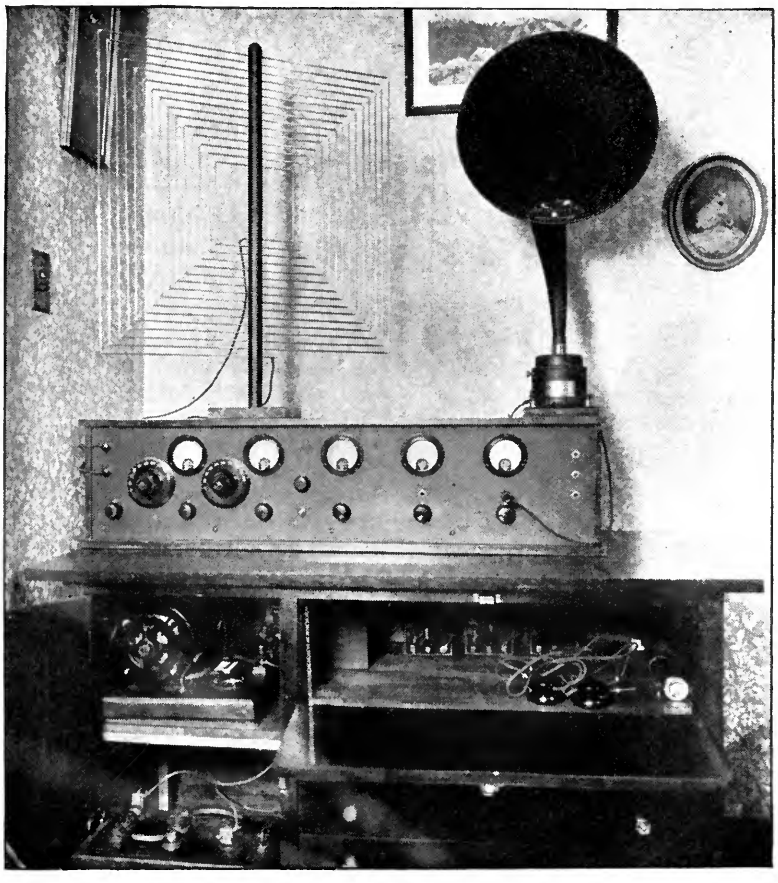


FIG. 6

A home fit for a super-heterodyne. Note the self-supporting loop

tube reflex receiver, which corroborates our own experience with these tubes as amplifiers.

Mr. Dockstader finds that superior results are obtained with the WD-11 and WD-12 when a higher voltage A battery is employed with a thirty- to sixty-ohm rheostat. The rheostat is placed in the negative filament lead, while the grid return, through the secondary of the amplifying transformer, runs to the negative terminal of the "A" battery. As Mr. Dockstader suggests, the increase in efficiency is due to the bias secured by the potential drop across the rheostat. A fixed resistance should be substituted for part of the extra resistance in order to prevent possible burning out of the tube if too little resistance is used, such as might well be the case if a rotary rheostat were used alone. Equally satisfactory results can be obtained by placing a small C battery, of one and a half to three volts,

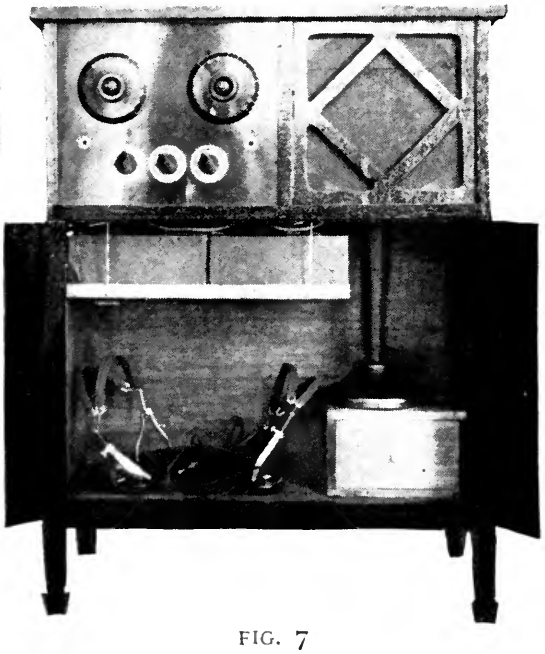


FIG. 7
An interesting example of original construction

negative to the grid, between the lower side of the transformer secondary (T3 in all of our single-tube reflex diagrams) and the negative of the filament battery.

WHERE TO BUY INDIA INK

HIGGINS White Label India Ink, such as was used in the home manufacture of grid-leaks described in the R. B. Lab a number of

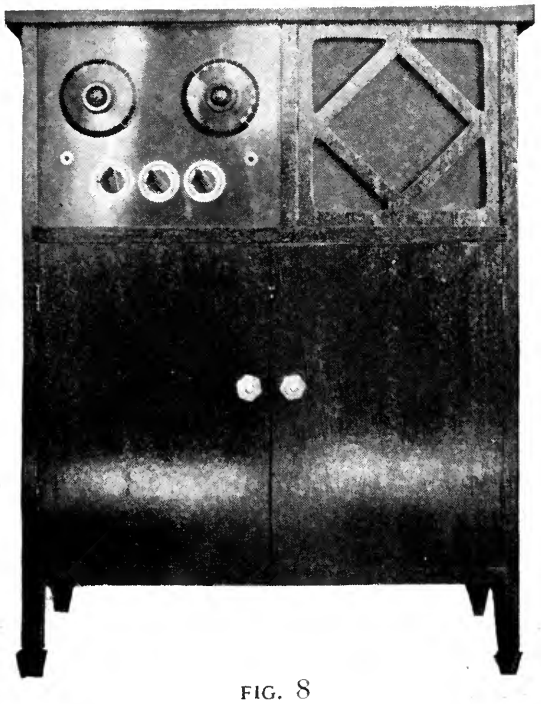


FIG. 8
A Radio Broadcast circuit plus the ingenuity of the builder

months ago can be bought from any large stationery store handling artists' supplies. However, experimenters living in small towns may find it rather difficult to obtain through a local dealer. It is suggested that readers having difficulty in securing this particular grade of ink, order direct from Brentano's, Fifth Avenue and 27th Street, New York City. Thirty cents is the postpaid price for a small bottle—enough for a hundred grid-leaks of varying resistances.

LEAVES FROM AN OLD TIMER'S NOTEBOOK

ELECTROLYTIC RECTIFIERS: In using electrolytic rectifiers of the lead-aluminum type for the rectification of A. C.

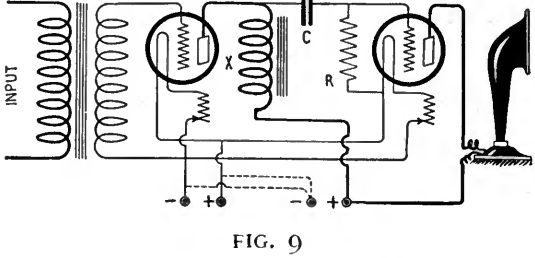


FIG. 9
How to use an amplifying transformer with a blown out winding

for the plate potential in bulb transmission, or for the charging of storage batteries, a slight purple haze about the metal elements, more noticeable in the case of high voltage rectification, is an indication of perfect operation. Defective rectifiers are characterized by sparking and general pyrotechnics in certain jars. This, as is understood, necessitates a replacement of jars, but be sure and replace the jars that do *not* spark. Those that spark are the *good jars*, and spark only because they are overloaded by the inoperation of the inactive cells!

BUILDING YOUR OWN LAB

ANOTHER month rolls by, and the lab is growing. RADIO BROADCAST suggests for July a set of "Spintite" wrenches. These wrenches may be purchased singly, in various sizes, but are most conveniently obtained in the standard set of seven as shown in Fig. 11.

The Spintite wrench is used in place of the usual flat wrench, but works much faster with a screw-driver motion. Two handed co-operation of screw-driver and wrench insures well spun nuts that will not vibrate loose when advanced construction makes access to them difficult or impossible. The intelligent use of these tools will slice many minutes, and sometimes hours, from a difficult assembly job.

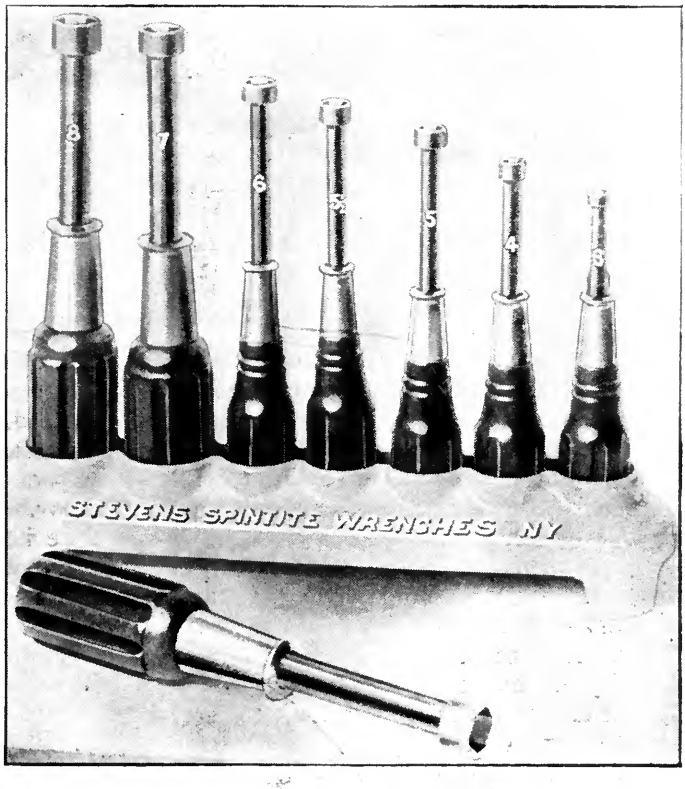


FIG. 11
A handy set of wrenches for the laboratory

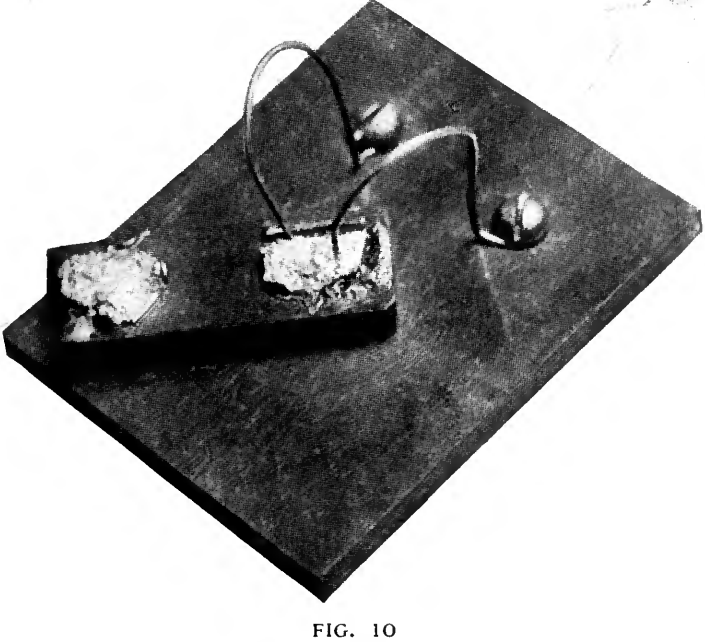


FIG. 10
An interesting and simple detector
It is almost a "fixed" crystal

HOW TO MAKE YOUR OWN BUS WIRE

CUT some No. 14 bare copper antenna wire into five-foot lengths. Twist one end of a length around a nail permanently fastened and place the other end in the chuck of a hand drill. Then, with a steady pull, turn the handle of the drill first in one direction and then another for a few turns. A stiff piece of round wire, far cheaper than the "store" bus wire, results.

Broadcasting Personality

How S. L. Rothafel, Better Known as "Roxie," Brings the Human Touch to Radio in His Famous Sunday Evening Capitol Theatre Concerts Sent from WEAF, WJAR, and WCAP.—Is "Roxie" the Anticipated Genius of Radio?

By JAMES C. YOUNG

WHAT does the radio public want?

"I don't know."

Such was the answer of S. L. Rothafel, one of the most successful impresarios of the air. Sitting at his big desk in the Capitol Theatre Building on Broadway he confided some of the troubles which beset a radio director.

"No general reply will answer your question," he said, "but perhaps we can state the matter a little differently. It is the personality of the performer that sways or fails to sway the great unseen audience distributed over thousands of miles, but drawn together in a common thought by the pulsations of the air.

"This is the most appreciative audience in the world and also the most critical. Above all else, it is a sincere audience, and accurately measures the human quality of the performer before the microphone.

"When a man begins to speak, let us say, the audience in his vast theater instantly divines whether he knows his subject, whether he merely is speaking in the professional sense, or sends words worth while across the reaches of space. If the man is sincere, moved by high purpose, his audience hands over its confidence; if he is prosaic, indifferent, just talking to kill minutes, his audience is likely to tune-out with one accord.

"I am convinced that the radio performer's personality is more important than his voice, his subject or the occasion. Any of these may be poor or inopportune and still a speaker will succeed. But if his personality is flat, his purpose vague, he certainly will not command respect on the radio circuit."

Mr. Rothafel has a trick of catching one knee in two strong hands, then whirling this way and that in his swivel chair, as he talks. It is not difficult to see why he has caught the imagination of radio audiences. He has a sparkling eye and a moving vitality that impart confidence and enthusiasm. His Sunday night programs broadcast from WEAF, WJAR, and WCAP, are awaited by radio owners everywhere. Certainly there is nothing of the casual, hit-or-miss quality about these programs. They have all the finesse, the completeness and satisfaction of a theatrical performance that just strikes the nail of public favor.

THE PIPE AND "ROXIE"

S. L. Rothafel in an unaccustomed moment of repose. Roxie fairly vibrates his personality through the microphone Sunday nights when he and his gang are on the air through WEAF, WCAP, WJAR

"Sometimes when I am in a radio studio waiting for our turn I study the effects of personalities unknown to me, at the moment they come in contact with the public," said Mr. Rothafel. "There is something psychic about the result. The same waves of the air which are carrying away the words or music of the performer—or other waves of much the same sort—bring back the reflection of the public mind. An experienced

observer can sense in a minute or two whether the performer is succeeding. And without exception I would say that the big factor is personality, no matter what the medium of expression."

"Can't you apply that psychic sense in advance and decide whether a performer will succeed or fail?"

"I hope you will not think me boastful," said Mr. Rothafel," but I never offered more than one number which failed. And that was my fault. I did not present it properly."

> "I am convinced that the radio performer's personality is more important than his voice, his subject, or the occasion. Any of these may be poor or inopportune and still a speaker will succeed. But if his personality is flat, his purpose vague, he certainly will not command respect on the radio circuit."—ROXIE.

The Capitol company—known to fame as Roxie's Gang—includes more than thirty-five performers and his programs range all the way from the severely classical to "Sally in Our Alley." Between times these programs dip into philosophy, poetry, folk lore, and musical compositions of every possible shade. But the presiding genius of this company and these programs is his own most popular performer. The typical Rothafel prelude, introductions and final "Good night," are awaited weekly by an expectant host wherever the far-flung radio waves travel.

The next time a reader hears one of those programs, let him employ his imagination a bit and transport his psychic self to the studio. Here is the microphone, everything is ready, a girl singer steps up to the instrument. Now just observe the impresario. He raises a finger, the girl watches his face, and at the sign of an eyelid she begins to sing.

HOW ROXIE TURNS ON THE PSYCHIC TAP

AS THE first notes rise Mr. Rothafel "registers" for her benefit how she is getting on. Her eyes never leave his face. A wag of the head, a shake of the finger, a change of expression, govern her efforts. For the moment the director is her audience, taking the place of all that multitude, perhaps listening to some old ballad. Mr. Rothafel is no mean actor. He conveys to the girl every emotion which she stirs. He has a plastic, expressionable face; for the moment his own personality drops away. He literally is the audience, sensing just how it feels, and as the girl goes on he carries her over every bad spot in the road—if there happen to be any.

Perhaps her expression is a little over-drawn; maybe the pathos is a trifle too deep. Right there the director shakes his head and frowns and the expression comes down a key, into the more natural, easy mode which is needed. If the girl were singing by herself—on her own, so to speak—she never would know that she had reached a little too far, that her technique had faltered. But with a director at her elbow who literally turns on the psychic tap and interprets for her how the audience responds, she has a valuable aid to genius.

Still Mr. Rothafel says that he cannot gauge what the public wants. That statement is no gesture of modesty; he means to imply that the public wants many things at many times.

"It is deceptive to speak of the public taste," he said. "We have to consider the individual tastes of a great audience we never see. Every person in that audience, if asked the question, would express a different opinion about any number suggested, or any subject. Therefore we must try to unite all of these minds on themes which touch their imagination."

Mr. Rothafel is a bit of a seer when he is not directing programs. Philosophic observations stand forth from his speech. Here he indulged in an analysis of the public mind.

"Imagination is the greatest power in the world," he said. "It is the thing that moves mountains and captures audiences. The public has a quick, sympathetic imagination. We hear a great deal about what the public wants and what it does not want. Once in a while the public has a chance to choose for itself and the choice is always well made. This public of which we hear so much has more intelligence and good taste than it is usually credited with having. There is one secret route to the public heart—first, be sincere; then lay hold of its imagination."

This emphasis on sincerity cropped out several times in Mr. Rothafel's conversation. "We have taken the radio seriously," he resumed. "As yet I do not believe that its potentialities

are understood. It is in a fair way to become one of the greatest mediums of public intercourse. Radio furnishes a similar parallel to moving pictures. As the film performance was an extension of the drama, so the radio widens the possibilities of the spoken word. It brings a speaker or performer in contact with an audience so much greater than we ever conceived of before that one man's power of communication is infinitely magnified.

WHAT RADIO CAN DO FOR OUR SENSES

I BELIEVE that the radio will give us a new appreciation of what language means. In many ways it is the most elastic medium of speech. When we go to a theatre or a public address virtually all of our senses are put to use. We see the speaker or dramatic spectacle, we hear the words or music, we are comfortable or otherwise. Each faculty is employed in some way. The radio audience, seated quietly in its thousands of homes, employs but one sense. All of its faculties are concentrated in listening, probably the simplest of all our conscious efforts, simpler even than the use of sight. Few distractions affect the radio audience. It is at ease. The whole power of its collective intelligence centers in the sound waves which converge in the receiving instruments. Therefore a performer receives a fixed attention impossible to obtain in any other way. For that reason his audience is more critical, more understanding. It comprehends his personality fully and accurately. Its sympathy is whole-hearted when he can command it. Sometimes I have asked audiences to listen in darkness to our programs. The effect is heightened until the man a thousand miles away is in just as intimate contact with us as if he stood in the same room."

When the Capitol company achieved its continued success many cities and organizations invited Mr. Rothafel and his artists to appear in public. That raised a nice point of psychology.

"I was doubtful about the result," he said. "Every person familiar with our radio programs had a conception of how we looked and

"ROXIE" AND HIS CAPITOL THEATRE GANG

Who broadcast each Sunday evening from WEAF, New York. These are thirty-five of the most popular entertainers on the air; they are:

TOP ROW: Clark Robinson, Alfred Lufrio, Joe Wetzel, James Parker Coombs, Pierre Harrower, Victor Arden, Phil Ohman

THIRD ROW: Carl Scheutze, Alex Gluck, Hyman Barmasch, Attilio Bianco, Chas. Thetford, David Mendoza, Ignace Nowicki, Herman Hand, Robert Denti, Louis Schmidt, William Roeschell.

SEATED: TOP ROW: Ava Bombarger, Marjorie Harcum, Gladys Rice, Evelyn Herbert, S. L. Rothafel ("Roxie"), Betsey Ayres, Marguerite McKee, Florence Mulholland, Eugene Ormandy ("The Blue Blond").

SEATED, BOTTOM ROW: Yasha Bunchuk, Tommy Dowd, Douglas Stanbury, Maria Gambarelli ("Gamby"), Susan Dunbar, Bully Robyn ("Wee Willie"), Dr. William Axt ("Dr. Billy"), Alex Kosezgi

acted. It might be a severe strain on their friendship to see us in life. We fully comprehended that we were just ordinary folk like everybody else. Our radio entertainment was the best thing we could do, our finest efforts. We had put into the work all of our hopes and enthusiasm. When the public saw us it might think we were a very ordinary crowd, after all."

But insistent requests brought an experiment. The Capitol company began to appear in public. And no company of entertainers in the world ever had a finer reception. So far these appearances have been few, notably in Providence and Pawtucket, R. I., and Washington, D. C.

"On the way over to Providence, we found that everybody knew us," said Mr. Rothafel. "Our public acquaintance began with the sleeping car porter. He addressed a half dozen of our performers by name just as intimately as though they had been friends for years.

"When we got to Providence the word of our coming had preceded us. I never had such an experience. A newsboy came up to me in the station and said, 'Gee, Roxie, that was a great bill you had last Sunday, and the story you told sure was a whopper.'

"Everywhere we went in Providence, people seemed to know us, first names and all. We were scheduled to appear there in a large store. When the time came a crowd filled the streets for blocks, everybody from mothers with baby carriages to staid business men. And they had such a welcome for us that we felt as if each one was our personal friend. It was a touching thing; it made us realize that we had a great responsibility to the public; that we must do better than ever before if we possibly could. The esteem of those good people was the finest tribute any of us ever had. We left Providence resolving that we would put into our radio programs the best of our hearts and minds."

The Capitol company raised $3,500 in Providence for a charitable purpose, a comfortable sum in Pawtucket, and more than $10,000 for the Walter Reed Hospital in Washington. Mr. Rothafel and his associates hope to obtain radio receiving sets for all the veterans in Washington hospitals.

The affection of radio fans is boundless. Every day or two the Capitol company receives evidence of this regard. A group of citizens in Attleboro, Mass., got together and sent the director a silver loving cup, by way of expressing their good will. It is a dull day in the Rothafel offices when a crate of oranges fails to arrive from Florida or some other token sent by friends far and near.

Each new form of entertainment, of the dramatic appeal, has brought with it the rise of some man who comprehended its

This bit of verse was written by J. P. (Daddy) Coombs and was read on the air by Mr. Rothafel after he and his Gang had made a visit to the Walter Reed Veteran's Hospital in Washington. "Roxie" is bringing all of his considerable radio influence to bear to secure contributions from his radio listeners to equip veterans' hospitals with radio receiving sets.

When darkest night
Falls on our sight
And Life seems dull and gray—
Remember friends
That nature sends
The night to follow day.

Then do not grieve
When dewy eve
Shall change to night's black pall
The breaking dawn
At glorious morn.
Will gladness bring to all.

When shadows loom
From out the gloom
This truth you'll surely find
Turn toward the light
Its radiance bright
Will leave all gloom behind.

A kindly word
Is gladly heard
And treasured in the heart
A bit of song
Remembered long
By friends tho' far apart.

So "There you are"
Friends near and far
Good night. Good night to all
You've heard the song
May joy prolong
Its echoes wher'ere they fall.

possibilities. Perhaps Mr. Rothafel is to be the genius of the radio. His efforts, and the efforts of his company, have caught the public fancy in a more pronounced way for a longer period than the efforts of any other group or individual. Radio programs still are a matter of much uncertainty. No station in the country has been able to decide what the public wants—and Mr. Rothafel says he doesn't know. But evidently the public knows and his guesses about its state of mind are remarkably accurate.

ROXIE'S PROGRAMS ARE EXPERIMENT

LOOKING over the Rothafel programs it is evident that he believes in variety; also that each program is something of an experiment. One of his recent successes was the offering of "Massa's in the Cold, Cold Ground." That is a song which but few Americans of this generation ever heard. It came from the pen of Stephen Foster, author of the many negro melodies which gradually have become American classics, perhaps our only distinctively American songs.

Mr. Rothafel, with the same sure instinct that prompted Foster to write the song, decided to test its possibilities by radio. Any one who has heard these plaintive notes will recall that it is sung almost in a monotone and is especially suited to a mellow voice.

When the singer in this case stepped up to the microphone Mr. Rothafel waited with considerable anxiety for the results from his psychic contact. But the song had not gone beyond the first bars until he signalled "all's well." Then, toward the end, he took the singer's arm and together they walked across the studio, the last melancholy notes gradually blending with the air—that insubstantial element which had just borne to an awed audience the story of an old slave's sorrow that his good master should lie "in the cold, cold ground."

It requires but little acumen to see that Mr. Rothafel is the sort of man who has studied life at close range. He was born on a Minnesota farm back in 1882 and reached New York at the manly age of thirteen. Soon he was employed as "cash boy" in a Fourteenth street store. But he lost the job because his employer thought he had too much imagination, that he was always dreaming. Since then he has changed his job pretty regularly; every time it became narrow and cramped him he struck out anew, until he is directing head of the world's largest motion picture theatre and the leading producer for radio audiences.

He has had a wide range of jobs between the two extremes. These included the work of a book agent and a Marine. He has knocked around the world and rubbed shoulders with all sorts and conditions of men. Doubtless that is why he understands the genus so well. He really got his start in a little Pennsylvania town with a second-hand moving picture machine and a few chairs in an upstairs room reached by way of an alley.

Although without technical musical education this impresario directs orchestras by the sense of feeling, arranges all of his musical selections, devises scenic and lighting effects, and does a dozen other things that are supposed to require the strictest sort of technical training. He long since proved that he understood the public mind better than most men and his later success with radio programs has greatly broadened his field of effort.

Working twelve hours a day, despite all these honors, Mr. Rothafel continues to maintain the common touch. An usher in his theatre said that he was "a regular fellow" and the elevator man thought the same thing. He looks only moderately like his photographs, because they show him in repose and he is always in action. He smiles, frowns, relaxes, concentrates, gets out of his chair and sits down again, with a regularity and rapidity that show the speed and sweep of his mental range.

And at 42 he says that he is just getting ready to do some real work.

WILLIAM H. CARY, JR. has written a tremendously interesting story telling what is the latest in radio from Paris—and the provinces. He has been in France for several months listening-in and talking with radio men everywhere. The article will appear in an early number of this magazine. They are busy with radio in France, and it is not uninteresting to know "what the other half thinks."

ONE OF THE UNITS IN THE PARADE

This super-heterodyne, which is the one described in RADIO BROADCAST last January, is bringing in WOO, Philadelphia, on a loop on Forty-Third street, New York

When Radio Replaced the Brass Band

How New York Radio Dealers Organized a Novel Band-less but not Music-less Parade

BY WENDELL BUCK

CAN you imagine a real, honest-to-goodness parade without brass bands? No. And neither could we until a few weeks ago we saw a truly wonderful parade without a single band in it. But don't mistake us: there was music, and lots of it.

Some weeks ago the New York Edison Company held an electric truck parade down Fifth Avenue. More than four hundred electric vehicles of almost every conceivable size and appearance lined up at Fifth Avenue and Sixtieth Street for the parade. Loops, loud speakers, and receiving sets were installed on many of the trucks. Neutrodynes and super-heterodynes were prominent, particularly the "supers," which certainly did themselves proud so far as supplying good, clear music for the parade was concerned.

The Super-Heterodyne built by the RADIO BROADCAST Laboratory was there in all its glory. Before the parade started, WOO, Philadelphia, came in on a loop loud enough to be heard half a block away, despite the heavy rumble of city traffic. Later KDKA came in fully as loud as WOO.

A hundred odd spectators gathered for the informal morning concert from Philadelphia, clustered about the truck, and asked the wide variety of questions which only real radio fans can ask.

By two thirty all the trucks were lined up with their many loud speakers pouring forth plenty of music to supply ample atmosphere for the parade.

A few minutes and they started down the Avenue.

Thousands of pedestrians stopped, looked, and listened. Several thousand more came pouring from the side streets and stores along the way.

Whenever the trucks stopped for a moment —which was seldom—a good-sized group gathered around each truck to see just what was

going on, and to try to complete their radio education.

Everybody in the parade was happy until the trucks reached certain more or less untravelled streets in Greenwich Village. Then the RADIO BROADCAST super had its acid test, and emerged victorious.

After standing the wear and tear of, let us say, five thousand cobblestones, the five thousand and first proved too much. The R. B. super with its loop fell three feet to the floor of the truck. And, believe, it or not, it worked just as well (possibly a bit better) during and after the disaster.

However, we hardly suggest dropping your own set from anything higher than a book case.

Here's a Good Idea

A thing of interest and novelty itself, there is little more of novelty which can be brought to either selling or owning radio. Radio has definitely arrived at the stage in its development where it has cast off the knickerbockers of novelty and assumed the long trousers of stability. Radio has arrived. But there are always generous quotas of doubting Thomases in every sizeable community whom the radio dealer ought to convince. A parade, such as Mr. Buck describes would be as interesting to the spectator as effective for the dealer.—THE EDITOR.

WHERE THE RADIO DEALER COMES IN

FROM the point of view of manufacturers and radio dealers, the parade was particularly successful. It put radio before the New York public in a novel and impressive way. Thousands who had merely a casual acquaintance with radio, who had a vague desire to know more about it, or even were on the point of purchasing a set, must have been brought a step or two closer to a purchase when they saw the truck parade roll down the Avenue. And many a skeptic regarding radio must have been converted on the spot.

Think of it! Seventy-five radio sets mounted on electric trucks rolling over rough streets and supplying uninterrupted music all the way. And these were not only local programs, but distant ones as well.

The Edison Parade certainly did radio a great deal of good. It didn't make people rush to the nearest radio store to buy a set. *But it sold the practicality of radio* to thousands of new prospects. The next time Mr. So and So, who saw the parade, passes a radio store, he will undoubtedly drop in to hear the various sets demonstrated—and he will probably end in purchasing one.

Courtesy New York Edison Company

READY TO ASTOUND THE NATIVES

A neutrodyne truck in the radio parade swinging into action

Courtesy New York Edison Company

THE PARADE AT REST

Lined up on Fifth avenue alongside Central Park. Signals were poured wholesale from the large loud speaker for'ard on this well arranged Sleeper truck

Radio dealers and manufacturers should profit by the New York example. Why not hold a radio parade in your city? It is sure to arouse widespread interest; and if properly managed should be the talk of the town. Local newspapers will be only too glad to give so novel an event considerable space. And there is no reason why the articles shouldn't be well illustrated. I don't see any reason anyhow for radio and radio dealers hiding their light under a bushel.

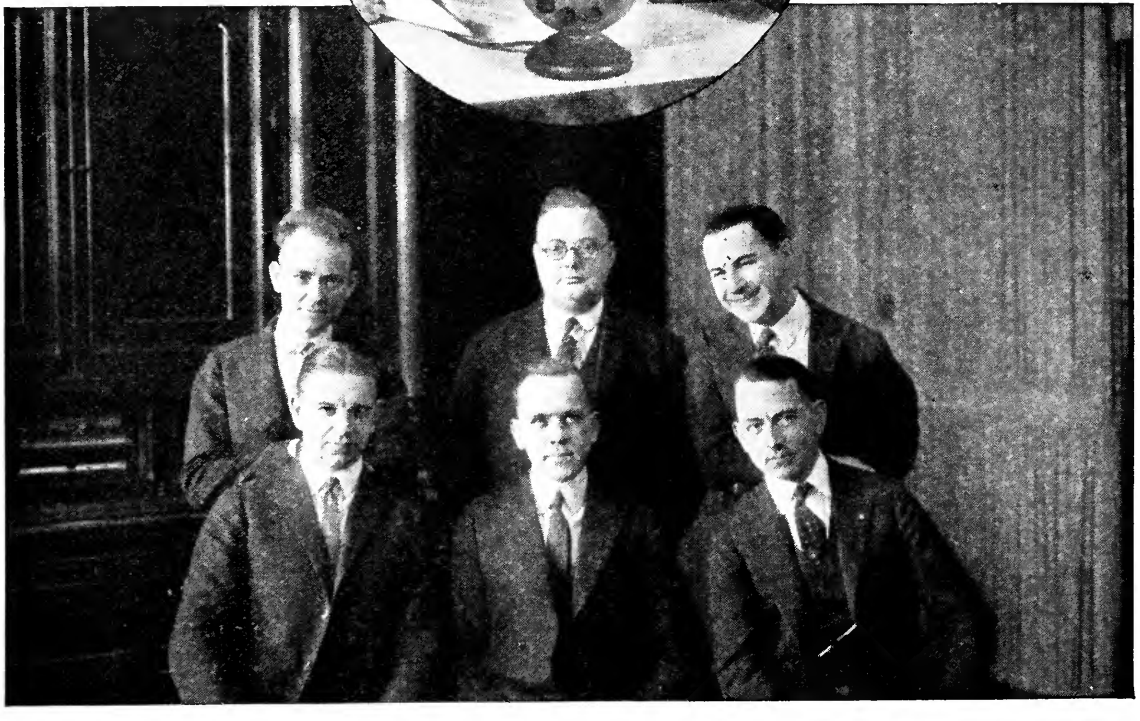
How the Radio Voices Look

WGY WOC WLAG WFI

AT WLAG
Is Eleanor Poehler, who announces and directs its radio destinies

AT WOC
Is Frank W. Elliott, manager and occasional announcer of this widely heard and popular station

AT WFI
Is John Vandersloot, announcer and studio director



AT WGY
Is this battery of announcers; they are:
FRONT ROW, left to right: Robert Weidaw, Kolin Hager (chief announcer), Carl Jester;
BACK ROW: William Fay, Asa O. Coggeshall and Edward H. Smith

How to Build a Good Low-Power Transmitter

Using Standard Parts and Good, Yet Not Expensive Methods of Construction

By ASHLEY C. DIXON

This set was built by Mr. Dixon on his ranch at Stevensville, Montana and is known to radio listeners as KFJR on broadcasting, and 7IT, and 7XAF on code work. Amateurs who are interested in building a small transmitter for code and voice should have no difficulty in duplicating Mr. Dixon's transmitter. RADIO BROADCAST readers will recall "What Radio Means At a Rocky Mountain Ranch," by Mr. Dixon in this magazine for January.—THE EDITOR

THE following article describes in as non-technical language as possible, how to build an all-purpose transmitter of low power and exceptional range. By all-purpose transmitter is meant one which may be used for amateur CW telegraphy, ICW or modulated buzzer, phone, as well as for broadcasting. This transmitter uses two 5-watt tubes, giving an actual output of about 15 watts on CW and 6 on broadcast. No attempt is made to go into theory or technical details, nor into alternative designs or substitution of parts. It is taken for granted that an exact duplicate of 7IT-KFJR is to be constructed by a person with enough knowledge of radio transmitters to permit his holding an amateur license.

Three pictures of the panel assembly are shown, Figs. 1, 8, and 9, one of the 50-henry choke, Fig. 4 showing comparative size and details of construction, and one of the transmitting room showing location of batteries, switches, etc. There is a panel diagram, Fig. 3 one of the top stage, Fig. 7, another of the base, Fig. 10 and the hook-up, Fig. 2, which many readers will instantly recognize as the Hartley circuit, with Heising modulation system for telephone.

The panel may be selected from any one of the several kinds of panel material now on the market. The writer used mahoganite. The dimensions are 12″ x 20″ x $\frac{1}{4}$″. This panel should be strengthened by some strips of $\frac{3}{8}$″ x $\frac{1}{2}$″ maple around the sides and top edge. Fasten these strips by $\frac{3}{4}$″ brass screws.

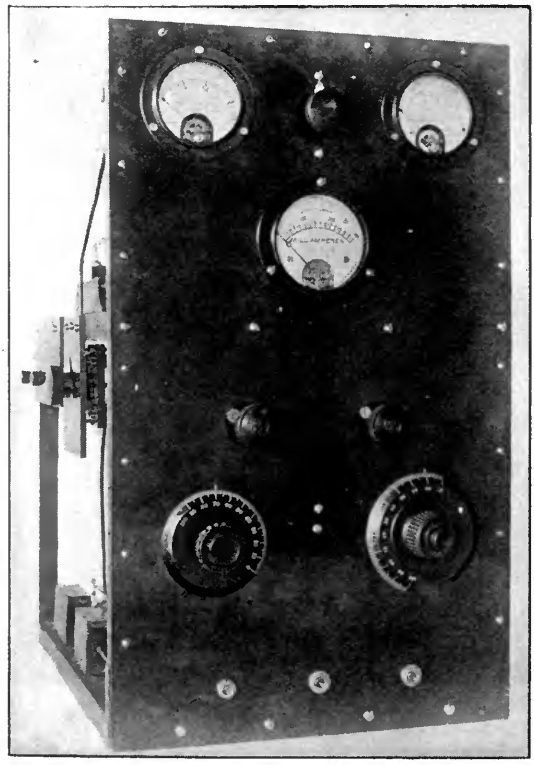


FIG. 1

The base is 12″ x 14″, as is the "top stage" upon which will be seen the oscillation transformer, tubes, etc. These two platforms should be of some substantial hard wood about $\frac{3}{4}$″ to 1″ in thickness. Fasten them securely to the panel with 1″ brass screws, and brace in the rear with maple strips as shown in the pictures. You now have the frame upon which to assemble everything but the filter system, and power supply.

WHAT GOES ON THE PANEL

STARTING in the upper left-hand corner of the panel, we find the antenna ammeter. This should be of the thermo-coupled type, and have a scale range from 0 to 1½ amps. In the diagram this instrument is indicated at A. In the right corner is a filament voltmeter, having a scale of 0–10 volts DC. This voltmeter is cut into either tube circuit by a series-parallel switch, both instruments being represented in the drawing at V with the switch just above. The connections as shown permit the voltmeter to be cut out at the vertical position, cut into either tube circuit by turning to the left or right. In the center is the milliammeter, used to indicate the plate current flow. It is represented at M.

These instruments are flush-mounted and considerable care should be exercised in cutting the holes for them. The writer drew circles of the proper diameter, and then cut them out with a hand bracket saw, using ordinary scroll-saw blades. The job is fairly easy if one does not try to hurry it. Just below the top stage, are located the filament rheostats, the knobs of which can be seen in the front view. These are RCA Model PR–535 instruments, and are marked on the diagram. They must be placed in the positive filament lead.

Below the rheostat knobs, and between the two dials can be seen two screws. These hold the inductance L2, which is a 50-turn Giblin-Remler coil, and which is back panel mounted. This inductance, together with the variable condenser C2, is used to control the modulation when the set is used for telephone work. We will return to them later on.

The dials control two .001 mfd. (43-plate variable condensers. Any of the better sort of receiving condensers may be used. C1 is in series with the counterpoise lead (left dial), and is used for wavelength adjustment when working below 220 meters. For broadcasting (258 meters at KFJR) this condenser is cut out by a series-parallel switch which may be seen mounted on the side of the top stage in the pictures, but which is not indicated in the schematic drawing. However, wiring in this switch is a very simple matter.

C2 is the above mentioned modulation condenser, and should have a vernier adjustment as a very fine graduation of capacity is necessary for securing the best modulation and radiation when using the set for telephone transmission.

Below the dials are three jacks. The center one is a "closed circuit" jack into which is plugged the key connection. The key circuit is indicated at K in the drawing. The key is con-

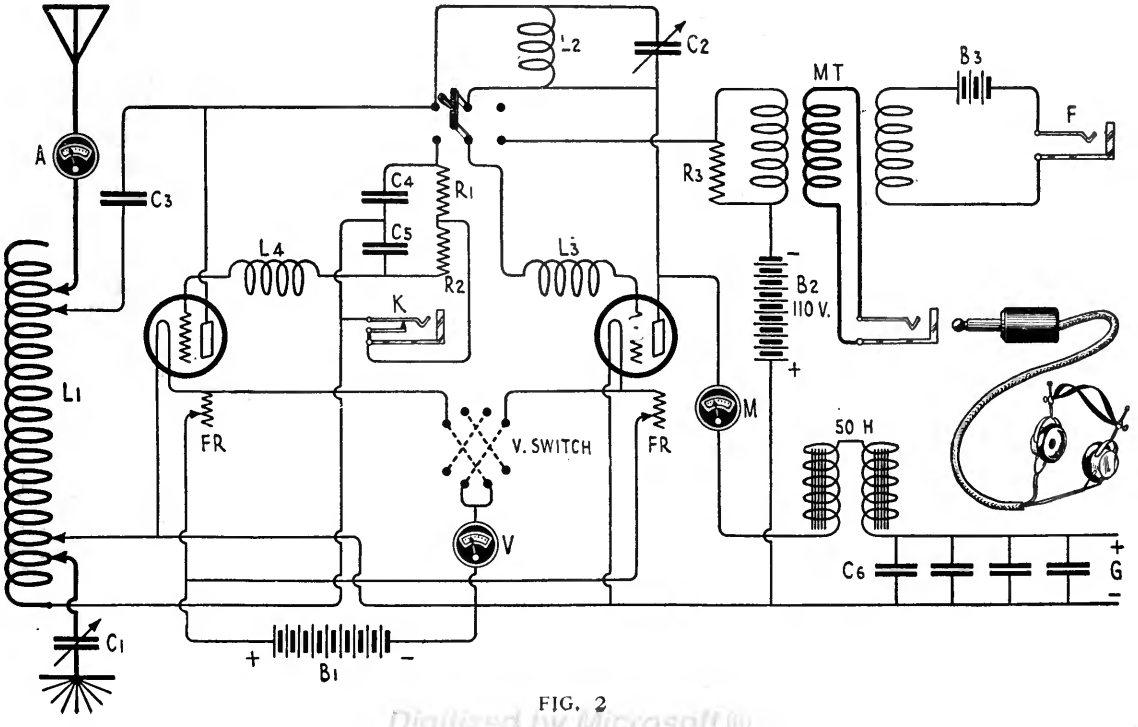


FIG. 2

nected in for CW work with an ordinary plug. The jack at the left is used to connect a headset into the microphone transformer circuit to check up on the volume as shown at MT in the diagram. The microphone F is plugged into the right hand jack which leads to the primary of the microphone transformer. This is a RCA Model UP–414, and is indicated at MT.

THE PARTS USED

ON THE top stage are located the two 5-watt tubes, the grid inductances L3 and L4, the fixed condenser C3, and the oscillation transformer L1. The last is a most important item since an otherwise good transmitter may be ruined by a poor transformer. The one used here, and recommended, is the RCA Model UL–1008. It has the lowest capacity losses of any type of transformer known to the writer.

The condenser C3 is a model UC–1014 Faradon, having a capacity of .002 mfd. and is intended to stand voltages up to 3000 DC.

The tube sockets are placed in front of the oscillation transformer, and are spaced on 6" centers. On either side of each tube is located a small grid inductance, L3 and L4 in the diagram. Here we come to the first piece of home-made apparatus. They are made by winding 20 turns of No. 28 enameled wire on short sections of pasteboard tubing $1\frac{3}{4}$" in diameter. The tubes are mounted on a couple of wood spool ends, screwed to the stage; and the coils connected into the grid circuit as shown.

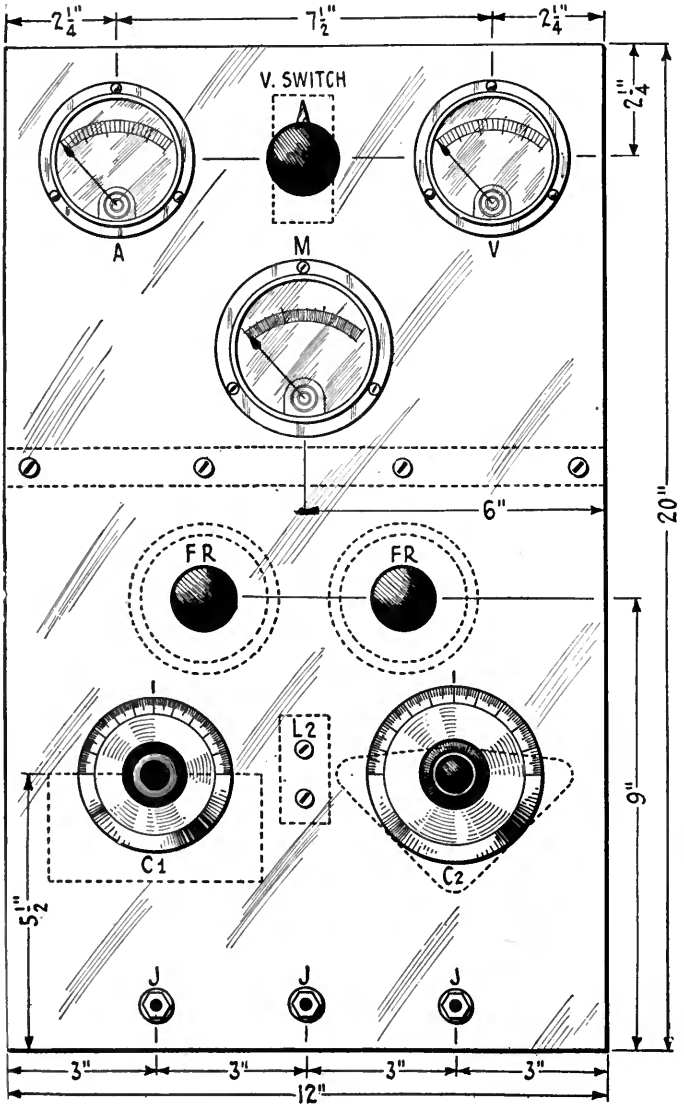


FIG. 3

Next comes the base on which are mounted the following items, all of which can be seen by consulting the two side views of the set. At the back are placed five small No. 4156 Burgess B batteries. These function as grid bias or C batteries, maintaining a negative potential on the modulating grid. There is practically no current drawn from these batteries, and they will last a long time.

On the right side of the base is a small double-pole double-throw switch, used to change over from CW to telephone. In the first instance the tubes are connected in parallel, and in the second, one will act as modulator and the other as oscillator. This last hook-up of the tubes provides for what is known as the Heising or constant current system of modulation, which is, in the writer's opinion, by far the best system known to-day. This switch and its five connections will be noted just below L2 in the drawing.

In the center of the base is the modulation transformer, referred to above as MT, and on the left are located two UC–1014 Faradon transmitting condensers of .002 mfd. each; also two transmitting grid leaks made by the Radio Corporation and

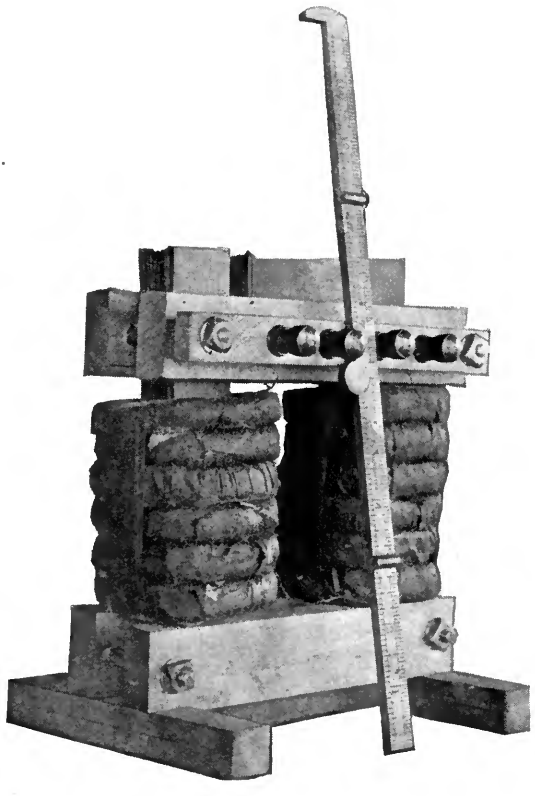


FIG. 4

listed as UP–1719. They have a resistance of 5000 ohms each. The condensers are diagrammed as C4 and C5, and the leaks as R1 and R2.

One more item of especial value is R3. This is an ordinary grid leak of $1\frac{1}{2}$ megohms resistance, and is of a considerable value in clearing up the modulation of music and speech. It is shunted directly across the secondary of MT.

Use ordinary No. 14 hard drawn copper wire for all connections, and cover with a good grade of oiled cambric spaghetti. Use rosin for flux, and have a good connection at every soldered joint.

There are six terminal connections to be brought out, two for the antenna and counterpoise, two for the filament battery, and two for the plate current supply. These may be conveniently located by mounting a couple of small pieces of panel on the side and rear of the top stage, and soldering the several connections to binding posts screwed into these.

Next in order, and quite important from a telephone standpoint, comes the filter system. The inductance in this filter also acts as a plate circuit reactor, keeping the plate current supply constant—a most essential item for the Heising modulation system.

BUILDING THE CHOKE COIL

THE picture of the 50-henry choke coil (50H) gives a good idea of the size and construction of this item. It is made by winding 12,000 turns of No. 30 enameled wire in the form of pies, 1000 turns to each pie. These are wound on a $\frac{1}{2}''$ wide, and $1\frac{3}{4}''$ diameter square wood spindle, which is fastened to a thin flat board about 3″ square on one side, with a similar piece clamped to the other side, so it can be removed to facilitate taking off each coil as wound. The spindle

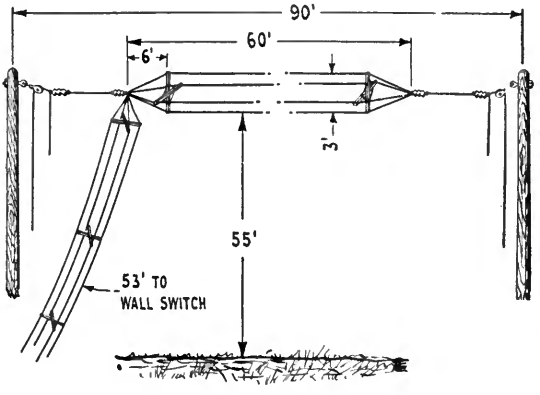


FIG. 5

and side-boards are mounted on a shaft of some sort (a $\frac{1}{4}''$ bolt will answer nicely) and turned with a crank. It will materially aid in removing the pies of wire if a single layer of string is wound on the spindle before each winding is started, and then pulled out after the side plate is removed.

Each coil, as removed, should be carefully wound with insulating tape capable of stand-

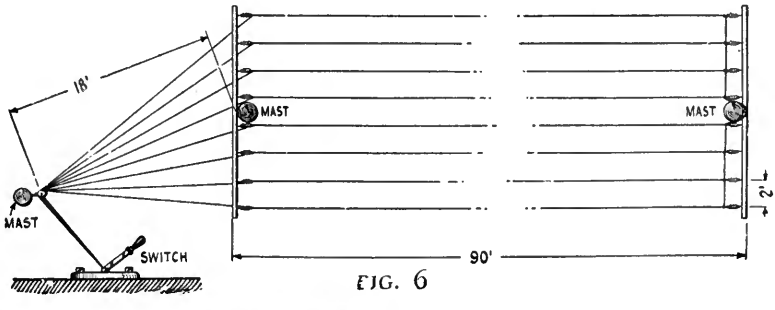


FIG. 6

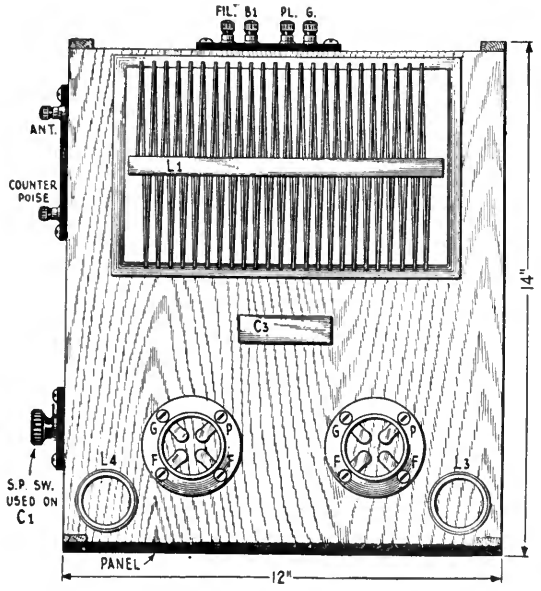


FIG. 7

ing twice the potential delivered by the dynamotor.

The core of the choke is built up of thin strips of silicon steel, alternating long and short pieces on each side, so that the finished job will be of an even diameter at the corner joints, with the sides. The built up core should have a cross section diameter of 1". The thickness of the laminations is of no particular note, except that for convenience the gauge of the metal should permit of its being easily cut to size with a pair of tin snips. The pies of wire are next slipped upon the steel core, and connected up in series, terminating at two binding posts. Four appear in the picture, but only two are used.

A very necessary feature in the core construction is the air gap which will be noticed at the top of the core. This should have an opening of half an inch, or slightly over. The complete inductance may be mounted as shown, or in any way that suits the ideas of the builder. The frame should be of hard wood.

A technical description of the 50 henry choke is given by Ballantine in his *Radio Telephony for Amateurs**, page 178. With the exception of using 500 turns less of wire, our choke is a copy of the Ballantine choke.

The other part of the filter system is simply four 1 mfd. condensers (Faradon UC–490) placed in parallel directly across the generator terminals. These are noted as C6 in the diagram, and their relative position with reference to the choke can be seen. In the general view of the station it might be noted that the choke and condensers are placed in a box behind the switch panel, and directly under the transmitter.

The last item to complete the indoor part of the station is the power source. The plate supply is derived from a 500 volt DC Esco dynamotor. The filament supply is derived from an 8 volt storage battery. Due to the fact that there is no electricity at our ranch, the dynamotor is driven from 12 volts of storage cells. Others more fortunate can use ordinary 110 volt or 220 volt AC supply to run the motor of the motor-generator.

THE ANTENNA SYSTEM

THE writer firmly believes that most of the remarkable success achieved with this particular 10-watt Hartley set is due to the antenna system used. It was adopted after several months of experimenting. And having a goodly number of acres upon which to string wire, the size was not evolved from any lack of space, but rather from the indicated needs of the transmitter.

The masts are too wood poles, about 55′ high above ground, and spaced 90″ apart. The

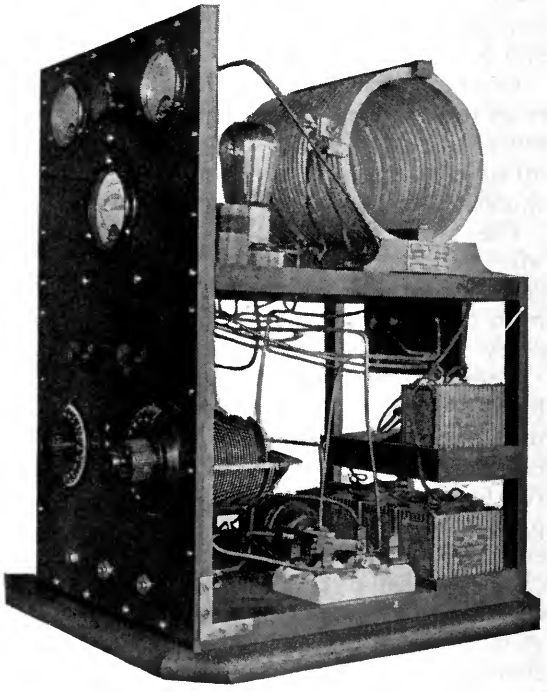


FIG. 8

*Published by David McKay. Philadelphia, Pa., Price $2.00 net.

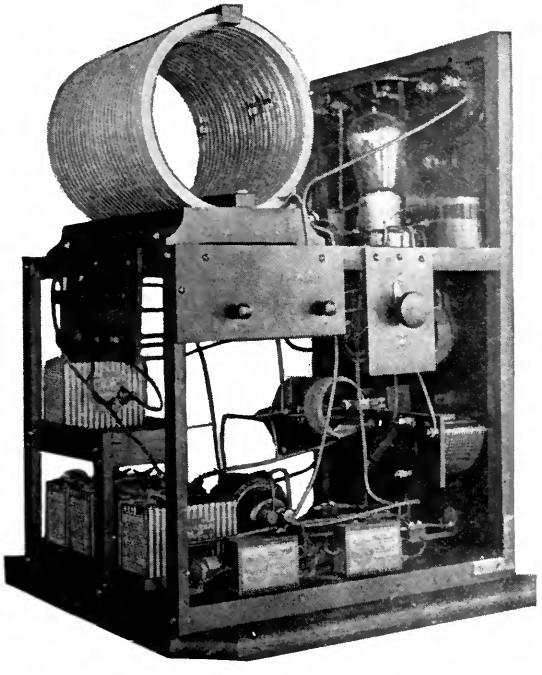


FIG. 9

one at the lead-in end of the antenna is 20′ from the wall of the transmitter room.

The horizontal portion of the antenna consists of four wires in the form of a cage, spaced by light wooden spreaders to a diameter of 3′. The cage is 60′ long, and tapers to a point at each end. The tapering sections are 6′ each. The antenna is supported by two wires extending from each mast and broken by two 10″ electrose insulators at each end. The reason for spacing the masts on a 90′ center, while the antenna is only 60′ long, will be presently seen.

The lead-in is also a cage of four wires, spaced 16″ apart at the top, and tapering to a junction at the grounding switch. The lead-in spreaders are of heavy gauge wire, soldered to the lead-in, and are 8′ apart.

The counterpoise is made of 8 No. 14 copper wires, directly under the antenna, and spaced on 2′ centers. A 14′ piece of 2 x 8 is bolted to the outside of each mast, eight feet above the ground, and the counterpoise wires stretched between insulators fastened to these cross members. The counterpoise wires are connected electrically at the "off" end by a wire soldered to each one, bridging them together. At the lead-in end they are continued past the mast, and drawn together in a long 18′ taper, making the total length of the counterpoise 108′. All eight wires are then twisted into a cable and brought 12′ to the grounding switch, mounted on the outside wall of the transmitting room. It is three feet through the wall and up to the binding posts, from the grounding switches of antenna and counterpoise. The connecting wires are led through 18″ porcelain wall-bushings, protecting the wires for a space of 5″ on each side of the wall.

TUNING THE SET

THE Hartley circuit is very critical in adjustment, and a maximum radiation at the several wavelengths can only be secured by experimenting with the clip contacts on the oscillation transformer. But just as a starting point, the writer will give a couple of adjustments as used at 7IT–7XAF-KFJR. For 195 meter CW work the key circuit is connected at the first turn, the counterpoise at the fourth, the negative filament at the seventh, the plate at the sixteenth, and the antenna at the seventeenth turn. The counterpoise-series condenser is set at 65 on the dial. By adjusting this condenser, wavelengths from 220 to 145 may be secured.

When used for broadcasting on 258 meters, the following adjustments are made. The series condenser is cut out; the grid or "key" circuit is left at the first turn; the counterpoise is connected to the seventh; the filament to the tenth; the plate to the twenty-third; and the antenna to the twenty-fifth turn. Other ad-

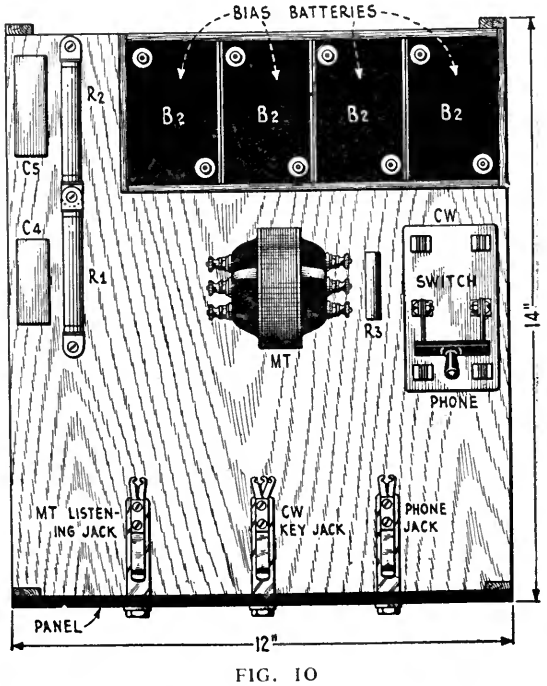


FIG. 10

justments will be found by the experimenter. But in every instance the indicated plate current should be kept below 100 mills for CW and at about 60 mills for telephone. The set will only radiate from 1 to 1.4 amperes on CW and about 1.25 on telephone. But forget the radiation and watch the DX!

The transmitter built by the writer and his son, has been in use for the last six months both as broadcasting station KFJR and amateur station 7IT. As 7IT, the set has been reported as heard in all districts of the country, twice by WNP, once by Mr. W. G. Rose of 46 Trewince Road, London, England and also by Australian 3BQ, Mr. Maxwell Howden, Melbourne, Australia. With it, stations on both coasts have been worked, as have a host of others as far south as New Mexico. The consistent range for CW seems to be something more than 1,500 miles under average winter conditions.

LIST OF PARTS REQUIRED

1 Weston Thermo-ammeter 0–1.5
1 Weston DC Voltmeter 0–10 v.
1 Jewell Milliammeter. 0–300
2 RCA PR–535 Rheostats
2 Branston R-67 Series-Parallel Switches
1 4 inch double-pole double-throw knife Switch
1 43 Plate Dayton Condenser
1 44 Plate Duntley Vernier Condenser
2 Premier Open Circuit Jacks
1 Premier Closed Circuit Jack
1 50L Giblin-Remler Coil
3 RCA UC–1014 Faradon Condensers
2 RCA Tube Sockets
1 RCA UL–1008 Oscillation Transformer
1 RCA UP–414 Microphone Transformer
2 RCA UP–1719 Grid Leaks
1 RCA 1½ Meg. Leak
4 RCA UC–490 Condensers
2 RCA UV–202 Radiotrons
6 Eby "Commander" Posts
500 Volt Esco Generator (Dynamotor or Motor-Generator)
5 lbs. No. 30 Enameled Wire
5 lbs. Silicon Steel (Sheet)
30′ No. 14 Copper Wire, hard drawn
30′ Spaghetti.
1 Mahoganite Panel 12″ x 20″ x ¼″
Hard Wood Base, Maple Strips, Screws, etc.

THE FINISHED TRANSMITTER INSTALLED

At Mr. Dixon's Montana ranch. By following the instructions in the accompanying article, the reader can easily duplicate for himself this transmitter

THE PIT

Center of the world's grain trading. Here daily meet the traders whose transactions regulate the wheat prices of the nation. Through the coöperation of the Chicago Board of Trade and their radio station WDAP, all interested farmers in the vast wheat belt can daily listen to the prices and stock exchange information directly from the Pit

Linking the Farmer with His Market

How the Chicago Board of Trade Brings the Wheat Pit to the Farm

By ROBERT H. MOULTON

MORE than six centuries ago Roger Bacon was scoffed at when he said that machines for navigation were possible without rowers, so that huge ships guided by one man might be borne with great speed; that cars might be made so that they could be moved without a draught animal; and that even flying machines, a device with artificial wings in which a man might soar through the air like a bird, were possible.

What would these scoffers have said if the prophetic Bacon had only gone a little further and added that it was possible, too, for a man situated alone in an isolated spot to hear the voice of the world by use of a seemingly simple device; for the farmer tilling his acres on some remote prairie to snatch from the air a voice which would tell him the exact value of his produce in the world market at almost any hour of the day!

WHAT IS HAPPENING

AND this is precisely what is happening under the latest method of broadcasting grain price quotations by radio telephone. A special survey recently made by the Government through county agricultural agents located in the different states, disclosed that in 2,850 agricultural counties alone there is an average of 51 sets of radio per county, or a total of more than 145,000 sets in such counties.

One of the most important radio stations now broadcasting market news and price

quotations is station WDAP, located on the top of the Drake Hotel and owned by the Chicago Board of Trade. The Board of Trade, indeed, was a pioneer in this work. This radio magic had scarcely astounded the country when the grain trade leaders of Chicago recognized its great value in distributing market information. They were quick to see that it would perform the invaluable feat of linking the country grain merchant with his market, and of keeping the farmer in close and constant touch with all factors which might affect the price of his produce.

Accordingly, the Board of Trade early in the spring of 1922 started its radio service, the market quotations being broadcast from station KYW of Chicago. In spite of the somewhat limited facilities and the newness of the venture its success was instantaneous. Letters and telegrams began pouring in, commending the service, and urging that it be continued and extended. They came not only from individual farmers, but also from country elevators, shippers, banks, business houses and even educational institutions that use the Board of Trade price quotations in class work.

More Than Music From the Air

One farmer in Ohio tells how he got a tip from the ether which yielded him $19.60. The tip was an unexpected rise in the live stock market, coming at a time when the farmer was preparing to sell a shipment of hogs to a local buyer. As a result of listening-in he got in touch with the city market and $19.60 was his profit over the local buyer's quotations, after all shipping expenses were paid.

Since then the farmer has made good use of radio. This is how he links the ether with his agricultural business:

"When I installed my outfit in 1922, I determined to get something from the air besides music. I could receive reports from two large city markets, and a number of smaller ones; and to keep tab on these I bought a ledger.

"At the top of each blank page I wrote down the city where the market was located and the names of the principal dealers therein, with their addresses. This book is kept on the table where the radio is located, and when I have something to market I get in touch with one of these cities, and write down quotations as I receive them. Then I 'tune in' for another city, and get their prices. Afterward, I go over these reports and compare them.

"It is a simple matter then to estimate distance, shipping cost, and so forth and from this I can select my market.

"Dealers in these cities are aware of my method, and I have made arrangements with them by letter to accommodate my shipments at any time. This not only applies to live stock, but to poultry, eggs, and butter. The latter articles are shipped by parcel post the morning after the quotations are received.

"I have a wide range of markets to select from, where formerly I was compelled to depend upon a local buyer's quotations, or those in the newspaper, which were always two days late.

"And the radio offers another advantage: By getting weather reports and crop conditions from different parts of the country, I can guess pretty accurately the trend of the market."—News item in the New York *Times*.

Definite advices soon showed that in Illinois alone nearly five hundred towns and villages were using the quotations. Hundreds of farmers not in easy communication with towns obtained small radio receiving sets for home use. Reports from other states told a story of similar interest in the new service.

HOW WDAP WAS BOUGHT

IT WAS then that the Board of Trade determined upon a permanent, continuous broadcasting service. This led the association to purchase outright the big radio sending station WDAP. The power of this station at that time is indicated by the fact that on many occasions messages were repeatedly sent to steamers 2,500 miles at sea off the Atlantic Coast, the messages being confirmed back by radio telegraph. Yet even this failed to satisfy the requirements of the Chicago exchange, with the result that the station was recently remodeled (July, 1923), making it one of the most complete of any in America.

To-day a lone dealer in any isolated district of the grain belt may tune-in with his small receiving set and in a moment be as

THE RECORD

On this blackboard are posted the price changes as they occur. The radio operator gets his information here and sends it broadcast

fully informed of the value of his grains as are the best posted merchants in the great central markets. Not only does he receive the quotations then being established by trades on the exchange floor of the Board of Trade, but he likewise receives the most intimate and important current market news. This news includes receipts, visible supply, weather, conditions in foreign lands that might have a bearing on the value of American grain, and such other items of interest that help to make up the daily budget of information covering grain production and distribution. Fortified with this knowledge, the dealer, once largely in the dark, is prepared to be judicious about shipping his grain to market.

THE PIT REPORTERS
Who observe and record all price changes in the pit

"RAPID FIRE INFORMATION"

AS FOR the farmer, listen to this letter from a tiller of the soil: "We live on a farm 100 miles northwest of St. Louis, Missouri, and 15 miles away from any railway station. Six months out of twelve we consider a trip to the railroad station a 16-hour job—get up at 4 A. M. and get home around 8 P. M. ourselves and teams worn to a ragged edge. We seldom got prices on wheat, corn, oats, and hogs until they were a week or more old, and so we just had to guess at when it might be a good time to ship our stuff to market. But now, with our little receiving set we get rapid fire information, and we always listen-in to reports before we start to market with our grain, and quite often the neighbors gather here to hear the markets."

This homely letter suggests how one radio receiving outfit can benefit hundreds of farmers, congregating around the crossroads' store or other assembling points. Country banks, mills, and elevators have come to see the importance of having radio receiving outfits for the benefit of the farmers, the market news being posted on bulletin boards where all who come may read.

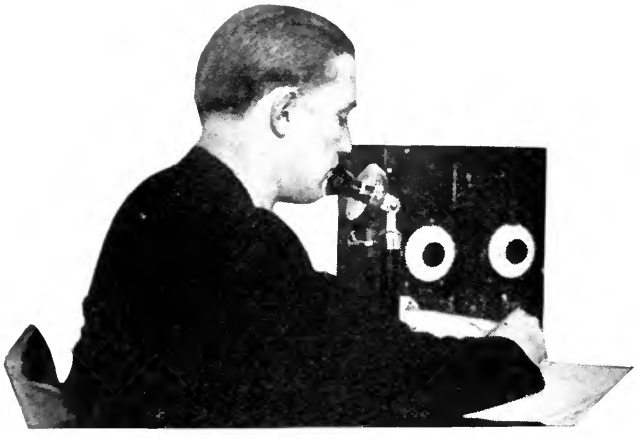
BEHIND THE SCENES IN CHICAGO

IT IS interesting to go behind the scenes and see the manner in which the price quotations on grain, which reach the farmer by radio, originate.

The daily sessions on the Chicago Board of Trade open at 9:30 in the morning and close at 1:15, except on Saturday when the closing hour is noon. A few minutes before the opening, the spacious trading floor of the exchange is astir. Traders are changing from street coats to light jackets before entering the pits. Messengers are scurrying about, hands crammed with order blanks. From one corner of the room comes the steady click of countless telegraph instruments.

Suddenly, on the stroke of nine-thirty, a giant gong sounds. It is like the crack of a pistol at the start of a hundred yard dash. The pits are galvanized into life. Overnight orders to buy and sell grain and provisions are rapidly executed Buyers, representing the consumer, seek the lowest price. Sellers, representing the producer, seek the highest price. The figure at which these two forces meet represents world values.

In one corner of the room is a huge blackboard on which a man posts the opening prices within a second or two after they are registered in the pits. Seated in a glass cage and overlooking this blackboard is a radio announcer. He is in direct communication with radio station WDAP a-top of the Drake Hotel a mile away, and without an instant's delay is calling off the quotations to an army of dealers and farmers scattered throughout the grain belt.



THE W D A P ANNOUNCER
Sending out the market quotations from his desk in the Board of Trade

One of these farmers, for example, is Jim Pepper, far out on a lonely ranch in South Dakota. He wishes to learn whether the time is opportune to ship his wheat. He steps to his little radio receiving set, tunes in to the 360-meter wavelength, and what he hears runs about as follows:

"This is station W–D–A–P Drake Hotel, Chicago Board of Trade—— Station W–D–A–P. . . . Opening prices on the Chicago Board of Trade. . . . May wheat. . . . One, twelve and a quarter. . . . July wheat. . . . One ten and three-eighths. . . ." So it goes.

The opening prices of the three active futures in each grain, wheat, corn, oats, rye, barley, and in pork, lard and ribs are given. This information is followed by important market comment such as receipts and shipments; estimated car lots; Liverpool cables; estimated cattle, hogs, and sheep; live stock receipts and prices; weather forecast; receipts of hogs; cash grain prices, and so on. Additional market information, including closing futures quotations, is sent out at the close of each session. In the evening, beginning at seven o'clock, musical programs are given which entertain city folks as well as farmers.

It is in connection with his grain, however, that the farmer looks upon the radio news service maintained by the Board of Trade as a real blessing. It has always been a difficult matter for him to choose what he considers the most opportune time to ship his grain. Usually he is not in a position to study the daily price changes, and certainly not on the very day the changes are taking place.

2500 PRICE QUOTATIONS—FREE DAILY

BY THE new radio method the farmer is closely linked with his market. He may have, hot off the wires, the latest news that is likely to affect prices of grain and provisions; he may have the freshest statistical information from Government and other crop reporting sources; he may have price quotations almost while they are being posted. Indeed, all the facilities of the vast crop-reporting system of the Chicago Board of Trade, which have ever been one of the marvels of modern commerce, are now placed at the disposal of the farmer free of charge.

An average of twenty-five hundred quotations, or price changes, on wheat, corn, oats, rye, barley, pork, lard, and ribs are issued from the Chicago exchange on every business day. A majority of this average daily number concerns wheat. Since Chicago is the largest and most important grain exchange in the

"BUY AND SELL"
Orders come in and are signalled to the traders in the pits. Prices at which the transactions are made are noted by the pit reporter and flashed by Morse code to the blackboard operator who posts them. The WDAP announcer then reads these quotations into the microphone

world, these quotations are of vital interest to everyone concerned with the production of distribution of these commodities and to persons in scores of related industries.

Even before radio broadcasting grew to be generally used, every one of these quotations was available in all cities and towns throughout America, where wire facilities are maintained, within a few seconds after the price is registered in one of the pits. This almost instantaneous service is possible by means of the complex and ingenious "ticker" system, which is more or less of a mystery even to members of the grain trade.

Let us follow a single quotation. Commission houses that are members of the Board of Trade have their representatives in the trading pits. We will suppose that a commission house receives an order from a miller or cereal manufacturer to buy ten thousand bushels of May wheat at, say, a dollar and ten cents a bushel. This order is immediately telephoned to the firm's telephone operator on the trading floor. He rushes a memorandum to the firm's representative in the pit and the latter immediately executes the order.

The price at which the transaction was made is noted by an official reporter on a raised platform over the pit. This is possible because all trades, both as to quantity and price, are carried out through the medium of the sign language, or system of signalling with the fingers, employed by the traders, and which is an open book to one familiar with it. The pit reporter writes the price on a slip of paper and flips it to a man at his side, who stamps the paper with a chronograph, a machine which registers the time of the trade down to the second. A third man on the "telegraph bridge" receives the slip, stamps it with another chronograph, and hands it to a telegrapher who operates a master key.

A flash by Morse code places the quotation in the offices of the ticker company. There it is put on the keyboard of the ticker, and is immediately clattering along to hundreds of offices. Meantime, a master circuit on the telegraph bridge has sent the quotation through six automatic repeaters which work with lightning speed and to which is attached a network of wires covering the United States and Canada.

Such rapidity has been attained that the average time consumed from the moment the trade is made in the pit until the price appears on the ticker is only three and three-fifths seconds.

In the past the Board of Trade has spent fortunes in an effort to give the farmer first hand information on the ever-shifting world supply and demand. With the radio, the effectiveness of this service is vastly increased. The complete ownership and operation of station WDAP brings the association no financial return. But it is working to the mutual advantage of the members and their world-wide clientele. It is a step forward in the endeavor of the exchange to acquaint the public in the grain business and out with the operations of the world's greatest grain exchange and the largest international enterprise located in the Middle West.

According to Henry A. Rumsey of the Board of Trade radio committee, plans are now under way to send out from station WDAP complete educational courses, ten minute talks, covering various subjects in agriculture. The first courses will probably deal with grains, beginning with the preparation of the soil, then the planting, harvesting, marketing, and on down the line through the trade channels until it reaches the consumer.

"Our primary object," Mr. Rumsey said, "Is to send out unbiased market reports. In broadcasting reports we do not give out anything that would tend to express opinion of influential persons. We try to give only fair, unbiased information gathered from official sources and a correct report of the value of the products. From this information we hope the farmer will be able to determine the value of his products and know when he is being offered a fair price. Our interest in the radio is from a strictly service point of view." The president and secretary are the only members of the Board of Trade who are allowed to speak from station WDAP.

Results of the "How Far" Contest

Who Won the Six Prizes in the Two Contests and How Far They Heard

DECIDING one of RADIO BROADCAST's distance receiving contests is only a shade less difficult than the biblical difficulty that wise King Solomon had in deciding the ownership of the infant. The decision in both the divisions of the contest—that for home built sets and that for bought or ready made receivers—was not altogether based on the total mileage, but on the entire character of the contest entry, of which the requested photographs, description, and diagram, as well as the log, were a part.

Entries there were of all sorts, some of which admittedly did not comply with the terms of the contest but were sent in as a bit of sport—most of these were fine. For instance, there was R. Bartholomew, of Garrochales, Porto Rico, who won our last "How Far Have You Heard?" contest, who sent us in a carefully typewritten log of stations he heard on his prize set, the De Forest D-10 which he received last May. And from Apia, Samoa, came a long-delayed letter from Mr. Quincy F. Roberts, the American vice-consul, with his entry, which contained some phenomenal "longest single jumps." And, it must be confessed, there were some entrants whose riotous imagination led to ridiculous entries on their logs. Those few got scant attention.

THE WINNERS

READY MADE RECEIVERS

		Prize Won
First Prize	Mrs. Eva L. Rhodes Utica, N. Y.	Mu-Rad, type MA-15 receiver
Second Prize	O. B. Evans, Mount Pleasant, Michigan	Fada Neutrodyne "160"
Third Prize	Alex. B. Nicol, Bogota, New Jersey	Sonochorde Loudspeaker

HOME BUILT RECEIVERS

First Prize	Dr. W. C. Wolverton, Linton, North Dakota	Complete set of parts for Haynes super-heterodyne
Second Prize	M. F. Winne, Webster Groves, Missouri	Complete set of parts for a "Knock-Out 3-Tube Set" described in February RADIO BROADCAST
Third Prize	Kenneth Danielson, Thermopolis, Wyoming.	Complete set of parts for "Knock-Out 3-Tube Reflex Set" with Sodion detector tube.

A FEW REMARKS

IN OUR distance receiving contests, the first prize has been won by a woman. It was accomplished by Mrs. Eva L. Rhodes of Utica, New York, who logged a total distance of 85,510 miles, with best single jump of 2,480 miles, and a total of 140 stations heard. The second prize winner in the first group, Mr. O. B. Evans, of Mt. Pleasant, Michigan logged 84,620 miles, his best single jump was 2,345 miles, and he heard a total of 129 stations. Mr. Alex. B. Nicol, of Bogota, New Jersey was the third prize winner. He heard 93 stations totalling 68,520 miles with best single jump of 3,149 miles.

ABOUT THE HOME BUILT SETS

ONE of the best and most complete logs of reception we have ever seen came in with the winning contest entry of Dr. W. C. Wolverton, of Linton, North Dakota who received 148 stations during the contest period totalling a distance of 121,535 miles with the longest single jump 3,000 miles. The second prize winner, Mr. M. F. Winne, of Webster Groves, Missouri heard 175 stations with a total distance of 115,088 miles, and his best single jump was 2,070 miles. Kenneth Danielson of Thermopolis, Wyoming, won the third prize in the home built sets division with 149 stations totalling a distance of 135,190 miles. His best distance jump was 2,180 miles.

WHAT THE CONTEST PROVES

IN AN early number, we shall publish a list of the entrants in the contest, the distance they succeeded in attaining, and the type of receiver they employed. These facts, taken together with the location of the contest entrant should provide some very interesting reading for those who are curious to know what a given type of receiver with ordinary intelligent handling will do in a given locality. Many receivers were ruled out of this contest because they were radiating. RADIO BROADCAST is firmly opposed to radiating receivers. If radio receiving is to be made pleasantly for everyone, radiating receivers cannot continue in use. And in this connection, it is interesting to note how generally interference from radiating receivers was recorded on the logs of the contestants. So, every receiver whose performance was considered in this contest was a non-radiating receiver. See what they did!

How the Vacuum Tube Works

WHAT MAKES THE WHEELS GO 'ROUND: V

By WALTER VAN B. ROBERTS

The central feature of most radio receivers—and indeed of modern radio transmitters as well—is the vacuum tube. It cannot, therefore receive too much attention. "How the Vacuum Tube Works" is the fifth article in Mr. Roberts' series which began in March. Each article is a unit in itself and those who did not start reading with the first article will have no difficulty in starting now.—THE EDITOR.

A QUALITATIVE idea of the process of detection can be got from Fig. 21. A simple but complete receiving set is shown, along with the grid potential-plate current characteristic of the tube for the particular plate battery voltage used. A three-volt C battery is assumed, and the dot on the characteristic at minus three is called the "operating point" because it is about this point that fluctuations occur. When radio waves of the frequency for which the antenna is tuned are arriving, they cause current of the same frequency to flow in the antenna circuit, of which the coil is a portion. These currents flowing through the reactance of the coil produce alternating potential differences between the ends of the coil and hence fluctuations of the grid's potential relative to the filament. From the way the characteristic curve bends, it is easy to see that if the grid potential moves one volt to the right the plate current will increase more than it would decrease if the grid potential moved one volt to the left. Thus if the grid potential is fluctuating between the values —2 and —4 (at any frequency) the average value of plate current will be greater than if the grid potential were fixed at — 3. Furthermore, if the grid potential alternates between — 1 and —5 the effect is still more pronounced. As a result of this we may say that the average value of plate current is increased by the presence of high-frequency current in the antenna, and the amount of increase is greater the greater the current in the antenna. Hence the average current through the receivers varies in the same way as the voice current used at the transmitting station to modulate the radio waves, so that the voice is reproduced by the receivers. A "soft" or gas-filled tube detects in the same way, but is more sensitive owing to peculiarities in its characteristic. However, to get the advantage of these "kinks," a critical adjustment of filament current and plate voltage is required, for which reason the "soft" detector is not recommended for general use.

46. THE "SQUARE LAW" FOR DETECTION

THIS same result may be reached in a more quantitative fashion by using the previously mentioned equation for plate current, $i_p = K (B + \mu \times \text{grid potential})^2$. For suppose the voltage input to the grid is a sin pt, where a is the amplitude of the alternation of grid potential. Then $i_p = K [B + \mu (C + a \sin pt)]^2 = K [(B + \mu C) + \mu a \sin pt]^2 = K (B + \mu C)^2$ which is direct current of constant strength $+ 2 K \mu (B + \mu C) a \sin pt$ which is radio-frequency current, for above audible frequency $+ K \mu^2 a^2 \sin^2 pt$ which reduces to radio-frequency current of twice the wave frequency plus a new direct current of strength $\frac{1}{2} K \mu^2 a^2$. This last term is the addition to the normal direct current through the receivers, and is greater the greater the amplitude of the incoming waves, as was concluded previously. This analysis however shows *ex-*

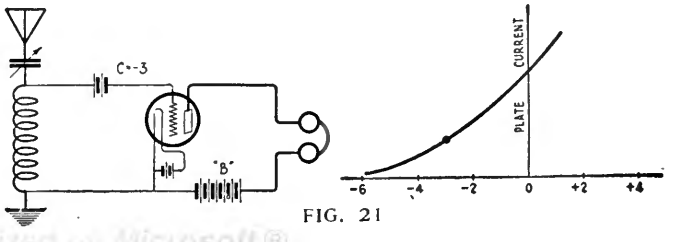


FIG. 21

actly how the average current through the phones varies with the amplitude of the incoming waves; it varies as the *square* of the amplitude. The fact that the detected current varies as the square, and not merely directly as the amplitude, is very important, for reasons that will be taken up in connection with radio-frequency amplification later on.

47. DISTORTION

TO OBTAIN a complete analysis of demodulation, however, we must substitute in the equation for plate current the whole sum of frequencies that compose the modu-

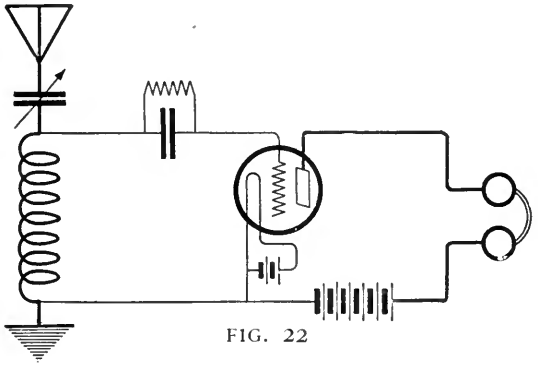


FIG. 22

lated waves. Let the voltage input due to the carrier be a sin pt, and that due to the upper side band $\Sigma\, b_i \sin (p + q_i)\, t$ and that due to the lower side band $\Sigma\, c_j \sin (p - q_j)\, t$ where $\frac{q_{i,j}}{2\pi}$ may be any frequency from say 30 up to 5000, and b_i and c_j are the amplitudes. The Σ indicates in a shorthand way that we are considering the sum of all such terms present. The equation for plate current then becomes $i_p = K[(B + \mu C) + (a \sin pt + \Sigma\, b_i \sin (p + q_i)\, t + \Sigma\, c_j \sin (p - q_j)t)]^2$. The expansion of this into a sum of simple terms is quite straightforward but rather tedious. Neglecting steady direct currents and currents of frequencies above audibility, we get as a result of the expansion not only the terms proportional to $\Sigma\, ab_i \cos q_i t + \Sigma\, ac_j \cos q_j t$ *either* of which represents the frequencies present in the original voice, but also a term proportional to $\Sigma^2\, b_j c_j \cos (q_i + q_j)t$ which represents frequencies not necessarily present in the original voice, but of small magnitude compared to the desired terms if the coefficients b_i and c_j are small compared to a. If these coefficients are very small the quality of the received voice is good but the incoming waves are so little modulated that the signals are weak. If the coefficients are large (that is, the waves are strongly modulated) then the signals are strong but the quality is impaired by the extraneous frequencies becoming noticeable. A compromise must be struck at the transmitting station between overmodulation and consequent distortion and undermodulation and loss of signal strength.

48. DETECTION AND HOW THE GRID CONDENSER AND LEAK OPERATE

A DIFFERENT method for detection than the above is the one commonly used as it is somewhat more sensitive. The difference as shown in Fig. 22 is the removal of the C or "grid bias" battery and the substitution of a small capacity condenser shunted by a very high resistance. The operation of the circuit may be roughly outlined as follows: in the absence of incoming waves the potential of the grid is the same as that of the filament. Incoming waves cause the grid to become alternately more positive and more negative than the filament. While the grid is more negative nothing happens, but while it is more positive it attracts electrons. These electrons cannot get off the grid once they are on it (the grid is not hot like the filament) except via the high resistance which is called the grid leak. If for

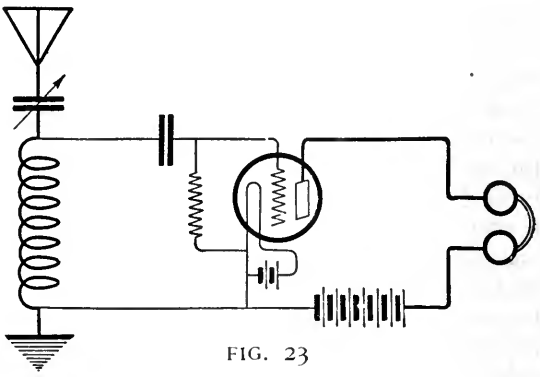
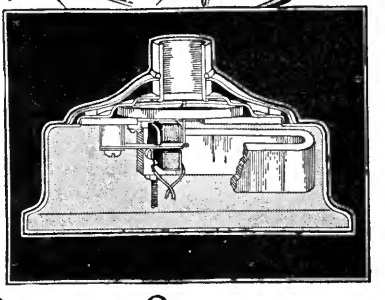
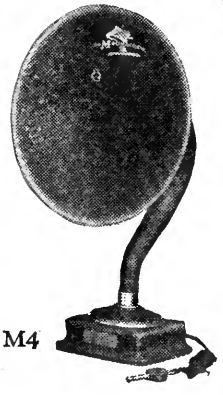


FIG. 23

the moment we suppose there is no grid leak provided, we can see that after a very few waves have come in the electrons drawn to the grid will charge it to a steady negative potential equal to the maximum instantaneous potential of the top of the coil in the antenna circuit. This steady negative potential causes a reduction in the plate current. Even if the waves cease coming in or their amplitude is diminished, the grid retains its negative charge since there is no way for the electrons to get off it. So we put in a very high resistance path by which they may slowly (compared to the wave



THE mechanical principles of Magnavox Reproducers are as marvelous as the vocal chords of a great singer.



M4

The latest Magnavox Reproducer; beautifully finished. Requires no battery.

$25.00

The Reproducer Supreme with a Human Throat

The semi-dynamic mechanism of the new Magnavox M4 Reproducer, shown above, insures utmost clearness of tone—a remarkable advance over the ordinary instrument requiring no battery. There is a Magnavox for every type of receiving set.

Magnavox Reproducers—R3 and R2 electro-dynamic with Volume Control; M4 and M1 semi-dynamic, requiring no battery . . . . . $25.00 to $50.00

Magnavox Combination Sets—the only instruments combining electro-dynamic Reproducer and Power Amplifier in one unit $59.00, $85.00

Magnavox Power Amplifiers—the most efficient audio-frequency Amplifiers; one, two and three stage $27.50 to $60.00

To obtain the fullest usefulness and enjoyment from your receiving set, equip it with Magnavox—for sale at good dealers everywhere.

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New Model with Volume Control

The famous electro-dynamic Reproducer; operates soft, medium or loud as desired.

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New York Office: 350 West 31st Street

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★ Tested and approved by RADIO BROADCAST ★

frequency) escape so that if the amplitude of the incoming waves slowly (i. e., at voice frequency) diminishes, electrons will leak off until the grid potential drops to the new maximum value of potential at the upper end of the coil. Thus the potential of the grid more or less faithfully follows variations in the *amplitude* of the incoming waves and hence causes the plate current to do the same, which is exactly what is required for the purpose of demodulation. In this system, the greater the strength of incoming waves the *less* the plate current, exactly the reverse of the other system. The connections shown in Fig. 23 are often recommended. In this case the grid being connected to the positive end of the filament draws electrons all the time, but similarly to the type of demodulation (first described, the grid current increases more during the positive half wave than it decreases during the negative half, so that the result is the same.

Supplemental List of Broadcasting Stations in the United States

LICENSED FROM APRIL 19 TO MAY 16 INCLUSIVE

CALL LETTERS	LOCATION	(KILOCYCLES)	WAVE-LENGTH	POWER (WATTS)
KFPX	Pine Bluff, Ark.	1240	242	100
KFPY	Spokane, Wash.	1060	283	100
KFQB	Fort Worth, Texas	1180	254	100
KFQC	Taft, Calif.	1320	227	100
WCBW	Macon, Ga.	1330	226	10
WCBX	Newark, N. J.	1290	233	100
WCBY	Buck Hill Falls, Pa.	1120	268	10
WCBZ	Chicago Heights, Ill.	1210	248	50
WDBA	Columbus, Ga.	1270	236	20
WDBB	Taunton, Mass.	1310	229	10
WDBD	Martinsburg, W. Va.	1120	268	5
WDBE	Atlanta, Ga.	1190	252	10
WDBH	Worcester, Mass.	1120	268	100
WDBI	New Orleans, La.	1240	242	10
WDBJ	Roanoke, Va.	1310	229	20
WDBK	Cleveland, Ohio	1210	248	100
WDBL	Stevens Point, Wis.	1080	278	500
WDBN	Bangor, Maine	1190	252	5
WGN	Chicago, Ill.	810	370	1000
WRBC	Valparaiso, Ind.	1080	278	500

LIST OF BROADCASTING STATIONS DELETED MARCH 1 TO APRIL 30

CALL	LOCATION	CALL	LOCATION
KDYW	Phoenix, Ariz.	WEAS	Washington, D. C.
KDZF	Los Angeles, Calif.	WIAR	Paducah, Ky.
KFCM	Richmond, Calif.	WJAF	Muncie, Ind.
KFDL	Denver, Colo.	WJAZ	Chicago, Ill.
KFEJ	Tacoma, Wash.	WJH	Washington, D. C.
KFHS	Lihue, Hawaii	WKAY	Gainesville, Ga.
KFJW	Towanda, Kans.	WMAW	Wahpeton, N. Dak.
KFOB	Minneapolis, Minn.	WMAZ	Macon, Ga.
KNV	Los Angeles, Calif.	WPAH	Waupaca, Wis.
KSS	Long Beach, Calif.	WPAQ	Frostburg, Md.
KUS	Los Angeles, Calif.	WQAD	Waterbury, Conn.
KXD	Modesto, Calif.	WQAV	Greenville, S. C.
WABK	Worcester, Mass.	WRAD	Marion, Kans.
WBAD	Minneapolis, Minn.	WRAZ	Newark, N. J.
WBBI	Indianapolis, Ind.	WSAH	Chicago, Ill.
WCAY	Milwaukee, Wis.	WSAL	Brookville, Ind.

TOTALS

Number of U. S. broadcasting stations	584
Number of Canadian broadcasting stations	44
Number of Cuban broadcasting stations	34

$5.00

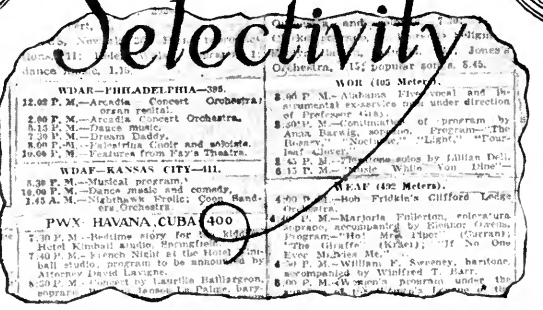
ULTRAFORMERS
Types A and B

New improved long wave frequency transformers, especially designed by R. E. Lacault, A.M.I.R.E., Consulting Radio Engineer of this company and inventor of the Ultradyne.
The Ultraformer (Type B) may be successfully employed in any circuit where long wave radio frequency transformers are essential.
To protect the public, Mr. Lacault's personal monogram seal (R. E. L.) is placed on all genuine Ultraformers. Ultraformers are guaranteed so long as the seal remains unbroken.

Send for 32 page illustrated book, giving latest authentic instructions on drilling, wiring, assembling, and tuning 6 and 8 tube Ultradyne receivers.

50c

Selectivity



—*A dominating feature*

An Ultradyne Receiver operating in New York City can easily tune out the powerful broadcasting of WOR Newark, N. J., **405 meters** and bring in WDAR Philadelphia—**395 meters;** PWX Havana, Cuba—**400 meters;** WDAF Kansas City—**411 meters.** Regardless of close similarity in wave length, the Ultradyne selects any station—brings in broadcasting clearly, distinctly, faithfully.
The "Modulation System" of radio reproduction is used exclusively in the Ultradyne. It is the latest achievement of R. E. Lacault, A.M.I.R.E., Consulting Radio Engineer of this company and formerly Radio Research Engineer with the French Signal Corps Research Laboratories.
The "Modulation System" increases the sensitiveness of the Ultradyne over that of any known receiver. Weakest signals are made to operate the loud speaker. A superior instrument to even the famous Super-Heterodyne.

Ultradyne performance is the envy of the radio industry.

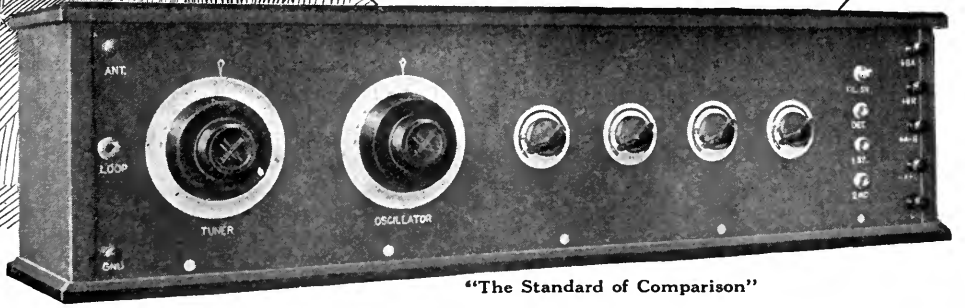
Write for descriptive circular

ULTRADYNE

The Improved

SUPER-HETERODYNE

PHENIX RADIO CORPORATION
5-7 Beekman St. New York



"The Standard of Comparison"

★ Tested and approved by RADIO BROADCAST ★

QUESTIONS AND ANSWERS

QUERIES ANSWERED

PLEASE EXPLAIN IN DETAIL THE NEUTRALIZATION OF THE ROBERTS CIRCUIT . . . *J. B. D.*, Galveston, Texas.
WHAT IS THE ADVANTAGE OF USING A COUNTERPOISE WITH MY RECEIVER? . . . . *G. B. N.*, Cleveland, O.

PROPERLY NEUTRALIZING THE ROBERTS CIRCUIT

HERE is a further explanation of the system employed by Mr. Roberts to overcome oscillation in the radio-frequency amplifier. Detailed instructions for their construction appears in the articles by Mr. Roberts in the April and May issues of RADIO BROADCAST. The winding N is used to prevent regeneration. The coils N and P are wound on the same form and as close together as is physically possible.

Assuming that the set has been made, proceed as follows: Turn the tickler coil up so that it is closely coupled to the secondary coil in the detector circuit. Using the variable condenser shunted across the secondary, tune-in the whistle of a transmitting station and then fix this adjustment. Then slowly rotate the first variable condenser, first one way, then the other, listening to the changes in intensity, not pitch, of the squeal. If it so happens that the squeal first increases gradually then quickly slumps down, then quickly increases and quickly decreases, it is evident that the proper balance has not been obtained. Try sliding the neutralizing tube in the opposite direction of its original position for only a short distance and repeat the variation of squeal intensity. When the neutralizing tube has been adjusted so that at a certain point on the dial of the first condenser there is a comparatively quiet spot a few degrees either side of this point but gradually and equally increasing, and decreasing as the dial is rotated further away from this point, the proper location for the neutralizer has been found. This explanation will be better understood by referring to Fig. 1. "X" shows the silent point extending from B to C while A-B indicates a gradual increase in intensity and C-D indicates a gradual decrease in squeal intensity.

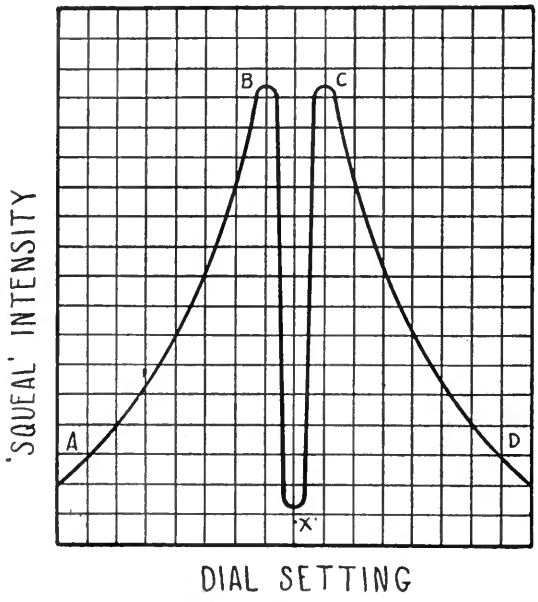


FIG. 1

A COUNTERPOISE FOR THE RECEIVER

SHARPNESS of tuning without any sacrifice of volume has been the goal of many constructors who "build their own." The need for sharper tuning has manifested itself more in the larger cities having several broadcasting stations, and when using certain types of receivers, especially the reflex set.

One of several ways to obtain this sharpness of tuning is by the use of a counterpoise instead of the usual grounding arrangement. A counterpoise is very similar to an antenna, is composed of one or a number of wires and is insulated in the same manner as an antenna. Usually it is placed beneath the antenna and elevated from the ground by several feet, to suit the taste of the individual constructor. If there is danger of tripping persons by having it quite near the ground, then it will have to be elevated at least "head high."

For use in the city, where such a system most applies, the counterpoise may be erected in the cellar or basement of the house, when the other space is not available. If this is the case, suspend the wire or wires from the ceiling far enough so that there is no chance for it to touch other objects.

The important point to remember is to have the counterpoise insulated up to the receiver. A general idea of counterpoise construction may be had from Mr. Dixon's article in this issue.

"The Choice of Radio Experts"

Specially Designed

For the Super-heterodyne and Long Wave Reception

Shielded Electro-statically and Electro-magnetically

TYPE 271

Medium Frequency Transformer

AMPLIFICATION of wavelengths around 10,000 meters falls between the ranges of radio and audio frequencies. It, therefore, requires a transformer materially different in design from radio or audio frequency transformers. The type 271 M. F. Transformer is specially designed to meet the specific requirements of medium frequency amplification. For use in the Superheterodyne and in long wave reception it is unequalled.

It is shielded electrostatically and electromagnetically.

Very compact and rugged. An instrument of high electrical efficiency.

★ *Price, $5.00*

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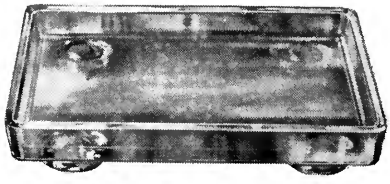
New Equipment

THOROPHONE LOUD SPEAKER

The new Thorophone is built on the solenoid principle, with a constant air gap which prevents varying impedance in the receiving set when the speaker is being used. It has a power amplifying unit, and the horn is of thorite. This composition is cellular and it will not resonate with any sound wave. It is a very good speaker. Made by Winkler-Reichmann Co., 4801 So. Morgan St., Chicago, Ill. Price $45.00

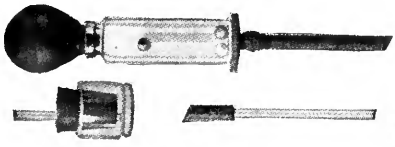
NA-ALD SUPER DE LUXE DIAL

Like the other Na-ald dials, the Super De Luxe is manufactured from black bakelite. It is made in the $3\frac{7}{8}$" size with the graduations clearly marked in white. Made by Alden Mfg. Co., Springfield, Mass.



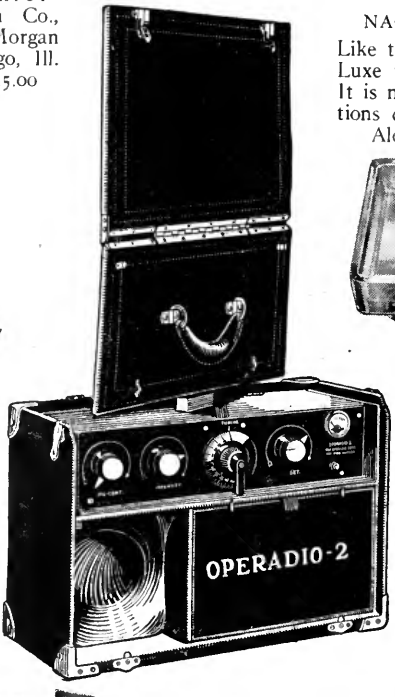
TUFGLAS BATTERY TRAY

A practical and satisfactory means of insuring your rugs and carpets against damage from the acid electrolyte. Made by Russell B. Cressman, 200 Fifth Ave., New York. Price $1.50



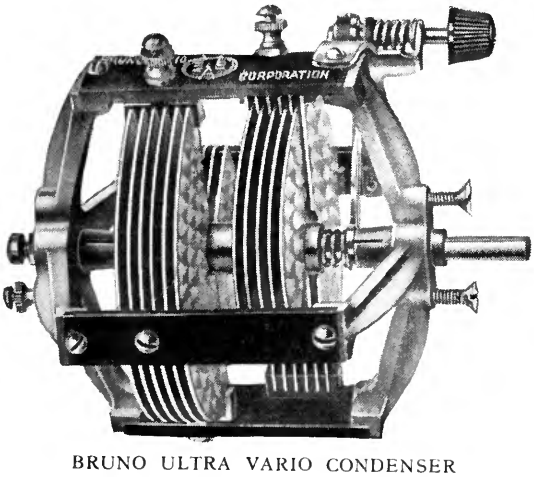
THE CHASLYN BALL BATTERY TESTING SET

Consisting of a Ball Battery Tester, a Battery Depth Gauge, and a Battery Water Filler. A complete and efficient equipment for learning the condition of your storage battery. Made by the Chaslyn Co., 3845 Ravenswood Ave., Chicago, Ill. Price $1.00



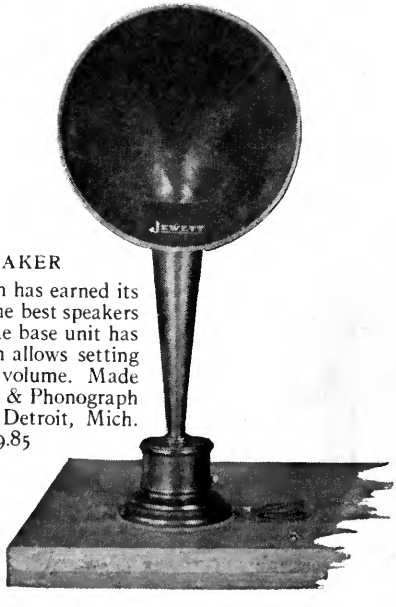
OPERADIO RECEIVER

In this carrying case the manufacturers combine a six-tube receiver, batteries, loud speaker and loop antenna very effectively. The loop is built inside the top of the case, which is shown open in this cut. Made by Operadio Corp., Chicago, Ill. Price complete $190



BRUNO ULTRA VARIO CONDENSER

A well designed condenser in both electrical and mechanical details. Its construction makes its use possible as two separate .00025 mfd. condensers, or in series to produce a capacity of .000125 mfd. Its regular maximum capacity is .0005 mfd. Made by Bruno Radio Corp., 300 Water St., New York City

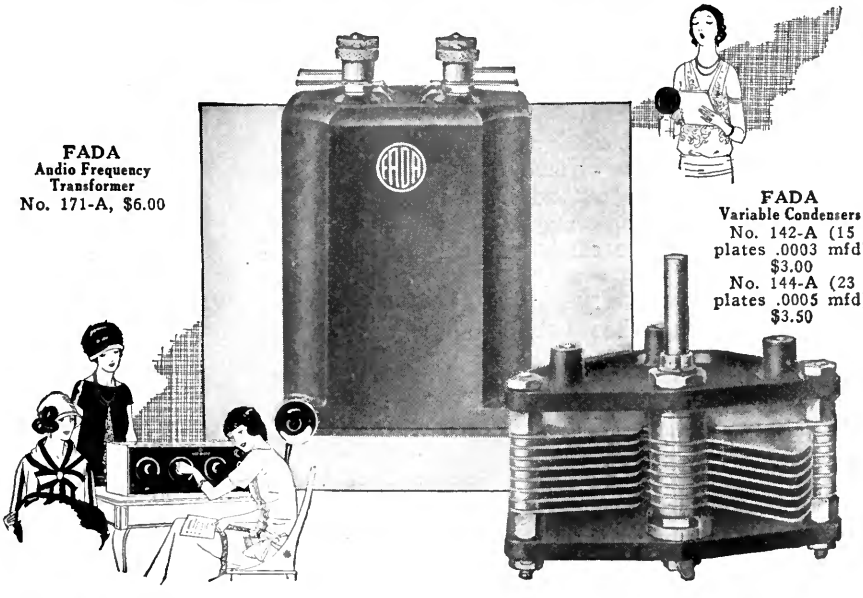


SUPERSPEAKER

A loud speaker which has earned its right to rank with the best speakers now obtainable. The base unit has an adjustment which allows setting for the most suitable volume. Made by the Jewett Radio & Phonograph Co., 5680 12th St., Detroit, Mich. Price $29.85

FADA ★

Transformers and Variable Condensers



FADA
Audio Frequency Transformer
No. 171-A, $6.00

FADA
Variable Condensers
No. 142-A (15 plates .0003 mfd) $3.00
No. 144-A (23 plates .0005 mfd) $3.50

More volume—finer tuning

POOR condensers absorb radio power—that cuts down volume. Poor condensers add resistance—that broadens tuning. You can sharpen your tuning, increase selectivity and get greater volume with the new FADA "low-loss" variable condensers. Use them. The low power factor and low equivalent series resistance prove their superiority. FADA "low-loss" condensers are more efficient than many so-called precision condensers and have a capacity ratio of 40 to 1 as compared with 30 to 1 usually encountered. Two sizes—No. 142-A (15-plate .0003 mfd) at $3.00 and No. 144-A (23-plate .0005 mfd) at $3.50.

Performs as well as it looks

The new FADA Audio Frequency Transformer is encased in bakelite with nickeled binding posts and soldering lugs. It looks "quality" all over. And it performs up to its appearance. It has a high average amplification over all the broadcasting wave-bands and reproduces voice and music with a volume and tonal fidelity that is surprising. A wonderful addition to the audio frequency stages of Neutrodyne receivers and equally efficient in other types. This new transformer, No. 171-A, is made possible by correct FADA engineering principles and by uniform production methods. Ratio 4 to 1. Price $6.00.

Ask your dealer for FADA Transformers and Variable Condensers

F. A. D. ANDREA, INC., 1581 Jerome Avenue, New York

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★ Tested and approved by RADIO BROADCAST ★

Among Our Authors

RADIO receivers sometimes temporarily impair "domestic tranquility" as well as bring enjoyment to their owners. Henry J. Peck, in the second of his covers for this magazine has rather well caught one of the moods of a radio owner, we think. We can promise the reader another cover by this artist in an early number.

WILLIAM H. CARY, JR., has left France, where he has been for some months, to begin a trip around the world. We expect to hear from him what the Indo-Chinese are doing with radio and how broadcasting is coming along with the Sumatrans. As a matter of fact, this interesting writer gave us to understand in a recent letter that he was really exploring to see how "far-flung" the ends of the earth really were.

EDWIN H. ARMSTRONG has not been back so long in New York from his honeymoon which he spent last winter in Florida. Mr. Armstrong, with his quiet manner and quite fascinating drawl, is often seen around the busy campus of Columbia University in or near the radio laboratories.

JULIAN KAY, whose second article in the "What's in a Name?" series appears this month, has left New York temporarily to do some research work with vacuum tubes in Boston, but he promises this will not prevent him from sending us the other articles in the series, the next of which will appear soon.

ZEH BOUCK

ZEH BOUCK, the editor of "In the R–B Lab" and pleasantly frequent contributor to RADIO BROADCAST, is one of the prize winners in the recent radio drama contest held by W G Y. Bouck in his eager effort to pen a stirring drama, called it *Bootleg*. The snapshot shows that "learned Theban" in a queer Bermudan carriage in front of Tom Moore's House Tavern at Bermuda, where two of the scenes of his radio play are laid. He claims to be leaving the place, but we dunno. . . .

JAMES C. YOUNG is a well-known New York newspaper man whose frequent contributions to the Sunday New York *Times* are familiar to readers of that excellent newspaper. Like all newspaper men, and Mr. Young is indeed a good one, he has a wide acquaintance. The other day he was out on a revenue cutter and. . . Anyhow, he has written an extraordinarily interesting story about radio on the "rum fleet" off New York, which will appear in this magazine soon.

WENDELL BUCK is engaged in radio advertising. Not very long ago he left New York for the uncertainties of Chicago to take up his duties for a large New York retail radio store whose Chicago branch has just been opened.

A. C. JR. AND A. C. DIXON

ASHLEY C. DIXON is a native of Chicago and attended school and the University of Chicago there. He moved to Montana in 1911 and has been there ever since on his ranch at Stevensville. "My former hobbies were hunting and amature photography", he writes, "but now I think my present and future hobby is radio." His son A. C. Dixon, Jr. stands beside him in the photograph. Dixon, Sr. has an amateur radio operator's license, while his son, at 15 holds a commercial operator's ticket.

NO TRUE fisherman hides his prowess under even a secretive conversational bushel, and here we see Robert H. Moulton with part of a $12\frac{3}{4}$ pound fish caught in Black Lake, Wisconsin. Mr. Moulton is a graduate of Columbia University, spent some years on a Chicago newspaper, and is now in that city as a free-lance writer on a wide variety of subjects. He took the photographs which illustrate his article "Linking the Farmer With His Market" himself.

R. H. MOULTON

Radiola Regenoflex, with Radiola Loudspeaker, and 4 Radiotrons WD-11; with space for batteries inside; (complete except batteries and antenna) $206

With a Radiola *on the Front Porch*

All the jazz of the big orchestras in faraway big towns comes through *clearly* for dancing. The fine music is true, sweet toned, undistorted. The sports news rings out with all the thrill of bleachers or ringside. The Regenoflex is a leader among the new Radiolas that are making this a great radio summer!

A Radiola *Regenoflex* on the front porch—and that porch can be way up in the mountains, or off at the seashore—but it's not too far away to be in on the fun.

The improvements in its mechanism offer greater sensitivity and greater selectivity; clearer tone; and complete simplicity. Where *quality* of reception counts as much as distance, the Regenoflex is the receiver for this summer's fun!

This symbol of quality RCA *is your protection*

"There's a Radiola *for every purse"*

Send for the free booklet that describes every Radiola.

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Dept. 37 (Address office nearest you.)
Please send me your free Radio Booklet.

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Street Address

City R. F. D.

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10 So. LaSalle Street, Chicago, Ill.
433 California Street, San Francisco, Cal.

Radiola

REG. U.S PAT OFF

★ Tested and approved by RADIO BROADCAST ★

Roger B. Whitman, *Country Life*.

A PROPER SETTING FOR A SUPER-HETERODYNE

One of the eight-tube super-heterodynes, built in the RADIO BROADCAST laboratory, operating on a loop beside the North pool in the gardens of the Doubleday, Page & Company plant, where RADIO BROADCAST is published. A radio receiver can be ornamental, and decorative as well as useful