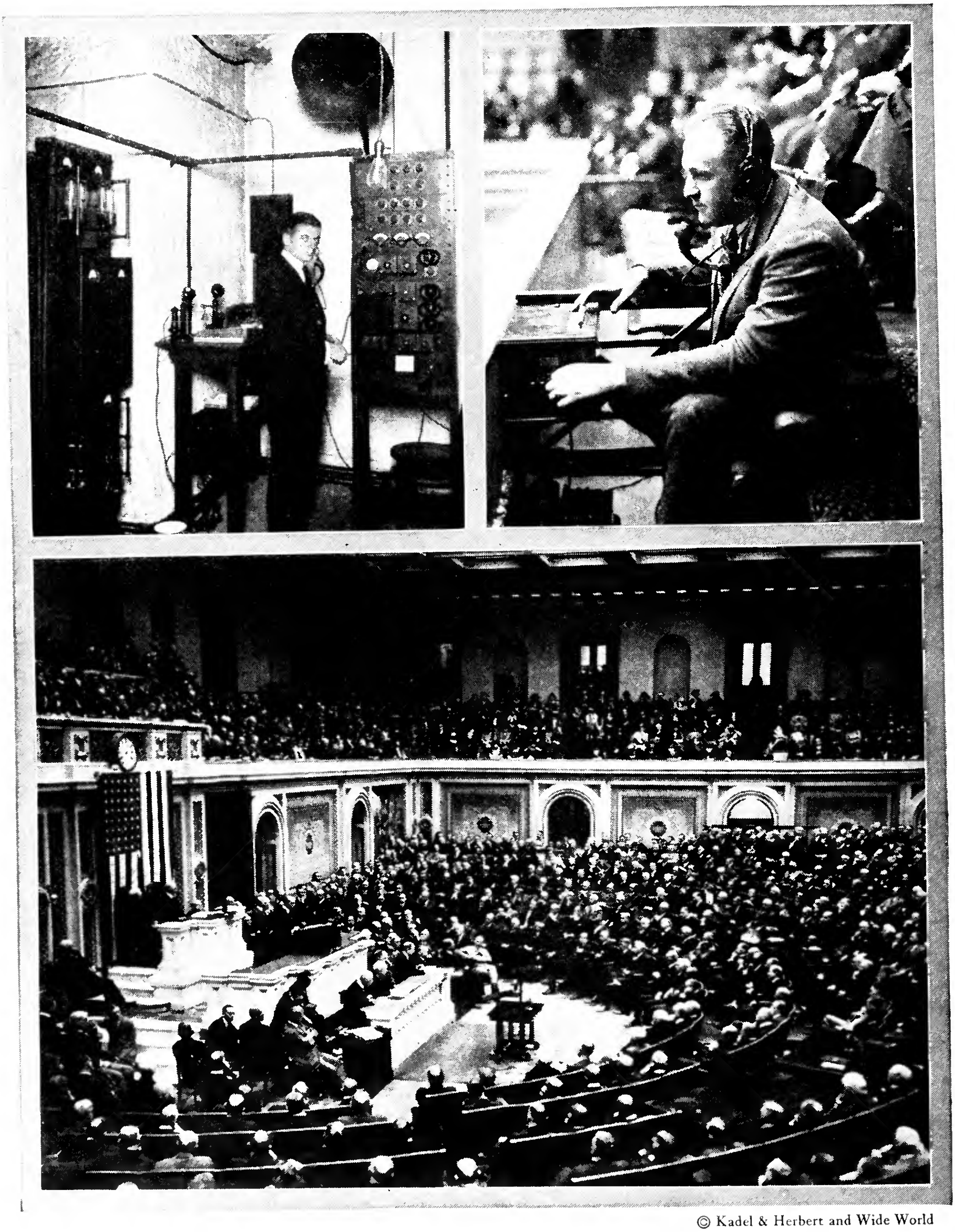

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A PAGE IN RADIO HISTORY

At 12:40 P. M., on Thursday, December 6, 1923, the President's voice as he delivered his annual message to the Congress was heard not only by the Congress, but by all who could listen-in on any one of six stations (WCAP, WEAF, WJAR, WDAF, KSD, and WFAA). People from Maine to Texas heard the speech so clearly that the President's New England inflection was easily noticeable. Two microphones may be seen in front of the President's manuscript. UPPER LEFT: The amplifying panel located in the basement of the Capitol. UPPER RIGHT: The microphone control operator in the balcony of the house

RADIO BROADCAST

Vol. 4 No. 4 February, 1924

The March of Radio

BROADCASTING BROWNING

A VERY interesting experiment has been inaugurated through the co-operation of the management of Station WEAF and the Home Study Department of Columbia University. The question has frequently been put: Is there a demand for the transmission of real educational material over the radio channel? Does the radio public want only amusement from the evening's radio hour or would an educational course of high order, presented by an authority, be welcomed and appreciated?

Undoubtedly, a very large part of the present-day radio audience prefers jazz to a Philharmonic concert; of two equally available stations, one modulated by the whining tones of a saxophone orchestra and the other by the voice of an eminent Shakesperean scholar, there is no doubt as to what wavelength most of the sets would be tuned to. Elementary talks on radio and kindred subjects, such as storage batteries, loud speakers, and the like, unquestionably get the attention of the average radio listener, but probably this is because the knowledge thus gained is to be used the following evening in improving the reception of popular music. This is not the type of talk we have in mind in asking the question about the value of radio as a means of education.

A certain amount of sound education is undoubtedly being absorbed by the radio listeners as a result of the excellent musical programs being broadcasted nowadays by the better class of stations; one cannot listen, for example, to a worth-while rendition of "Elijah" accompanied by explanatory comments on the work and its composer without absorbing some knowledge of music and its masters. The well known and much appreciated "Roxie," with his excellent staff of artists, is doing much to make us appreciate good music. Many people have heard better music at Roxie's Capitol Theatre concerts than they ever heard before, and their taste for good music by high-grade performers has been whetted as a result. A radio impressario of the right kind can educate the musical tastes and appreciation of his audiences quite painlessly. We remember a mildly sarcastic comment directed at our well loved Professor of Chemistry, whose lecture notes were liberally diluted with stories, good and otherwise. A more sober-minded colleague, whose son had attended the chemistry lectures, inquired whether the chemistry department considered story telling as a major course, and if they didn't why were there so many stories in a course in general chemistry? "Well, you see," was the retort, "many of the boys really don't like chemistry; it seems to them dry and uninteresting—but they do like stories of the kind I tell

BROADCASTING BROWNING
Hoxie Neale Fairchild, Supervisor of Home Study Courses at Columbia University, whose first radio lectures on Robert Browning were favorably received

them. So they swallow the stories, I inject a little chemistry, and that goes right down at the same time as the stories and before they know it they have really learned a little chemistry, and have enjoyed doing so."

But education gained in this fashion isn't what we have in mind when we consider the question whether radio can be used as an educating medium. Is there a demand for out-and-out educational lectures on art or literature? Is there an appreciable percentage of the radio listeners who wish serious talks by acknowledged authorities? Furthermore, is the demand for such a radio program sufficiently real to induce people to pay enough for it to make the work self-supporting? This is the question to which WEAF and Columbia are seeking the answer. One of Columbia's scholars, an authority on Robert Browning and his work, is giving a series of ten twenty-minute talks on this poet alone. A synopsis of the ground covered is sent to those interested, *for the sum of five dollars*. The synopsis is so arranged that much more benefit may be derived from the lectures themselves if one has properly studied it before listening to the evening's lecture, as the lecturer continually refers to it during his talk.

This is probably the first time that an attempt has been carried out to make radio directly self-supporting. Fortunately, the lecturer was well chosen. He is gifted with a good radio voice, it is as easy to listen to him by radio as though one were in his class room. Now the interesting point is this: although any one can listen-in on these talks without paying the five dollars, and although the talks are of no material value to the listener (i. e., they do not increase his earning capacity or make the adjustment of his radio set any easier), *the demand for the Browning synopsis has been immediate* and after the first lecture the director of the work told us that the cost of conducting the work had already been paid for by the copies sold! The American Telephone and Telegraph Company has been sufficiently interested in this experiment to give the use of its station to the University, without cost, for carrying out this experiment in education. In the course of the next two months we shall get more interesting information as to the success of this course.

Bureau of Standards Tests Receiving Sets

A LENGHTHY report is at hand giving the work of the Bureau of Standards in making comparative tests of the better known receiving sets on the market. The sets tested are, of course, not tabulated by name, but those familiar with the radio receiver market will easily identify them since they are described in detail.

An extremely wide range in sensitiveness and selectivity is shown when comparing the different types of receivers; we have known that such was the fact but have never seen before an unprejudiced compilation of the merits of the sets put on the market by the various manufacturers. The comparative merits of the sets tested is probably not of very great importance because of the frequency with which changes in receiver design are incorporated by any wide awake manufacturer. This publication of the Bureau will probably be of considerable value to radio engineers and manufacturers, however, as indicating what seems to be a very reasonable ground upon which to judge the merits of a set, and thereby pointing the way to improvement in design.

General Electric Company to Invade the Middle West

THE General Electric Company has chosen Denver, Colorado, as the site of a broadcasting station to be erected as soon as the station at Oakland California, is completed. Work in Denver will probably be in progress before the spring of this year.

Denver will have the third, and probably the last, station in the G. E. string of broadcasting stations. The first, WGY in Schenectady, has been in successful operation for the last eighteen months and both the Oakland and Denver stations will be modeled after it in so far as technical equipment is concerned. They will each have the same power and sending radius, it is presumed, as WGY, which station has, under favorable conditions, been heard simultaneously all over the United States, in England, Hawaii, and several countries of South America.

JOHN GREER HIBBEN

President of Princeton University. In a recent letter to RADIO BROADCAST, President Hibben summed up his conception of the educational possibilities of radio as follows:

I am in hearty sympathy with your efforts and I feel that much may be done in disseminating broadcast to the people of the United States a knowledge of the world, both of the past and present, in its physical constitution and the intellectual, moral, and spiritual influences which move, control, and direct the activities of mankind. I feel that radio does not realize the large scope of its possibilities if it aims only to give momentary pleasure and diversion.

Data on Standard Single-Layer Coils

IF YOU are interested in having standard coils with which to compare those you are using in your experiments, it is worth your while to send to the Bureau of Standards for Letter Circular No. 103, entitled "Description of a Series of Single-Layer Inductance Coils Suitable for Radio-Frequency Standards." One wouldn't ordinarily think it worth while putting out a circular on single-layer coils, but the Bureau has thought it sufficiently important to publish the data, undoubtedly with the idea of cutting down the amount of standardization measurement work which the staff is called upon to do. A whole series of coils is minutely described, the values of inductance lying between eight and five thousand microhenries, there being a practically constant ratio between the adjacent coils of the series.

With Justice for All

AND still they ask: "Who is going to pay for broadcasting?" Several performers recently demanded pay for their services, their managers having refused to allow them to appear before the microphone without suitable remuneration. Certainly the radio public should pay. But how much, and how?

The tactics of the self-styled American Society of Composers, Authors, and Publishers, in trying to force broadcasting stations to take out licenses for the privilege of putting their jazz on the air have been frequently commented upon and frequently condemned. The arguments of their counsel at meetings of the broadcasters, as well as at court proceedings, were specious, beside the point, frequently untrue. Their statements were conjecture rather than fact. On investigation, it was found that the society did not include as much musical talent as its high-sounding name would lead one to believe. A survey showed that

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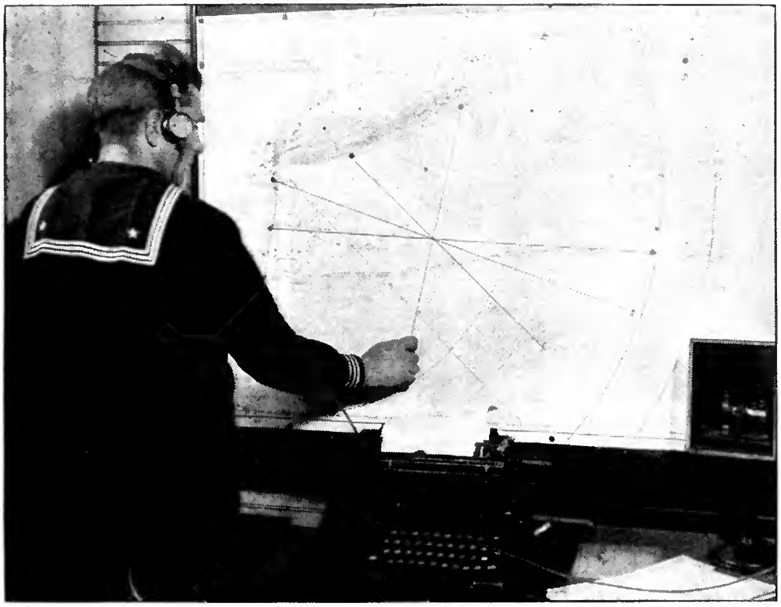
Representative broadcasters ignored altogether the demands of the small but noisy band of jazz writers. As we have mentioned before, the outcome was the formation of the National Association of Broadcasters. A successful business man, having intimate knowledge of the musical game, Mr. Paul B. Klugh, was selected as executive chairman to guide the destinies of this new society which is attempting to solve the question of broadcasting rights and income for the broadcasting station. The story of their present and anticipated activities convinces one that they are attacking the problem in a fair and unbiased fashion.

The Broadcasters' first activity was devoted to the question as to whether or not broadcasting did have a real advertising value. So they set about to get real information on the matter. Two experiments they made show, beyond peradventure, how powerful an agent radio is in making songs popular. The result of such advertising was sure and decisive. In one case, a two-year-old song was selected as a test piece. This song had been put out on phonograph records but the sale had not been large. At the time of the test, the piece was stagnant, most stores reporting practically no sales. An inventory of the records in stock was taken by an agent of the broadcasters. A short time after a good station had broadcasted this song, using an accomplished artist to "put it over", another canvass of the stores showed that *80 per cent. of the phonograph houses had sold out the record.* With such facts to go on, the broadcasters *knew* what they were talking about.



PLOTTING A SHIP'S POSITION

The compass bearings of a given ship, reported to the central station in New York by several radio compass stations, are indicated by lines drawn from the receiving stations on a map. The ship's position is the point at which the lines cross

A composer now sends in his song and it is examined by well-qualified musical critics. If it passes the judges, the members of the association put it on the air. If the song is a hit, the author at once begins to receive whatever royalties on the sheet music the copyright law entitles him to. With no advertising expense of his own, he begins to reap the benefit of the radio advertising. If the song proves sufficiently popular to justify its reproduction for the phonograph and player piano, the broadcasters begin to get some return for selling the song to the public. Their contract with the author stipulates that a certain reasonable percentage of the mechanical royalties shall accrue to the Association of Broadcasters; if the song is successful, the author receives all the royalties from the sheet music sales. But he shares the royalties from the records and piano rolls, with the National Association of Broadcasters.

This solution of the problem looks logical, and eminently fair to the author. He stands to lose nothing if his song doesn't "go," and if it does, his interests are identical with those of the Broadcasters' Association, so he may be sure that his song will be given as much prominence as possible. We hope the new scheme proves a success.

Guiding Our Mail Planes

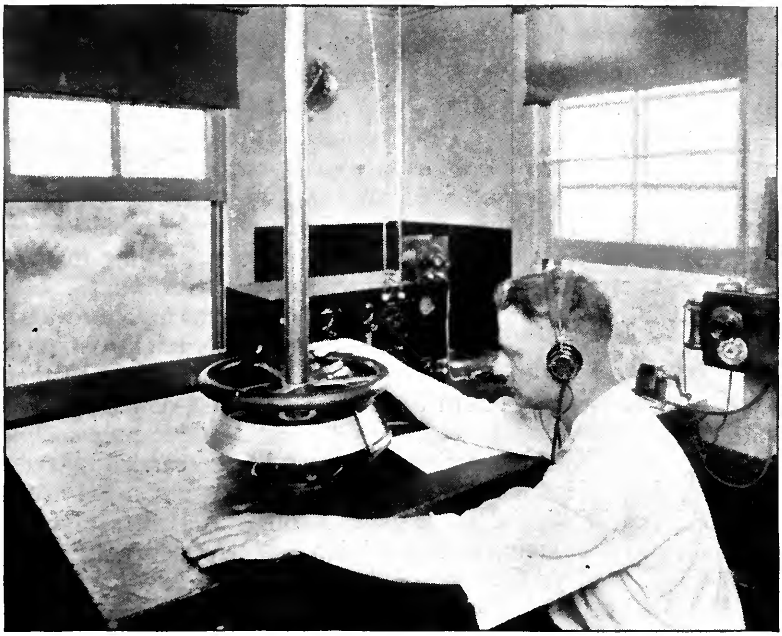
WE SCARCELY realize the extent to which aviation is gradually working itself into the transportation scheme of our country. Trips of the air route-mail carriers are now expected as regularly as those of the mail cars. It is evident that fog and snow present very great danger to the air mail carrier, and that anything which will increase his safety must be developed and utilized as soon as possible. The General Electric Company has undertaken the development of transmitting and receiving sets which are suitable for airplane installation, and tests recently carried out indicate that two-way communication from plane to ground may be reasonably expected with these sets, up to a distance of about one hundred miles, under average conditions.

One contribution to the safety of the airmen, which has had no wide application up to the present, is the "radio beacon"; this is a transmitting station, located at a landing field, which sends out signals in such a manner that when an aviator picks up the signal he knows at once his bearing from the field. In its present form, the radio beacon consists of a transmitter which sends out directional signals, the direction of transmission being adjustable. A characteristic signal, say two dots, is sent due north for a second or two and then the station is silent; five seconds later the two dots are again sent out, but the maximum signal is now a certain number of degrees from north, say thirty degrees west of north. This process is repeated until the signal has been sent all the way around the compass and then after a longer silent period another cycle of signals is sent out. As soon as an aviator comes within the range of such a radio beacon he can at once tell his bearing from the landing field. These beacons will probably be installed at the air mail fields as soon as funds are available.

WGY and KDKA Recommended as Wavelength Standards

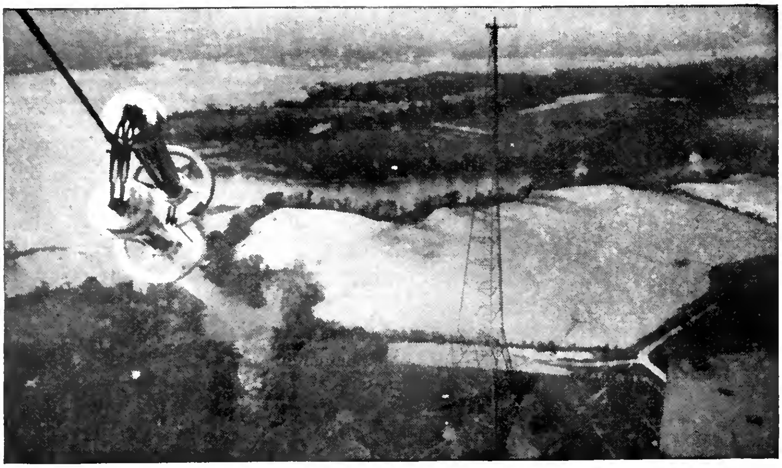
AS A result of the supervision the Bureau of Standards has been exercising over some of our broadcasting stations, they have found that two of the better known stations have maintained their frequency sufficiently constant to enable them to be recommended as secondary wavelength standards. For those who are within range of the Bureau of Standards, of course, observations of the standard frequencies periodically transmitted from WWV give the best method of calibrating a receiving set, but WGY and KDKA have kept their assigned frequencies so closely that for ordinary purposes, their daily transmission may be used. WGY sends on 790 kilocycles, has a maximum observed deviation from this frequency of 0.5 per cent. and an average deviation of only 0.2 per cent. This means that the carrier wave of this station is, on the average, within one meter of 379 meters. KDKA transmits officially on 326 meters and her carrier wave is generally within one meter of this specified wavelength.

These two stations then may be used as frequency standards for any but the most



A RADIO COMPASS RECEIVING STATION

At Sandy Hook, N. J. The operator is shown turning the wheel which adjusts the position of the big loop aerial. This station is connected by land wire to the control station shown on page 274



AN INSULATOR'S VIEW OF ANNAPOLIS, MD.
Taken from the top of one of the towers of the Government transatlantic radio telegraph station (NSS)

precise work. The Bureau of Standards will soon publish results on the frequency of other stations, as soon as sufficient observations have been made to justify their estimate of probable error.

Once You Hear Them Speak . . .

ON SEVERAL occasions lately we have had demonstrations of the great possibilities of radio broadcasting in forming and influencing public opinion.

Just before Lloyd George sailed for England after his circuit of the United States and Canada he was tendered a farewell dinner by the Lotus Club, in New York, where many of America's leaders were present to do honor to Great Britain's best known citizen. In responding to the welcome given him, Lloyd George expressed again, as he had done repeatedly in his many talks in various parts of the country, the importance of unity of ideas and ideals of the two great English speaking peoples. He regarded, so he said, the intertwining of the two flags in the banquet hall as the most helpful sign on the horizon for the future of the world, there being in his mind, of course, the tremendously complex and discouraging situation in Europe with its conflicting and antagonistic interests.

The master of our steel industry, Charles M. Schwab, in commenting upon Lloyd George's idea of the intertwined flags, acknowledged the importance of the idea they symbolized, but said he regarded as much more important the presence in America of Lloyd George himself. For the message he could bring to our people and deliver by word of mouth was a far more potent agency in cementing the friendship of America and Great Britain than the mere intertwining of flags. And surely all those who heard Lloyd George would agree with Mr. Schwab; the dynamic force behind the argument and exposition of the War Premier stirred everyone.

It is evident that some means must be provided to let such messages be heard by as many Americans as possible; the spoken word is so much more appealing than the next morning's press version of what the speaker said, absorbed between sips of breakfast coffee. The press now is more mighty in spreading information, but it is written on the wall that the spoken word will soon supplant it as the primary agent in forming public opinion. This spoken word will be carried by radio waves.

On the eve of Armistice Day, thousands of Americans heard their ex-Chief Executive deliver that stinging rebuke, meant to arouse the indignation of those who might influence our government to give more thought to Europe's problems. So faithfully was the radio transmission that one could not help picture, behind that trembling and hesitant voice, the broken man who had but a short time before been the world's leading figure. His voice was passionate with appeal and condemnation. Those who listened to him were impressed by the tremendous earnestness with which this man had pursued his ideals. Whether or not we believe in his arraignment of our government's inaction and aloofness, we must acknowledge radio as the medium for conveying messages of this sort to the people. The appeal of type is as nothing compared to that of the spoken word when delivered in the manner used by Mr. Wilson on the evening of Armistice Day. By the help of radio, the mere whisper as it comes from the lips of the speaker covers vast spaces of our country. Each of us feel then more directly in touch with those we have elected to guide our country's policies.

On Thursday, December 6th, the people throughout the East and Middle West heard the President delivering his message to Congress. Country-wide reception of such an event can, of course, come about only when many stations all over our country are arranged for simultaneous transmission of one speaker's voice. But such a knitting together of the radio channels is rapidly taking place. Six stations broadcasted the President's recent message. By the use of high-quality cable and wire connection, or by inter-connecting radio channels, we shall soon have a dozen or more stations all operated by a single microphone.

The Long Arm of the Explorer

WE HAVE often stated that one of the most important services radio can perform is to help keep in touch with the rest of their race those intrepid investigators who feel, and follow, the urge to penetrate into distant and uninhabited parts of our world. We stay-at-homes can find entertainment at the theatre or the companionship of our acquaintances, for instance, and can use the wire service for communicating, but to the lonely explorer, with no wire connections and limited means of entertainment, radio is proving a great boon.

During the last month, two instances have forced us to notice this rôle which radio is playing. The daring engineers of the Government Geological Bureau, on their trip of exploration down the Colorado cañon, many times thought of as lost by those knowing the danger of this seldom attempted trip, informed us after they had successfully finished their long journey that radio kept them in continual touch with the ouside world. Two thousand feet down in a crack of the earth's crust, often so narrow that daylight scarcely penetrated, with the raging falls and rapids to tax to the utmost their ability and endurance, when a misstep or accident meant almost certain death, radio cheered and heartened them in the evening by bringing down into their camp, music, news, and entertainment. It is not impossible that a small transmitter might have kept them in continual communication with the outside world, in spite of the unfavorable conditions under which the transmitter would have had to work.

A still more striking instance of radio serving the explorer is seen in the MacMillan polar expedition, now ice-bound off the coast of Greenland. Instead of being cut off from us for a year or more, as would have been the case but for radio, this polar expedition is able to be practically in constant touch with the home land. Not only is the *Bowdoin*, MacMillan's ship, able to get messages from the more habitable portions of the earth, but it is able to transmit them to us with a reasonable certainty of coming through. Recently MacMillan actually dedicated, with his own voice, the new home of the Chicago Yacht Club, of which he is a member. From a microphone on board his ice-bound boat, his voice was able to leap across the vast spans of ice and

GRAND OPERA IN THE MEADOWS

This car of Lloyd's *Sunday News*, equipped with a receiver and loud speaker, brings the concerts of the British Broadcasting Company to those who would not otherwise hear them snow which separated him physically from his fellow club members, so that their dedication program could be actually carried out by their most distinguished member.

Fading

IN SCIENTIFIC Paper No. 476 of the Bureau of Standards, an attempt is made to interpret the results of the fading tests carried out by the Bureau with the assistance of about one hundred widely scattered amateurs who volunteered to try and get data which could be compiled in an effort to find out the how and why of fading. Does fading occur at all stations simultaneously and to the same extent? If so, it would seem to indicate a general absorption of the signal in the neighborhood of the transmitting station. Or does the signal increase in stations in one location when it fades in stations in another? If so, it would presumably indicate that the energy which should be normally sent in one direction had been refracted or reflected and sent in another. Is there any law or order about this fading phenomenon?

The scientists at the Bureau attempt to answer the question, in the light of the results of the tests they had carried out, but the answer is quite evidently only conjecture. Sufficiently accurate data is not at hand to permit a reasonable attack on this problem as yet. Data of the kind required for the solution of problems of this nature cannot be collected by amateurs—that is, amateurs in the sense that they have had no experience in taking accurate radio measurements. If one judges radio transmission by what is heard in the telephone receivers, his data will indeed be of but little value. The ear is of practically no use as a measurer of sound intensity, as may be inferred by any one who has been listening to a signal, as the static gradually increased in intensity. The ear always interprets such an occurrence as a fading of the signal.

This fading phenomenon will be analyzed and explained some day, but it will undoubtedly be solved only after skilled investigators, equipped with the very best radio measuring instruments, have spent much time and effort on the problem. As the question is an extremely important one, we may rest assured that the answer will soon be forthcoming, if one is possible.

Batting a Dot About

TO THE electrical engineer there is nothing novel in the idea of "remote control." Our great electric power stations, generating hundreds of thousands of horsepower, are operated entirely by one man in a small room overlooking the generator room, who manipulates a set of push buttons. All of the heavy switches and similar apparatus are set into motion by motors and electromagnets, the current for which is controlled by these buttons in the supervisor's tower.

RADIOGRAMS TO AND FROM ENGLAND WENT THROUGH HIM

In the recent transatlantic broadcasting tests. He is Mr. H. E. Fulton, operating at Radio Central, Broad Street, New York. The buzzer fastened on the telephone instrument was used in communicating with the RADIO BROADCAST receiving station at Garden City, N. Y.

But the crowning achievement of automatic remote control was carried out a short time ago when two tremendous radio stations, one in America and the other in Europe, automatically controlled each other's apparatus. It is possible to put one of our large radio stations "on the air" by a series of very delicate electrically controlled switches, called relays. One of these

THE FIRST HARMONICA BAND TO GO ON THE AIR
Organized in Junior High School No. 61, New York City. Harmonica bands are being organized throughout the country as a result of the successful venture undertaken at this school

relays may be operated, by the help of suitably disposed triodes, by the minute currents picked up from a radio station thousands of miles away, and this was what was done on the occasion we have in mind.

A telegraphic "dot," sent out from the Radio Corporation's "Radio Central" on Long Island, was picked up by a receiving station in Poland, over four thousand miles away. Suitably amplified and controlled, this dot put the transmitting station at Warsaw into operation, the American station having in the meantime ceased radiating. The dot thus sent out from Warsaw was received in America and here used to put our station back on the air for another dot, the operator in America not touching his sending key after sending the first dot. The dot from this side of the Atlantic then began its travel to Poland and on arriving there carried out the same operation as the first one, and thus the dot, started in America by the operator pressing his sending key for an instant, was tossed back and forth from America to Europe several hundred times. Except for disturbing influences, such a game of radio baseball might be kept up indefinitely.

This experiment opens an interesting method for checking messages to the engineer responsible for getting traffic through. He could arrange that the Warsaw station be controlled by the message received there from New York, the operator in New York, tuning to the wavelength of the Warsaw transmitting station, can listen to the message as received in Poland.

To one gifted with any imagination, such a test opens up all sorts of possibilities. The physicist sees how he may perform a wonderful experiment to check the results of the famous Michelson-Morley test. This test apparently proved that light waves travel with a fixed velocity through space, independent of the speed of the light-emitting source. The speed of light east and west was compared with that going north and south. Due to the high velocity of travel of the earth on its axis and through space, it seemed possible that the velocity of a light wave would be different in the different directions. They found no difference at all, although their apparatus could easily detect even smaller differences than was to be expected in the test. This remarkable experiment, the results of which underlie the modern theory of relativity, was carried out over comparatively short light paths. Now it is within the realm of possibility that two sets of radio stations might be used to repeat the test. Radio waves, we believe, are exactly the same as light waves except for wavelength. This experiment, using light waves, could just as well be proved by radio. A pair of stations with east and west transmission, automatically controlled, as in the case mentioned above, could be compared with the transmission with a similar pair having north and south transmission (say New York-Warsaw pair and a New York-Argentine pair). There will be a certain difference in time required for transmission between the two pairs of stations due to the different distances, but this difference changes as the earth rotates, if the results of the Michelson-Morley test are not correct. If, therefore, two such pairs of stations, operating as "radio clocks" should be left running all day, and if it could be shown that one gained on the other with a periodically changing rate, as the earth revolved, our ideas on light phenomena would have to be materially revised. It is not improbable that this striking means of checking the time period of radio waves will soon be used to advantage.

"And now, little Kiddies, what do you think Peter Rabbit answered?"
(This was the eloquent cover of *Life* for November 1, 1923)

An Interesting Court Decision

MANY a radio enthusiast will at some time or other get an idea which has commercial value; if he is employed in the technical division of a radio manufacturing company, the decision recently handed down in the case of the Burgess Laboratories against the French Battery and Carbon Company will prove interesting. The decision is neither new nor novel, but it serves to bring up again a certain aspect of the patent problem which must interest all who have inventive minds.

One of the members of the Burgess Company, a man who did much of the technical development for the company, severed his business connection here and entered the French Battery and Carbon Company. Naturally he was of value to his new associates primarily because of the experience and knowledge he had gained while working with the Burgess Company. He began to improve the products of his new employer, who was in competition with his old one, in the dry-battery market.

It appears that many of the improvements he soon incorporated in the products of the French Company were conceived while still under contract with the Burgess Company. If so, according to the decision of the Court, he has no right to use these ideas in improving the product of its rivals.

But how is one to tell when he first conceived an idea? And did he conceive it completely or only in part at this time? Whatever he conceived, in line with the general character of his work, while in the employ of a company, belongs to that company, and he is not free to use it for any one else. It is not necessary that the idea should have been shown workable, or "reduced to practice," as the patent law has it; if the mere conception of the idea can be shown by one's former employers to have been gained

"BY REQUEST" WJAZ GOT 4284 TELEGRAMS IN FOUR HOURS

Left to right: Mr. C. H. Handerson, WJAX, Cleveland; Mr. Raymond Walker, Manager of Bureau of Music Release; Senator Frank W. Elliott, WOC, Davenport; Mr. Eugene McDonald, Jr., WJAZ, Chicago; Mr. Paul B. Klugh, Executive Chairman; Mr. William S. Hedges, WMAQ, Chicago; Mr. J. Elliott Jenkins, WDAP. Chicago; Mr. C. B. Cooper, Department of Commerce Radio Committee; Mr. John Shepard, III, WNAC, Boston; Mr. Powel Crosley, Jr., WLW, Cincinnati. Executives of the National Association of Broadcasters in their convention at the Hotel Commodore, New York, are examining the results of a test of the size of a listening audience at WJAZ. 4284 paid telegrams, averaging 75 cents each in cost were received in four hours. It is estimated that only one person in a hundred would be willing to spend this amount, and that therefore the number of listeners-in on that night may fairly be estimated at 400,000

while the inventor was working for them, the idea is theirs, not his.

Strange as this may seem at first, it is seen to be the only reasonable and just decision to make in cases of this kind. All of the company's secrets are opened for the instruction of their investigators—they pay him what is thought by them a reasonable salary in the hope and expectation that his brain will yield something worth more to them than the salary they have paid him while the idea was incubating. It is a kind of a bet they make on their experimenting staff; salaries are paid for years without anything of actual money value being turned out by the experimenter, but he is still employed in the hope that his direct, or indirect, contributions to the output of the factory will more than offset what he costs the company.

It is evident that if the court should rule otherwise than it did in this case, and as it always rules in such cases, it would be possible for an investigator to work for a company for a year or two, learning all their secrets, drawing a salary, turning out nothing, and then, when a valuable idea came to him, sell his idea and services to a rival concern. Such would evidently be unfair procedure, and if it could be successfully carried out by technical workers, would do much to wreck the wonderful research organizations which many of our large companies have built up during the last decade.

In awarding a verdict for the Burgess Company the Court said: "The question here involved is not whether the invention was reduced to practice or whether it was merely an abandoned experiment, but whether it was 'made or conceived' during the life of Mr. Ruhoff's [the investigator whose transfer of association caused the suit to be brought] contract with the [Burgess] Laboratories, which contract was by its terms automatically continued in force until Mr. Ruhoff resigned to go with the French Company. If the con-

TWO FOOTBALL GAMES AT ONCE
Radio reports of the Yale-Princeton game being received at Hoboken, N. J. on the football field of Stevens Institute of Technology. R. W. Gast has the receivers on and T. J. Kauffeld is telling the stands how the Bulldog's fangs are sinking deeper in the neck of the Tiger

tract required that an invention should be actually or constructively reduced to practice in order to come within its terms, any laboratory worker could appropriate to himself the results of his discoveries while at the Laboratories by postponing the reduction to practice till he had severed his connection with the Laboratories."

Radio Replaces Flowers and Fruit at Hospital

IN THE old days, when we went to see a hospital patient, we brought him food, with the dull-witted notion that hospitals neglected the culinary niceties, and it was therefore our duty to smuggle in something that the sick person would enjoy. We knew he would enjoy it, because we were bringing him his favorite dish. We never could understand that smart nurse's edict that "he couldn't have it now."

Or we went to the florist's and tried to choose between roses tied with a ribbon and carnations gracefully arranged in a basket. And then we were often amazed to find that someone else had thought of the same thing, and perhaps, with more success.

To be sure, the thought is what counts, and it should not be inferred from this that flowers and fruit and reading matter are not giving pleasure to thousands of hospital patients even while we are writing this. But when a patient is swamped with flowers, forbidden to eat delicacies brought in from the outside, and either unable or disinclined to read, the chances are he would like nothing better than just to lie back and listen to what's going on in the air, from a receiver which he can control with a turn of his wrist.

Ellis Hospital has seen radio so far merely as a diversion, one that is bulwark to the morale of the patient who has long hours alone. Under daylight saving, the program begins only a little while before visitors must leave, and they continue long enough to top off a day as giddily as it is ended at home. This hospital owns a portable tube set which is taken to any patient who expresses a desire to have it.

"I read the other day about a hospital in Philadelphia where radio can be turned on or off anywhere in the place at will," said the head nurse. "The whole building is equipped, and any patient who wishes to hear the programs is able to, while those who tire of it need not be annoyed. Maybe some day we'll have one like that."

J. H. M.

The Factor That Limits Long-Distance Reception

Why the Most Sensitive and Selective Set Possible Cannot Hear Any Station Anywhere

By A. J. HAYNES

Vice-President, Haynes-Griffin Radio Service, Inc.

WITH the advent of ultra-sensitive receiving sets, such as the tuned radio-frequency and super-heterodyne circuits, radio fans are coming up against a new proposition in the way of long-distance reception. The general feeling seems to be that long-distance reception can always be attained provided the set is sensitive enough—that is, has sufficient radio-frequency amplification ahead of the detector tube. And of course, looking at the theory of radio-frequency amplification in an off-hand way, this would seem to be the case.

A radio signal sent out from a transmitting station in the form of a wave has a diminishing progression, which, theoretically, will never reach absolute zero. In a way it is similar to the case of a man who starts to walk from New York to Boston, resting when he reaches half way. Then he starts on the remaining distance and rests when half of that is covered then he walks half the remaining distance again, and so on. Eventually, of course, he will reach Boston, but theoretically he will always have a remaining distance to go.

Accordingly, the weakest radio impulse sent out by a broadcasting station theoretically continues forever. But there is a practical limit to the distance at which this impulse may be picked up. Just what this limiting factor is has been given little thought and certainly is not understood by the average broadcast listener. In his mind, the only limiting factor is, his receiving set. Increase the sensitiveness of the receiver and you increase your receiving range—that is the generally accepted theory. It sounds reasonable, doesn't it? Pick up any newspaper radio edition and you will see that the hunt is still on for the ultimate reversed, ingrowing circuit that will permit the user to tune-in San Francisco or Seattle, at will, from New York.

THE MAN WHO WANTED EVERYTHING . . .

RECENTLY, there was brought to my attention an incident which, if it were not for its pathetic side, would be extremely humorous. A well-to-do man living in New York City came to the conclusion that he wanted a radio installation. He couldn't use any ordinary form of antenna, or at least he refused to do so, but wanted a loop set of standard manufacture —the finest to be had. One of the best makes of receiving sets was put in, and the installation man was expressly instructed to stay with the owner that evening to show him how to operate the set, and if possible to pick up some distant stations, although the set was located in a house in the heart of New York City. By a stroke of rare good fortune it so happened that he had a particularly fine location for loop reception. When the set was completely installed, the buyer started asking the installation man to bring in various stations, starting with Pittsburgh, Boston and then Chicago. Much to the operator's own surprise he complied with each of these requests in turn, and was highly elated at his phenomenal success. Then, following Chicago, came the blow.

"Now, get me Los Angeles," said the purchaser of the set.

The operator looked up with a smile on his face, taking the request as a joke. But the man was in earnest, and because Los Angeles could not be brought in at that minute, he ordered the set taken out and said that he was "through with this radio business," and "hoped that some day they would get it perfected."

This may be an extreme case, but it indicates how unreasonable we often are and how little the basic theories of radio are known to the general public.

. . . AND WHY HE COULDN'T GET IT

BUT to get back to the subject in hand—why couldn't the operator get Los Angeles? Why can't you always increase the distance by increasing the sensitiveness of your set? The fact is, there is a limit. It can't be done.

To explain this clearly, let us consider a form of receiving set such as the super-heterodyne which can be arranged to provide an unlimited amount of radio-frequency amplification. What is there to prevent, for instance, the carrying of this amplification as far as we wish? If the radio wave, even from the weakest transmitter, actually does go on and on, why can't we merely add radio frequency and receive farther and farther? The answer is simple, and depends upon a single factor of fundamental importance to radio reception—*static.*

THE "STATIC LEVEL"

NOW, static is, as we are accustomed to think of it, a crashing sound in the receivers resembling thunder crashes during an electrical storm. It is extremely bad in the summer time and practically absent in winter. However, under this heading of static can be classed, for the sake of convenience, all types of radio-frequency noises: local interference from induction, elevator clicks, buzzes, etc. In the winter, on a seemingly perfect night for radio reception, when, perhaps, not a particle of electrical disturbance can be heard in the ordinary regenerative set, still there is static present, as will be readily learned if one starts to experiment with sensitive receivers. *It is the quantity of this radio-frequency noise that exists which is the limiting factor in our distance reception.* In other words, no matter how low the "static level" drops, if we amplify sufficiently we can bring it back to a roaring series of crashes and clicks in the phones. And unless the signal which it is desired to receive is present with greater intensity than the static, it cannot be heard.

It is an impressive sight to look out over a body of still water and see a submarine sink slowly below the level of a smooth sea. This is the finest analogy to a radio wave and the static level that I know of. The signal goes on and on, always diminishing in value until it reaches the point where it sinks below the surface of the static level; and, as in the case of the submarine, which cannot be seen below the surface of the water, no matter how powerful the field glasses employed, so will a radio signal disappear below the static level and be lost to the listener no matter how sensitive the receiver. This could well be called the threshold value of the transmitting station's wave. "Threshold value," a term used in physics, indicates (as applied to a radio signal) the critical value above which the signal is audible and below which it disappears.

There is always an infinite amount of small electrical disturbance present in a city. Its intensity depends upon conditions and locations in which receiving work is done. In some locations this static interference is so bad that it makes long-distance work out of the question, regardless of the type of set used. Naturally, the man who buys the finest receiving set obtainable expects the finest kind of reception, and it is sometimes hard to explain to him that he cannot get results in spite of the apparatus he uses. Without knowing the cause of the trouble, he immediately puts the blame on the equipment and the dealer's judgment, or capabilities. I know of many in-

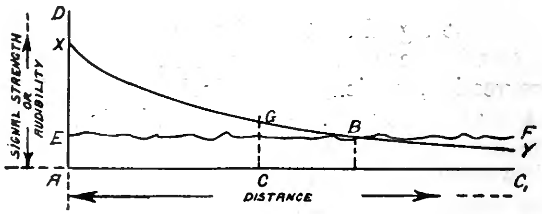


FIG. 1

The distance from the Pacific to the Atlantic Coast is represented by the line AC. XY indicates the strength of a broadcast signal sent from the Pacific Coast. It can be heard in New York (C), with sensitive enough apparatus, because, at that point its strength is still greater than the static strength. But at B (somewhere out on the Atlantic Ocean), the strength of static and signal are equal

stances where radio enthusiasts who are trying to solve this static problem have spent hundreds of dollars shifting from set to set. They vainly hope to find a "good set," as they would call it, when, as a matter of fact, it is their receiving conditions, not the sets, that are fundamentally wrong.

"DEAD SPOTS"

ANOTHER problem frequently encountered is that of "dead spots." It is an undeniable fact that there are many places, not only in the city (although the complaints generally come from cities), but even in what seemingly are ideal receiving locations, in a country community, where signals are not always received with good volume. And perhaps some fairly close station that should be received well comes in weakly or is not heard at all. In the latter case, however, provided the radio-frequency noises are not bad, a sensitive receiver will bring up these near-by stations, in spite of "dead spots." On the other hand, the ratio of radio noise—or static, as we are calling it—to signal strength is increased in such a locality so the possibilities for doing good long-distance work are decreased in the same proportion.

These dead spots can be attributed to numerous causes. In a city, it often happens that the receiving location is surrounded by a good many steel structures. It may be that some of these steel structures have a natural frequency corresponding to some particular wavelength. If this is so, any station of this wavelength is difficult to receive, because the main energy of the wave is absorbed before it reaches the receiving stations. In a way, this situation is similar to that brought about by stepping behind a big tree while out in a strong wind. The tree absorbs the force of the wind while you, behind it, receive little or none of its energy.

Again, a receiving installation will sometimes receive short wavelengths admirably, but cannot receive long wavelengths satisfactorily, or vice versa. This trouble is also invariably blamed upon the dealer or the type of set used. But here again the cause is usually due to one range of wavelengths being absorbed more than another, a situation brought about by surrounding conditions.

RECEPTION UNDER VARIOUS CONDITIONS OF STATIC AND SIGNAL STRENGTH

HOWEVER, the large part played by the ratio of signal to static, in our distance reception, is the main point I wish to emphasize.

Let us suppose again the case of a set with unlimited powers of radio-frequency amplification. Suppose this set is located in New York City, and while in the course of operation on a certain night, a Pacific Coast station is picked up and brought in beautifully. No noise, no interference, nothing but clean-cut speech and music. On the following night, perhaps, the same set is tuned-in on the same station when they are on their usual schedule; but with the same adjustments and same amount of amplification being used, nothing is heard. Then the operator starts increasing his radio-frequency amplification. He continues this until the set is amplifying to the point where the static level on that particular night is brought up to audibility. He begins to hear clicks, buzzes and bangs in his re-

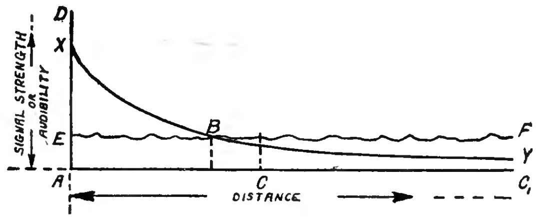


FIG. 2

Here, the static level is the same as in Fig. 1. But the broadcast signal is weakened in its passage eastward, due to conditions between the Pacific (A), and the Atlantic (C) Coasts, with the result that it sinks below the static level before reaching New York (C) and no receiver now known can receive it

ceivers—and still no signal. Why? The signal was there the night before and could be brought out clearly with less amplification than he is now using. And to-night, every additional step simply increases the roar in his phones. If the signal is being brought in, it is so weak in comparison to the noise that it cannot be heard.

The answer is just this: for some reason, somewhere between Los Angeles and New York, certain prevailing conditions weaken the wave sent out by this particular station to a greater degree than the night before. Its energy has fallen off more quickly, and by the time it has reached this particular location in New York it has dropped below the level of radio-frequency noise and cannot be brought above it again by any ordinary methods.

This can well be illustrated by the diagram, Fig. 1. Let the two points, A and C, represent the Pacific Coast and New York, respectively, with the intervening distance, indicated by the line between them. Let the height above the line AC, measured along the line AD, represent signal strength or audibility. The irregular line, EF represents the static level that existed on the first night of reception. The line XY represents the radio signal that is sent out from the Pacific Coast as it travels toward the East. It will be seen that the farther it goes in the easterly direction, the more it falls off and approaches the line AC, but as this is the decreasing progression that carries on to infinity, it will never actually reach the line AC, but at some point such as B, east of New York City, it is bound to run under the static level, EF. In this particular case any receiver in New York that is capable of giving sufficient amplification to reproduce a signal of intensity CG will be able to bring in this station. At this point the signal audibility is well above that of the static level and can be reproduced without interference from this source.

Now let us turn to Fig. 2. Here the same conditions prevail, with one exception—the signal-static ratio is changed. It can be seen that we have two variables here, both of which lie between fairly wide limits—that is, the actual signal strength itself represented as the distance of the line XY above the line AC and the strength of the static level EF (which is shown at the same height above AC in both Fig. 1 and Fig. 2, indicating it to be the same strength on these two nights). However, in Fig. 2, the line XY is seen to pass under the line EF before it reaches New York. In other words, due to poor conditions prevailing between the points A and C, the radio signal is not carrying as well the second night as it did the first, falling off more rapidly. And after it has passed beyond the point B,

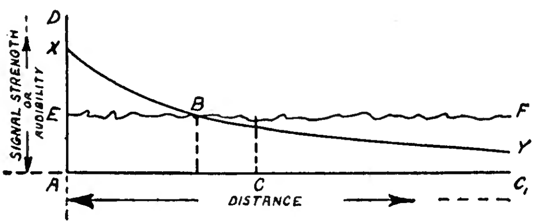


FIG. 3

On this night, the signal which reaches New York is represented as of the same intensity as in Fig. 1. The static is worse, and there is "nothing doing" on West Coast signals

where it reaches the static level, it is lost, as far as radio reception, as we know it, is concerned.

There is another case that might be considered: the signal strength on these two succeeding nights might have remained the same, or varied only slightly, while the static level itself changed. This condition is illustrated in Fig. 3, where the signal strength represented by XY is identical with that indicated in Fig. 1, but the signal-static ratio or the line EF, is higher. If this were the case on the second night, the operator would never have attempted to increase his radio-frequency amplification, because when he turned his set on with the same adjustments as he had on the first night, i. e., would immediately get a terrific roaring in his phones that would force him to decrease his amplification; and even though the signal itself was present with as great intensity as on the preceding night, the static would be "in" with still greater volume. And when he decreased his amplification to the point where the noise had diminished sufficiently to listen-in, there would not be enough amplification to bring in the signal.

Now, if you follow this thought closely you may ask: What is the use of a sensitive receiving set? What, for instance, can be done with a good super-heterodyne that cannot be done with any other receiver?

This can also be illustrated most simply with the diagram, Fig. 4.

Supposing the same lines, AC and AD, to represent distance and signal strength respectively, and supposing the same signal to be sent from the Pacific Coast, let us see what happens with different types of receivers, and how it is possible to receive farther on one type than another. Suppose, further, that the signal submerges beneath the static level at point B, some indefinite point between the Pacific and Atlantic Coasts. Now let us consider three types of sets: first, the ordinary crystal set; second, the regenerative receiver, and lastly, a super-heterodyne with unlimited powers of amplification (the latter, for instance, being capable of bringing any radio-frequency noise that is above the line AC, into audibility). The amplification power of the regenerative set may be indicated by the dash line GH—that is, it is capable of receiving any radio-frequency impulse whose strength is represented by the distance AG above the line AC, and lastly, the crystal receiver whose power of reception is represented by the dash line IK, and which will receive any radio-frequency impulse whose strength is greater than the distance of the line IK above AC.

In this diagram we are supposing a good average winter night with the static level, EF, very low. In fact, it is well below the limit of amplification of a good regenerative receiver as indicated by its distance below GH. In other words, no static disturbance or noise will be heard on either the crystal or the regenerative receiver.

The signal starts from the Pacific Coast from point X. (While, of course, it travels out from this point in all directions we are only considering its easterly bearing.) At first, it falls off very quickly and passes below the line IK at M. This means that the distance IM is as far as the signal can be heard at this particular time, on a crystal receiver. It may be ten miles. It may be fifty. The signal continues on at point N, where it falls below the line GH, which represents the amplification limit of the regenerative receiver. This station then, may be received at this particular time with a regenerative receiver at any point between G and N. Now, it may be seen that this signal travels still a great distance before it reaches the point B, where it passes below the static level and is lost to any form of receiver. And here is where the more sensitive set gets in its work; for the set that is capable of giving sufficient amplification to get down below the static level at this particular time, can receive that radio signal anywhere over the distance up to the point B, which in this case we are supposing is practically twice as far as the regenerative receiver will go. Here is a real gain, and it is made possible by one thing only—the low static level of the static interference represented by the line EF. If this line EF were as high as, or higher than, the line GH (as would be the case on almost any summer night), the regenerative receiver would be able to receive over just as great a distance as

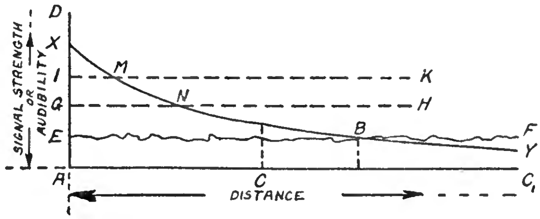


FIG. 4
A crystal set can receive San Francisco's signal at IM distance from the transmitting station, a regenerative set at GN distance, and a super-heterodyne at any distance up to point B

the receiver with unlimited powers of amplification. *Therefore, the factor which limits the range of a radio receiver is not only its sensitiveness but the signal-static ratio.*

I do not mean to say that this condition will never be overcome. There are already systems of radio telephone broadcasting (such as single side-band transmission), which will improve the signal-static ratio; but with the radio reception and broadcasting we have to-day, this condition certainly does apply and is the fundamental factor that limits our long-distance reception. If the radio fan can realize this, he will no longer complain when on a bad night he can do no better with his neutrodyne or even super-heterodyne than he can do with his old regenerative set. He will realize that, on that particular night, either the signal strength itself has fallen or the static level has risen.

The Choice of a Receiving Tube

Some Useful Data on Radiotron and Cunningham Tubes

By B. S. HAVENS
General Electric Company

THE choice of a tube to use for a particular purpose depends in general upon three main considerations:

1. The purpose for which the set is to be used:
   a. Broadcast listening for the enjoyment of entertainment programs.
   b. Experimentation on apparatus and circuits.
   c. Long-distance code reception.
2. The type of set in which the tube is to be used; that is, the electrical circuits involved, number of tubes used, and whether a loud speaker is included in the equipment.
3. Whether storage batteries, No. 6 dry cells, or flashlight dry cells are to be used for filament operation.

THE UV–199 AND C–299

THESE tubes require a minimum of filament energy. In fact they use only .18 of a watt, or about one eightieth the power consumed by a 40-watt electric lamp.

The bulb is of small size, and a special base and socket suitable for such a small tube are used. On account of the small size of this tube, the capacity between electrodes is lower than in either of the other tubes, but when it is used in a standard socket the capacity of the adapter employed added to the capacity of the tube makes it practicable without changing the circuit. This tube is particularly suited for portable sets in which it is necessary or desirable to use ordinary dry cells, or flashlight cells for filament operation.

The small electrical capacity between the electrodes makes it a very satisfactory tube for radio-frequency amplification. This tube does not require critical adjustment of plate voltage, and tapped plate batteries are not necessary, whether the tube is used as a detector or as an amplifier.

THE UV–200 AND C–300

THESE tubes are particularly desirable for the skilled radio experimenter interested in code work and reception over great distances. They are not suitable for dry-cell operation because the filament requires one ampere at five volts.

Their action as a detector is very critical with respect to filament voltage and plate voltage, and is not as uniform between different tubes of the same type or as constant in any one tube as in the case of the high-vacuum tubes (UV–199, C–299, UV–201–A, and C–301-A).

They are very sensitive to weak signals, especially spark and modulated CW signals, when skillfully handled by experienced operators in a circuit particularly equipped for the proper voltage operation of filament and plate.

They are not recommended for audio- or radio-frequency amplification and should never be used with a plate voltage greater than that obtainable from a 22½-volt B battery at full voltage.

These tubes require a little patience and skill in adjustment for the reception of weak signals. Under certain conditions they have a tendency to be slightly more noisy in operation than either of the high-vacuum tubes which are practically free from such disturbances.

UV–201–A AND C–301–A

THESE tubes are powerful amplifiers, inherently better than the UV-199, and are particularly suitable for loud-speaker operation.

They are designed to give the best possible amplification for general use, their amplification property not being sacrificed to any extent to give a minimum of filament energy.

The operation of these tubes is almost free from variations caused by slight changes in plate and filament voltage. Accordingly, they are quiet in operation and have a longer operating life than any of the tubes mentioned above.

They are equipped with a standard base and thus fit in many sets already constructed, unless they have been made especially for UV–199's, C–299's, or WD–11's.

The filaments require a much greater amount of electrical energy for their operation than does the UV–199 or C-299, but the UV–201–A and C–301–A tubes can be operated from dry cells in the case of one or two tubes used only a few hours per day at a lower expense than with the use of a storage battery.

As an audio-frequency amplifier, these tubes are somewhat superior to the UV–199 or C–299.

As a detector, the UV–201–A or C–301–A are about the same in response as the UV-199 or C–299 and are to be recommended over the UV–200 for most general purposes, except in equipment specifically designed for the latter tube as regards potentiometer adjustment for plate voltage and very fine adjustment for filament voltage.

The UV–201–A and C–301–A are ideal for a one-tube set employing dry cells or a multi-tube set when a storage battery is available for filament operation.

Critical adjustment of filament and plate voltages are not required and it is not necessary to have taps on the plate batteries.

Although the capacity between the electrodes of the UV-201–A and C–301–A are somewhat greater than the UV–199 and C–299, their greater inherent amplification makes them just as satisfactory in most radio-frequency amplifier circuits.

When used for audio-frequency amplification, a negative grid bias or C battery should be used [see page 80, RADIO BROADCAST for Nov., 1923], the C battery voltage depending upon the plate voltage employed. The following table gives the correct value of C battery with different plate voltages:

PLATE VOLTAGES	C BATTERY VOLTAGE
40	0.5 to 1.0
60	1.0 to 3.0
80	3.0 to 4.5
100	4.5 to 6.0
120	6.0 to 9.0 (not to be used with UV-199's or C–299's.)

From Binding Post to Varnish

By HOWARD S. PYLE

UP IN the cold, lonely timberlands of the north—down in the warm, tropical countries—on hundreds of ships on the seven seas, myriad tiny voices of the night bring cheer and comfort and entertainment to eager listeners. And all through proper manipulation of a few simple controls on a small wooden cabinet. It is an accomplishment to inspire awe, and we have a respect for the little cabinet that forms a medium of contact with the world about us. So faithfully and efficiently does the little mystery box serve us, that many do not stop to wonder how and where and by whom the delicate apparatus was assembled and arranged within.

The writer recently made an investigation of the manufacture of modern broadcast receiving equipment, concluding his search with a trip through one of the largest and most modern factories of the independent radio manufacturers.

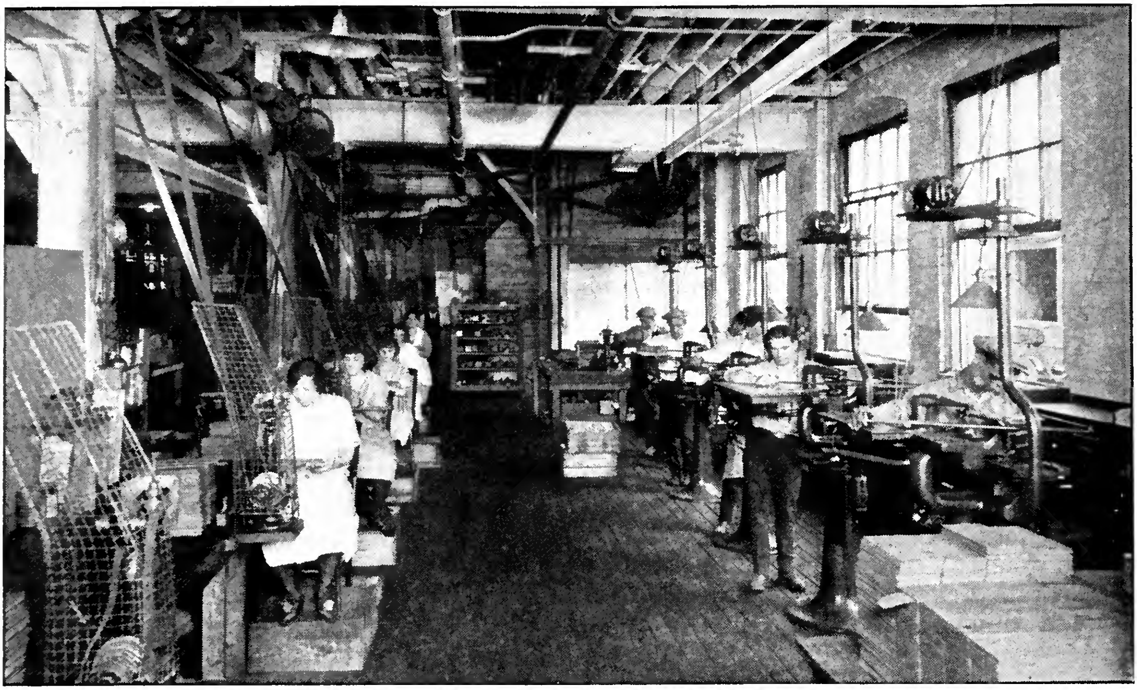
The entire plant had been laid out after the policy followed by the Ford Motor Company: the raw materials are routed through a definite manufacturing cycle. As each part is completed, it is delayed at an operating station until the arrival of the next part required in the receiver assembly. By this method as a panel progresses through the factory, various completed parts are added until the panel reaches the testing department with a completed set attached to it.

The first photograph shows the individual units being made up. The girl at the extreme right is operating an automatic screw assembling machine—a combination power-driven screw driver and socket wrench. To the left, other operators are seen with automatic rheostat winding machines. A large proportion of the special machinery found to be imperative in accurate work, has been developed within the plant.

Following the completion of the various parts, they are delivered to the assembly department, to be incorporated in the receivers at the proper stations during their progress along the assembly tables.

In the photograph on page 290 we see the first stages in the construction of a four-tube re-

HERE THE PARTS ARE MADE UP



ENGRAVING AND FINISHING PANELS FOR FOUR-TUBE RECEIVERS

ceiver—an extremely popular product of this particular manufacturer. In the operations pictured, the panels appearing in the lower right-hand corner are machined to the desired dimensions, sanded, and then subjected to a finishing operation which completely removes the gloss and gives the panels a pleasing, flat, grained finish. They are then passed through a gang of drills, each operator drilling but one size hole, thus eliminating change of drills and lessening the possibility of error. The next step is through the engraving machines. A battery of five are seen behind the blank panels in the foreground. Here the work is also divided, so that one machine operator engraves only a small amount of "copy." Thus each man becomes expert in engraving some particular character such as a trade-mark or a group of letters or figures.

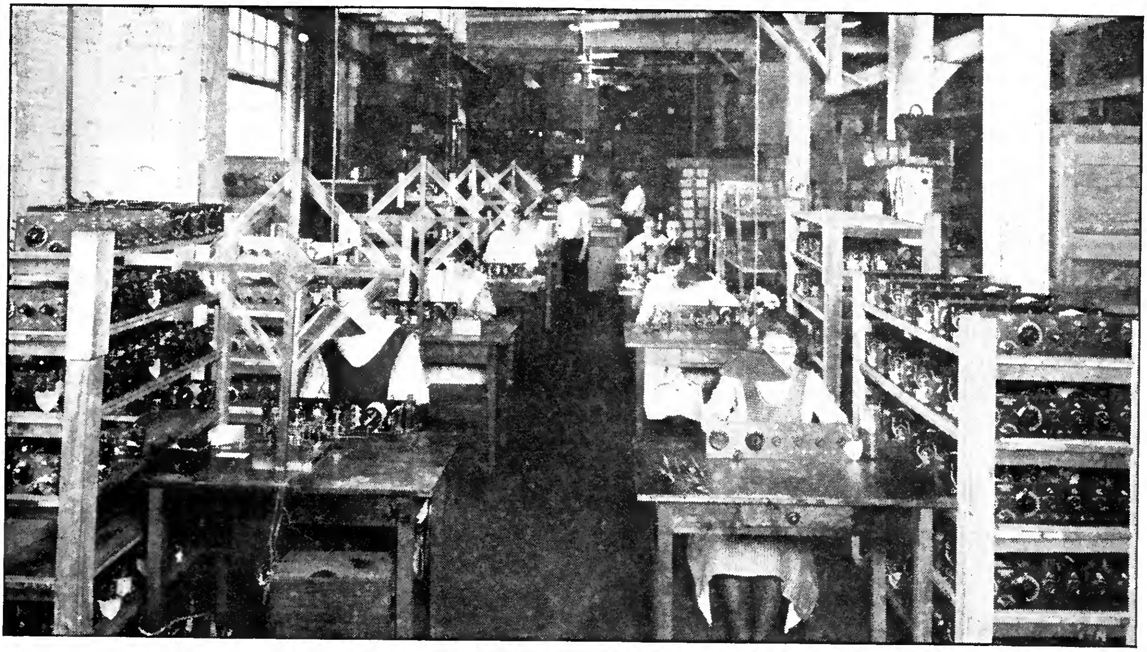
The panel is then ready for the assembly department. One row of long tables permits the progressive passage of the panel through the various stages of assembly. A separate row permits an uninterrupted line of receivers of five different types to be constantly in production. One worker, for instance, secures the filament rheostat and the two audio-frequency transformers in place, the next places on the binding posts, and so the work progresses down the line until all of the parts are assembled on the panel.

Next in order is the wiring, or "hooking-up." It has been found desirable to limit the number of wires placed by any one operator. Hence we find one worker caring for but two or three wires, the instrument then passing to the next station where two or three more are placed. This procedure enables each operator to work rapidly without sacrificing accuracy. In a plant where the bonus system is in vogue, this division of labor works to the advantage of both employee and manufacturer.

When a number of instruments are completely wired they are passed to the testing department on "wagon-racks." Several of these wagon-racks are shown at the right in the upper picture on the opposite page.

Passing along the right-hand row of tables, each instrument is subjected to an inspection for possible loose connections and given a thorough brushing and cleansing of all soldered joints with benzine and alcohol. This serves to eliminate leakage paths which might be caused by excessive soldering flux.

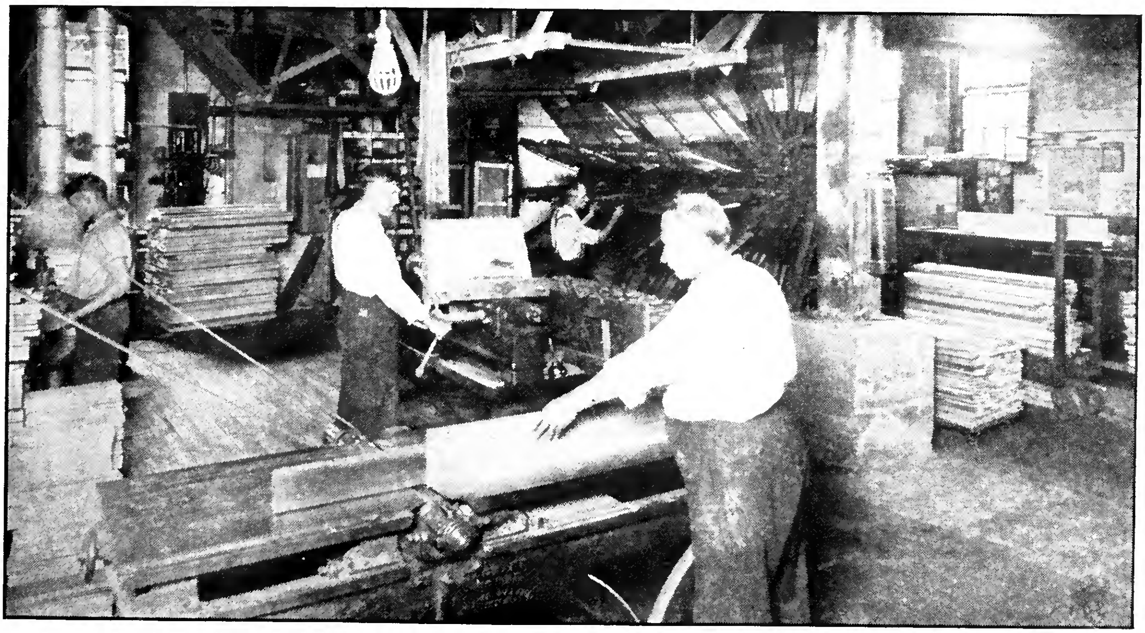
The instrument is then delivered to the radio-frequency test tables. Two small, continuous-wave oscillators installed in this department furnish energy for testing receiving



HERE THE RECEIVERS ARE INSPECTED AND TRIED OUT

sets on actual radio-frequency signals. One oscillator is adjusted to a wavelength of 200 meters and modulated at a frequency of 1000 cycles. The second oscillator is adjusted to 600 and modulated at 100 cycles. These testing oscillators are arranged on a loop, and the energy is transmitted to the series of loops shown in the photograph. A receiver must function at both wavelengths before passing the testing department.

It has been found practically impossible to locate faults in radio-frequency apparatus unless actual radio-frequency currents are applied to the instruments under operating



CABINETS IN THE EARLY STAGES OF CONSTRUCTION conditions. In other words, receivers which have satisfactorily passed a mechanical and electrical test, are often inoperative when connected to an antenna system. The testing system just described enables a really satisfactory test to be made, the loop antenna design being such as to represent the electrical characteristics of the average antenna erected to receive broadcasting.

A receiver satisfactorily passing all tests is finally routed to the table at the rear of the testing department where the necessary instructions are placed in the cabinet and the serial number entered on the cards. The set is then packed for shipment.

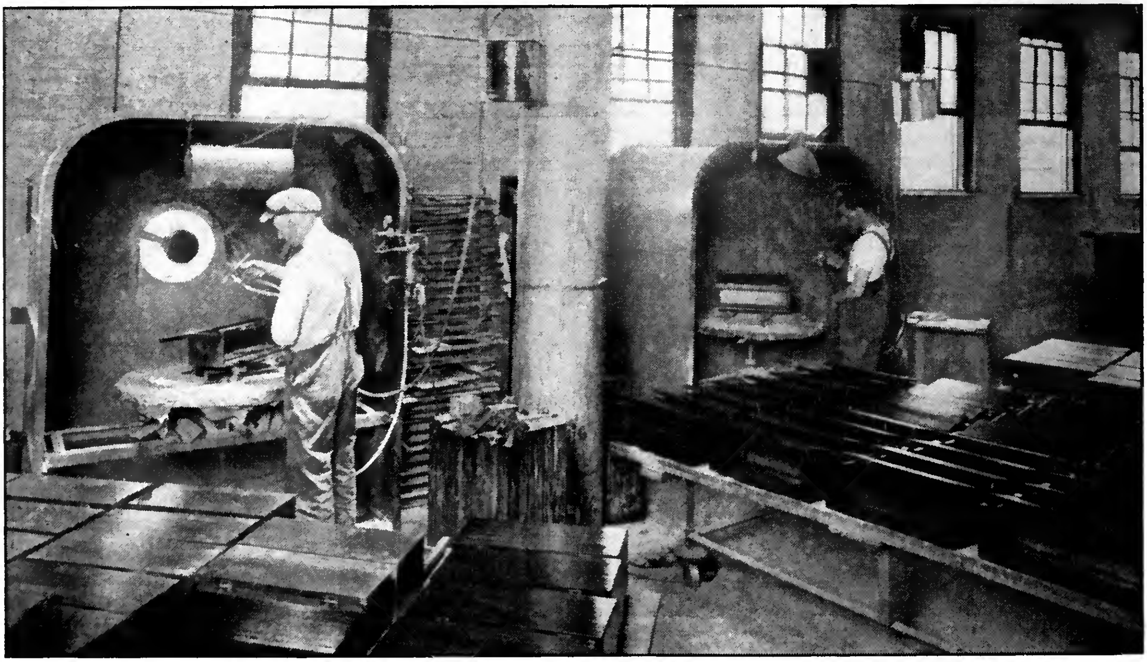
In order that all of the parts entering into the final assembly may be manufactured in the one plant described, a wood-working department is maintained, which is among the largest and most modern in this country. Here the cabinets and other wood work used in the manufacture of radio equipment are turned out, with a considerable surplus for outside distribution. An example of the modern machinery in use throughout the entire organization is seen in the "sticking-machine"—the paddle-wheel-like machine shown in the lower picture on the previous page. This has replaced the old method of setting up long lines of cabinet work held together by means of "gluing-clamps."

A cabinet, upon leaving the wood-working plant, goes to the spraying department where the finish is sprayed on the cabinet instead of being applied by hand with a brush.

Completing the equipment of this manufacturing plant is an up-to-date printing establishment in which are published all catalogues, instruction sheets, and circular matter, as well as a weekly newspaper.

From the foregoing, it can readily be seen that radio as an industry has assumed a definite place in the business world. Conditions, so chaotic two years ago, have so shaped and stabilized themselves that an establishment such as the one described, representing an investment of many thousands of dollars and employing hundreds of workers, is recognized as a sound and substantial industry. The fly-by-night manufacturers of a year or two ago are now practically extinct. Good workmanship, correct policies, and a desire to give the public dollar for dollar value, have narrowed the great new field of radio manufacturing down to a comparatively few progressive manufacturers.

HERE THE FINISH IS SPRAYED ON



Is the Amateur at Fault?

By CARL DREHER

> The author makes a plea for tolerance and common sense in the relations of amateur and "B C L" toward one another. In this article, he takes the radio amateur to task for the interference he sometimes creates with his spark or continuous-wave transmitter; but the severity of his criticism is tempered with constructive suggestions and with a sympathetic understanding of the amateur's point of view. Next month, Mr. Dreher will put the broadcast listener on the carpet.—THE EDITOR.

I HOPE the spirit of this article will not be taken as one of "A plague on both your houses"—the houses referred to being not those of Capulet and Montague, but those of the broadcast listener and the telegraph amateur. I grew up as a radio telegraph amateur, myself, and it is now my fortune to cater, professionally, to the broadcast listener. I am in a position, I believe, to know both factions and to view their differences with an impartial eye. Neither party is without faults; or, to be accurate, each class contains individuals who have more radio faults than a regenerative set has squeals. A frank analysis of these members of the groups will, I feel, be in the interest of the radio art as a whole.

When seventeen years ago I listened, wonder-stricken, to my first wireless signals, the art was at a sort of scientific frontier. Like other pioneers, we suffered somewhat from loneliness and hardships, self-inflicted, to be sure, but none the less poignant. Signals were few and we were ignorant as to the proper procedure to follow in receiving those few, so that an amateur would sometimes listen for weeks without hearing anything. Yet he would listen for hours every day, holding his breath a good part of the time, in the hope of hearing a few dots and dashes. When a silicon crystal jarred out of adjustment in the middle of a message the owner would be plunged into despair, for he was not likely to get it into adjustment again that night. When he hit a sensitive spot in his explorations there was no signal on the air nineteen chances out of twenty; and when someone was sending it was a fair bet that the sensitive area would be passed over, for the crystal was apt to be about as good as a piece of anthracite. Some of the boys did use coal, as a matter of fact. Long before this time, even, experimenters were using an electrophorus to make a spark in one room of a house, and listening on a telephone receiver connected across an autocoherer, consisting of a needle laid across two pencil leads, in another room; and that was radio.

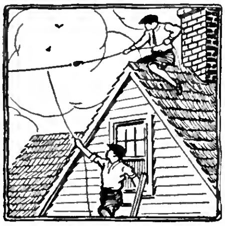
It had one salient advantage—every one did what he pleased without bothering any one else. The frontier, in other words. My friendly indictment of the present telegraph amateurs is that some of them seem to think that they are still in that state.

THE BOY THAT SITS ON THE KEY

FOR example, I happen to live in New York City, near three or four amateurs with C. W. transmitters. My business makes it necessary for me to listen-in on broadcasting wavelengths, almost all evening and practically every evening. I have a wave-trap to take care of these amateurs; still, as they are very near me, enough stuff gets through to interfere with reception, sometimes even to limit out the broadcasting stations in my receiver. (The transmitters are fed on AC, I may remark, quite imperfectly filtered, and with prominent key thumps). Anyway, between 8:00 and 10:30 in the evening these transmitters are supposed to be off the air. Sure enough, they are not used for signaling during these intervals, but not infrequently one of the boys holds down his key for a minute, presumably to test radiation, and then stops without signing. A natural enough procedure—my friend gets an idea for squeezing another eighth of an ampere out of his set, and of course he has to try it right away. Why wait until 10:30? In 1906, or 1912, or even in 1920, there would have been no harm at all. But to-day our careless friend interferes with twenty or thirty broadcast listeners in the surrounding apartment houses when he touches his key at this time. Instead of music, they get a loud 60-

cycle hum which is music only to the ears of a telegraph amateur. And the broadcast listeners have no recourse at all. The operator is careful not to sign his call letters, so it is impossible, even for a listener who knows the code, to make a definite log entry and complain to the U. S. Supervisor of Radio in the district.

For the time being, the amateur seems to be getting away with it. But what will happen in the long run? The broadcast listener is only too prone to ascribe to the amateur interference for which the amateur is in no way responsible as well as that for which he is responsible. As a practical proposition, therefore, it behooves the amateur to have the broadcast listener interfered with as little as possible. If he himself causes such interference gratuitously, he is helping to accumulate a weight of resentment and irritation which, in time, may be exceedingly dangerous to the amateur's interests. Public feeling gathers its forces slowly, but they are very great once they get started, and occasions have been known where it was hard to stop them at a reasonable point.



The amateurs have their privileges, and, like other people, act as if they will always have them. But these are not inalienable rights. The idea of further restrictions in transmitting seems preposterous to many present-day amateurs. But the idea of having to confine themselves to a particular wavelength, and taking out a license, and emitting a sharp wave, seemed preposterous to some of the amateurs of 1912. I well remember the indignation of one old fellow who snorted indignantly at the idea that he could no longer talk back to the commercial stations and send as he pleased—which was on 800 meters with a spark gap in the aerial, a kilowatt or so of power, and a wave as broad as the ocean. Even after the "W" calls had been assigned and the new law was in full effect, the amateurs had, for a time, much greater liberty than at present, and I well remember hearing Doctor Hudson sending a deadhead to the National Electric Signaling Company's station at Bush Terminal, asking Mr. Hogan to look for his pipe, which he had left at the station on a visit. At that time this procedure was quite in order. Those days are past. They were picturesque, but picturesqueness is a poor argument for survival.

WHY THE AMATEUR SHOULD "WATCH HIS STEP"

I AM speaking specifically of the urban amateurs. Out on the farms the situation is much less acute. But in the cities the ether simply cannot carry all the traffic imposed on it, taking into account that broadcast receivers must be built to be handled by laymen not engineers, and that within a few hundred feet of an antenna radiating an ampere or two, eliminating the signal from such an antenna is a more or less dubious proposition. There is one Procrustean way of doing it, and that is to eliminate the amateur. This proposal is in fact made, and in no very subdued tones. Personally, I am warmly against it. I doubt, also, if it can be done. But there is no reason to be certain and cocksure. No organization is so great that it can throw aside prudence and give no thought to the morrow.

If the amateur is wise, he will read the handwriting on the wall, adjust himself quietly to new conditions and superior forces, save what he can—which is considerable—and so keep a reasonably prominent place in the radio game. He has one fine argument on his side—the demonstrable fact that the amateur telegraphers are the best source of material for army and navy radio men in time of war. This argument, if not pushed to absurd lengths, will sustain the amateurs perfectly well. If it is used to prove that amateurs should be allowed to do what they please with the air at all hours in time of peace, it will suffer the same fate as the syllogism to the effect that since skill with firearms is a virtue in time of war, gangsters should be allowed to kill all the bank-messengers they please for practice. The comparison is overdrawn, but it makes the point clear.

As for justice, one should not rely on it too much. The son of the present Secretary of Commerce is a prominent and competent amateur, and as long as Mr. Hoover is in the Cabinet the amateurs are assured of justice. But Mr. Hoover will not be secretary forever, nor even for a decade. The next secretary may be a broadcast listener. In fact, he is twenty times as apt to be a broadcast listener as a code man. And at some time, thunderous key thumps or raw AC on the plates or forty-eight CQ's in a row or a spark set next door may have prejudiced him against the amateurs. This prejudice may easily be shared by a majority of the Congress. What then? Justice is a very relative and elastic term, and one is too apt to get it after one is dead.

SUGGESTIONS FOR REDUCING TELEGRAPH INTERFERENCE

IF THESE points are conceded, specific suggestions for reform are in order. Without going into the matter exhaustively, we may enumerate four, as follows:

1. Use of artificial antennas for testing.
2. Technical restrictions on C. W. as well as spark sets.
3. Establishment of a reduced-power rule for local communication.
4. Reforms in calling and traffic handling.

The carelessness, amounting almost to profligacy, of the American code amateur is illustrated by this single observation—it is next to impossible to find one who owns, or who has ever owned, an artificial antenna, which permits testing a transmitter without radiating. Instead, practically all amateur testing is done on the air. If I had a tenspot for every time one amateur has asked another, "How is my spark?" or, "How do you like this note?" I should be in a position to pay the German debt, and have enough left over to relieve me from the necessity of following radio for a living. Let us concede that many receiving sets are not all they should be, that their owners are inexpert in the operations of tuning, that the amateurs are blamed for much interference of which they are innocent—conceding all this, why should an experimenter be allowed to use the air for endless tests? The air should be used for communication. Most tests can be performed privately. An artificial aerial and a receiving set will tell Brother Jones that his new chopper gives a note like a rasp in difficulties with a piece of battleship steel, without an inquiry dispatched to Brother Smith across the city. The same remark applies to Brother Brown's telephone set, which transmits a band of frequencies from 400 to 1000, so that Brown could not understand himself talk if he did not know what he wanted to say. Brown should not attempt to talk to Smith with this set; he should have Smith come to his home and listen to it on an artificial antenna, just as he would, in simple charity, keep the windows closed while he was learning to play the oboe. If the air were reserved for communication; and if only such tests as actually require a distant listener, or a wavelength setting on a particular aerial, were permitted on a radiating antenna, and if this rule were applied to amateurs as it is applied to commercial stations, an immense gain in freedom from interference could be realized.

C. W. TRANSMITTERS NOT ABOVE REPROACH

UNDER the second head, it is in order to question the current belief that C. W. transmitters do not cause interference. This is true only relatively in any case, and for direct-current plate feed, and when the radiation is unmodulated, and, finally, when "key transients" are suppressed. At present there are regulations covering the emission of a pure and sharp wave from commercial stations, but these are not enforced in the case of amateurs, because in the earlier state of the art, as long as the amateurs stayed down around 200 meters they were not apt to interfere with commercial traffic, and the radio inspection service had all it could do to regulate marine radio. Since the advent of broadcasting, conditions have changed, so that it is only a matter of time when amateur as well as commercial stations will be subjected to technical regulations. The paramount consideration, now as before, is the protection of life and property at sea. Broadcasting has added a secondary but important consideration—the elimination of interference on broadcasting wavelengths. This will involve restrictions on amateur tube transmitters, as well as on spark sets, and, just as the commercial interests were able to agree on fair and practicable standards for spark transmitters in 1912, it will, before long, be in order for the amateurs, and the other interests involved, to agree on proper technical standards for amateur transmitting sets, in common with other sending stations. The prevalent notion that an amateur has done his whole duty when he has put in a tube transmitter and does not exceed the upper wavelength limit for his class, and stays off the air between 8.00 and 10.30, will not, I believe, stand the test of time.

My final criticism, calling for reforms in calling and traffic handling, applies to a great many amateurs—to a majority, I think—

but in fairness it should be stated that an appreciable number of amateurs handle their keys as well as commercial operators; they are, in fact, distinguished from the latter only by the fact that they receive no pay for their work. I am a great admirer of virtuosity in traffic dispatching, and am glad to pay my compliments to these men. For every good operator among the amateurs there are, however, ten bad ones. The percentage may be the same among commercial operators, but the latter are at least restricted in the degree of badness they can reach, by the certainty of getting fired by the company, or having their licenses revoked by the Department of Commerce. An amateur, on the other hand, is free to send a string of CQ's as long as a Beverage aerial, to prolong a conversation interminably, and to send the code with such misspacing and mangling of the characters that reading his traffic is simply guesswork. The recent introduction of an amateur extra-grade license may do something to improve conditions, but personally I feel that the issuance of transmitting licenses should be limited to applicants who can pass the first class commercial requirements, and who have acquired a decent "fist" in sending. The good men in the ranks would not be affected by such a ruling; most of them have such licenses already, or can get them whenever they like. As for the others, let them prepare themselves, or do without; that is the rule everywhere. This proposal, incidentally, has been put forward by leading amateurs.

Charles Proteus Steinmetz

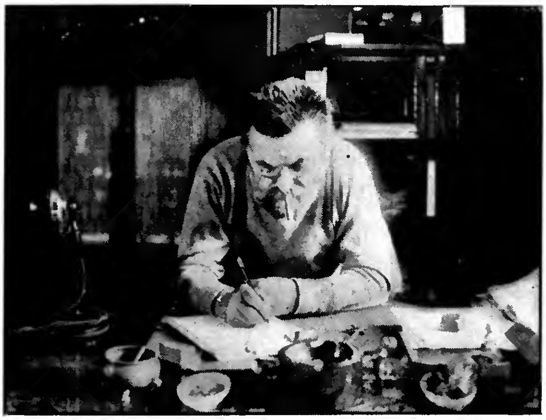
By J. H. MORECROFT

FEW radio listeners have any idea of the contributions Charles Proteus Steinmetz made to their hobby; his name was practically never mentioned in connection with radio, and it was probably unknown to the greater part of the multitude which nightly tunes-in the broadcast programs. His death had no particular significance for them. But every trained radio engineer realizes that radio is only a small branch of the electrical engineering profession, and that it is only the engineers well schooled in general alternating current theory who will get far ahead. The large companies, by whom most of the future radio development will necessarily be carried out, seldom care whether or not an applicant for their engineering staff has had radio experience, but they always want to know the extent of his training in general physics and electrical theory. This idea cannot be too strongly emphasized by those who are occupied in guiding boys who expect to enter the engineering profession; the fundamental electrical actions must be thoroughly mastered before great progress can be made in any special branch of engineering such as radio.

Having in mind, then, that the ultimate progress of radio cannot depend upon the relative merits of one circuit compared with another, or high vacuum tubes versus sodium tubes as detectors, but that it is rather based on those broad principles which guide the undertakings of all our large electrical industries, then in the death of Steinmetz we can well say radio has lost one of its most resourceful contributors.

Steinmetz' contributions to theory and development in the field of general alternating-current electrical engineering stand out more prominently than those of any other single man. To many Americans, Edison serves as the most prominent expounder of the electrical science, but this is only because some of his achievements, notably the early electric generators and the incandescent lamp, come more closely into contact with the everyday life of the general public than do the achievements of Steinmetz. In the record of the proceedings of the American Institute of Electrical Engineers, for instance, no engineer has to his credit more important work than has Steinmetz. Much of the material he wrote will always remain inaccessible to the general radio public; alternating-current theory, even in its simpler phases, is not easy, and Steinmetz was generally busy with only the more complicated aspects of it. He could, however, and did often get down to the level of the embryo engineer and talk interestingly and instructively on the elements of his science.

His progress and attainments in our country must often serve as an inspiration to other immigrants. Landing at Castle Garden as a penniless youth he soon found the niche where his thorough training in mathematics and electrical theory would serve him best. After entering the employ of the General Electric Company his advancement was sure and rapid. Alternating-current theory was then being developed; many of the simplest phenomena seemed baffling to even the best engineers, so that a man of the vision and ability of Steinmetz simply had to forge ahead to the position which he held for more than twenty years. Only ten years after this crippled, penniless youth passed through the immigrant gates at Ellis Island he was elected President of the American Institute of Electrical Engineers, the greatest honor his fellow engineers could confer on him.



THE LATE CHARLES PROTEUS STEINMETZ

In spite of the great physical disability, which must have proved a continual burden to him, he showed tremendous push and perseverance; his mind was ever keen to grapple with the new problems continually presenting themselves to the scientific worker, and what his mind was applied to, it generally mastered. Only a few days before his death one of our mathematical colleagues was commenting on Steinmetz's treatment of Einstein's relativity theory, as presented in a published series of semi-popular lectures. "You know," he said, "Steinmetz actually understood the stuff and he puts his ideas in such terse language that even a layman almost understands what Einstein was trying to say." We have often heard him get up to discuss a paper on some technical topic, presented by one of his fellow engineers, and many times we learned more from Steinmetz's discussion of the paper than we did from the paper itself.

In spite of his wonderful mastery of his chosen field he retained an unusual degree of modesty, and an openness of mind which made him ever willing to listen to the other side of the question. Typical of his dry humor was an incident at an engineering meeting, where in excited discussion was being waged regarding the feasibility of a certain type of machine—could such a machine work, was the question. After listening to the pros and cons by several engineers, Steinmetz got the floor, and after assuming the characteristic pose we all knew so well, expressed his admiration of the logic of those engineers who said the machine couldn't possibly work. "I myself," said he, "proved conclusively some time ago that such a machine was against all reasonable theory and couldn't possibly work. But since then," he added, with a dry expression on his face, "I've unfortunately seen it work." That, of course, ended the discussion.

A fellow engineer, one who had worked with Steinmetz and knew the abilities and eccentricities of this electrical genius by intimate association and sympathetic understanding, pays a splendid tribute to him in the Cornell *Daily Sun*. Says Prof. Vladimir Karapetoff: "It was impossible to make him do anything except what he himself desired to do. He stayed away from the works for days; he smoked in buildings in which the President himself did not dare to smoke; he used clockwise rotation of vectors when everybody was using the opposite rotation; he insisted on saying "ze" for "the"; he wore a soft shirt and shabby gray suit at formal functions; and he belonged to a political party which cussed his company and its principal customers for years.

"Modest, thoughtful, a prodigious worker, always ready to discuss an electrical problem on equal terms with any cub engineer, he was the very impersonation of the principle of losing one's self so as to find it again in bigger things. His contribution to our welfare and knowledge is beyond measure or computation and his life is a shining example of a quiet, straight, and unswerving path amidst the turmoil of conflicting passions, avarice, extravagance, cure-alls, pseudo-science, pseudo-patriotism, pseudo-life itself. And yet, with all, his life is also a glowing tribute to this great, broad-minded country of ours which early recognized his genius, took him lovingly in her arms, and carried him steadily to the pinnacle of his fame."

As we recollect the many talks by Steinmetz which it was our good fortune to hear, it seems that his life and work assuredly bore out the thesis which President Nicholas Murray Butler of Columbia University recently submitted to a group of engineering students, to whom he was giving an informal talk. Although he was "not an engineer and didn't pretend to understand the great problems which engineers undertake," yet his observations, those of a layman, had convinced him "that only those engineers really succeed and accomplish things who have imagination." Steinmetz was gifted with a wonderful imagination, and the products of this imagination he brought to concrete and useful forms by the workings of his well trained mind. Furthermore, he could really think—an activity in which few of us seriously indulge.

How the C Battery Prevents Distortion

Your Amplifier Need Not Distort Signals If You Know How to Apply the Proper C Battery Voltage to the Grid

By JOHN F. RIDER

TRANSFORMER-coupled audio-frequency amplification is almost as old as the three-element vacuum tube, yet its refinements are just appearing before the public. Before broadcasting became popular, when spark and CW signals dominated the ether, distortion in an audio-frequency amplifier was a rare complaint. The character of the signal did not require distortionless amplification. Very little attention was paid to the design of amplifiers, if the desired amount of volume amplification was obtained. Since broadcasting came in, the requirements for audio-frequency amplifiers have been much more exacting.

To-day, amplifiers are required which shall increase the intensity of the signal, yet retain all the fine variations of the voice impulse, so that the music emitted from the loud speaker is an exact reproduction of that picked up by the microphone in the studio. Even if the transmission is perfect, entirely without distortion, and if the detection is perfect, nevertheless the signal is distorted after passing through a two-stage amplifier. What has caused the distortion?

The C battery eliminates distortion, increases the life of the B battery, and makes the audio amplifier more economical to operate.

Fig. 1 is a schematic diagram of a standard two-stage audio-frequency amplifier. One can readily see that there are only two parts of the amplifier which can cause distortion: the coupling transformers and the vacuum tubes. In which of these two does the trouble lie? Extensive experiments have been made and are continually being made by the manufacturers of audio-frequency transformers, in an endeavor to produce a transformer that operates perfectly on all frequencies encountered in the broadcasting of voice and music. Their experiments have proved successful, and transformers that function admirably in that respect are now on the market. Therefore, let us also assume that the transformers in the amplifier have been matched for the tubes and are perfect. The entire unit operates excellently on weak signals, but the distortion persists when strong signals are being amplified. So, by the process of elimination, we have arrived at the vacuum tube as the source of our troubles.

We find by experience that, by reducing the brilliancy of the filament, we can minimize the distortion to a certain degree, but this method is unsatisfactory, as it results in a decrease of signal intensity.

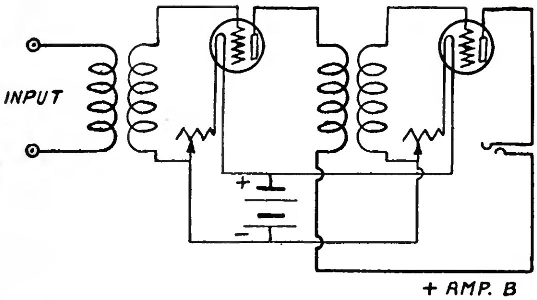


FIG. 1
Two-stage audio amplifier. If the transformers are of reliable make and matched for the tubes, any distortion must occur in the tube circuit

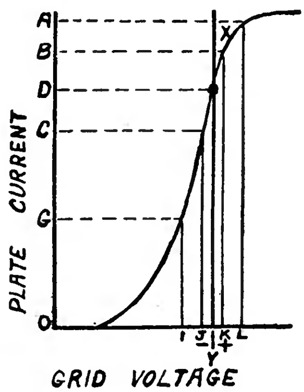
Therefore, we will focus attention upon the vacuum tube and see what part it plays in the amplifier. Also what other apparatus, if any, must be added to the amplifier so that the vacuum tube will operate with maximum efficiency, eliminate distortion, and still afford maximum amplification.

What is the three-element vacuum tube as used in our present-day amplifiers? It is an instrument consisting of an evacuated bulb, containing a filament that can be made incandescent so as to emit electrons; a grid, and another metallic object called the plate. Further, it is a voltage-operated device, which, when an alternating potential is impressed upon the grid, will produce the same alternations in the current flowing in the plate circuit but of greater amplitude. Now the question might arise in the mind of the reader: How can distortion occur in a vacuum tube if the alternations impressed upon the grid are reproduced in the plate circuit? This can best be explained by means of a plate-current, grid-voltage characteristic curve (Fig. 2). Before going into the explanation of the curve, a few remarks concerning the plate current might help the uninitiated.

Experiments have determined that when a filament is contained in an evacuated chamber and made incandescent, it will emit electrons at a certain rate per second, the rate depending upon the degree of incandescence. Also, that when another metallic object in the form of a plate is placed into that chamber and given a positive charge in respect to the filament (the positive terminal of the B battery is always connected to the plate), the electrons will be attracted to the plate, and a stream of electrons will flow from the filament to the plate. Now if we place a meter that will indicate the flow and quantity of any current in the plate circuit, we will find that when there is a flow of electrons within the tube (from filament to plate), there is a certain value of current flowing in the plate circuit. So we can say that the electronic flow is equal to a current flow within the tube. And we find that by varying the brilliancy of the filament (thus varying the number of electrons that are emitted from the filament per second), we can vary the plate current; also, that we can vary the plate current by varying the value of the voltage applied to the plate, for the greater the positive charge on the plate, the greater its attracting power, and a greater number of electrons are attracted to the plate. The plate current corresponds to the number of electrons reaching the plate per second. If we maintain the filament current constant and the plate voltage is also maintained at a constant value, there will be a definite number of electrons flowing across inside the tube, and the plate current will be constant. This value of the plate current is usually expressed as the amount of current the tube draws. When the plate voltage is held constant and the filament current varied from minimum to maximum, there will be a variation in the plate current from minimum to maximum. The maximum indicates that the positive charge on the plate has attracted all the electrons possible, and any increase in filament current in order to increase the number of electrons emitted will be of no use. When this stage is reached, we have reached the saturation point of the tube, i.e. for that plate voltage.

Now let us go back to the characteristic curve of the tube. We are to illustrate how distortion may occur within the vacuum tube, and we shall also show how it can be eliminated. The curve illustrates the operation of a three-

FIG. 2
Showing the relationship between the current and the grid voltage when the plate voltage and filament current are held constant



element vacuum tube as an amplifier, by showing the relationship between the plate current and the grid voltage, when the plate voltage and the filament current are held constant. The vertical line on the extreme left indicates the value of plate current (usually expressed in milliamperes); the horizontal line, on the bottom, the grid voltage; the vertical line in the center, the zero line, i.e., the dividing line between negative and positive grid voltage. To the right of this line is positive grid voltage and to the left, negative. The curve shows the variation of the plate current, and the bend X is the saturation point. Assume that the curve illustrates the characteristics of a UV-201-A as an amplifier with a plate voltage of 67½ volts. The dot on the curve and point D on the left-hand line indicates the normal plate current as explained in the preceding paragraph. Now suppose that an incoming signal of a medium intensity has been impressed upon the grid. The applied potential being of alternating character, an alternating positive and negative charge is therefore applied to the grid. This is shown by YJ as the negative charge and YK as the positive charge. By following up the vertical lines at these points and noting where they cross the plate current curve then following the horizontal line at that point toward the left vertical line, we see the value of the plate current in each case. The negative charge upon the grid has reduced the plate current a certain value below normal, and the positive charge upon the grid has increased the plate current the same value above normal. This phenomenon occurs because when there is a negative charge upon the grid it repels some of the electrons emitted from the filament and less travel to the plate, hence the plate current is reduced; the opposite is true when the grid is charged positively. The grid attracts electrons and a greater number travel to the plate, increasing the plate current. Expressing this differently, we can say that when the grid carries a positive charge it increases the attracting power of the plate. By glancing once more at the curve it will be noted that the increase and decrease in the plate current are exactly proportional to the grid potential variations, but are of greater magnitude; so the wave-form in the plate circuit will be exactly the same as those in the grid, and no distortion will take place in this case.

Do you know just how your tube works? What difference does it make if you apply more B battery, or more filament voltage? Mr. Rider answers these questions in this article.

Let us now assume that the signal has passed through one stage of amplification, or that the original input has been greatly increased. What happens when a stronger signal is applied to the grid? Since the signal is of greater intensity on being amplified, the alternating potential that is impressed upon the grid is greater. This is indicated by YI and YL, the former the negative charge and the latter the positive. We follow the various lines through once more, and note that the negative half of the applied grid potential has produced the plate current variation DG, and the positive half the variation DA, but that the two variations are not equal and therefore are not exactly proportional to the grid potential variations. The reduction in the plate current for the negative charge on the grid is greater than the increase for the positive charge, and the increase has been carried beyond the saturation point. Since the variations in the plate current are not exactly equal, the wave-form in the plate circuit is not an exact reproduction of that applied to the grid. The effect of this is distortion. Thus distortion is produced within the vacuum tube in amplifying circuits.

What is the remedy for this situation? To reduce the grid voltage would reduce the amplification. That would never do, for maximum amplification is generally desirable; therefore, we must reduce the normal plate current to such a point that equal increase and decrease will be produced in it by the grid voltage variations. Expressed differently, the operating point (normal plate current) must be shifted to such a position that the plate current variations will be equal at all times, and this point is midway between the two bends. We can do this by two direct methods:

1. By reducing the filament brilliancy, thus reducing the electronic emission.

2. By reducing the plate voltage, thus reducing the attracting power of the plate.

Neither method is completely desirable, for in each case we would not obtain maximum amplification. We shall have to resort to an indirect method of shifting the operating point

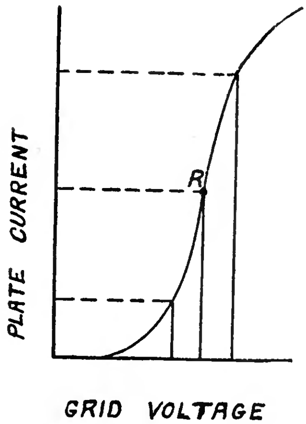


FIG. 3
Showing the "characteristic curve" when C battery (grid bias) is used

of the tube. We shall utilize the grid, we can either increase or decrease the plate current. As we want to reduce the normal plate current to a certain point, we place a constant negative charge upon the grid. This calls for the insertion of a source from which we can obtain this negative charge.

The most logical source would be a battery, and that is the means employed in actual practice. This battery is called the C battery, and is sometimes known as the "grid bias." The battery is connected as shown in Fig. 4, and we apply just enough negative potential to the grid to reduce the normal plate current to the point where changes in the grid potential due to the incoming signal, will produce equal increases and decreases in the plate current. Therefore, by means of the C battery, we can confine ourselves to operation on the straight portion of the characteristic curve, and place the operating point midway between the two bends. In this way, the symmetry of the oscillations applied to the grid are faithfully reproduced in the plate current, the variations are proportional, and distortion is eliminated. Further, the greatest amount of variation is obtained in the plate current for the grid potential variation, and maximum amplification is also obtained. This is shown in Fig. 3. The operating point, R, has been reduced, and for the same value of input the greatest variation is obtained and the variations are proportional.

Fig. 4 is the same as Fig. 1, except for the C battery between the grid return lead of the transformer and the negative terminal of the A battery. That point is the proper position for the battery, and not between the grid of the tube and the grid terminal of the transformer.

The patent rights for the use of a C battery in an amplifier are owned by certain radio concerns, and because of their refusal to grant other manufacturers this right, separate C batteries are not found in the average amplifying unit. There is no ruling that forbids the radio fan to insert such a battery in his own amplifier. To overcome this patent situation, other methods of obtaining a negative grid bias are resorted to by the manufacturers. One is to connect the grid return of the transformer to the negative terminal of the A battery, and another to place the filament rheostat into the negative lead of the A battery and connect the grid return of the transformer to a part of the rheostat, so as to apply the voltage drop across the rheostat to the grid of the tube. These methods are limited in their degree of efficiency, since the required value of "grid bias" might be more than that obtainable by the above means. The value of the C battery is best determined by experiment, as it depends upon the controlling constants of the tube. The following table offers a close approximation to the C battery voltages to be used with a given plate voltage.

PLATE VOLTAGES	C BATTERY VOLTAGE
40	0.5 to 1.0
60	1.0 to 3.0
80	3.0 to 4.5
100	4.5 to 6.0
120	6.0 to 9.0 (not to be used with UV-199's or C-299's)

The C battery:

1. Eliminates distortion.
2. Reduces the normal plate current, thus increasing the life of the B battery and making the amplifier more economical to operate. This is illustrated by the following experiments:

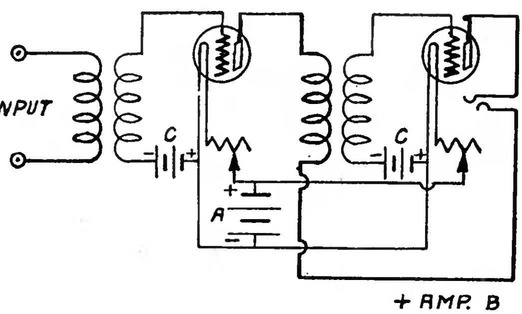


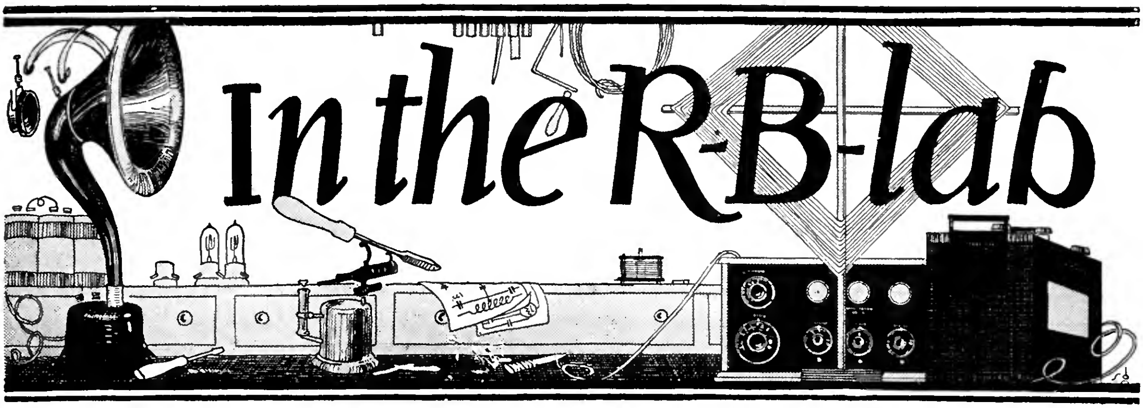
FIG. 4
Showing how the C battery is connected in an audio-frequency amplifier

A receiver consisting of a regenerative detector and two stages of audio-frequency amplification, as in Fig. 1, was put into operation. The amplifying tubes were VT-2's and drew approximately 1.2 amperes on the filament. A potential of about 150 volts was applied to the plate. The signal strength on local stations was tremendous, but the music was distorted. A milliameter was placed into the plate circuit, and with above filament current and plate voltage, the two tubes drew approximately 32 milliamperes normal current. To minimize distortion, the filament current was reduced until the music sounded best (i. e., till amplification was best), yet the tubes drew 22 milliamperes. (It can be readily seen that with this amount of current being drawn from the B batteries, they cannot last very long. That is the case with many amplifiers in use to-day. The operators are told to increase the plate voltage if they desire greater signal strength. That is true, but the other constants must also be in proportion, if efficient operation is desired.) Now the filament current was brought back to normal—1.2 amperes—and C batteries were added as in Fig. 4, until maximum intensity was obtained without any trace of distortion. With the C batteries in, greater signal intensity was obtained than previously, due to the fact that we were operating on the straight part of the characteristic curve, and full plate-current variations were obtained. When in this state, the reading on the milliameter was noted, and it was only 5 milliamperes for both tubes. The increase in the life of the B battery is readily apparent.

A great deal of the distortion that is attributed to the loud speaker may be taking place within the second stage of the amplifier. Who can tell?

PRESIDENT COOLIDGE READING HIS ANNUAL MESSAGE TO CONGRESS

The two microphones on his reading desk actuated six broadcasting stations. Behind the President are Senator Cummings, President *pro tem* of the Senate, and Speaker Gillette, presiding



The "lab" department has been inaugurated by RADIO BROADCAST in order that its readers may benefit from the many experiments which are necessarily carried on by the makers of this magazine in their endeavor to publish only "fact articles" backed by their personal observations.

THE LATEST REPORTS ON THE GRIMES CIRCUIT

IT IS doubtful if any other circuit made public in recent months has received so enthusiastic a welcome by the broadcast fan as the Grimes Inverse Duplex. The difficulties encountered in making this circuit function as it should, have not daunted the experimenter, and every mail received by RADIO BROADCAST contains new evidence of his unflagging interest in the circuit.

The Grimes circuit is a queer one. It is a puzzle, and deserves all the light that experimentation can throw upon it. Our readers who have experimented with this set, in either the three bulb or four bulb form, are divided sharply into two factions—those who claim it is the best circuit in the world, capable of the most remarkable results, and those who cuss it causticly as a set that will howl, squeal and do everything but receive signals.

However, the circuit *will* work, and we are going to let our successful readers give a few pointers on how it is done—including, here and there, a few words of our own.

A FOUR-TUBE SET

FIGS. 1 and 2 show the four-tube set constructed by Mr. Martin A. Zeiger in his endeavor to duplicate the installation of Mr. Shalkhauser, the winner of Second Prize in RADIO BROADCAST'S last "How Far Have You Heard" contest. The corrected circuit for Mr. Shalkhauser's set was published on page 142 in the December number, while other details will be found in the September issue.

These photographs of Mr. Zeiger's set are particularly interesting in that they show very clearly an accepted way of placing the parts, mounting, etc. Fig. 2 is also illustrative of the care and neatness in wiring which so often determines whether or not a receiver will work.

In order to make Mr. Zeiger's apparatus function, it was necessary to add two small fixed condensers (.001 mfd,) across the secondaries of the audio transformers nearest to the detector, as was recommended last month in reference to the corrected diagram. The selection of tubes was found to be eccentric, to say the least, and an indiscriminate juggling of a half dozen UV-201-A's was necessary before results were at all satisfactory. Filament control was such as to necessitate separate rheostats on each tube, *no two tubes being burned at the same brilliancy.*

The tendency towards self-oscillation in a reflex set (its predominant fault) is in a direct ratio to the number of tubes, or, more correctly,

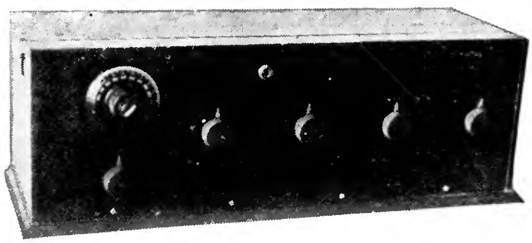


FIG. 1
A compact four-tube Grimes set. Potentiometer, condenser and four rheostats are the only controls

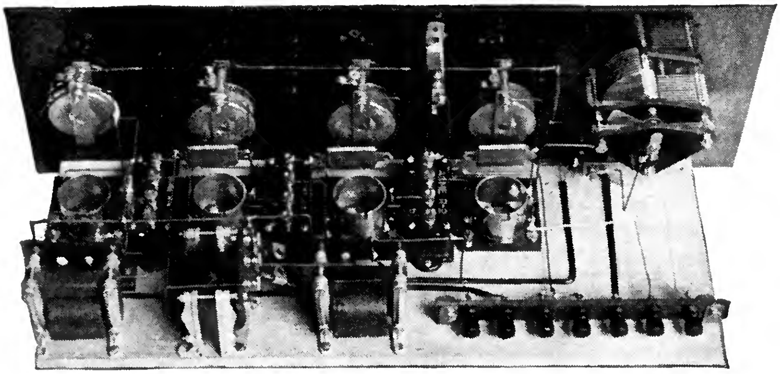


FIG. 2
The Interior of Mr. Zieger's set. Note the rear connections, the neat wiring, and the placing of the transformers

to the number of reflexed stages. That this is so was demonstrated quite conclusively in Mr. Zeiger's set, which was much more unstable than a three-tube set recently brought to the attention of this department. The various adjustments of tubes, rheostats, etc., mentioned above, were necessary in order to stop self-oscillations, which adjustments, however, caused the tubes to be operated in such a manner that they neither detected nor amplified to the best of their ability.

For this reason, we advise our readers not to attempt the building of a four-tube set duplexing all amplifying tubes, unless he possesses infinite patience and experimenting facilities—and luck! Our advice is: Build a four-tube set (or rebuild your present one if you are having difficulty with it), but rather than reflex through three tubes, reflex through only two of them, employing one stage of straight audio amplification. Such a set would use the standard three-bulb Grimes circuit as shown in the April, 1923, number of RADIO BROADCAST*, with a single stage of audio, added according to the directions given in the amplification article appearing in the July issue. The four bulbs would then be, two reflex, detector and one straight audio. This set will be much more stable than the average four-tube, all reflex set. It will probably give even louder signals than the full reflex set working at its best, for one step of straight audio amplification is always superior to a stage of reflexed audio, and the third step of R. F. is rarely of much advantage.

* Back numbers of the magazine may be had from the publishers at twenty-five cents each.

A PORTABLE SET FOR AN OPEN ANTENNA

FIGS. 3 and 4 show interesting views of the three-bulb set made by Mr. Leonard H. Searing, in which, for the greater part, he followed the circuit shown in the April, 1923, RADIO BROADCAST. His main variation from the original diagram is the use of a variocoupler which permits the set to be operated from an open antenna rather than on a loop. The primary of the variocoupler is in the aerial circuit with a variable condenser in series with the ground lead. The secondary is connected in place of the loop—a simple and self-evident change.

However, a loop may be used with Mr. Searing's set, and in order to facilitate the change from open antenna to coil antenna (loop), a standard double-circuit jack has been placed across the secondary of the variocoupler (be-

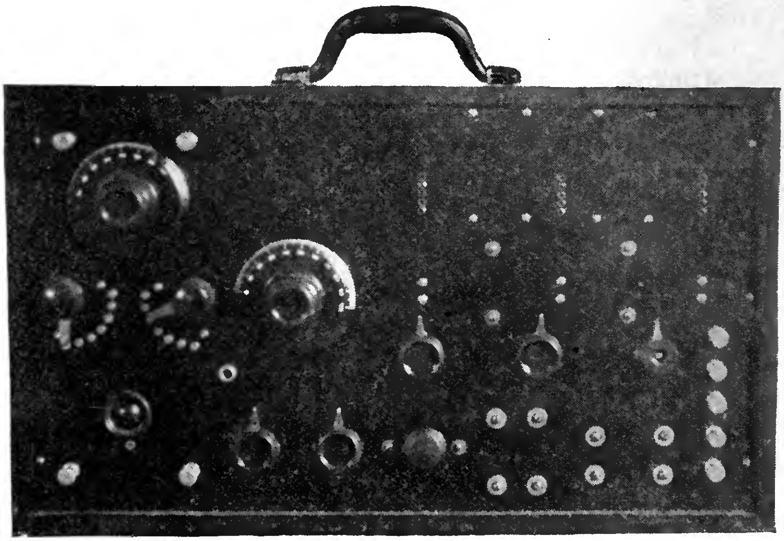


FIG. 3
A portable three tube Grimes set, for outside antenna or loop, built by Mr. Searing

FIG. 4
The interior of the three-tube set. Plenty of room here, and no crowding of parts

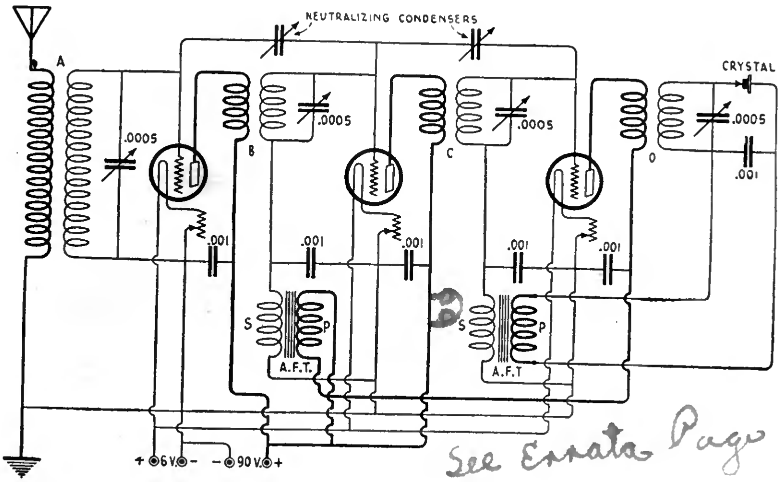
fore it connects to the secondary condenser). The inside terminals of the jack run to the variocoupler, while the outside prongs are connected across the secondary condenser from which they run to the potentiometer and grid of the first tube. The loop may thus be plugged in, a process which automatically disconnects the variocoupler. It might be more convenient to mount this jack in the top of the cabinet, making it possible to use a loop with a plug in the bottom of its upright support (after the manner of the De Forest reflex), thus doing away with the separate stand for the loop.

Mr. Searing obtains excellent results with this set, his only complaint being that it tunes rather broadly. This is surprising, for the use of the variocoupler should result in a very selective set. It is possible that Mr. Searing is using an antenna of unusually high resistance (of small-size wire). This will broaden tuning, and in several cases which have been brought to the attention of this department, it has decreased the selectivity of good receivers. No wire smaller than No. 14 should be used, and No. 12 is to be preferred.

It will be noticed, from Fig. 4, that the builder has not crowded his apparatus. Plenty of space in the Grimes circuit lessens the chance of undesirable complications.

NEUTRODYNING THE DUPLEX

AGAIN we emphasize the prevailing fault of reflex circuits—the tendency towards self oscillation. In an endeavor to overcome this, Messrs. John C. Stick and N. P. Moerdyke have evolved about the best Duplex circuit we have yet seen (Fig. 5), in which they have combined three effective methods for the reduction and elimination of self-oscillation. First of all, they have minimized the feed-back possibilities by not over-doing the reflexing, having thrown back the energy through only two tubes, leaving the first tube to function as a straight radio-frequency amplifier. Secondly, they detect with a crystal, eliminating the complications which attend bulb detection in such circuits, and which caused the De Forest Company to adopt similar means of rectification. Thirdly, they applied the neutrodyne principle, and, "obtained a great improvement over the straight Grimes hook-up. As in the neutrodyne, the tendency to oscillate, and the presence of body capacity, were *completely*



See Errata Page 48

FIG. 5
The best Inverse Duplex circuit we have yet seen. The neutrodyne condenser helps smother self-oscillations

eliminated, and the clarity and quality greatly improved."

The neutrodyning condensers may be made in many simple ways. Perhaps the best and most easily varied for experimental purposes, is made by twisting together two wires, two or three inches long. A few inches of regular two-conductor lamp cord will do nicely, though its lack of rigidity makes it less desirable than some other conductors.

A, B, C, and D are R. F. transformers, the primaries wound on 2 $\frac{5}{8}''$ tubing and the secondaries on 3" tubing. The primaries consist of 17 turns of No. 20 double-silk-covered wire, and the secondaries of 68 turns of No. 22 D. S. C. The remaining values are indicated on the diagram, Fig. 5.

The secondary of the first transformer may be replaced by a loop. It might, however, be advisable to retain the ground connection to the negative filament.

SPIDER WEBS AND THE ONE-TUBE REFLEX

THE photographs in Figs. 6 and 7 show a single-tube reflex set made after the complete instructions given in the November, 1923, issue of RADIO BROADCAST. The apparatus was constructed by Mr. C. H. Brown, and we are sure our readers will agree with this department that he made an excellent job of it.

Mr. Brown, however, departed slightly from the plans worked out by Mr. Kenneth Harkness, substituting spiderweb coils for the conventional layer windings in the original apparatus. It is likely that the spider-web inductances are slightly more efficient. No. 28 enameled wire was used, all windings being made with the same number of turns as specified in the November article, which any one considering such a set is advised to read. The primaries are also wound over the secondaries. $3\frac{1}{2}$-inch to 4-inch winding forms made from pasteboard, thin wood, or fibre are about the correct size; the winding starts $\frac{3}{4}$-inch from the center. Any *odd* number of segments or slits in the spider-web forms may be used. Between ten and thirty are the most common and convenient.

Mr. Brown has also replaced the fixed resistance with a standard filament rheostat, a change of which this department approves. The rheostat is connected in the identical position of the fixed resistance.

The crystal detector used in Mr. Harkness' set has not, at this writing, been placed on the American market, but the builder of this neat set found an efficient substitute. Any good crystal detector may be used in place of the French arrangement mentioned in the original write-up. A permanent crystal is now on the market, which needs no adjustment, and so reduces by one the controls that must be manipulated.

The set illustrated in Figs. 6 and 7 is particularly interesting because of these deviations from the original described in the November issue. It is an excellent example of what we have been endeavoring to impress upon our readers, that considerable variation is allowable (unless specifically warned against) in making up radio apparatus. Indeed, it is seldom desirable to follow directions to the letter, for such a procedure is obviously antagonistic to progress. One tube will generally work as well in a particular circuit as will another, as long as the correct voltages, resistances, etc., are used. If you do not possess a certain make of audio-frequency transformer specified by one builder, use what

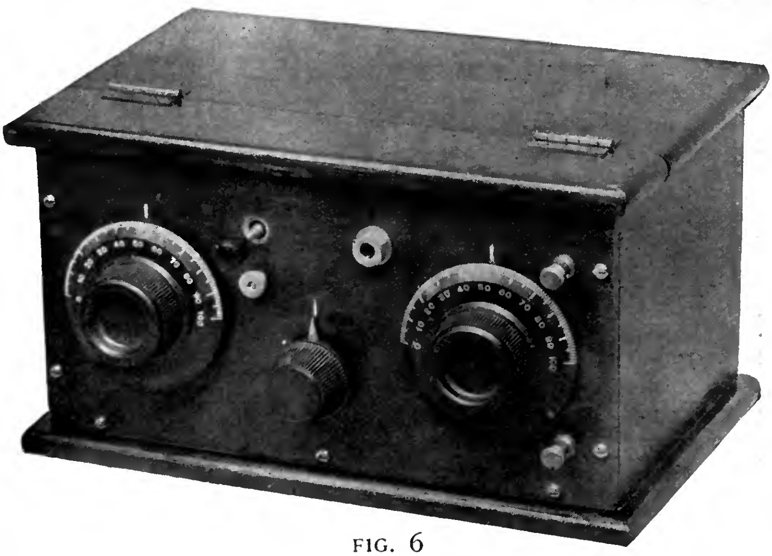


FIG. 6
Mr. Brown's neat reflex

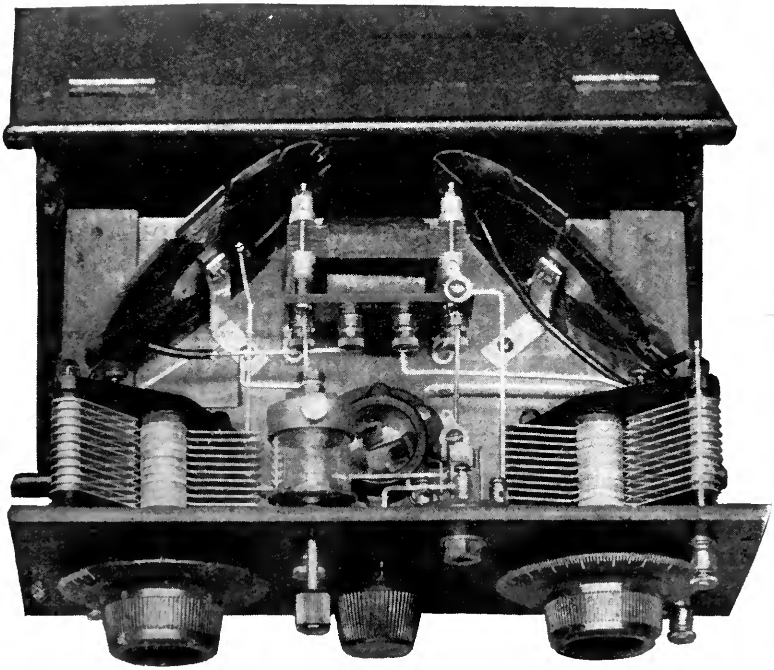


FIG. 7
The "works" of Mr. Brown's one tube reflex set. Note the spider-web coils

you have or can obtain, always, of course, confining yourself to good apparatus. Mr. Brown uses an Acme transformer; this laboratory has used the Amertran and Pacent with equally good results. If a set calls for a straight coil of wire, but you have (or prefer) a honeycomb, bank-winding, or spider-web, use it. The chances are it will work as well as, or even better than the inductance specified.

A radio set is of infinitely more value and pride to the owner, when it is, in part at least, a tribute to his own originality and thought.

TRANSFORMERS AND REFLEX SETS

WITH the stir that reflex sets are making in radio circles, a word as to the proper series connections between radio- and audio-frequency transformers is quite appropriate, and will, perhaps, clear up some of the difficulties under which many of our readers seem to be laboring.

There are, of course, certain ends of both radio and audio transformer windings which should connect to the grid and plate, with the remaining terminals of the secondary and primary going respectively to the filament and plus (positive) side of the B battery. In the majority of cases, these terminals will be found marked as "G," "F," "P" and the plus sign, +, or in another equally obvious manner. However, in a few cases, the reader may be left in doubt. In the case of a single-layer primary and single-layer secondary radio transformer, such as is found in the neutrodyne circuit, the coils are always wound in the same direction. Then if the start of the primary is led to the plate, the start of the secondary must run to the grid. In the case of audio transformers, the outside leads from primary and secondary run to the plate and grid respectively. It is generally a simple matter to determine the outside leads by noting how far from the core they enter the windings.

In reflex sets the *grid* terminals and the *plate* terminals must always run to those two elements of the tube, either directly or through the windings of another transformer. The windings must always be "pointed" or heading in the right direction. For instance, the grid connection from an R. F. transformer will go to the grid, as it should, while the filament end of the secondary winding will run *to the grid connection of the audio transformer*. Thus the filament connection of the R. F. transformer finally reaches the filament, after running through the secondary of the audio transformer, while the grid connection of this latter transformer reaches the grid by running through the secondary of the radio transformer.

The circuit shown in Fig. 8 (the Inverse Duplex as improved by Mr. Eric Shalkhauser), indicates this principle very clearly by the lettering at the transformer terminals.

LOADING THE TWIN VARIOMETER SET

By WM. H. WEST

SINCE the new allocation of wavelengths, the majority of owners of the twin variometer type of apparatus have experienced difficulty in receiving stations transmitting on waves above four hundred meters. The September, 1923, GRID section of RADIO BROAD-

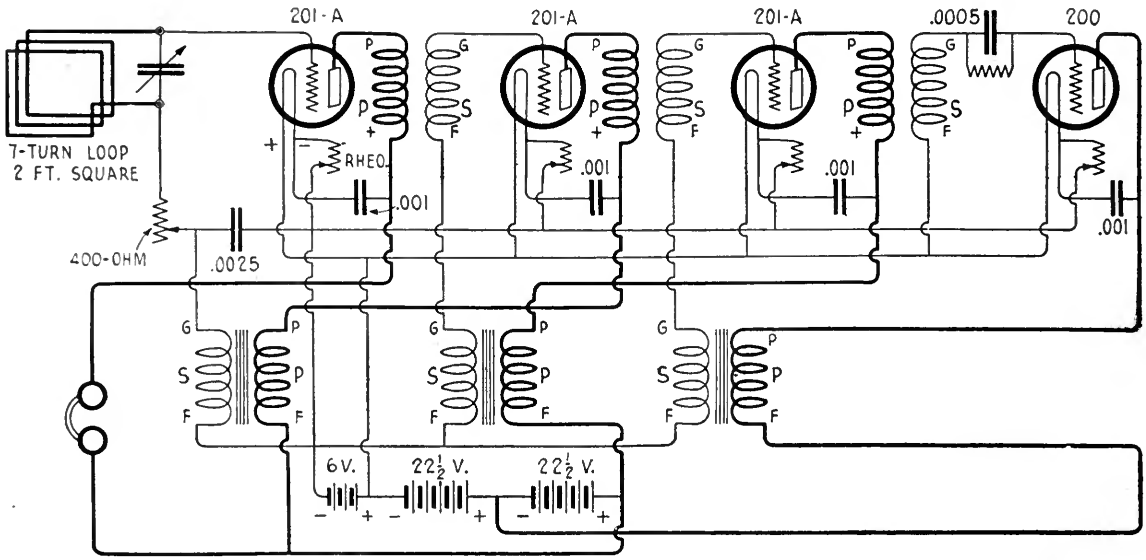


FIG. 8

The terminal initials of the transformers plainly indicate the principle involved in lining up the windings

CAST told how the wave range could be increased by means of added capacities. However, on many sets, greater efficiency and better results can be secured through a genuine load, that is, by means of inductance.

Such an inductance may be wound on a 4-inch tube with 75 turns of No. 22 to No. 24 wire. If you care to take a little more trouble in winding the coil, it can be done in such a way as to take up less space for the same amount of effective inductance. This is accomplished by winding 44 turns of wire in a pyramid bank winding on the same size form. This means that the first layer will have 9 turns, and each succeeding layer one turn less.

In order to avoid, as far as possible, the dielectric losses which are apt to be present when shellac or some similar substance is employed as an adhesive, it is suggested that the coil be painted with collodium, which is obtainable from any druggist.*

Fig. 9 shows how this inductance is mounted beside the plate variometer, and in the same plane with the stationary windings. The coil should be located on the far side of the variometer, in order that it will have no inductive effect on the remainder of the set. The electrical position of this coil is in series with the secondary of the variocoupler, i.e., between the lower lead and the filament battery. Before the set will regenerate properly, it will in some cases prove necessary to reverse the leads to the coil.

*This bit of advice applies to any other type of coil, and it is worth following.—THE EDITOR.

In many cases it is a good idea to provide a panel switch for cutting the extra coil in and out of the circuit. This is quite necessary when it is desired to receive amateur wavelengths (below 220 meters).

It will be observed that on short waves regeneration is effected by means of the tuned plate method, and on the longer waves, by a combination of tuned plate and tickler feedback to the grid circuit from the plate variometer to the coil. This arrangement gives adequate regeneration over the entire range.

A standard receiver employing this addition and using an aerial of average proportions, was found to have a wavelength range of from under 200 meters, to over 900 meters; and it could be made to oscillate, with little difficulty, on all waves.

Slightly different characteristics were noted on the short waves after the change was made, but results were every bit as good, and on waves over four hundred meters, a much better signal was obtained.

BUILDING YOUR OWN LAB

THIS month's suggestion for the growing workshop is a good hack-saw, accommodating different lengths of blades, costing from seventy-five cents to one dollar. A small assortment of blades should be bought at the same time. Four small blades with fine teeth for metal work, and two larger blades, with coarser teeth, for working hard wood, rubber, and bakelite, are desirable.

Any material with which the electrical experimenter has to deal can be cut by the hack-saw. It is particularly convenient in metal work, and it saves much time and labor on pieces too large for filing. It is also handy in cutting panels to size, and, on some woodwork, it makes a much neater job than the ordinary cross-cut saw.

In the usual position, with the teeth of the blade facing down, the hacksaw is unable to cut more than four or five inches before the motion is obstructed by the frame of the saw. However, the blade may be turned at right angles to the ordinary position (Fig. 10), and a cut of any length may be made with the blade in this position (providing, of course, that you do not saw so far from the edge of the material, that the frame is again in the way).

The vise described last month is just the thing to use when working with the hack-saw.

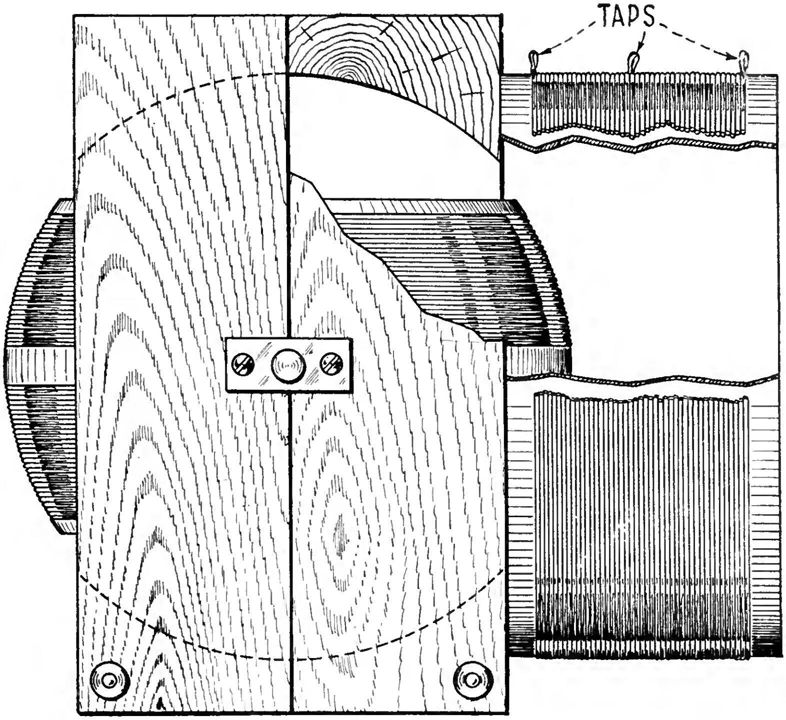


FIG. 9
How the extra coil is mounted on the plate variometer. The use of three taps, one for eliminating the coil altogether, is sometimes desirable, but not necessary

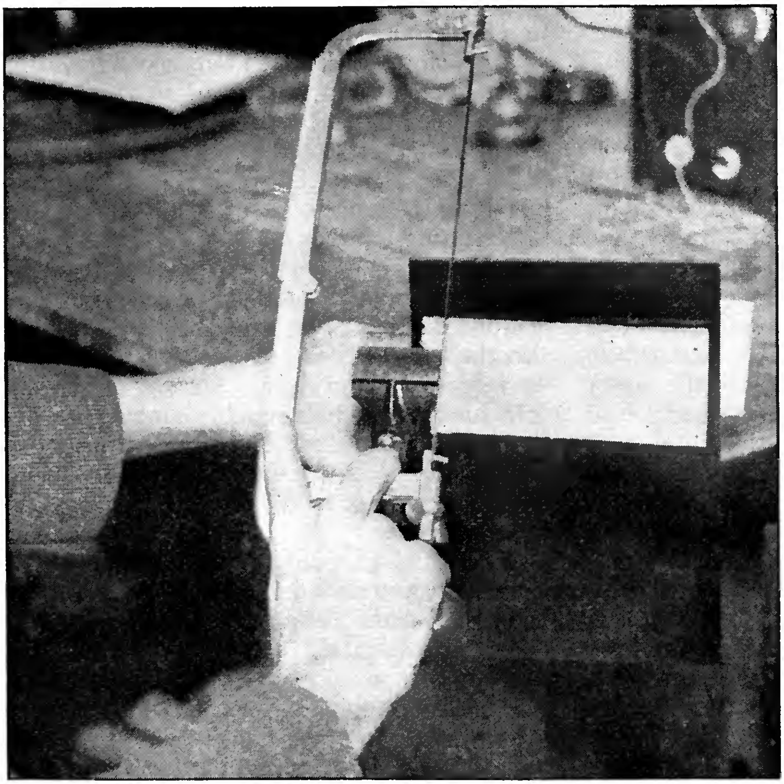


FIG. 10
Making a long cut with a hacksaw, the blade turned sideways

Operating the Neutrodyne Receiver

Directions for Tuning, How Best to Use Different Kinds of Tubes, and How to "Shoot Trouble"

By KIMBALL HOUTON STARK
Chief Engineer, F. A. D. Andrea, Inc.

This is the third and final article of this series on building the five-tube Hazeltine-circuit receiver. The first two articles appeared in RADIO BROADCAST for December, 1923, and January, 1924, respectively.

IN THE first and second articles you have learned how to assemble and wire your neutrodyne receiver and have found it necessary, after its complete assembly, to adjust it for capacity neutralization.

The necessity of such a neutralizing adjustment is characteristic only of neutrodyne receivers. Due to the radical difference of the circuit, the method of tuning is also quite different from the tuning of the usual regenerative or non-regenerative receiver. Consequently, instructions must be very explicit.

In this article, we shall accordingly study in detail the method of tuning neutrodyne circuit receivers and in addition, some general information will be given on antennas, vacuum tubes and "trouble-shooting."

TUNING THE RECEIVER

THE procedure of tuning your neutrodyne receiver, providing antenna, ground, and all battery connections have been properly made, is as follows:

1. Insert the recommended vacuum tubes (See paragraph on the use of different tubes) in their respective sockets and with the power rheostat at its correct position for the type of tubes you are using, and with the vernier rheostat knob turned to the left as far as possible, and with the plug of the loud speaker inserted in the "horn" jack, pull out the knob of the filament switch on the panel front, causing the three amplifier tube filaments to light.

2. Turn the vernier rheostat knob to the right slowly. When the filament current is turned on, the first indication that the receiver is functioning properly will be indicated by a slight noise in the phones. As the rheostat knob is turned farther to the right, this slight sensitivity indication does not increase in volume until a point near the end of the rheostat adjustment is reached. At this point will begin a comparatively loud "hissing" and "frying" noise. For the best signal reception the rheostat should be turned back slightly to a point just before this "hissing" and "frying" starts.

3. With the detector tube at approximately its right operating point, set "Neutroformer" dials 2 and 3 at the same dial setting. Select any particular dial setting, but take for instance the wavelength of station WEAF, 492 meters. Dial settings for this particular station are about 66 or 67. Setting dials 2 and 3 at this point, rotate dial 1 very slowly over its entire range from 0 to 100. If any broadcasting station is operating at the particular time at 492 meters, it should be heard at a maximum when the setting of dial 1 is approximately in the range of 10 or 15 above or below these settings of dials 2 and 3.

4. When signals from any particular broadcasting station are coming in, it is advisable to readjust dials, 1, 2, and 3 slightly and possibly also the vernier rheostat, in order to increase the intensity of the signals.

In tuning, the dials should be moved slowly. It may be found that the tuning adjustment will have to be changed slightly when shifting the phone plug or loud speaker plug from one jack to another.

Dials 2 and 3 should be rotated slowly at the same time, and about in step with each other. Then with dials 2 and 3 on the setting for a particular station, dial 1 is rotated until signals come in with maximum strength and clarity. Sharpness of tuning of neutrodyne receivers when using short indoor antennas is much greater than when using outdoor antennas.

In tuning neutrodyne receivers, the broadcasting stations will not be picked up by hear-

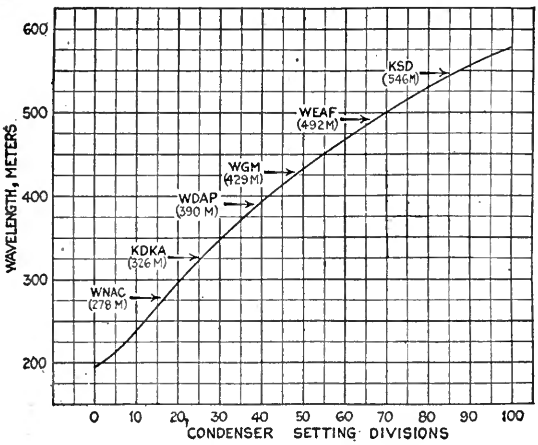


FIG. 1

Wavelength calibration curve showing approximately at what settings of dials 2 and 3 the various stations may be expected

ing "beat notes" and the usual regenerative whistling. As the dials are rotated the programs of different stations will be heard, first softly then with greater intensity and clarity as all adjustments are properly made for that particular station.

THE WAVELENGTH RANGE

THE Neutroformer coils specified in these articles are designed to cover a wavelength range of from approximately 200 to 600 meters. The wavelength calibration curve is shown in Fig. 1 and has several broadcasting stations' wavelength calibration points indicated.

USING DIFFERENT TUBES WITH THE NEUTRODYNE

IN THE early stages of neutrodyne receiver development, receivers were constructed that allowed the neutralization of a given tube and circuit capacity and which did not operate efficiently when different vacuum tubes having different capacities were used. With the placing on the market of the UV-201-A and the dry-cell tube, this matter of basic design was very carefully studied, and now they, and other tubes, can be used with comparatively good success. It has been found that C-301-A tubes are the best for the radio- and audio-frequency amplifier circuits. The C-300 or UV-200 is the best to use as detector tube. The UV-201-A is very good as an amplifier tube and is a close second to the C-301-A. I have been in intimate touch with many users of neutrodyne receivers and a great many of them have had good success with WD-11, WD-12, VT-1, VT-2, 216-A, and UV-199 tubes. When using any of these various types, it is, of course necessary to make sure that correct filament voltages as well as filament current is supplied to the tubes and in general the chart given in Fig. 2 covering "Operating Data for Vacuum Tubes" will be found variable. The lettered notations as regards the suitability of the tubes has been described with neutrodyne receivers particularly in mind.

The volume obtained using UV-199's or other dry-cell tubes is generally less than the volume obtained using UV-201-A or C-301-A

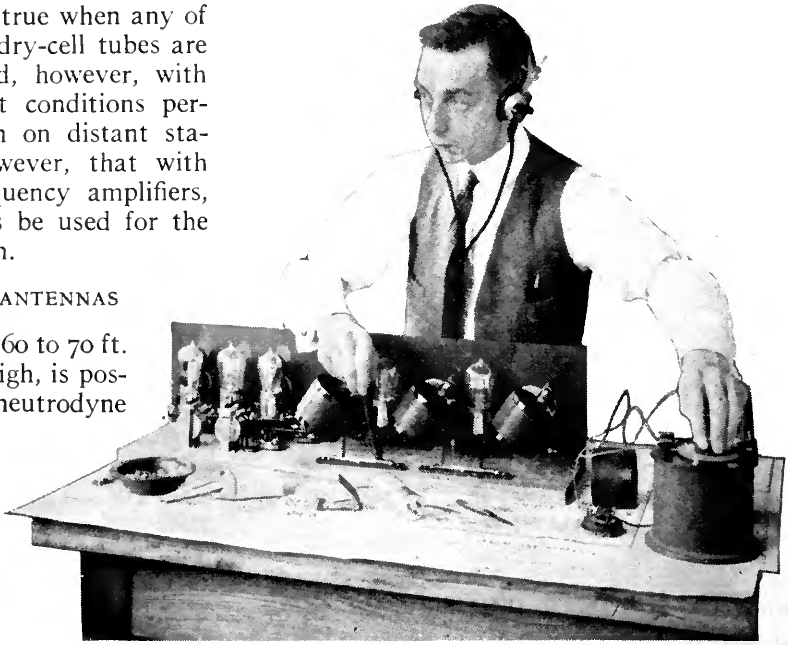
OPERATING DATA FOR VACUUM TUBES

TYPE OF TUBE	FILAMENT VOLTAGE	FILAMENT CURRENT (AMPERES)	"A" BATTERY SOURCE	PLATE VOLTAGE	USED AS: DETECTOR	R.F. AMPLIFIER	A.F. AMPLIFIER 1ST STAGE	A.F. AMPLIFIER 2ND STAGE
WD-12	1.1	0.20	1 DRY CELL	22½ TO 90	A	X	C	D
UV-199	3.0	0.06	3 DRY CELLS	22½ TO 90	D	A	C	D
UV-201-A C-301-A	5.0	0.25	6 VOLT STORAGE BATTERY OR 4 DRY CELLS	45 TO 120	C	A	A	A
UV-201 C-301	5.0	1.00	6 VOLT STORAGE BATTERY	45 TO 120	D	A	B	B
UV-200 C-300	5.0	1.00	6 " " "	18 TO 22½	A	Y	Z	Z
VT-1	4.0	1.10	6 " " "	22½ TO 67½	A	Y	B	B
VT-2	6.0	1.35	6 " " "	90 TO 350	D	B	B	A
216-A	6.0	1.35	6 " " "	67½ TO 120	D	B	B	A
UV-202	8.0	2.35	10 " " "	90 TO 500	X	D	B	A

LEGEND
A = EXCELLENT B = VERY GOOD C = GOOD D = FAIR X = POOR Y = VERY POOR Z = UNSUITABLE

FIG. 2

tubes, and this in general is true when any of the other different types of dry-cell tubes are used. The volume obtained, however, with dry-cell tubes under correct conditions permits loud speaker operation on distant stations. It is suggested, however, that with UV-199 tubes as radio-frequency amplifiers, C-301-A or UV-201-A tubes be used for the audio-frequency amplification.



MR. STARK ADJUSTING THE SECOND "NEUTRODON"

THE MOST SUITABLE ANTENNAS

AN OUTDOOR antenna 60 to 70 ft. long and 30 to 40 ft. high, is possibly the best for use with a neutrodyne receiver. The multiple-wire antenna is generally no better than the single wire type for receiving.

A great many people desire to use an indoor antenna, either through necessity or to eliminate the trouble and expense of an outdoor installation. With a five-tube neutrodyne receiver, constructed in accordance with these articles, such an arrangement is feasible and in fact very good results can be obtained if one does not insist on getting the distant stations. A stretch of wire 50 or 60 ft. long in an apartment will work nicely, but this same length of wire should not be coiled around the wall in a single room and the same results expected.

There is still loop reception to be considered. Many people are using neutrodyne receivers with loop antennas. There are several methods of connecting a loop to the receiver: connecting one terminal of the loop to the antenna binding post; connecting both terminals to the antenna binding post, thus shortening the loop itself; connecting the loop in series with a variable condenser and then connecting the condenser and loop in series with the antenna and ground binding post; and connecting one terminal to the antenna post and the other to the ground post. This is the arrangement most frequently used. In any of these cases it will usually be best to have the ground binding post to the receiver connected to the ground wire. The five-tube receiver described is not designed primarily for loop reception and an outdoor antenna is strongly advised.

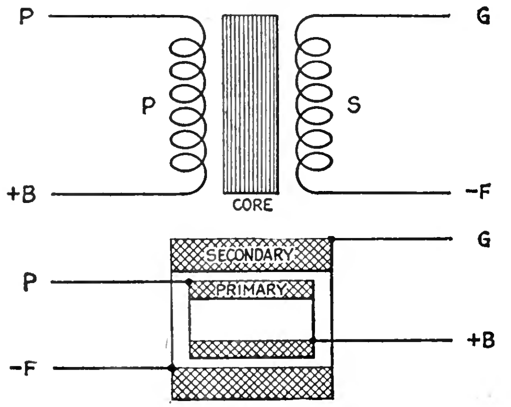


FIG. 3
Showing the audio-frequency transformer connections

"TROUBLE SHOOTING"

THERE are people, who build receivers, that have very little technical knowledge, and it is somewhat difficult to describe to them technical processes. Even the simplest thing which the radio amateur or experimenter takes for granted are at first puzzling to the uninitiated, and it is not surprising that many people who have constructed neutrodyne circuit receivers have not been able to obtain complete satisfaction at their first efforts.

A detailed list of "trouble-shooting" instructions that will usually aid the home constructor to put the breath of life into his receiver satisfactorily follows:

Check all connections very carefully with the picture wiring diagram given in the second article of this series (RADIO BROADCAST, Jan. 1924). After your own check convinces you that your wiring is correct and absolutely identical with the diagram, it is best to have someone else check it over so that the same mistake will not be repeated.

A point of great importance is that the variable condenser of the Neutroformer unit rotary plate terminal be connected directly to the negative terminal of the vacuum-tube socket of the amplifier tubes. It will be noted in the diagram, however, that this wire from the rotary condenser plate terminal of the third from the right hand Neutroformer connects to the +90-volt terminal of the detector tube.

Audio Transformers: Many times, when howling occurs, reversing the connections to the primaries of either one or both of the audio-frequency transformers will remedy the trouble. The drawing Fig. 3 shows the correct arrangement of transformer terminals and also the best plan of connecting the various leads from the transformer windings to the terminals.

Fixed Condensers: In special cases, where trouble with balancing out is had, it may be advantageous to cut out entirely the fixed condenser (capacity .006 mfd.) which is connected from the detector tube plate terminal to ground of the negative A and B batteries common lead. Eliminating this condenser and re-balancing carefully will many times secure a very good minimum or inaudible signal balance.

Dirty Contacts: Connections which lead from the elements of the vacuum tube to the direct terminals are soldered to the tube contact pins and these soldering connections oxidize and become dirty very quickly. One should see that the bottoms of these tube contact pins are always bright and clean.

Neutroformer Mounting: The neutrodyne circuit requires that all electromagnetic coupling as well as electrostatic coupling be balanced or neutralized. Accordingly, the mounting of the Neutroformer is of great importance, and the correct angle that they should be mounted at is 54.7 degrees from the horizontal. A slight variation from this angle will cause trouble in balancing out. If the experimenter drills his own panels, great care should be taken to see that this angle is correct.

Be sure that all your connections are OK. Then if your set is built in accordance with the directions given in these articles, the results will repay you many times over for your work.

Various Circuits and What They Mean

PART III

Capacity and Inductance and Their Relation to Tuning in Radio Circuits

By ZEH BOUCK

In response to our requests to readers for information on just what type of articles they desire, we have received many letters which indicate that the radio public is growing more interested in the theory of their science. It is an obvious fact that greater enjoyment and efficiency can be derived from any type of apparatus when the theory of its action is comprehended. However it is difficult for us to know just how far we may delve into the fundamentals of radio and yet appeal to the layman. Let us know how you like this article, and if you would care for more of a similar nature.—THE EDITOR.

THERE are some bits of radio theory which are of great aid to the enthusiast in getting the most from his apparatus. Among these theoretical facts which cannot be scorned with impunity, is what actually occurs during the process of tuning. Just what does happen when one juggles the condenser and inductance dials on the receiving set? Many enthusiasts have wondered, but have been deterred in satisfying their curiosity by the fog of mathematics which more or less covers the theoretical functioning of C (capacity) and L (inductance).*

However, the only mathematics of which

* The reader is advised to read the article on "inductance," appearing in the January RADIO BROADCAST, and which is the second in this series.

one need boast, in order to understand the theoretical significance of tuning, is a knowledge of fractions and equations which is herewith slightly reviewed.

A common fraction is designated by two numbers, the numerator and denominator, placed respectively above and below a bar indicating a fraction,—$\frac{1}{2}$, $\frac{5}{16}$, $\frac{1}{4}$ etc. There are very few of us who are unfamiliar with these relics of elementary schooling.

If the *denominator* of a fraction is made larger, the value of the fraction is quite obviously made *smaller*. Thus $\frac{1}{16}$ is less than $\frac{1}{2}$. And so, if we have two quantities called X and Y, X being equal to $\frac{1}{16}$ ($X=\frac{1}{16}$) and Y being equal to $\frac{1}{2}$ ($Y=\frac{1}{2}$), Y is a larger quantity than X.

THE EQUATION

AN EQUATION, as its name declares, is a statement of equality: For instance, $10=2 \times 5$ or $8=\frac{16}{2}$. We can see by observation and from the definition of an equation, that if one side of an equation is multiplied or increased, the remaining side increases automatically (in order to maintain an *equation*) and in proportion. Thus in the equation $10=2 \times 5$, if the 2 on the right-hand side of the equal mark is changed to 4, the 10 must be changed to 20, and the equation read $20=4 \times 5$. In the equations $XL=2\pi f\ .25$, and $XL=2\pi f\ .5$ in the latter equation represents twice the amount of XL in the former equation.

Likewise, if one side of an equation is reduced, the other side decreases in proportion.

REACTANCE AND RADIO CURRENTS

THOUGH it has been many times stated and explained, it will do no harm to reiterate that radio currents in the antenna and in most of the circuits of receiving and transmitting apparatus are "alternating," that is, they travel first in one direction and then in another, *changing polarity from positive to negative.* As was shown in the preceding article on "inductance," a coil of wire carrying an alternating current will have induced in it an E. M. F. (electro motive force which results in a current) in a direction opposite to the inducing current. This is called, for obvious reasons, a "counter E. M. F." Therefore, we have, in an inductance carrying radio electricity, perhaps a tuning coil, variometer, etc., *two currents which are opposing each other,* the counter E. M. F. tending to hold back the original current; and, if the counter E. M.F. is sufficiently powerful (the inductance of the coil sufficiently high), *it will retard the current until the voltage has changed polarity.* In other words, the current may be on the plus side of an alternation when the voltage is on the negative side; and as work (such as making a sound in the receiver) can be accomplished by electricity only when voltage and amperes come together, power is lost by this inductive effect. It is obvious that the slightest loss of weak radio currents must be fatal to reception.

This ability with which a coil builds up a counter E. M. F. is known as reactance, i. e., "acting back on." Now, as the counter E. M. F. is caused by the rise and fall of the magnetic flux generated by the original current, the strength of the counter E. M. F. varies with the rapidity with which this field rises and falls, in other words with the frequency of the current. Indeed, all of this may be summed up in the following formula for reactance:

$$XL=2\pi f l$$

XL is the reactance which is computed in ohms, for its effect on a circuit is very similar to that of resistance. L is the inductance in the circuit (for the greater part, the coils of wire, etc.), and as L increases, for instance, by adding more turns of wire, the reactance, XL, will necessarily become greater. (Increasing one side of an equation automatically increases the other side). F is the frequency of the current, and, likewise, as that becomes higher, so does the reactance. (The frequency of a radio current, of course, changes with the wavelength. However, the proportion is an inverse one. That is, when the wave is decreased, the frequency increases; when the wavelength increases, the frequency is lessened. The reader must bear this in mind, so that when we have occasion to speak of a wave change, he may instantly interpret our words in terms of frequency, and vice versa.)

In brief: *in a coil of wire carrying a radio current, there exists a tendency to nullify or make useless that current—a tendency that varies directly with the size of the coil and the wavelength of the current.*

Coils of wire, or inductances, are necessary in every radio set, for the transference of energy from the antenna to the tube circuit, and from one circuit to another. But it is quite apparent that if a set consisted of inductance alone, it would not work, because due to the reactance, the current would lag—be altogether useless—and no signals would be heard. There must, therefore, be some way of overcoming the difficulty of neutralizing the reactance. There is, and in order to name this something, the reactance of inductance has been qualified by the word "positive." That is, instead of saying a coil of wire merely has reactance, it is said that it possesses positive reactance, while the thing that overcomes it is known as *negative* reactance: the reactance of a capacity or condenser.

It has been shown that positive reactance causes the alternating current to lag or slip behind the voltage, but a circuit having a great deal of capacity has just the opposite effect, and causes the current to "lead" or jump ahead of the voltage. Thus, by carefully balancing the lag and lead, with coils and condensers, it is possible to bring the current into step, or electrically, into "phase" with the voltage. When this condition is realized, efficiency will be the greatest and the most work accomplished.

This current lead which characterizes a circuit containing a predominance of capacity, is due to a "displacement current" which anticipates the direction of the current which is to follow. This displacement current varies with the capacity of the condenser and the frequency of the E. M. F. in a manner that is best illustrated by the formula for negative reactance:

$$XC = \frac{1}{2\pi fC}$$

XC, the reactance, varies *inversely* with the frequency and capacity. (It will be remembered that positive reactance varies *directly* with the change in the qualities which are responsible for it.) If the condenser or frequency is increased (*the denominator of the fraction*), the reactance drops, and vice versa. We now arrive at the point where this information throws light upon the tuning of a radio circuit.

WHAT REALLY HAPPENS WHEN YOU TUNE

BOTH kinds of reactance, positive and negative, change with the wavelength or frequency, and to receive energy at any particular frequency, the two kinds of reactance must be equal to each other at that frequency so that the current will be in phase with the voltage. This point of equilibrium or balance is called the "resonance point." *All circuits have some resonance point*, no matter what the values of capacity and inductance may be. In other words there is always some wavelength at which the negative reactance will balance out the positive reactance. This may be shown by examining the two formulas simultaneously: $X = 2\pi fL$ and $XC = \frac{1}{2\pi fC}$. *Now, follow this carefully*: If we start at an extremely high frequency (a high value of f), we shall find (regardless of the values of L and C) that XL is much greater than XC. As the frequency is lowered (the wavelength raised) XL of course becomes smaller, while XC (the denominator decreasing) becomes greater. Hence, at some point or another (the resonance point), XL will be exactly equal to XC, and the wave (frequency) at which this occurs will be *that to which the circuit is tuned.*

All of this may seem slightly confused, but we believe it will be clarified by a more concrete example, for which we shall specify a regular three-coil honeycomb, three-circuit receiver, the circuit for which is shown in Fig. 1. During our hypothetical tests, the honeycomb coils will not be changed—in other words, L, or inductance, will be constant. There is a condenser in series with the primary coil, and another shunting the secondary. The capacity between antenna and ground acts as an additional capacity, which, in conjunction with the primary variable, is virtually a shunt across the primary coil. Thus each coil, primary and secondary, have condensers across them, the capacities of which are decreased by turning down the scales of the variable condensers. Hence what proves true of one circuit (in so far as varying the condenser is concerned) will be true of the other, and so, only one circuit, the primary, will be considered.

We shall assume, at the start of our experiment, that the primary is tuned to four hundred meters, and the primary condenser is set at fifty degrees, about one half of its scale. We now move the condenser down to twenty-five degrees. What has happened? We have increased the negative reactance (by decreasing C, or the denominator of the fraction). If the negative reactance has been increased, then the new resonance point will be one at which the positive reactance is also greater (remember they must always balance). How can the positive reactance increase to meet this negative increase? By increasing the inductance or frequency, or L and f in the formula $XL = 2\pi fL$. But we have said that the honeycomb coils, or L, are not to be changed, so that leaves f, or frequency, as the only possible variation. Therefore f must rise, and so it does until the increasing positive reactance equals the negative reactance which rose when the primary condenser was lowered. But when the frequency rises the wavelength comes down. Thus lowering the capacity in a condenser decreases the wavelength. The reverse is equally true and obvious, i. e., the condenser capacity increases,

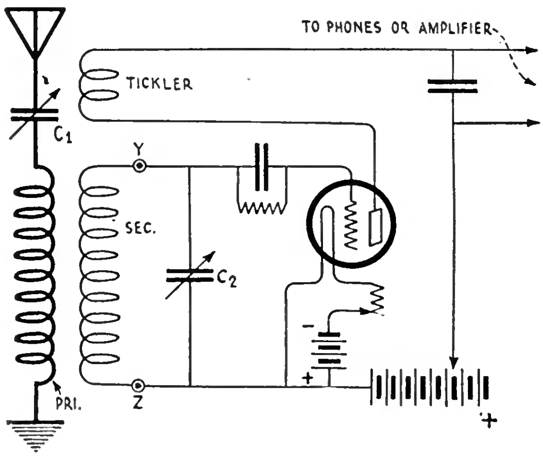


FIG. 1.

Diagram for a three-coil honeycomb set. For best operation, the primary, secondary, and tickler coils should be comparatively large, the tuning being done with condensers C1 and C2, the latter should be of small capacity, as outlined under "undesirable effects of capacity"

the negative reactance is lowered, and to lower the positive reactance to the same value, the frequency must come down—and the wavelength rises.

The effect of varying the inductance in the circuit is also easily followed in the same manner. If the inductance is increased (perhaps more turns of wire are put into the circuit by means of taps), the positive reactance is increased in accordance with the formula $Xl = 2\pi fL$. Therefore, at the new resonance point the negative reactance must also be higher. But; as the condenser or capacity is not to be varied, the frequency must drop (lowering the denominator of the fraction in $XC = \frac{1}{2\pi fC}$) or the wave rises. Hence increasing the inductance in a circuit increases the frequency of wave.

UNDESIRABLE EFFECTS OF CAPACITY

THAT is all there is to the mystery of tuning, and a comprehension of the foregoing will be of value to the experimenter in showing the true functioning of capacity and inductance as no analogy or less scientific explanation could do. A little thought will now indicate why it is desirable to eliminate all stray capacity from a circuit. In the circuit of Fig. 1, the strength of the signal depends on the E. M. F. induced across the coil, or between the terminals Y and Z. The larger this coil, or the higher the inductance, the greater will be this E. M. F. and the strength of the received signal. Hence it is always best to increase wave by means of inductance rather than by shunting with capacity, On a honeycomb set, experienced operators always use the largest coil permissible for a given wavelength, keeping their condensers as near to the zero point as possible.

For this same reason, shellac, and similar adhesives which, through their dielectric qualities, increase the distributed capacity, are eliminated from efficient windings. The honeycombs and duolateral windings, the spider webs, etc., were all designed and invented with the idea of decreasing capacity and permitting a higher value of L for a given wave. Professor Hazeltine has developed the neutrodyne system with the same purpose in mind. Short wave radio frequency amplification had been impossible for many years due to the high capacity between the elements of the vacuum tubes boosting the waves, so that not sufficient inductance could be used for an efficient transference of energy.

Announcing Some Announcers

"CHIEF MIDNIGHT AGGRAVATOR"

Earl Martz, director of programs and announcer at WDAL, the Florida, *Times-Union* station, who puts his collection of Midnight Aggravators on the air from 12 to 1 o'clock. Their sparkling jazz is being heard "from Maine to Cuba and all through the West," says C. M. A. Martz

EDWARD F. HARRINGTON

Studio director of WCX, the station of the Detroit *Free Press*, out there in Michigan

CREATOR OF "RADARIOS"

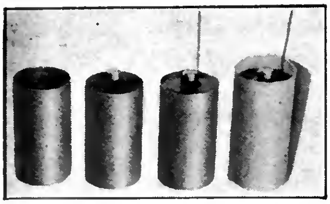
Herewith Fred Smith, studio director of WLW, the Crosley Manufacturing Company station in Cincinnati, who originated the type of drama broadcasting known as the "radario"

MARTINEAU OF KPO

E. J. are the initials, although it's "H. J. announcing." He is director of the Hale Brothers station in San Francisco

TRANSFERRED FROM WJZ TO WRC

Bruce Lum's handsome voice now issues from his handsome self at the Washington, D. C., station of the Radio Corporation of America

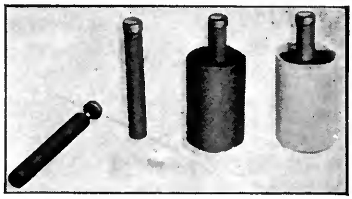


$\frac{1}{15}$ OF A B BATTERY

First, the zinc case; next, the core in the case; then, the top of the core is sealed, after the electrolyte has been poured in; and finally, the insulating wrapper

THE HISTORY OF A ZINC CASE

Which forms the exterior of one of the fifteen units of a B battery. Presses reduce the diameter of the cap until it reaches the size shown at the right



THE CENTER OF THE CELL

The "mix" of black substance in the cell is compressed mechanically and then the core is driven into it. When the core and "mix" are thus united, the whole is wrapped tightly with cheese cloth

The Anatomy of the B Battery

WE BUY what is called a B battery, connect it to our set, use it until it is "low" or "dead," discard it, and get another which will deliver the necessary voltage. We know that it is heavy and more or less foolproof, and contains a number of cylindrical cells, with "chemicals" inside them. But do we ask ourselves how they are built and tested and what the "chemicals" are?

B batteries are carefully made. They are put through long tests to determine their life. Every bit of material which goes into them has passed the chemical board of review in the factory—and there are no more critical souls than the chemists.

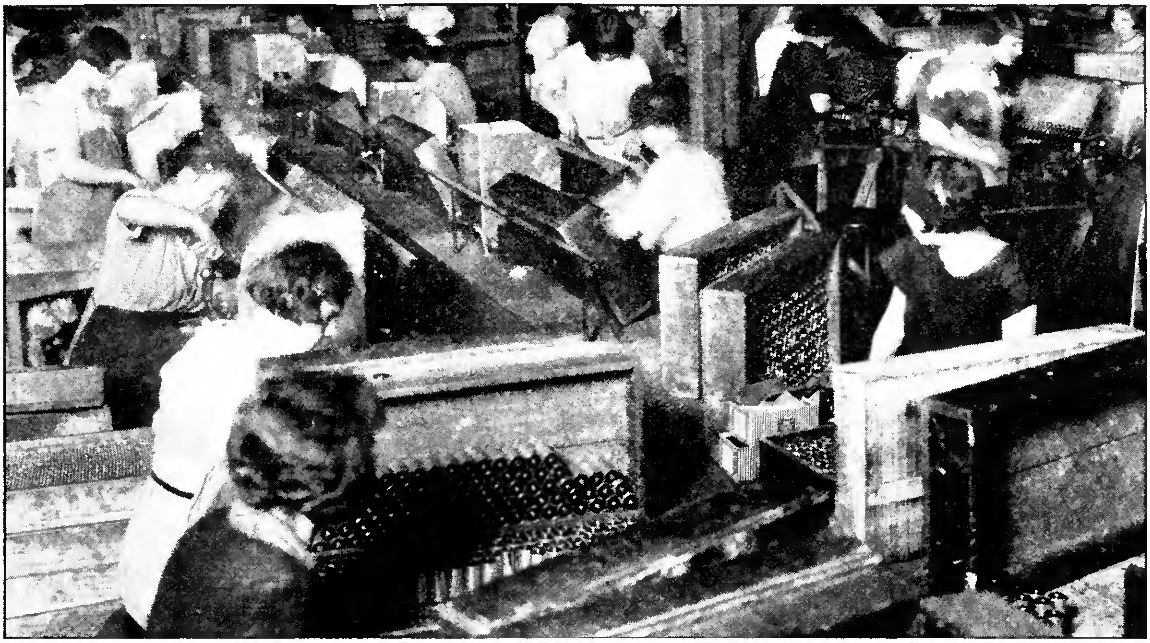
Your B battery of 22.5 volts contains fifteen little cells, each with a voltage of 1.5. These fifteen cells are connected in series. And while there are other sized cells on the market, the process of manufacture is about the same.

First, the zinc case is stamped out. When this is completed, the carbon core is made. Then it is wrapped with a certain grade of cheese-cloth, and capped with a bit of shiny brass. The breath of life to a dry cell is manganese dioxide ore, graphite, sal ammoniac and zinc chloride—the gelatinous electrolyte. Paraffin is used liberally in cell manufacture to keep moisture out and for its value as an insulator. The carbon cores are dipped in paraffin, as are the washers used in the cell interior.

The finished core and the finished zinc can are ready for assembly. The core, even with its winding of cheese cloth has plenty of space between it and the zinc casing. This space is where the electrolyte is placed. It is the electro-chemical action between the carbon core and the zinc case, aided by the half-damp electrolyte between, (which is put in by compression hammers) that causes a voltage to be developed between the zinc and carbon terminals of the cell.

EACH UNIT MUST PASS THIS METER

Only cells which measure up to the proper open-circuit voltage and the proper short-circuit amperage go into B batteries

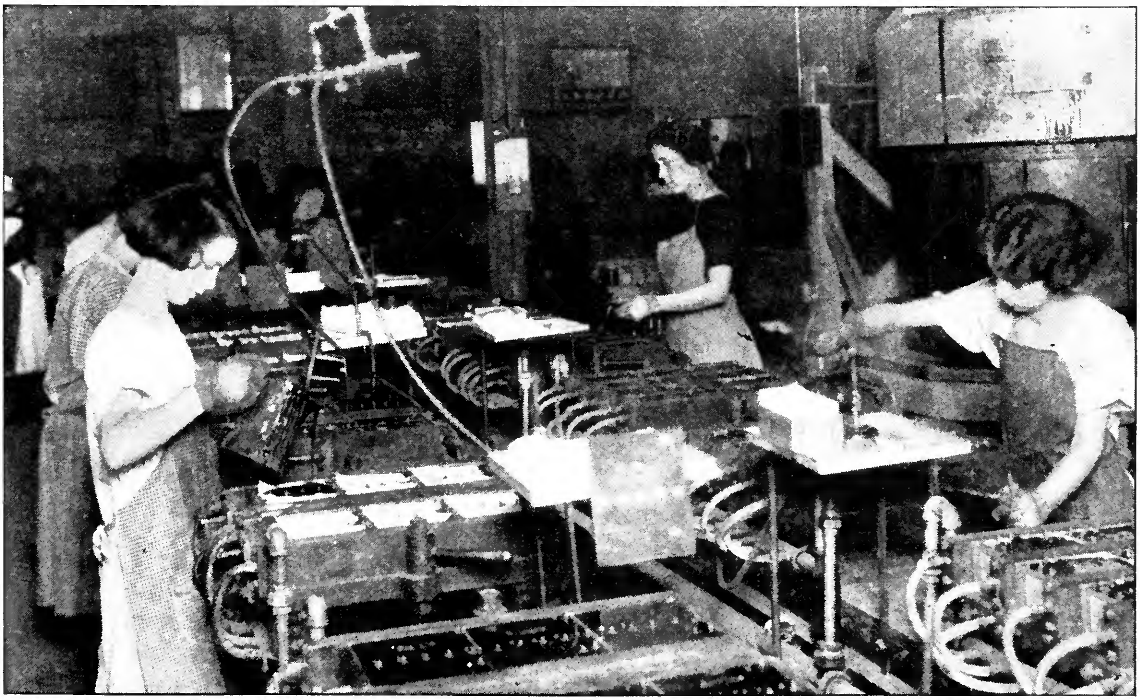


WHOLESALE SOLDERING

Cells are soldered in groups of three instead of five, although the latter would be easier, in order to reduce the voltage drop. In all the soldering and insulating a non-corrosive compound is used to flux the solder. Any other flux would cause current losses inside the finished battery block

THE FINAL STEP IN MANUFACTURING

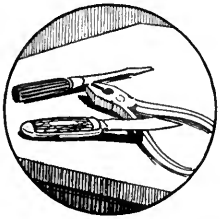
The picture shows the process of pouring the sealing and insulating compound around the completed cells. One layer of the hot mixture, a layer of cheese cloth, to prevent the sealing mixture from cracking, and two additional layers of compound are added to the battery. The terminals are then tested for proper voltage, stamped, and the battery is finished



The Young Heart

By ROBERT OLIVER

PROWLING about among the city's radio stores, as I often do, to keep posted on the "market" as it relates to the price of parts and accessories, I have on numerous occasions encountered an elderly gentleman who seems to have a passion for buying all kinds of equipment. I have seen him at the "five and ten" and at down-town "gyp" shops, as well as in the more expensive places around Grand Central.



He is not a mere "looker," as the clerks dub those poor wistful wishers who yearn to possess but haven't got the price and those who *can* raise the price, but who *can't* make up their minds. No, he is not a "looker," for he buys, buys, buys.

I am sure this old man has accumulated a stock of radio parts sufficient to build a dozen sets, enough parts to keep a man busy for weeks putting them together—and taking them apart as soon as some particular hook-up has been given a trial.

There is a sort of free-masonry among radio fans. If you happen to sit next to a chap on the 5:15 who is solemnly drawing peculiar designs in his notebook, the odds are ten to one that it's a hook-up. There is no grand hailing sign, in this fraternity. Almost any one of a thousand questions touching upon radio will suffice. For instance, if you inquire, "How many volts are you using on your detector?" you are introduced at once. There is a warmly responding interest and you're off, as if you had known each other for years. No icy reserve, no elevated eyebrows, no "Pardon me, but you have the advantage of me, sir."

I wanted to talk to the elderly gentleman, for he had aroused my genuine interest. I had found it so easy to begin conversation with a radio bug that I laid no careful plan of approach, but merely asked:

"Pardon me, do you find radio an interesting pastime? And if so, why?"

Casually drawing out of my left-hand trouser pocket an assortment of switch points, binding posts, crystals, etc., I jingled them carelessly in my hand as a sign that I too was a devotee, I might say, a slave.

Recognizing in me a brother of the thirty-third and last degree of that fraternity which is doing so nobly in furnishing the funds that keep broadcast stations going, the elderly gentleman greeted me with what seemed to me to be sincere pleasure.

Receiving his package of parts from the clerk, he withdrew with me to a corner of the establishment where we could chat in seclusion. "You ask me," he said, "if I find radio an interesting pastime? and if so, why?"

"I trust you will overlook the unconventionality of the occasion," I replied, "when you know that I have no wish to pry, but seek only to fraternize for a moment with one of the brethren of the guild."

"My boy," exclaimed the old man with feeling, "I am glad you asked me that question. Yes, I do find radio an interesting pastime. Frankly, it has become almost a passion with me. In answer to the second part of your question I will show you my purchases for to-day."

Eagerly he untied the package. "This you will recognize as a single-coil mounting. I have no immediate need for it, but I bought it because hook-up No. 46, as I recall it, calls for a 75-turn honeycomb. What's that? Oh yes, I number the hook-ups as I file them away. I file them as they come out. It's the only way I can keep track of them. I am now up to No. 24, according to my record, and when I get to 46, or perhaps it's 47, I shall need this mounting. And here are two rheostats, they come in handy when I am in a hurry and haven't time to dismantle some other set to get the rheostats. And this transformer—I bought it at a bargain. I have three at home, one just like this, but I simply couldn't resist buying it—a real bargain, I think, and I know it is good.

"And here are several grid leaks, a condenser, some bus-bar wire, and several dials, and two phone plugs. And this," his hand trembled as he unwrapped another package which he had taken from his pocket," this is a sending key."

"A sending key!" I exclaimed. "You mean—you mean you are a Ham?"

"No, my boy, I am not a Ham, but before I get through with radio, I will need that key. I am learning the code now. Yes, never too old to learn, as I told Jack the other day. Jack is the boy next door, a bright young chap. We are learning the code together. We are practising now with a buzzer. As we get it down a bit better, I am going to rig up a bulb on the buzzer set and we will learn to read the code by the blinkers.

"Oh, yes, I'm going to have plenty of use for that key, if I live. I wonder if you will understand?" He peered into my eyes, searching for the answer to his question. "The fact is, my boy, I am way behind in my play. It's only a little while ago that I learned *how* to play. Did you ever stop to think how far behind a busy man gets? I am years and years behind in my play. As a boy I started to work at a very early age. Most boys in my day had to work. Some of the well-to-do lads, there were a few in those days, had time to make home-made telegraph sets, and bladder-skin telephones, but not I.

"I had to work and work hard. I never learned how to play. As time passed I married, brought up my family and that kept me busy, so busy I had no time to play. I had one big aim, to see my children well started. Years passed, my children left one by one to begin life on their own, and then one day my wife passed on. There was then nothing left, apparently, for me to live for.

"Time hung heavily on my hands. I found myself waiting for the end. Life held little of interest, until one day the radio bug bit me.

"I needn't tell you how it came about. Perhaps you will recall how it was in your own case. I soon became a most enthusiastic fan. I began to build sets. For years, without realizing it, I had stifled a hunger to build something, to play with tools, to tinker, to experiment. I was too busy.

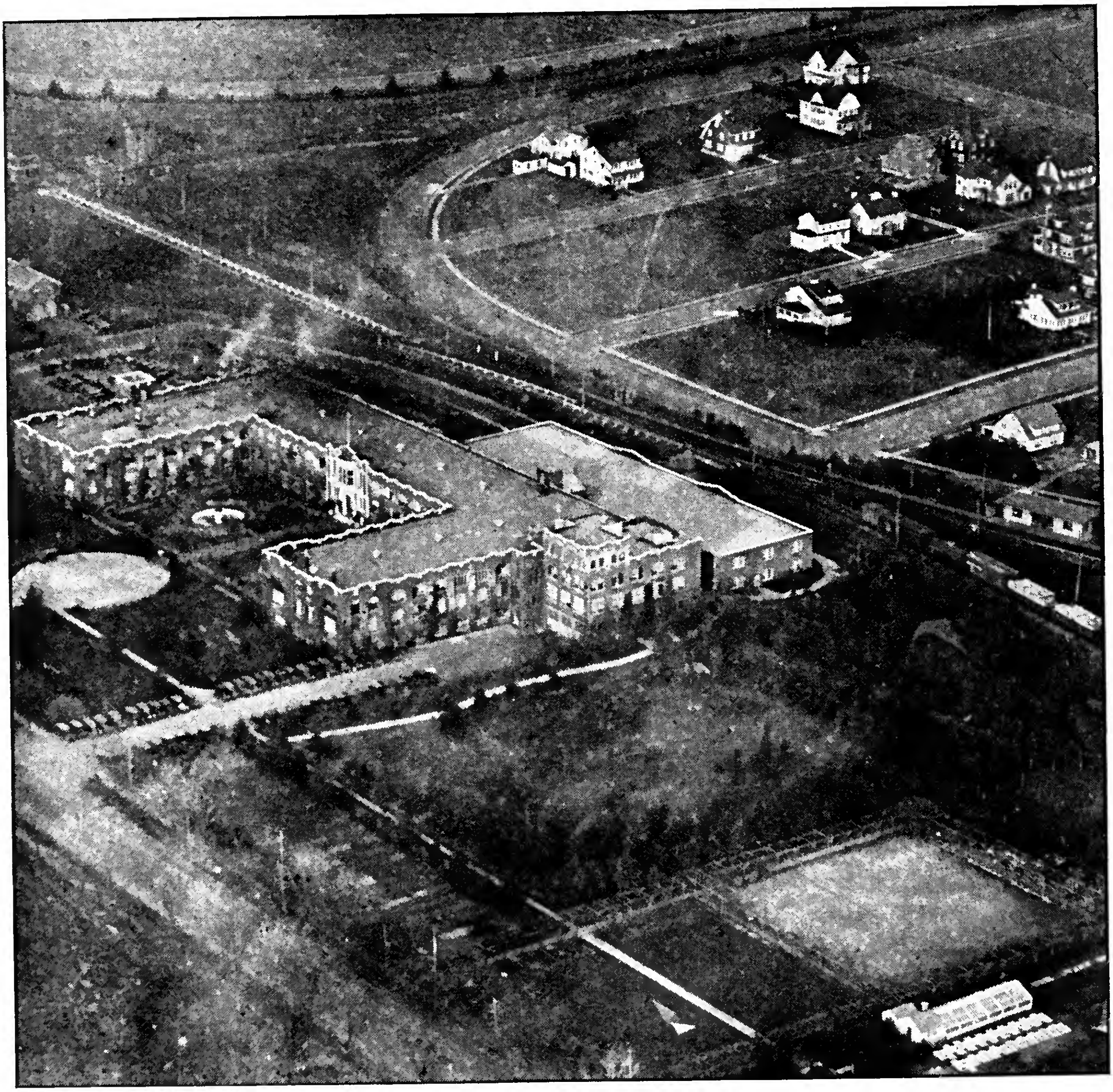
"At my age, many men go to seed. They turn their faces toward the sunset and hasten the setting of the sun by dwelling upon the approaching end. Not so with me. Radio has opened a fascinating realm of study. I am reading up on the principles of electricity, the construction and action of storage batteries, the science of sound, the chemistry of light, Everything of a scientific nature is interesting to me now.

"WE ARE LEARNING THE CODE TOGETHER"

"And then there is the code. If any one tells you a man is too old to learn, tell him for me it is not so. Stir up the stagnant brain cells with something of absorbing interest and you *can* learn.

"The days are too short. I begrudge the hours I spend in sleep. I am so far behind in my play. Now I have so much in common with the boys of the neighborhood. Perhaps you think it more seemly that I should sit quietly on my porch in carpet slippers and skull cap smoking a long pipe instead of playing with the boys. No, I forget I am old. I am always busy. I sing at my work bench. My heart is young. The boys come to me and we have good times, splendid times together. We speak the same language, a language of enthusiasm and happiness."

As he tied up his packages, I noted an eagerness in the movements of the old man. His eye sparkled with enthusiasm. There was a faint flush on his wrinkled cheek, and under his coat beat the heart of a boy. We took leave of one another, and went our separate ways. I felt that I had received adequate answer to my question, "Do you find radio an interesting pastime? and if so, why?"



THE CENTER OF ACTIVITY IN THE RECENT TRANSATLANTIC BROADCASTING TESTS

Airplane view of the Doubleday, Page & Co. offices and plant (Country Life Press) and gardens. The diminutive building just to the left of the greenhouse, at the lower right, is the new RADIO BROADCAST laboratory. Here, during the week of the tests, the super-heterodynes and a six-tube reflex set were used in hearing England. Here also were received, by telephone and telegraph, messages from hundreds of American listeners-in who themselves heard England. A direct wire from the laboratory to the Radio Corporation's "Radio Central", at Broad Street, New York, controlled the transatlantic radio telegraph circuit. Informing London how the British broadcasting stations were coming in was thus a matter of seconds. (The editorial office of this magazine is in the right inner corner of main building. Telephone and buzzer lines connect the office and the "shack")

How Loud Shall the Loud Speaker Speak?

By R. H. MARRIOTT

Radio Aide, United States Navy, Bremerton, Washington

IN THE dining, dinning or dancing room of a certain popular United States city hotel, several young fellows with slick hair and urban manner supply power intermittently to saxophones, drums, horns, pieces of wood, pieces of metal, and a piano. The room is full to overflowing with the sounds they produce.

Twenty miles away, at the end of a trail and between hills, in a little clearing in the big timber, is a log cabin. There, the finest phonograph records are played with a very soft fibre needle. There are woods sounds and a babbling brook. There is no din. And there are many who walk miles to enjoy that place.

I live between those two places and hear radio broadcasting, and hear criticism of what broadcasters broadcast, and criticism of what loud speakers speak.

Some criticisms deal with the subject of loudness. For example the Watts family has the Listener family in to hear their radio, and the next day Mrs. Listener remarks to a neighbor that the Watts's radio loud speaker is too loud, and Mr. Listener tells his fellow men that the Watts's radio is mighty noisy. On the other hand some listeners are dissatisfied with other radios because the sounds are too faint.

"What is normal loudness?" is often asked. A good answer is: "Conversational loudness is normal loudness." A good rule is to adjust the radio equipment so that the broadcast announcer talks as loudly through the speaker as he should talk if he himself were in the room.

In the quiet home, very little power is required to bring the sound to the ears at conversational loudness. In a boiler shop conversational loudness needs to be as loud as in a quiet place, and must also be as loud as the boiler shop noises. In the boiler shop, the ears are strained and the voice is strained. The sound is painful and the producing of the sound waves is painful.

Loud speakers should not be operated in a way that pains the listeners and strains the radio equipment. If the loud speakers are operated in a noisy place, they must be operated louder than the noises. In trying to make the broadcast louder than the local noises the radio and sound equipment may be strained so the equipment adds squeaking or sputtering sounds. Usually the next step is to make the speaker speak still louder so the broadcast that the speaker gives out, added to the noise it gives out, are together very much louder than the local noises, and then the broadcast is heard. That hearing is sometimes a painful process.

The tendency to overcome local noises by making a loud speaker speak louder is wrong because instead of securing pleasing sounds, that method, if pursued far enough, will certainly produce painful loudness. If the same amount of effort, thought, and money are applied to eliminating the local noises, better results should be obtained. Closing a door will sometimes shut out more noise than one amplifier could overcome. And if the broadcasting station is close enough, a crystal detector can furnish power enough to give pleasing results in a soft walled room.

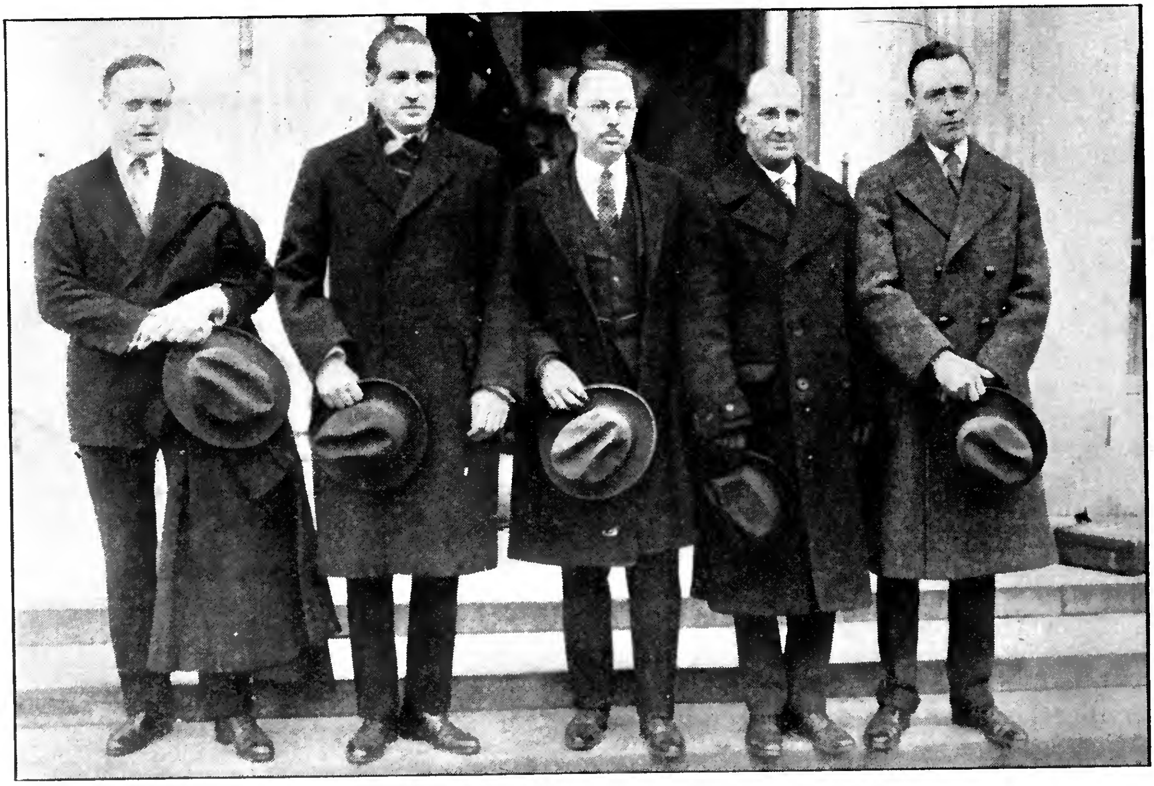
Not only is painful loudness sometimes the result of attempting to drown out interfering loud noises, but painful loudness and straining of receiving equipment is sometimes the result of attempting to overcome reflection of sounds. For example: If part of the sound from the speaker comes direct to the ear while another part of that same sound goes direct to a hard surface and is there reflected to the ear, that reflected sound is usually an interference. The reflected sound has traveled farther and therefore does not enter the ear with the same sound it started with. It more or less deforms the direct sound that is entering the ear when it gets there. If all of the sound given by the speaker is small, then the undeformed difference between the strength of the direct sounds and reflected sounds may be too small to be intelligible. By increasing all of the sound from the speaker the difference between the direct and reflected sound may be made intelligible, but the total loudness may be painful and the radio receiving equipment may be strained.

Glass in windows reflects or transmits nearly all of the sound that strikes the glass. The glass windows let in noise interference from the outside and produce reflection interference inside. Open windows produce no reflection, but let noises come in. Double glass with a dead air space between will cut out much of the interference from the outside, but the inside glass will reflect. Soft, thick, closely knit curtains will reduce the noises from the outside and reduce the reflection inside. Noises may be prevented from entering through a ventilation opening by hanging a heavy curtain, that is broader than the opening, in front of the opening and a few inches from it.

Hard, smooth plaster walls and ceilings usually produce the most reflection and interference because of their size. Soft paper or cloth having a deep soft surface like blotting paper or felt will reflect very little sound.

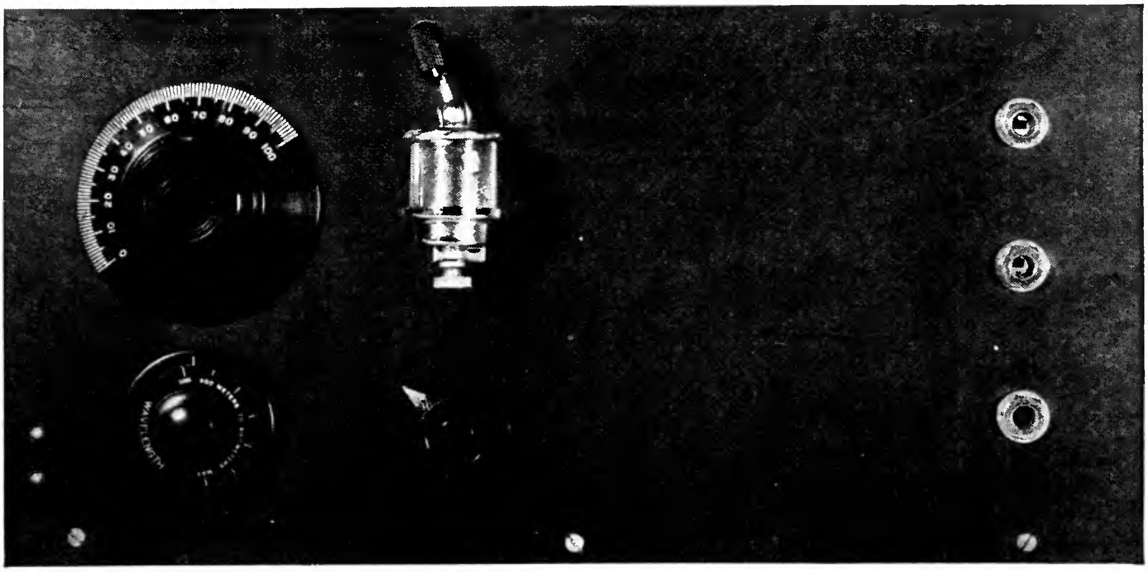
Any hard, smooth surface is a sound reflector which usually produces interference, while soft material like upholstery, felt, or shoddy absorbs sound and prevents interference. Any hard and rough surface reflects but it reflects from many adjacent angular surfaces and does not produce much interference, because the reflected sound waves are thrown into each other contrariwise and neutralize themselves to a considerable extent before they reach the ear.

Painful loudness can usually be avoided by choosing the room with the softest lining for your loud speaker, by cutting out and shutting out local noises, by selecting for reception a broadcasting station that is near enough to give too much volume, and then by cutting down the volume here and there until the announcer talks like a gentleman.



SEEK RELIEF FROM CODE INTERFERENCE

Representatives of the *Boston American*, the National Association of Broadcasters, and the Radio Club of America called on the President suggesting that commercial traffic be abolished on 450 meters—that more funds and increased personnel be granted the Department of Commerce for radio—that the radio laws of 1912 be brought up to date by revision. Left to right, Walter Howey, Managing Editor, *Boston American*; George Burghard, President, Radio Club of America; J. V. L. Hogan, Radio Club of America; J. Shephard, Vice-President, National Association of Broadcasters; and Paul Godley, Radio Club of America



THE RESULT OF CAREFUL WORKMANSHIP
Front view of the reflex set described below

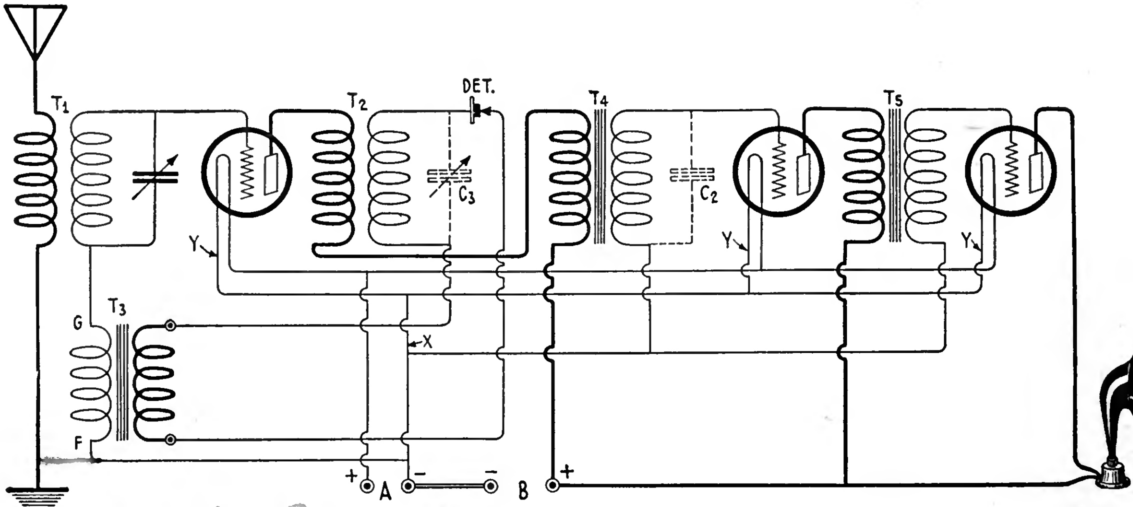
A "Knock-Out" 3-Tube Set

A "How To Make It" Article

EVER since the publication in the November RADIO BROADCAST of the "knock-out" one-tube set developed by Mr. Kenneth Harkness, enthusiastic readers, sensing the possiblities of further amplification, have clamored for the addition of two audio stages. Many have added a single stage successfully, as suggested in this magazine. However, the addition of the ultimate second external step has been made impossible by howling, on which the usual remedies of grid biasing, the lowering of plate voltage, the mounting of transformers at right angles, and the use of separate A and B batteries have had little or no effect. These are methods of stabilization which are ordinarily effective in the correction of magnetic feed-back, that is, the interlocking of magnetic fields, resulting in undesirable induced effects.

Investigation in the RADIO BROADCAST laboratories showed that the feed-back in the case under discussion was almost entirely capacitative—capacity between the exterior amplifier and the reflex part of the circuit through external objects, such as the operator, near-by electric wiring, etc. When the phones were used on the last or second stage, the receiver squealed loudly when the tuning dials were approached but the squealing ceased the moment the operator was grounded. Shielding will probably suggest itself immediately to the prospective builder as the obvious solution, but, in many cases, it will be only partially corrective. Perhaps, if the complete set were boxed and paneled in metal, the howling tendency would be totally eliminated, but this, as experiments have shown, tends to lessen the rectifying effect of the detector—probably through capacitative bypass.

The solution of the problem was found in the RADIO BROADCAST laboratory, by localizing the difficulty, and applying what is probably the effect of shielding, to the localized area. The grid of the second tube (the first external amplifier) appeared to be the crux of the situation, and a small condenser, C_2, connected between this grid and the ground, completely and definitely eliminated the howling. In



See Errata Page 488

FIG. 1

The "Fundamental Circuit." Build your set with this as a basis if you do not care to follow explicitly the instructions given by the writer, or if you cannot obtain the parts designated. You may use such rheostats, jacks, transformers, etc., as you have on hand and as are within the latitude always allowed the constructor

this particular, and rather unusual connection, there exists also, perhaps, a neutrodyning effect—the system applied so successfully to the elimination of capacity phenomena in radio frequency amplification.

THE CIRCUIT

WE HAVE drawn up for the benefit of our readers, two circuits, the fundamental circuit, Fig. 1, and the specific circuit, Fig. 2. The fundamental circuit, which we shall first consider, is the basis on which the majority of enthusiasts, who are unable to obtain the exact instruments used by RADIO BROADCAST in building the set, must work.

T1 and T2 have been described in detail in the November RADIO BROADCAST, and a very interesting variation, the use of spider-webs, is covered in the "R. B. Lab." Department for this issue. If a homemade T2 is used, the tentative condenser, C3 capacity, .0005, will be necessary. If a Ballantine Varioformer is employed, this condenser is done away with. The audio transformers, T3, T4, and T5 may be any reliable make, such as Acme, Federal, Amertran, etc., with a ratio of approximately five to one. The same make or type of transformer need not be used throughout the circuit. "Det." represents any good crystal detector.

C2 is the anti-capacity condenser, and should be as small a capacity as is effective. Generally a .0005 Micadon suffices. This condenser, incidentally clears up other objectionable noises, and noticeably reduces A. C. induction from near-by lighting wires (electric lights in the vicinity of the operating table, etc.). In a few instances, and with some tubes, this condenser may be unnecessary.

No rheostats are shown in the fundamental circuit. If UV-199's are used, and a steady three-volt source is available, the filament adjustment may be eliminated. If the builder desires to use individual rheostats, one for each tube, they will be connected in the filament circuit at "Y". If a single rheostat is decided upon, as is most likely, it should be inserted at "X". In all cases of resistances, it will be noted that the secondaries of the external audio transformers are brought down to the battery side of the rheostats. This places a desirable negative potential on the grids.

No jacks have been indicated. The constructor may use any type he possesses, or can obtain conveniently, filament control or otherwise. Various types of jacks have been pictured and described in the April issue of RADIO BROADCAST. While jacks are of course advisable, the set will function at all times on the last amplifying stage.

THE SPECIFIC CIRCUIT

THE set as built by RADIO BROADCAST employed the T1 exactly as described in the November issue. T2 is a Ballantine Varioformer. T3, T4, and T5 are Amertran transformers. Standard sockets (De Forest) were used with adaptors for the UV-199's, for which tubes this particular set was designed. A single ten-ohm rheostat controls all tubes through filament lighting jacks of the most easily obtainable type. C2, the anti-squeal condenser, is a .0005 Micadon. The detector is a De Forest stand with a Fada cat-whisker and arm. Forty-five volts were used on the plates of the tubes, and four and a half volts on the filaments.

BUILDING THE SET

OUR first experiments with this apparatus were conducted with the set built up on a base-board, as shown in Fig. 3. Such temporary construction is always a good idea, and is invariably followed by veteran experimenters. It facilitates various tests, and makes possible the definite designing of the ultimate apparatus. The base-board measured sixteen by ten inches, and Fig. 3 shows very plainly the distribution of the instruments. It will be noted that, even in the temporary installation, wiring has been done with at least a semblance of care. Neat wiring consumes a bit more time, but it is worth the extra trouble. In the case of inoperation, it eliminates careless running of leads as a possible and frequent source of difficulty.

Figs. 4 and 5 show the completed set of so simple design that any one can follow our instructions. It was with simplicity in mind that RADIO BROADCAST has eliminated all constructional gymnastics, such as shelves, brackets, etc., which often strain the ability of the average fan. Straight base and panel mounting has been adhered to throughout, with the possible exception of T1, which may be mounted on a three inch square shelf resting on top of the reflex audio transformer, if the experimenter is unable to accomplish the feat of securing it to the variable condenser.

Fig. 6 is a working drawing of the panel. The comparatively large hole, $1\frac{3}{4}$ inches in diameter, passing the Ballantine Varioformer (which should be of the panel mounting type) is made by drilling a circle of small holes.

The base (see the insert of Fig. 6) is 13 inches long, six inches wide, and $\frac{3}{4}$ inch thick. This thickness makes a firm support for the panel which is fastened to it by three screws, $\frac{3}{8}$ inch up from the bottom. This, in conjunction with rigid wiring, holds the panel quite firmly. The base, one inch shorter than the panel, makes possible the use of a cabinet with grooved sides into which the panel is slid.

Fahnstock clips have been employed for the battery connections, and are screwed to the rear of the base, between the audio transformers as shown in the insert. "A" indicates the A battery terminals and "B" the high voltage connections.

CONSTRUCTION HINTS

THE panel should, of course, be drilled, grained if desired, and fastened to the base-board as the first step in construction. All panel instruments, C1, T1, T2, detector,

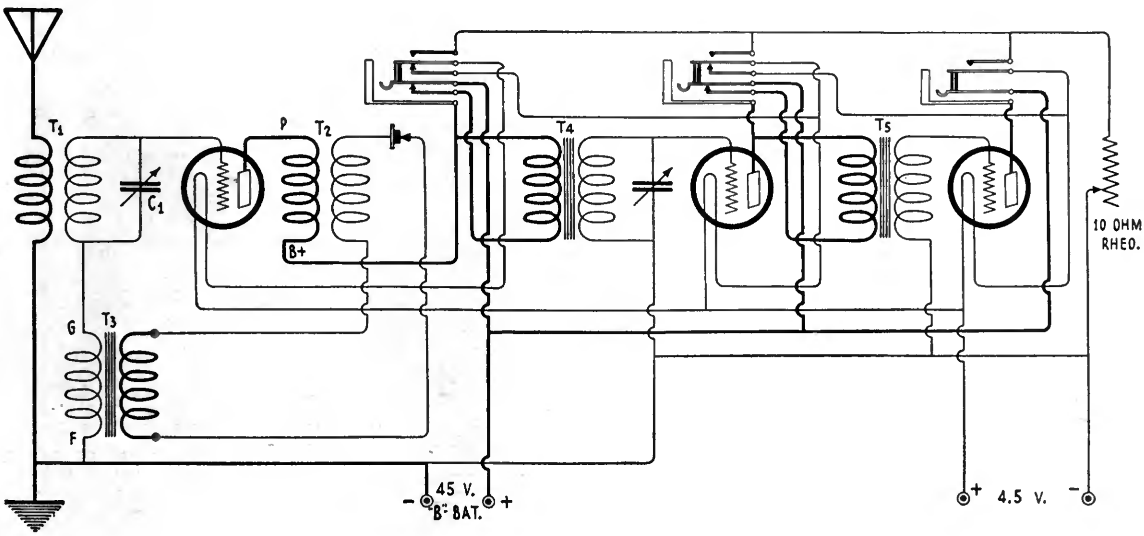


FIG. 2
The "Specific Circuit." This is the modification of the fundamental circuit used by RADIO BROADCAST in building the set described

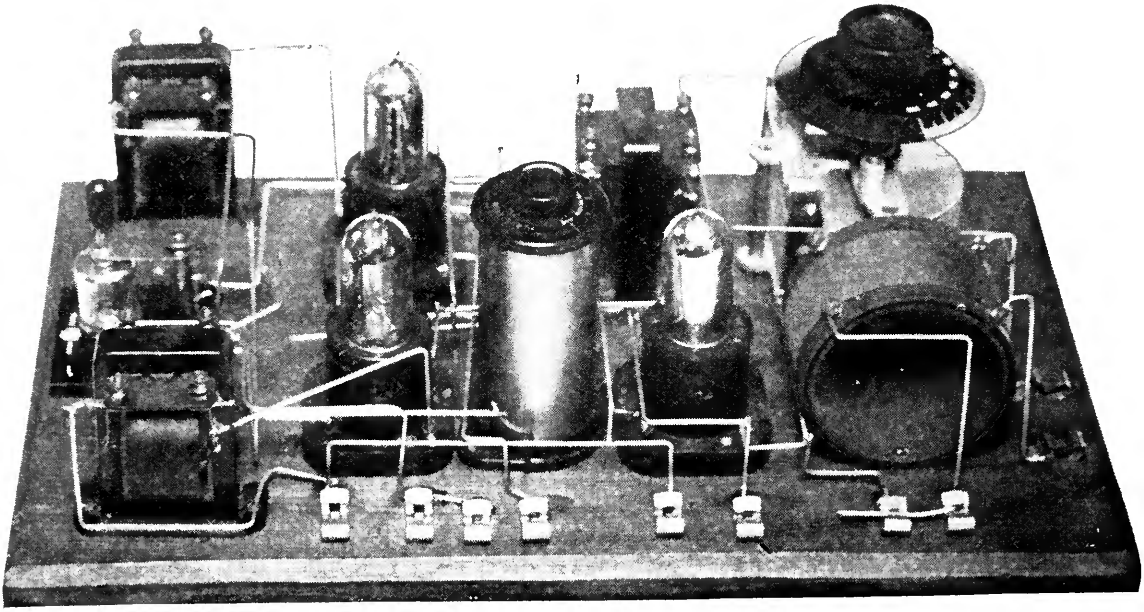


FIG. 3
The temporary set, built up on a base-board, where it was completely tested, and when it was proved satisfactory it was properly wired on the panel, as seen in Fig. 4

rheostat and jacks, and antenna and ground binding-posts, are next mounted, along with the sockets and T3 on the base. The positive filament connections on the sockets are wired with a single straight piece of bus-bar wire, and the connections of the reflex or tuning circuit are made complete. T4 is next mounted, along with the Fahnstock clips, two on each side. All filament control connections are now made, as well as those to transformer T4.

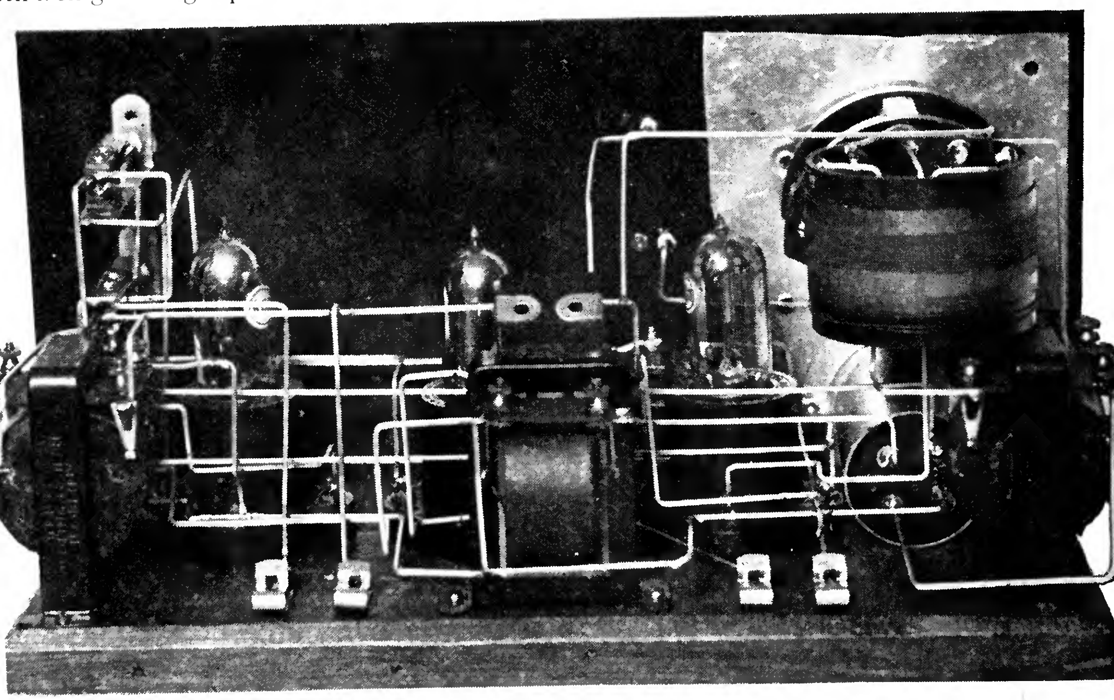


FIG. 4
Rear view of the completed set. Note the neat wiring, and the partial shielding

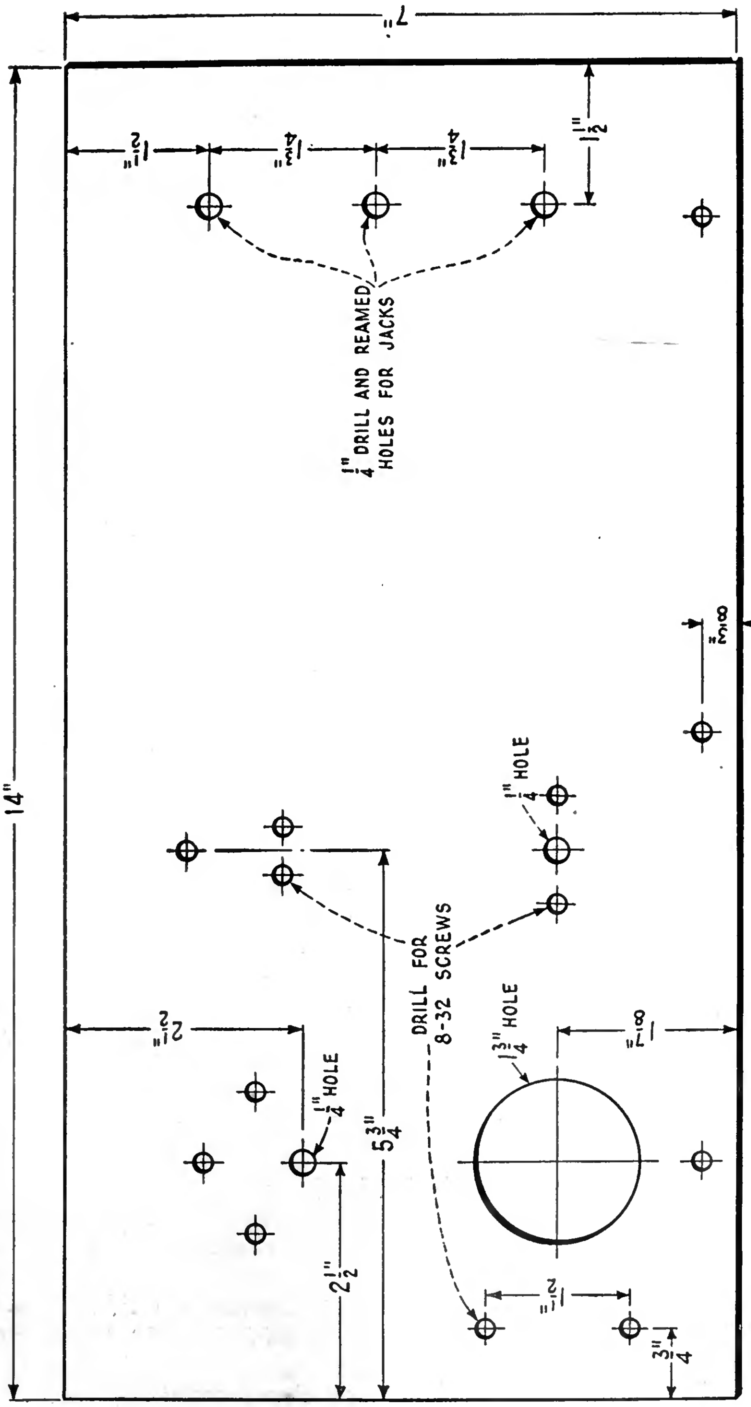


FIG. 5
Working drawing of panel, half actual size

Allowance in wiring the jacks must be made for the position of T5, which is the last instrument mounted and wired. It is suggested that wiring be done with bus-bar or hard-drawn copper wire, avoiding all types of insulation. Wiring, for the sake of neatness and efficiency, should be run straight and with right angles, and, needless to emphasize, all joints soldered.

Shielding may be used, and in some cases it may eliminate the necessity for the anti-capacity condenser, C2. However, it is suggested that the shielding be localized, and only

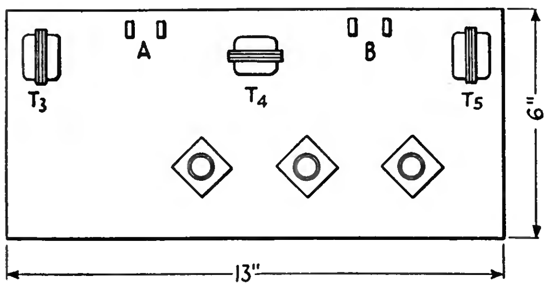


FIG. 6
Showing arrangement of units on the base

that one third portion of the panel on which the tuning elements are mounted be protected in this way. The shield is connected to the case of the Ballantine Vario transformer under the clamp which holds both the transformer and the shielding in place. The shielding is not grounded.

RESULTS

THE set, as shown in Figure 4, is the best dry cell equipment that ever has been brought to the attention of the writer. It is remarkably sensitive, and will bring in distant stations on the loud-speaker. During comparative tests in New York City, Chicago was received on this little set, with greater intensity than on one of the most efficient regenerative receivers made. The regenerative set was using storage battery tubes, detector, and two steps, with one hundred and thirty volts on the plates of the amplifying tubes. The reflex set employed the same number of UV-199's, with a plate voltage of forty-five.

The second stage of external amplification is never necessary for loud-speaker reception of local signals, and, in the case of the UV-199, which is limited in the amount of power it can handle, will give only a slight additional amplification, and will probably distort signals.

The possibilities of this remarkable little set as a portable receiver need no delineation. Its senstivity is such that it will operate on the most makeshift of antennas, such as 125 feet of wire thrown over the limb of a tree (*a good ground, however, must be used*), and the necessary batteries add but little to the bulk and weight.

If You are Thinking

Of submitting an article to RADIO BROADCAST, you may save yourself and the editors time and trouble by considering the following notes as to what we want and what we cannot use:

WE WANT:

True accounts of the uses of radio in remote regions.

Short, true stories of adventures in which radio played an important part: unusual and interesting occurrences to you or your acquaintances.

Clear explanations of new or especially effective circuits or uses for apparatus.

Concise and logical discussion of some important problem or phase of radio, whether in the field of broadcasting, constructing, operating, buying or selling; or of reading or writing that has to do with radio.

True accounts, of some particular interest, relating "What Radio Has Done For Me."

Humor, when the object is not merely to appear funny, but to present some phase of radio in an attractive, amusing way. The same applies to drawings.

Clear, unusual photographs are always in order, as are good circuit diagrams.

A liberal rate is paid for material used.

WE CANNOT USE:

Fiction, unless it deals in a striking way with some subject of interest to those interested in radio.

Articles or illustrations to which RADIO BROADCAST would not have the exclusive rights.

The best way to do is to read several numbers of the magazine to get an idea of the various kinds of articles we publish.

The Right Insulator in the Right Place

The Best Kinds to Use for Cabinets, Coils, and Condensers

By PAUL McGINNIS

THE builder of a radio set thinks first of all of conductors, proper sizes of wire, and proper connections and is likely to overlook the fact that without insulators there could be no conductors. He knows in general that a rubber composition is better than wood for making panels, but he may ruin an otherwise good set by overlooking smaller details of insulation in out-of-the-way places behind the scenes.

The only difference between conductors and insulators is in their resistance to electrical current. In the class of materials called conductors, the cohesion between the atoms and their electrons is considered to be overcome more easily by electrical pressure than in the materials called insulators.

The vast difference in the common kinds of insulation is particularly important in radio where alternating currents of high frequency are used, and especially in transmitting apparatus where high voltage is employed. The problem of covering coil windings with a proper insulating compound is one which presents itself to the amateur at an early stage in his radio progress. He wonders whether he should use paraffin or shellac. The paraffin will rub off more easily, he thinks, and decides to use shellac, perhaps, because it is a "good insulator." Shellac is in fact a "good insulator," since one cubic centimeter has a resistance of millions of millions of ohms; but a glance at the accompanying table will show that paraffin may have more than 500 times the resistance of shellac! A coil wound with cotton-covered wire and dipped in paraffin is usually well insulated.

Sealing wax is good for fastening wires in place and generally for use where large quantities are not required. It remains firm and is easy to apply. It has a much higher resistance than beeswax or other ordinary waxes which the amateur is tempted to use.

Where large quantities of wax-like material are required, sulphur can be used to advantage. It is much better than sealing wax, as the table indicates. It may be better than ordinary paraffin and is much more durable where it is exposed to wear.

A beautiful panel can be made of wood, and its possibilities are tempting to the novice. When he hears of the high prices quoted for patented panel material, he has another argument in favor of wood.

If he does use wood, he should select the hardest available and give it a thorough painting with hot paraffin (hard wood like mahogany is best and is quite practical); but the best panels are made from rubber or some chemically-prepared insulating material. Hard rubber is one of the best insulators known, being superior even to porcelain or glass. Mica or moulded mica can be used to advantage for insulating small parts.

Climate may well be considered in addition to these fundamental characteristics of insulators, since both temperature and humidity change the resistance materially, and may make considerable difference in the operation of a station.

A change of ten degrees in temperature may make a change of sixteen times the original resistance of a substance such as beeswax. Sealing wax is one of the most stable insulators at normal temperatures, but all insulators are affected by heat. In government experiments, it was found that bakelite had 300 times as much resistance at 25 per cent. humidity as at 90 per cent. Such substances as marble, slate, and hard fibre, which are slightly porous, are also affected, but to a lesser degree. Although shellac absorbs much moisture, its resistance changes little with humidity.

SURFACE LEAKAGE

ONE of the chief causes for changes in the resistance of materials with humidity is surface leakage. This is an important consideration when choosing insulators for use in humid climates. The surface leakage is not caused by the material itself so much as by the film which accumulates on it. The film is composed largely of moisture condensed from the humid atmosphere. In general, hard substances have more surface leakage than soft substances. At high humidities, there may be a change of ten per cent. on account of surface leakage, and this deficiency lasts for several hours and sometimes as much as a month after the humidity is lowered.

Since good oil is one of the best insulating materials, it can be used to avantage in many places. When moisture meets an oily surface it tends to collect in drops which otherwise might spread over the surface and cause a filmy leakage path.

Air is an insulator, but is not so good as the ordinary solid insulators. Where bare conductors come close together they should be kept apart by some solid insulating substance.

In the case of condenser action, insulators exhibit another property quite out of proportion to their insulating power. It is called the dielectric constant and must be considered when building a condenser. Air is taken as the unit of measurement in the accompanying table and the constants of other materials are figured in proportion to that of air:

TABLE* OF COMPARATIVE RESISTANCES OF VARIOUS INSULATORS TO HIGH-FREQUENCY CURRENTS

The figures given must be multiplied by 1,000,000,000,000,000 to find the ohms resistance of a cubic centimeter.

Amberite	50
Bakelite	.004–20
Beeswax	2
Celluloid	.00002
Condensite	.00004
Dielectrite	.005
Electrose	.1–20
Fibre, hard	.00002
Fibre, red	.000005
Glass	.001–.05
Halowax	.02–20
Hard rubber	1000
Marble	.000005
Mica	2.–200
Paraffin, special	over 5,000
Paraffin, ordinary	10.–100
Porcelain	.3
Quartz	over 5,000
Redmonite	.2
Rosin	50.
Sealing Wax	8.
Shellac	10.
Slate	.0000001
Sulphur	100.
Wood, mahogany	.04
Maple	.00003
Poplar	.0005

*Prepared by the Bureau of Standards

TABLE SHOWING CHANGE OF RESISTANCE WITH TEMPERATURE

These figures show the ratio of the resistance at 20 degrees Centigrade to that at 30 degrees, based on experiments of the Bureau of Standards.

Sealing Wax	.9
Mica	1 to 2.
Shellac	1.5
Celluloid	1.8
Parawax	2
Bakelite	2.4 to 3.6
German glass	2.5
Red fibre	2.6
Hard fibre	3.2
Plate glass	3.2
Paraffined wood	3.6
Beeswax	16.

TABLE OF DIELECTRIC CONSTANTS AS USED BY THE SIGNAL CORPS

The capacity of a condenser using various substances as the dielectric is given in ratio to the capacity of the same condenser using air as the dielectric.

Air	1.
Glass	4 to 10
Mica	4 to 8
Hard Rubber	2 to 4
Paraffin	2 to 3
Paper, dry	1.5 to 3
Paper, treated as used in cables	2.5 to 4
Porcelain, unglazed	5 to 7
Sulphur	3 to 4.2
Marble	9 to 12
Shellac	3 to 3.7
Beeswax	3.2
Silk	4.6
Celluloid	7 to 10
Wood, maple, dry	3 to 4.5
Wood, oak, dry	3 to 6
Molded insulating material, shellac base	4 to 7
Molded insulating material, phenol base (bakelite)	5 to 7.5
Vulcanized fibre	5 to 8
Castor oil	4.7
Transformer oil	2.5
Cotton seed oil	3.1

I Had to Tell It

How Poetry and Vocal Salesmanship Combined to Make a Radio Newspaper Pay on the Great Lakes

By WILLIS KINGSLEY WING

"I DOUBT it," said the Superintendent. "You can't make a wireless newspaper go on the Lakes, even if you have got the longest run out here. Your passengers won't be interested in a daily paper when they are out for a pleasure cruise. This isn't salt water."

"But," I interrupted, "we have them for nine days and the trip is nearly 2,400 miles long. Buffalo to Duluth and back, you know."

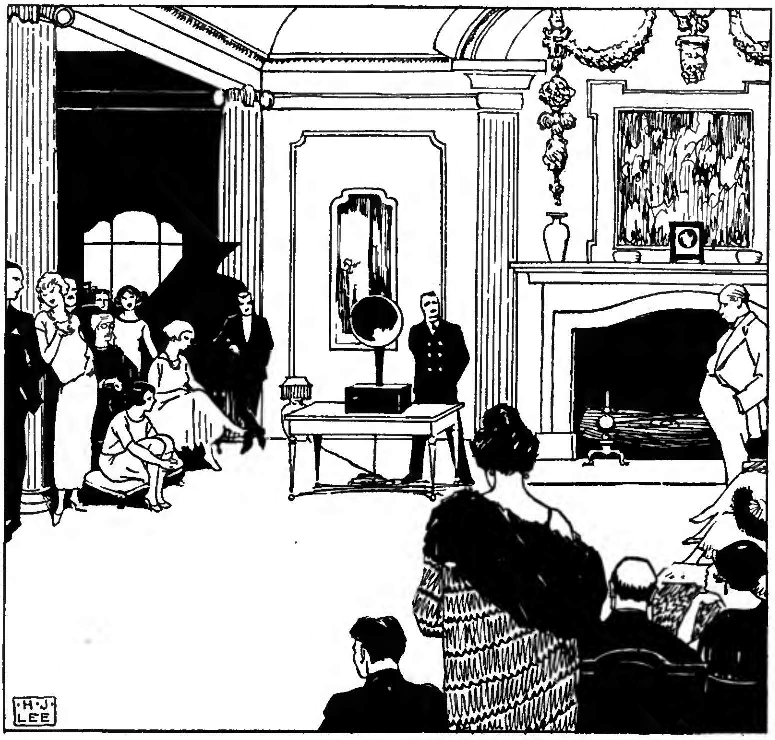
It was a warm day in early June and the Superintendent was in a hurry. He relented. "All right, go to it," he said. "Get your assignment slips for your vessel and hop down and convince the steamship owners. You haven't much time. Your ship sails in two days."

I got out of the wireless company's office, and past the long line of operators waiting assignment in the "static room" as quickly as I could. The battle was nearly won.

The steamship people weren't nearly as hard to convince, and in an hour we had all arrangements made. The arrangements for that paper—grandiloquently named the *Great Lakes Radio News*—cost me one luncheon and two special-delivery stamps. I submit that to the promoting people as about the last word in low "first costs."

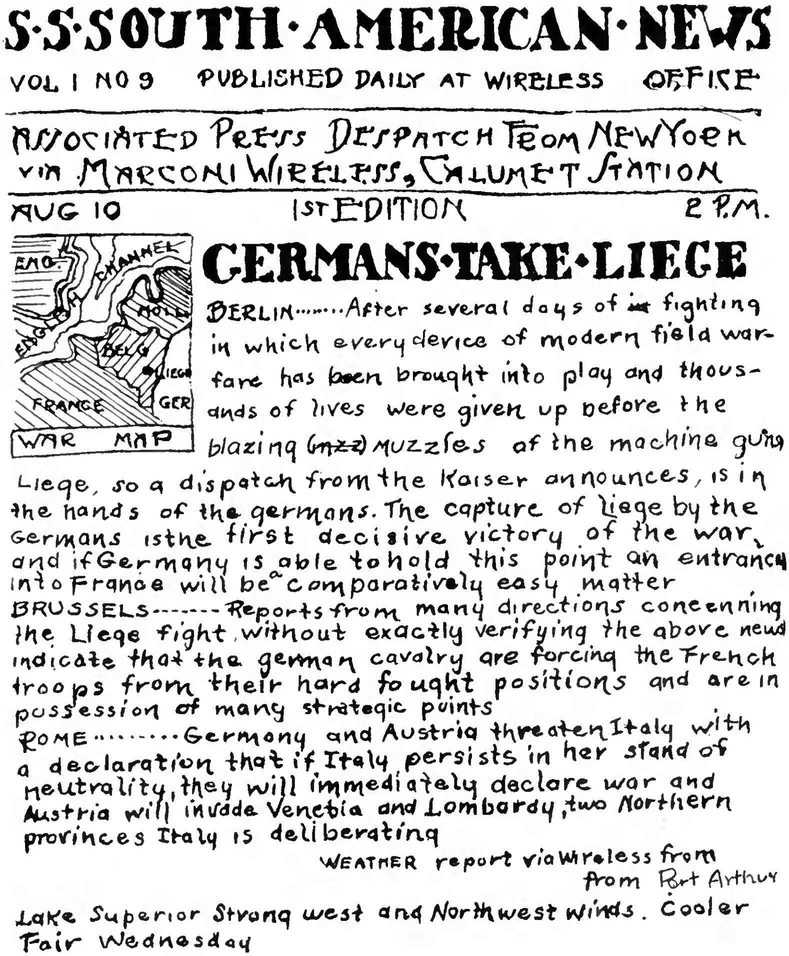
Wireless papers had been tried on the Lakes before and had failed. One of the first was printed on the SS. *South American* during the exciting days of 1914. My junior operator and I had the job of making a radio newspaper bloom where radio newspaper had never bloomed before.

We issued no metropolitan daily of 48 pages. Ours was a simple four-page affair, but it was all news. First we had the latest weather forecasts which came in by radio from the Canadian and American stations and then we featured the baseball scores. Five hundred words of condensed press matter followed, which we copied from broadcasting stations and high-power code stations. And, honorably bringing up the journalistic rear, was the passenger list—a highly important item. Few papers can exist without a social column and the passenger list was our social department.



THE YOUTH AND BEAUTY OF THE SHIP GATHERED IN THE MUSIC ROOM

The insurance people especially were positively agog waiting for the address of their president, back in C. But in the radio cabin, there were smiles of another wavelength



S·S·SOUTH·AMERICAN·NEWS

VOL I NO 9 PUBLISHED DAILY AT WIRELESS OFFICE

ASSOCIATED PRESS DESPATCH FROM NEW YORK via MARCONI WIRELESS, CALUMET STATION

AUG 10 1st EDITION 2 P.M.

GERMANS·TAKE·LIEGE

BERLIN......After several days of fighting in which every device of modern field warfare has been brought into play and thousands of lives were given up before the blazing muzzles of the machine guns Liege, so a dispatch from the Kaiser announces, is in the hands of the germans. The capture of Liege by the Germans is the first decisive victory of the war, and if Germany is able to hold this point an entrance into France will be comparatively easy matter

BRUSSELS-------Reports from many directions concerning the Liege fight without exactly verifying the above news indicate that the german cavalry are forcing the French troops from their hard fought positions and are in possession of many strategic points

ROME.........Germany and Austria threaten Italy with a declaration that if Italy persists in her stand of neutrality, they will immediately declare war and Austria will invade Venetia and Lombardy, two Northern provinces Italy is deliberating

WEATHER report via wireless from from Port Arthur

Lake Superior Strong west and Northwest winds. Cooler Fair Wednesday

ONE OF THE FIRST GREAT LAKES WIRELESS DAILIES

The edition was limited to fifty copies—the capacity of the hectograph on which it was printed

So, promptly at 6, the first copies of the sheet were waiting the early rising passengers, out for a promenade before breakfast.

However, our first issue did not roll off the press as easily as we had anticipated. The occult ways of a mimeograph were new to us, the paper jammed in the rolls, and the ink got all over the deck of the radio cabin and ruined one rather handsome uniform. I wouldn't have minded that first attempt so much if it hadn't been for a couple of grinning sailors outside our door, intent on superintending our unheard-of operation.

After the first couple of issues had been printed and partially sold (they didn't go so well at first), our wireless-journalism combine learned several things. First, we needed an advertising department, a sales force, and some interested reporters to scour the ship for news.

The passengers were eager enough to help us gather news. My junior and I passed the word to a carefully chosen few on the first trip, and after that it was easy. "Who is that fascinating-looking man?" some one asked me after we had established our paper firmly, by three successive and successful issues. The tip was passed to one of our star reporters, that bobbed-haired girl from Wellesley, I think, and in an hour we had unearthed the winner of a newspaper popularity contest in Wilkes-Barre, Pennsylvania. Oh, getting the news was easy.

When does a wireless operator have time to gather and print the news, you are probably asking yourself. That is easy. Since we had the steamship company print the blank forms—with space left for the news and passenger list to be mimeographed in, we had no worry about elaborate printing machinery nor fear of strikes in the composing room. Reporters demanding an unholy increase in pay after making a big news "beat" bothered us not at all. Ours was a close corporation and we two could "point to ourselves with pride" as Editor, Owner, Publisher, etc.

Blithely, I undertook the task of preparing the news and cutting the stencils for the mimeograph machine with our radio typewriter-of-all-work. And during the dull hours of the dog watch, my junior printed our daily masterpiece.

But our "news" did not always prove to be accurate. A man came to the radio office with an item about a birthday party being held in Parlor M for Miss Gumble in celebration of her 21st birthday. Serenely, we printed it. The next day Miss Gumble descended on the editorial sanctum. Miss Gumble was plainly

"HUSBANDS ACCOMPANIED PROTESTING WIVES——
"Small children and older men all came and made me verbal faces"

40. I don't see yet why she was so disturbed; we said 21. Anyhow, her friends thought it a great joke and we sold that issue out entirely. Figure it for yourself at ten cents each. Our publishing costs were exactly nothing, because the steamship company furnished the paper and the mimeographs. The mathematics, if you insist: 1 social note = 150 papers = $15.00. Easy.

The most consequential item we ever printed was probably the most innocent in intent. My watch at the key was nearly over, the paper was almost written, but at the very end was a disgusting gap. So in the "Ship Gossip" department, this harmless paragraph went in:

Shipboard conversational struggles are frequently difficult, and the *Radio News* is making its heroic struggle to aid the *Tionesta* traveling public to a way out. Any bona fide passengers (i. e., those who have paid their passage money and who can point to at least 8 laps around the deck per day) who submit five good conversational tags to replace the following will be given a year's free subscription to the *News:*

(1) "Isn't it calm?"
(2) "Have you walked your mile?"
(3) "Do you like the water?"
(4) "Don't you think ships are romantic?"
(5) "Are you seasick?"

The next morning one hundred and fifty (150) passengers, by actual count, dashed up to the radio cabin and demanded to know if I referred to *their* conversations in the radio room on this day or that. Husbands accompanied protesting wives, small children and older men all came and made me verbal faces. What did I mean by slurring them? But the husbands' eyes held a twinkle.

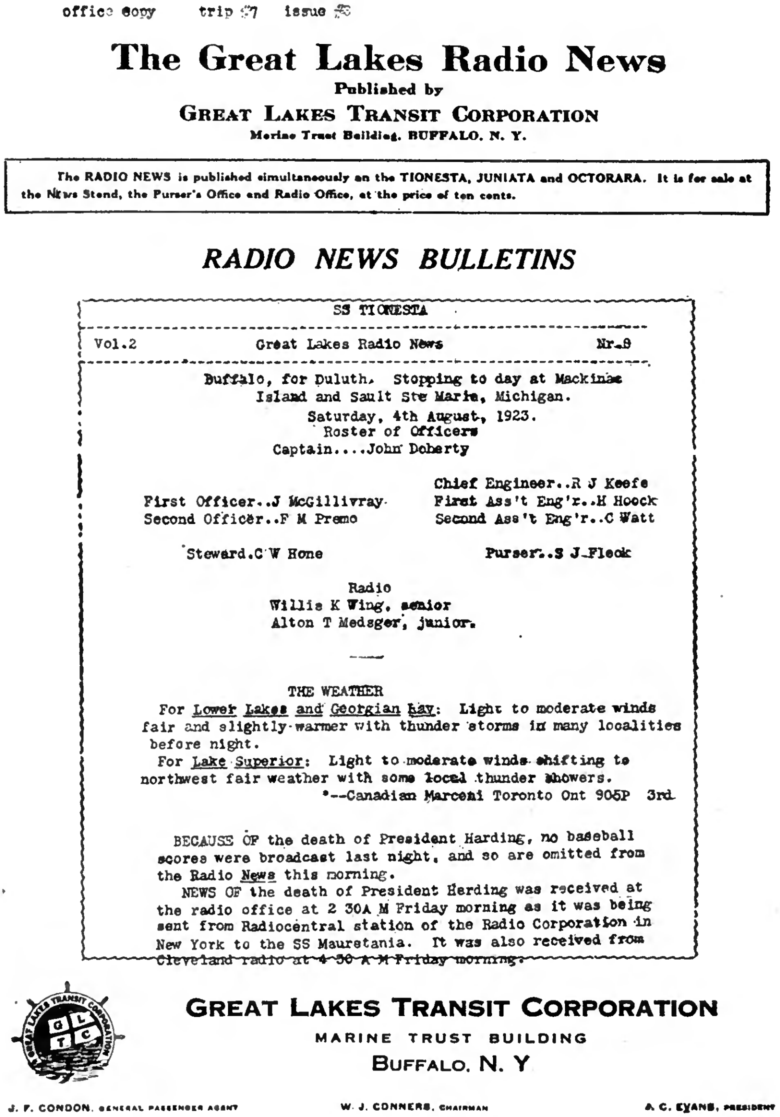
Another time we had a party of life insurance men and their wives aboard. The trip was awarded them as a bonus for selling $100,000 or more insurance in a year. Things were growing dull after the second day and the director of the party dropped in the radio room for a chat.

"What am I going to do to amuse these people to-morrow?" he asked, hardly expecting an answer. I looked at our broadcasting receiver, and was struck by one of the few good ideas I ever had. "Why don't you give them some special broadcasting: a personal message from the president of the company, back in C——?"

"But we can't arrange that," he argued. "There isn't time."

"You see that power amplifier on our broadcast set?" He admitted he did. "Well," said I, "we have a telephone transmitter rigged on it so we can talk into the loud speaker up forward, where the radio concerts come in. Your president controls the broadcasting station in C—— and if you will write a speech that he might give and dig up a man here in your party who talks like him, I'll do the rest."

We did. Our paper came out the next morning with the announcement of a special message to be broadcasted to the insurance party aboard our ship, and the whole crowd thought it was great. The actors got together in our cabin



office copy trip 7 issue 8

The Great Lakes Radio News

Published by

GREAT LAKES TRANSIT CORPORATION

Marine Trust Building, BUFFALO, N. Y.

The RADIO NEWS is published simultaneously on the TIONESTA, JUNIATA and OCTORARA. It is for sale at the News Stand, the Purser's Office and Radio Office, at the price of ten cents.

RADIO NEWS BULLETINS

SS TIONESTA

Vol.2 Great Lakes Radio News Nr.8

Buffalo, for Duluth. Stopping to day at Mackinac Island and Sault Ste Marie, Michigan.

Saturday, 4th August, 1923.

Roster of Officers

Captain....John Doherty

Chief Engineer..R J Keefe

First Officer..J McGillivray First Ass't Eng'r..H Hoock

Second Officer..F M Premo Second Ass't Eng'r..C Watt

Steward.C W Hone Purser..S J Fleck

Radio

Willie K Wing, senior

Alton T Medsger, junior.

THE WEATHER

For Lower Lakes and Georgian Bay: Light to moderate winds fair and slightly warmer with thunder storms in many localities before night.

For Lake Superior: Light to moderate winds shifting to northwest fair weather with some local thunder showers.

*--Canadian Marconi Toronto Ont 905P 3rd

BECAUSE OF the death of President Harding, no baseball scores were broadcast last night, and so are omitted from the Radio News this morning.

NEWS OF the death of President Herding was received at the radio office at 2 30A M Friday morning as it was being sent from Radiocentral station of the Radio Corporation in New York to the SS Mauretania. It was also received from Cleveland radio at 4 30 A M Friday morning.

GREAT LAKES TRANSIT CORPORATION

MARINE TRUST BUILDING

BUFFALO, N. Y

J. F. CONDON, GENERAL PASSENGER AGENT W. J. CONNERS, CHAIRMAN A. C. EVANS, PRESIDENT

WHAT THEY FELL FOR

The first page of one of our four-page dailies that found a ready sale at ten cents each

You have heard the weather forecast just received by radio telegraph from radio station WWW. This is the radio cabin, SS. *Tionesta* announcing. Copies of the *Great Lakes Radio News*, containing baseball scores, late news bulletins, and the complete passenger list are on sale at the radio office. Any passenger, with honest intentions, accompanied by ten cents, will be welcome at the radio office. This is the radio cabin, SS. *Tionesta* signing off.

Did it work? Why they flocked to the cabin for paper. It was positively insidious. But the shock was great the first time we tried it. One little old lady was sitting calmly enough reading Anthony Trollope, or somebody, directly underneath that solemn black horn of our loud speaker. When the voice suddenly boomed out of the horn, for no reason at all . . . well, she was surprised.

Our colored deck stewards used to sell many copies for us. Two of them would report every morning for their fifty copies each. Harry was the most comical negro I have ever seen. I didn't think he could ever be serious, but when he asked me to let him sell some copies for us I thought he might remain solemn long enough to sell his

and rehearsed, we assembled the party in the music room at the appointed hour, I put on my best announcer's voice, and the thing was done. How they fell for it! And when we published the speech in full in the next day's sheet we sold 300 copies. More income arithmetic. 1 broadcasting (fake) = 300 . . . But I refrain.

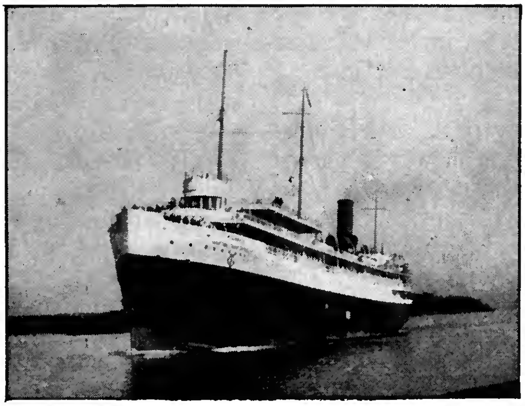
The morning weather forecast would come in and I would read it through the loud speaker and follow it with something like this (with a bow of acknowledgement to the broadcasters):

quota of fifty. So, the first morning he packed his fifty under his arm, never glancing at them. He had gone five steps down the deck when I heard to my horror: "Great Lakes Rado Noos. Stock market falls! Man killed in Albany! Terrible Chicago fire! See your name in print! Great Lakes Noos—ten cents!"

Harry sold the sheet. He had a new "line" each morning and I'll wager half his customers bought the paper to hear him tell about the fearful and wonderful contents. He was a sound salesman when he mentioned the "name in print" idea, for that worked great. That was another fundamental of journalism we learned. Any small-town paper can be a success if it prints the names of enough residents even if they do nothing more startling than take a calm morning drive to the county seat.

We had our tragedies, too. When static was bad it was almost impossible to get the baseball scores. What were we to do? We couldn't make them up out of whole cloth because the baseball fans would check against the daily paper at the next port. I thought in envy of a friend of mine on the South American run, who made up scores for two weeks once when his receiver went bad. He was safe, but we could only make excuses and dig up more personal items—which were nearly as good. One night about three I was jarred awake by my junior operator pulling at my arm. "Say," he cried, "I've got the passenger list printed but our ink has run out. What can we do? We can't print any news."

"Oh, let it go at that," I mumbled, "we'll sell what we have for five cents then."



WHERE THE RADIO FUN WENT ON
The good ship *Tionesta,* which makes an eight-day cruise between Buffalo and Duluth

Newspaper editors are always complaining that they are supposed to know everything from the date the Assouan Dam was completed to the number of children possessed by John R. Twirp, the famous movie star. And we two amateur newspaper publishers—radio operators on the side—encountered the same blind confidence on our ship.

We printed the weather forecast in the paper. And one day, striking some icy weather in Lake Superior, a confident man, shivering in last season's topcoat, stopped at the door: "Say, how hot was it in Sioux Falls to-day?" Distractedly, we made a guess, and the next one came along. "Did it rain in Kenosha yesterday?" Probably.

One trip we had an unusually inquisitive lot aboard. This day our paper contained some facts about the locks at Sault Ste. Marie, Michigan. One of the three locks in use there is 250 feet longer than those at the Panama Canal and they never fail to excite deep interest among the passengers. Just as we were pulling into the lock-channel about a quarter of a mile from them, a woman dashed up, quite breathless. One could see plainly she intended to miss nothing. My guess was that she was one of those mentally thirsty school teachers. "You know," she said, "I have wanted all my life to see the Locks. I've studied up about them, but there is one question I want to ask you. Which end of the boat goes in the Locks first?" How should one answer that?

Our paper brought a lot of interesting people to the cabin, too. I remember the oldish man from Georgia who told me about the thrill he got from tuning up his broadcast receiver in an out-of-the-way camp in Florida and letting a hundred or so of the natives who had never heard good music before in their lives listen to "Roxie" in far-away New York.

And there was the energetic woman who was on her way around the world in her automobile. She had just motored through Japan and got her first news of the Japanese earthquake from our modest radio paper. She was going it alone and told thrilling stories. An American flag on the radiator of her car had saved her from capture by some bloodthirsty Chinese bandits not three months before.

I remember best the lawyer in a small Michigan town who came in and read me Mencken and some of his own poems. Good verse it was, too. He had great stories of his trips to Washington, and interesting nights there at the Gridiron Club, where press correspondents from American and foreign papers come nightly. Our own little sheet was the introduction to that interesting evening.

For the life of me I don't know whether it was more fun printing our little four-page daily or talking to the people who came aft to our radio cabin to praise or blame us. Perhaps (you are thinking) the real thrill came when we looked at our bankbooks at the end of the season.

Perhaps.

When Cowboys Heard Bedtime Stories

An Adventure in Receiving at a Grand Canyon "Dead Spot"

By THOMAS H. McKEE

VISITORS to the north rim of the Grand Canyon, at Bright Angel Point in Arizona, appalled by a sense of remoteness, have exclaimed: "Radio is made for just such places as this! Why doesn't somebody put in a receiving set?"

In the light of the many trials and failures we have witnessed there, our answer has been: "Radio has been thoroughly tried out here and it won't work. The great forest about us absorbs too much of the strength of the ether waves; and with high amplification, static takes possession of the receiving set and drowns out all intelligible sounds. It can't be done. Nature is against it."

This region eighty miles from a post-office and two hundred from a railroad station is probably the most remote area of its size in the United States, and therefore an ideal place for radio to show its worth. But, in spite of ambitious efforts of both novice and expert, the north rim has hitherto remained a blank spot on the radio map.

The north rim stands a vertical mile above the river. Its altitude above sea level is eight to nine thousand feet. Northward from the brink spread a million acres of dense pine forest, cut by long side-canyons three to four thousand feet deep, each with precipitous walls and rocky rims.

The chief obstacle to successful reception has been the astonishing prevalence of static electricity. It is rampant both night and day, and as no one remains in the region in winter, the experiments have all been carried on in summer when static conditions are at their worst. All through the summer thunder-storms are frequent, with lightning stabbing viciously and constantly at the high pinnacles and promontories which stand out from the rim. No wise person ever stays near the Canyon's brink during these electrical bombardments, though withdrawal a few hundred yards from the verge brings one into a zone of reasonable safety. Standing there the stranger is filled with awe as his ear-drums are pounded by the mighty thunder-claps and the rolling reverbations from the Canyon walls. It suggests some bitterly fought contest of unseen Titans, whose struggles threaten the overthrow of the precipices themselves.

It is no uncommon thing for persons in shaking hands with one another to be startled by a spark passing between them. One wearing a silk-lined coat draws it off and on touching some other object emits a spark that lights his tent at night. But most curious of all this static phenomena is the effect frequently seen on people's hair. Persons standing on the tip of Bright Angel Point often feel their hair pulled strongly upward; and to see a bobbed-haired girl standing there with her hat off and her abbreviated locks stretched skyward into a sharp pointed cone is not only one of the most ridiculous of spectacles but one that brings spooky thoughts to the steadiest minds.

Even the United States Government failed in a serious and expensive effort to establish radio communication here. In 1917 elaborate sending and receiving apparatus was set up on Bright Angel Point, and also on the south rim just across the Canyon. The main purpose was to establish communication between the two rims. Although the air-line distance is only thirteen miles complete failure resulted. Radio science has advanced greatly since then, but so discouraging was the report on the general static situation on the north rim that despite the sore need for such communication Uncle Sam's men have never tried it again.

Two telephone lines lead into the region from the outside world. They are single wires with ground return, and static interferes with their operation so seriously that for long spells nothing intelligible can be sent over them. Thus it is that the rangers, hunters, cowboys, and occasional visitors, who make up the scanty summer population, remain out of all touch with the doings of the world. Even the recent death of a President remained for more than a week an unconfirmed rumor.

But fortunately for us of the north rim, and for the good reputation of radio, there remained at least one skeptic—Mr. A. W. Marksheffel, of Colorado Springs.

Mr. Marksheffel happens to be one of those who not only wants to know the reason for things, but is willing to exert himself greatly in discovering the truth about them. His enthusiasm and persistence in pursuing difficult radio problems have led him to undertake reception in several of the alleged "dead zones" in the mountainous regions around his home in Colorado, and his success there has proved that there are fewer of these unresponsive areas than is generally supposed. With carefully designed apparatus, skillfully operated, he has been able to bring in signals where there had been only failure before.

AT THE RIM OF THE GRAND CANYON
Mr. Marksheffel (at left) tuning-in broadcasting signals where none had ever been received before

Having earned a reputation as a successful radio trouble shooter, in his own state, Marksheffel accepted an invitation to come to the north rim and see what he could do with the radio situation there, or, rather, according to the local wiseacres, to see what that situation would do to him. It was a long expensive journey by auto, but with the prospect of a contest worth his while, he came.

He arrived at Bright Angel Point on the evening of August 27th, the very day on which the Government expedition, descending the river and mapping the Canyon's depths, landed at the mouth of Bright Angel Creek, a mile straight down below the point. The telephone running up from the river had, in one of its more communicative moments, informed us of their arrival, and that their radio-receiving set was then operating perfectly at the bottom of the gorge. With this auspicious news in mind we of the north rim watched Marksheffel with keen anticipation while he unboxed his apparatus for the test.

The arrival of a new and more promising set had served to bring to the Point that night an odd but interested group of observers. Half-a-dozen cowboys in chaps and sombreros had ridden in from the cow camps above; a couple of cougar hunters parked their rifles against a neighboring tree and joined the onlookers; there were two or three Forest Rangers in their natty, dress-up uniforms; while a few "dudes" of both sexes strolled over from the Wylie-Way Camp near by. All were eager for a chance to hear even one intelligible word from the outside world. But in the comments of those who had attended previous trials, only to go away in disappointment, there was a note of doubt and even of scoffing, as Marksheffel mounted his big loop aerial and tinkered with his connecting wires.

At last all was ready and Marksheffel raised his hand for silence. He swung his aerial to and fro and twisted the knobs of his tuners. For five minutes this continued, his countenance growing longer. The doubters smiled and whispered.

"She's dead as a salted mackerel!" the operator announced in vexation. He flung open the lid of his box and began tracing out his wires, while a young cowboy disgustedly remarked:

"This radio business is sure the bunk. Here I've rode ten miles to-night after a hard day in the saddle to hear talk come out of that little black coffin and nothing comes. I've done that same thing half-a-dozen times before, but never again. I'm through."

"Coffin is right, Jim," put in his mate. "There's a dead one in it. Come on, let's go."

Then Marksheffel spoke excitedly. "Here's the trouble!" he cried. "A broken connection! I'll stick the ends together and try it again."

Once more he clapped the phones to his ears and began adjusting the set. Then slowly over his countenance spread that look of rapture seen only on the face of the searcher in the air for something he at last finds.

"I've got it now! Quiet, please!" he said. "There's considerable static, but I can hear Uncle John telling his bedtime story in the *Times* tower in Los Angeles. I'll see if I can't clear out some more of the static."

A few moments more and he handed the phones to the nearest spectator, who happened to be the disgruntled young cowboy himself. That worthy tried vainly to get the head set on over his sombrero, but finally discarded the hat and put the receivers gingerly to his ears. Instantly he jerked them off and pressed them into the hands of his pal.

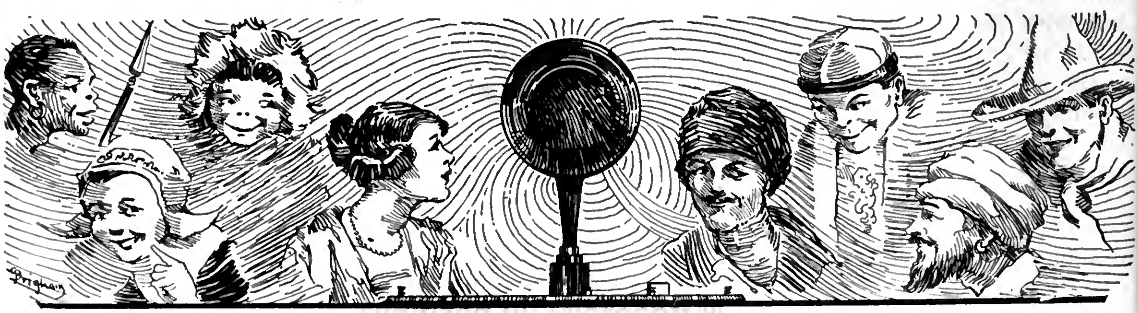
"It's there!" he shouted in delight. "Listen, Bob! It's real, honest-to-gawd talk!"

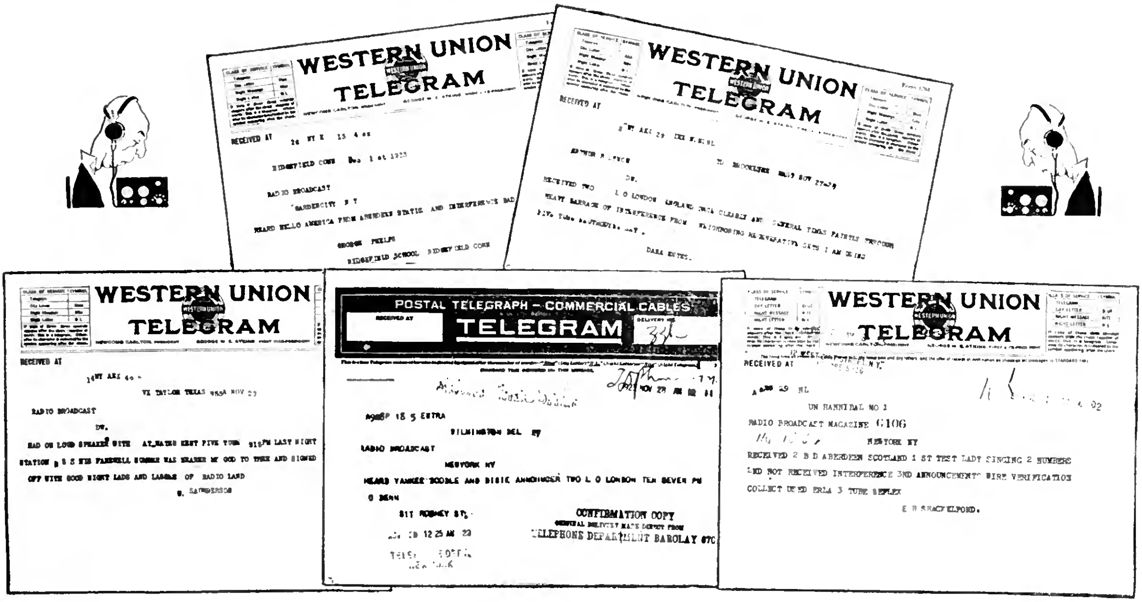
Then to Marksheffel he declared: "I take back all I said. You done it, Mister."

Bob, too, tried to jam the head set over his two-gallon hat, amid the laughter of the crowd, but in time got it in place. He also listened but a second and passed on the phones. Neither had listened long enough to understand what had been heard; for the moment they were possessed by the astounding fact that words were coming out of the sky.

Other phones were soon attached, the head sets separated into single units and passed around. While the company drank in the broadcasted messages and music, Marksheffel busied himself adjusting the apparatus to eliminate as far as possible the static which was still interfering. Later that evening be began bringing in other broadcasting stations.

There came a jazz orchestra from San Francisco, the daily news from Kansas City, a lecture on psychology from Los Angeles, and music, both vocal and instrumental, from other places. A peculiar feature of the situation, as developed that evening and verified later, was that no broadcasting could be heard from stations either to the north or to the south of us, but only from those directly, or almost directly, east and west. But a grand and glorious evening it was for us castaways.





Who Heard England?

IT WOULD be difficult to make an accurate estimate of the number of people on this side of the Atlantic who heard the British broadcasting stations during the recent broadcasting tests conducted by RADIO BROADCAST, but the following list, including the names of all whose reports of hearing England we have verified, does show how wide is the geographical distribution of the owners of successful receiving stations. 32 states and 4 Canadian provinces are represented. (The number after each state indicates the number of reports, telegrams, telephone messages, and letters, that were received from listeners in that state.)

New York (47), Illinois (35), Iowa (31), Missouri (27), Pennsylvania (26), Massachusetts (22), Ohio (15), New Jersey (15), Connecticut (11), Minnesota (7), Texas (8), Oklahoma(6), Kansas (4), Michigan (4), New Hampshire (4), Wisconsin (4), Arkansas (4), Nova Scotia (3), Tennessee (3), Ontario (3), Indiana (3), Virginia (3), Quebec (2), West Virginia (2), Maryland (2), Maine (2), Delaware (2), Kentucky (2), South Dakota (2), British Columbia (1), Florida (1), Georgia (1), Nebraska (1), Mississippi (1), Vermont (1), New Mexico (1).

NAME	CITY
Miss C. A. Acker	Savannah, Ills.
C. E. Adams	Warner, N. H.
H. Adams, Jr.	Shinnston, W. Va.
Jos. Allen	Lacon, Ills.
L. C. Alblinger	Ste. Marie, Ills.
J. J. Alblinger	Ste. Marie, Ills.
A. D. Alderman	Holyoke, Mass.
Dr. B. Appleberg	Kings Park, L. I.
Wm. Ashe	Kings Park, L. I.
R. B. Avery	South Bend, Ind.
Mrs. J. C. Allen	Monmouth, Ills.
R. Atherton	Harrison, O.
W. A. Armstrong	New York, N. Y.
C. C. Anderson	Barberton, O.
T. C. Anderson	Greenwich, Conn.
J. G. Bradley	Justin, Tex.
J. A. Belton	Brooklyn, N. Y.
M. J. Belton	Brooklyn, N. Y.
H. G. Brown	Peoria, Ills.
C. L. Besler	Hopkinton, Ia.
Dr. C. Barnert	New York, N. Y.
S. E. Brooks	Leeton, Mo.
W. Burke	St. Louis, Mo.
W. F. Burden	St. Louis, Mo.
Fred Black	Alva, Okla.
E. R. Blocker	Waco, Tex.
R. M. Brooke	Casey, Ills.
Fred. Becker	St. Louis, Mo.
N. C. Baechler	Louisville, Ky.
C. R. Bowser	Kingston, N. Y.
Dr. E. W. Burt	New Bedford, Mass.
N. J. Buck	Colts Neck, N. J.
V. W. Bihlman	Dayton, O.
C. F. Baker	Dallas, Tex.

NAME	CITY
R. Bonynge	New Preston, Conn.
H. G. Brown	Peoria, Ills.
T. C. Bethel	Paullina, Ia.
W. J. Bray	Kirksville, Mo.
E. Bertschinger	College Pt., L. I.
C. W. Booth	New Brunswick, N. J.
J. J. Brus	Davenport, Ia.
A. W. Baehr	Cincinnati, O.
R. Baxter	Grafton, Ills.
E. H. Breedlove	Bentonville, Ark.
B. W. Bridgman	Eau Claire, Wis.
R. C. Bacon	Boston, Mass.
N. A. Berg, Jr.	Butler, Pa.
G. F. Boynton	Wollaston, Mass.
C. W. Cain	Okmulgee, Okla.
H. Church	Chagrin Falls, O.
F. Cassen	Franklin Square, L. I.
W. F. Clancey	Evergreen, L. I.
H. J. Conant	New York
A. Coombs	East Bridgewater, Mass.
H. E. Clark	Monmouth, Ills.
S. W. Cobb	South Portland, Me.
James Cosgrove	Virginia, Minn.
A. B. Crossett	Niagara Falls, Ont.
R. Classen	Schenectady, N. Y.
C. G. Clark	Berwick, N. S.
Chambers RadioCo.	Charleston, Ills.
W. S. Currier	Rose Hill, Ia.
S. H. Croft	Philadelphia, Pa.
G. H. Cilley	Paoli, Pa.
A. F. Combs	Enid, Okla.
J. E. Clarkson	Amherst, N. H.
J. F. Carrol	St. Louis, Mo.
E. A. Dettloff	Bloomer, Wis.
D. A. Dowling	Glencoe, Mo.

NAME	CITY
W. Davee	West Point, Neb.
W. L. Dulany	Woodstock, N. Y.
D. E. Dougherty	Oneida, Ills.
H. L. Duffey	New Straightsville, O.
R. Dreyer	St. Louis, Mo.
O. A. Dixon	Raton, N. M.
P. A. Dinmoor	Lawrence, Kan.
F. E. Dunn	Keota, Ia.
H. S. Dolechi	St. Louis, Mo.
E. N. Duty	Charleroi, Penn.
H. N. Darst	Richmond, Tex.
F. J. Diehl	Freeport, Ills.
L. L. Dinkelspiel	West New York, N. J.
C. Denn	Wilmington, Del.
L. W. Edmonds	Brooklyn, N. Y.
A. Eichelberger	Alexander, N. Y.
Miss M. Eppley	Davenport, Ia.
C. Elliott	Brooklyn, N. Y.
D. Estes	Brookline, Mass.
G. G. Early	St. Louis, Mo.
J. C. Ewen	Bogota, N. J.
Miss G. M. Francis	Brooklyn, N. Y.
J. F. Fischer	Newman, Ga.
J. C. Fortune	Sydney, N. S.
K. M. Foster	Great Barrington, Mass.
R. Frazer	Windsor, Mo.
J. R. Farnsworth	West Point, Ills.
L. K. Garland	Appolo, Pa.
M. B. Gresham	Myrtle, Miss.
Miss L. A. Green	Smithport, Pa.
Goldsmith Bros.	Clarence, Ia.
F. A. Goodsell	Marshall, Mich.
M. R. M. Gwilliam	Bloomfield, N. J.
G. F. Gardner	Webster City, Ia.

NAME	CITY
R. M. Gridley	Beaver, Pa.
Mrs. L. E. Gooch	Willmar, Minn.
J. N. Good	Magog, Que.
J. R. Haviland	Brooklyn, N. Y.
F. Gerlacke	Sidney, O.
Mrs. C. G. Halsey	Westfield, N. J.
H. Higgins	Springfield, Mass.
A. G. Hollingworth	East Elmhurst, L. I.
A. R. Hodges	Ridgewood, N. J.
A. P. Hall	Norfolk, Mass.
C. E. Hense	Alburnett, Ia.
P. Hampden	Ridgefield, Conn.
T. W. Herrick	So. Duxbury, Mass.
B. B. Holvis	Cochranton, Pa.
F. L. Hall	Stamford, Conn.
W. W. Heaton	Mamaroneck, N. Y.
L. R. Horst	Rock Island, Ills.
Dr. L. M. Hardin	Flandreau, S. D.
H. E. Heyt	Duncansville, Pa.
F. G. Helyar	New Brunswick, N. J.
H. D. Harton	Nashville, Tenn.
J. W. M. Harry, Jr.	Havana, Ills.
J. S. Hays	Newkirk, Okla.
L. E. Harris	Ponsford, Minn.
R. Heckman	Liberty, Kan.
E. Hals	North Branch, Minn.
G. Hall	St. Loui , Mo.
H. F. Hoch	Webster Groves, Mo.
E. Hooker	St. Louis, Mo.
G. P. Hamilton	Eau Claire, Wis.
J. Harris	Windsor, Mo.
W. J. Hinchey	Medina, N. Y.
W. Henry	Keithsburg, Ill.
A. H. Helmar	Buffalo, N. Y.
C. E. Heyer	Sumner, Ia.
E. S. Jennings	Bridgeport, Conn.
W. A. Johnson	Lisbon Falls, Me.
E. I. M. Jamieson	Victoria, B. C.
F. L. Judd	New York
R. N. Jones	Johnsonburg, Pa.
W. Johnson	Cohoes, N. Y.
Rev. V. Jacobs	Williamsfield, Ills.
W. E. Jones	Rutland, Ia.
E. Jackson	Jacksonville, Ills.
Mrs. E. H. Johnson	Jessup, Ia.
T. O. Jones	Pittsburgh, Pa.
Station KDKA	Pittsburgh, Pa.
F. Koenig	Tarrytown, N. Y.
C. J. Kaznierczyk	Ramsey, N. J.
W. C. Kuehl	Manistee, Mich.
H. E. Kuehn	Baltimore, Md.
J. Kirkpatrick	Collison, Ills.
C. A. Kling	Vinton, Ia.
C. Kofie	Lakewood, O.
A. J. Kempien	St. Paul, Minn.
E. W. Kent	North Sydney, N. S.
R. R. Kegirise	Newcastle, Pa.
L. P. Kyle	Bristow, Ia.
T. Lewis	Waterbury, Conn.
F. H. Lutz	Buffalo, N. Y.
H. W. Lemberger	Burlington, Ia.
E. L. Le Fevre	Dayton, O.
C. E. Lowry, Jr.	Richmond, Va.
M. Loe.	Blanchardville, Wis.
J. C. Lopez	Princeton, N. J.
V. Lopicolo	St. Louis, Mo.
B. F. Lamoreux	Lanark, Ills.
A. J. Lorimer	Farnham, Que.
F. C. Ludecker	Glencoe, L. I.
E. B. Ludlow	North Pembroke, Mass.
G. A. Lowden	Tarpon Springs, Fla.
W. E. Long	Sterling, Ills.
H. C. Leighton	Salem, Mass.
G. F. Leland	Springfield, Vt.
F. D. Layfield	Princesse Anne, Md.
A. R. Laing	Tipton, Ia.
J. H. Lafers	Minneapolis, Minn.
C. C. Magrath	St. Louis, Mo.
Dr. F. N. McMullin	Philadelphia, Pa.
J. F. McMullin	Philadelphia, Pa.
Monahan Radio Shop	Memphis, Tenn.
Miss E. Morgan	Maunie, Ills.
S. H. Mapes	New York,
M. May	Brooklyn, N. Y.
C. M. Mackley	Peoria, Ills.
I. Meyer	Greenville, N. Y.
G. McPherson	Belleview, Tenn.
T. L. Munson	Cheshire, Conn.
M. Mackenzie	Flushing, N. Y.
J. C. Marr	Alta Vista, Ia.
D. Mueller	Chicago, Ills.
R. Merservey	Wooster, Mass.
L. Martin	West Lafayette, Ind.
J. Martin	Clinton, Ia.
R. V. MacNiel	Harrisburg, Pa.
C. L. Miller,	Harrisburg, Pa.
H. W. McClure	Ann Arbor, Mich.
K. Merritt	Mamaroneck, N. Y.
F. Menneke	Preston, Ia.
E. M. McCann	Lansing, Mich.
G. H. Murray	Metuchen, N. Y.
J. Martin	Waterbury, Conn.
C. L. McGhee	Edmond, Okla.
K. Miller	Lisbon, Ia.
C. R. McLaughlin	Philadelphia, Pa.
Mrs. F. Memmen	Minonk, Ills.
A. A. Mudge	Afton, N. Y.
F. Neiderlander	New Milford, N. J.
E. S. Nyce	Norristown, Pa.
G. W. Nicola	Muscatine, Ia.
E. E. Noe	Richland, Mo.
M. E. Newman	Boston, Mass.
Mrs. L. Owen	Peoria, Ills.
G. Phelps	Ridgefield, Conn.
E. J. Pritas	Bedford, Mass.
C. Parcell	Fredericksburg, Va.
W. Phillips, Jr.	Montclair, N. J.
W. R. Pettijohn	Hoyt, Kan.
J. F. Plumb	Cedar Rapids, Ia.
W. H. Palmer	Springfield, Ills.
O. H. Pool	Wynne, Ark.
W. H. Phelps	Winslow, Ills.
Miss Angela Pickart	Watkins, Ia.
D. Pitner	Sioux City, Ia.
S. Price	Hamilton, Ont.
R. K. Pierce	Port Colborne, Ont.
G. Pickett	Buffalo, N. Y.
H. L. Rex	Mauch Chunk, Pa.
E. L. Rice	New Haven, Conn.
Mrs.G.L.Rumberger	Nickleville, Pa.
A. C. Rothmund	St. Paul, Minn.
Radio Installation Co.	St. Louis, Mo.
E. A. Ryder	Keyport, N. J.
F. J. Reichert	Esopus, N. Y.
J. Ruckman	Providence, Ky.
R. L. Rockett	Ft. Worth, Tex.
J. T. Rick	Corsica, S. D.
K. P. Ruggles	Cuyahoga Falls, O.
F. C. Ryder	Wollaston, Mass.
F. G. Ruso	Albany, N. Y.
J. G. Riger	Buffalo, N. Y.
W. Ruse	Aledo, Ills.
N. P. Rawson	Richmond, Va.
A. K. Reading	Bettendorf, Ia.
R. Sheehy	Newfields, N. H.
D. A. Sanders	Nyack, N. Y.
W. Swathburg	East Orange, N. J.
W. B. Symmer	Beverly, Mass.
Miss Schramm	St. Louis, Mo.
E. Stoltz	St. Louis, Mo.
Mrs. J. M. Stevens	Hastings, Okla.
Mrs. H. Spooner	Wheeling, Mo.
W. H. Stephens	Prompton, Pa.
H. Sharp, Jr.	Cincinnati, O.
E. N. Schmitz	Stewart, Minn.
A. Selzer	St. Louis, Mo.
Miss F. L. Satterlee	Flushing, N. Y.
C. D. Schutte	Topeka, Kan.
R. B. Sturgis	Barnstable, Mass.
H. E. Simpson	Lakeport, N. H.
J. E. Shepherd	La Plata, Mo.
H. Sawyer	New York,
J. J. Shugart	Princeton, Ills.
L. D. Strubinger	Barrie, Ills.
A. G. Schmidt	Kirkwood, Mo.
G. Saunderson	Taylor, Tex.
E. H. Shackleford	Hannibal, Mo.
L. J. Schwingle	LaMoille, Ills.
H. W. Tribble	Rogers, Ark.
W. G. Thomas	Sheffield, Ills.
G. S. Tebbetts, Jr.	England, Ark.
L. A. Talbott	Audobon, Ia.
Miss E. Theye	Cincinnati, O.
J. Tritle	Alburnett, Ia.
K. P. Thompson	Seaford, Del.
D. J. Terwilleiger	New York,
P. E. Uniker	Stamford, Conn
J. H. Untzinger	Uniontown, Pa.
C. Vint	Beaman, Ia.
G. Vaux	Bryn Mawr, Pa.
A. R. Von Ottenfeld	Saranac Lake, N. Y
O. A. Volberding	Latimer, Ia.
Station WGI	Medford Hillside, Mass.
WGY	Schenectady, N. Y.
WOC	Davenport, Ia.
WOR	Newark, N. J.
WFAA	Dallas, Texas
J. C Walsh Elec Co.	Jacksonville, Ills.
P. O. Wass	Rockport, Mass
E. C. Washburn	Palmyra, N. Y
D. B. Wollcott	Kent, O.
W. B. Winslow	New York
H. Waje	Bronx, N. Y.
O. R. Williams	St. Marys, W. Va.
V. E. Wilson	Philadelphia, Pa.
S. A. Witham	Brookline, Mass.
Mrs. H. A. Wettstine	Hazleton, Pa.
J. L. Wilhelm	Indianapolis, Ind.
W. E. Walker	Bettendorf, Ia.
W. W. Webb	Alliance, O.
R. B. Whitman	Garden City, N. Y.
M. Wood	Rockford, Ills.
C. D. Zimmerman	Cleveland, O.
N. A. Yeny	Steelton, Pa.
C. S. Young	Allentown, Pa.
H. Young	Brooklyn, N. Y.
E. L. Young	Quincy, Mass.

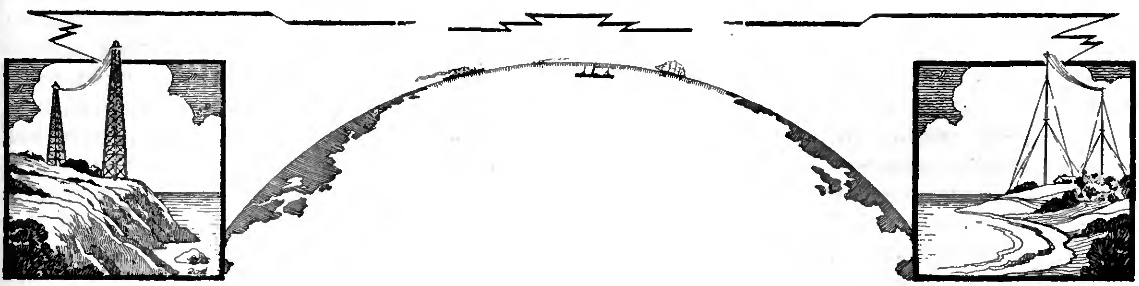
BRITISH LISTENERS-IN WHO HEARD AMERICAN STATIONS

ALTHOUGH radiograms from the *Wireless World and Radio Review* and the British Broadcasting Company were received by RADIO BROADCAST all during the week of the recent transatlantic tests, informing us that English listeners had heard excellently the programs of many of the American stations, there has not yet been time for many letters to come to us from the other side. However, we have reports from the following persons, and many of the communications mention the interesting fact that successful American reception was accomplished frequently with the use of only one tube.

NAME	ADDRESS	AMERICAN STATION HEARD
P. H. Audsley	Loftus, Yorks	WGY
M. Ault	Purley	WGY
Anthony	Liverpool	WGY
W. P. Ancock	Congleton, Cheshire	WGY
R. W. Arnott	The Garth, Monmouth	WGY, WHAZ
A. Ballentyne	Langside, Glasgow	WGY
R. Bates	St. Catherines, Lincoln	WGY
J. G. Bruce	Dundee, Scotland	WGY, WHAZ, WOR, WMAF
H. Brooks	Cheshire	WGY
Bates	Buckinghamshire	WGY
R G. Burder	Loughborough	WGY
H. Bendle	Chiddlehampton	WGY
H. B. Burke	Leeds	WGY

NAME	ADDRESS	AMERICAN STATION HEARD
Bickley	Birmingham	WGY
H. F. Bateman	Nelson, Lancashire	WGY
Basil	Liverpool	WGY
Brackney	Finchley	WGY, WHAZ
W. Copfield	Exton, Exeter	WGY
Cartwright	Bristol	WGY
H. Collen	Billericay, Essex	WGY
A. B. Clark	Stowmarket	WGY
E. J. Clark	Holloway	WGY
D. K. Cameron	Ryde, Is. of Wight	WGY
J. W. F. Cardell	Newquay, Cornwall	WGY, KDKA, WHAZ
"Capacity"	Dundee, Scotland	WGY
C. Chaplin	Colwyn Bay	WGY
C. B. Childs	Edinburg, Scotland	WNAV
R. Dunn	Leicester	WGY, WOO
W. Diggle	Blackpool	WGY
Dadd	Clapham Jct.	WGY,
Davis	London	WGY WHAZ
Drysdale	Keswick	WGY
M. Edoloff	Stoke Newington	WGY
A. Entwistle	Preston	WGY, WDAF, WHAZ
J. Ewing	Arbroath	WGY
W. A. Edge	Manchester	WGY, WHAZ
R. E. Fabian	Durham	WGY
G. Featherby	Bishop's Stortford, Herts	WGY
A. R. V. Garnett	Camberley	WGY
F. W. Glass	Durham	WGY, WJZ
H. J. Galliers	Brighton	WGY, WHAZ
W. P. L. Harrison	London	WGY, WHAZ
A. N. C. Horne	Queenstown, Ireland	WGY
Harvey	Woolwich	WDAR
S. Hunter	Limavady	WGY
Holmberg	Cheshunt, Herts	WGY
W. A. D. Howes	Staplecross, Sussex	WGY
H. E. Hiller	London	WGY
Hardman	Whitefield	WGY, WJZ
Healey	Perranborth	WGY, WHAZ, WOR
Howiston	Prestwick	WGY
Hughes	Douglas, Isle of Man	WGY
Hambling	London	WGY, WOR
Hill	Bristol	WGY
Hill	Letchworth	WGY
H. C. Henley	Breconshire	WGY
C. E. Horner	London	WGY, WJZ, WDAR, WSY
Holmes	London	WJZ
Hall	Doncaster	WGY
S. Hecks	London	WGY, WJAZ
Haywards	Haverhill	WGY
H. J. Jarrold	Norwich	WGY
J. F. Johnston	Altrincham	WGY
Jonston	Wallasey	WGY
J. E. Jeffrey	Banff	WGY
Rev. Jenkins	Enniskillen	WGY, WHAZ
W. H. Kinnersley	Bristol	WGY
R. Logan, Jr.	Ayrshire, Scotland	WGY, KDKA
Leach	Petersfield	WJZ
Maj. D. M. Lovett	Hollybank	WGY
L. Lott	Burnham-on-Sea	WGY, WHAZ, WOR
C. K. Murray	Romsey, Hants	WGY
H. Marsden	Manchester	KDKA
L. L. Miell	Bath	WGY, WHAZ
E. Millard	London	WGY
McAndrew	Kilmarnook	WGY
Mead	Longeaton, Nottingham	WGY
Mather	Fleetwood	WGY

NAME	ADDRESS	AMERICAN STATION HEARD
Macintosh	Inverness	WGY
Macrory	Londonderry	WGY
Munro	Oban	WGY
K.MacKenzie,R.N.	Linlithgow	WGY
J. Morris	Fleetwood	WGY
A. H. Orcutt	N. Birmingham	WGY
Oekll	Chester	WGY
A. F. Paterson	Montrose, Scotland	WGY
N. C. Powell	Hitchin, Herts.	WHAZ
C. Pycroft	Potefract	WGY
Parsons	Dorchester	WGY, WSY
F. P. Phillips	St. Anstell, Cornwall	WGY, WJZ
H. R. Phillips	Arundell	WGY
A. N. Porter	Redland, Bristol	WGY, WJZ, WOR
H. J. Price	Cardiff	KDKA, WGY
Paisley	Glasgow	WGY
Pilkington	Manchester	WGY
E. H. Rogers	Torrington, Devon.	WGY
R. C. Rowley	Bradford	WGY
A. G. Richards	Chorleywood West, Herts.	WGY
W. R. Redway	Exmouth, Devon.	WGY
N. Rofs	Woking, Surrey	WGY
Randell	Liverpool	WGY
Renfrew	Glasgow	WGY
A. Stevens	Lancashire	WGY
T. F. Salsbury	Oundle, Northamptonshire	WGY
W. R. Stainton	Leigh, Lancashire	WGY, WHAZ
S. J. Smith	Glasgow	WGY, WBAH, WHAZ, WJZ, WDAR, KPO (?)
N. T. Smith	Broadstairs, Kent.	WGY
A. G. Saunders	Runcorn, Cheshire	WGY, WHAZ, WOR
A. H. S. Stewart	Brighton	WGY
E. P. Sentance	Grantham	WGY, WHAZ
Sinclair	Bristol	WGY
A. Stevenson	Morecambe	WGY
A. Shaw	Colney, Lancashire	WGY
H. B. Scargill	Harrowgate	WGY
Slater	Vogablik, Kirkwall	WGY
Stone	Hinckley	WGY
Dr. Shepherd	Sheerness	WGY
Col. P. Smith	Newquay	WGY, WHAZ
Tye	Sevenoaks	WGY
A. H. Thornhill	Cambridge	WGY
S. W. Troupe	Brighton	WGY
Taylor	Burnley	WGY
Taylor	Ipswich	WGY
H. J. Walden	Peterborough	WGY
A. S. Walker	Brentford, Middlesex	WHAZ, WGY, KDKA, WFAA, KSD
Lt. A. R. Williams, R.N.	Kensington	WGY
C. R. Wicks	Westcliff-on-Sea	WGY
E.Watts&Son,Ltd.	Hove	WGY
O. W. Walker	Topsham, Devon.	WGY, WCAE
H. W. Walker	Brentford, Middlesex	WGY, WMAF, WHAZ, KDKA
Wood	Halifax	WGY, WOR
Warriner	Birkenhead	WGY
H. F. Wooler	Stockton-on-Tees	WGY
Wyatt	Portsmouth	WGY
Worth	Amberley, Sussex	WGY
Watkinson	Dumbarton	WGY
Wallington	Northampton	WGY
Whiting	Biddeford	WGY
Capt Young	Southampton	WGY
A. Y. Yeates	Lincoln	WGY



What Broadcasting Does for a Newspaper

Why Some Newspapers Broadcast, and Why Some Don't. The Opinions of Newspapermen Themselves on the Relation of Radio to Their Field

By WINFIELD BARTON

WHEN you sit down at night before your radio set in a happy glow, due partially to the good dinner you have just enjoyed, and partially to your pleasant anticipation of a good radio program soon to come in, you rarely stop to think, Why are these stations broadcasting? But someone has thought out the answer to the problem, "Who shall broadcast, and why?"

> *"What is the good of a newspaper running a radio?" . . . We asked ourselves frankly. We decided that the return in good will was not worth the expense involved.*
> —T. J. Dillon, Managing Editor, Minneapolis *Tribune*.

Broadcasting is only three years old. In this brief span, electrical manufacturers and retail dealers have seen fit to install broadcasting stations, and their pioneer work was quickly followed by enterprising newspapers.

And now the list of owners of broadcasting stations shows they are maintained by hotels, department stores, banks, government departments, electrical manufacturers, and newspapers.

The reasons for manufacturing and selling concerns entering the broadcasting field are quite obvious to all. But why should a newspaper install a broadcasting station? Is anyone going to buy the newspaper in a given city because he has heard the programs from their station? Isn't the circulation of a newspaper built on its editorial policies—and its "dress," to borrow from the advertisers? Does, then, a broadcasting station owned by a newspaper help to sell more papers? Naturally, this question is that which most deeply concerns the newspaper owners.

"There are several practical reasons why a newspaper should broadcast," says William S. Hedges, Radio Editor of the Chicago *Daily News*. "The creation of good will, that intangible, yet nevertheless invaluable asset for quasi-public institutions, such as newspapers, results from our broadcasting. Dollars may not directly follow from the pleasures experienced by listeners to programs broadcasted by newspapers, but the feeling of friendliness is there, and the friendship of the masses makes strength for the newspaper.

"It has been said that a newspaper has a harder time advertising itself than any other institution. Other firms, other institutions, can place their advertising in the newspaper, reach their clientele, and attract new patrons. The institution can advertise too, in other papers in the same city. The newspaper can, of course, advertise in other newspapers in its locality, but isn't that a confession of its own weakness? So we find the newspaper advertising on billboards. The power of billboard advertising is debatable. When radio broadcasting was made possible, the newspaper had a new means of advertising, though of course, an indirect one.

"The radio broadcasting station of the newspaper pours inoffensively its name into the willing ears of thousands of listeners. The various departments of the paper become known to great numbers who had never given a thought to the variety of newspaper service before. The automobile editor, giving his talks on motor trails, local traffic regulations, and helpful hints on safety in driving, interests that group among his listeners who own motor cars. And those who are interested in automobile tours, safe driving, and the problems of the motorist will turn to their radio-friend's column for information when they buy the paper. The broadcasting of football, baseball, and other sporting returns emphasizes the sporting department. So, in giving service to the public, the newspaper builds up its clientele.

"Some of these reasons for the newspaper entering the broadcasting field may not seem especially 'practical.' But newspapers do not gain their strength from being too 'practical' or cold-bloodedly commercial in their relations with the public. The newspaper must be willing to serve."

There are a number of representative newspapers with excellent broadcasting stations now in operation. Among these are the Detroit *News*, the St. Louis *Post Dispatch*, the Dallas *News*, the Fort Worth *Star-Telegram*, the Detroit *Free Press*, the Kansas City *Star*, and the Chicago *Daily News*. At one time, there were other papers maintaining broadcasting stations. The Minneapolis *Tribune* and the Atlanta *Constitution* are two of the best-known papers which have withdrawn from the broadcasting field. Many other newspapers have, at one time or another, made arrangements with broadcasting stations already existing in their towns to broadcast special programs on certain nights. The newspaper would thus buy special service from those qualified to give it, without itself incurring the expense of its own station.

> *Radio offers the newspaper a new opportunity to serve. The modern newspaper not only presents the news of the day, but it strives to instruct and entertain. . . . If, when we close our program each night, we leave our listeners a little better than when they started listening-in, we have done much. We. . . . cast our bread upon the waters, but the return of that bread, in the form of good will and increased circulation, is almost a certainty.*
>
> —William S. Hedges, Radio Editor, Chicago *Daily News*.

Not all newspaper-owners feel the same way about broadcasting as the Chicago *Daily News* does. Clark Howell, Editor of the Atlanta *Constitution* says:

"The *Constitution* quit broadcasting because, after we installed a station at great expense and operated it for a year, we reached the conclusion that the novelty had worn off, and we abandoned the service for much the same reasons which induced the Chicago *Tribune* to withdraw from the field.

"We do believe, however, that there is a great future in radio for commercial purposes, and when the Georgia Institute of Technology asked our aid in securing a radio plant to enable it to teach radiography in its commerce department, we were glad to make a contribution of our radio plant for that purpose. That station is now in practical use at Georgia 'Tech.'

"As a novelty, we were glad enough to operate the plant for a year, but we saw no reason why a newspaper should maintain this service as a permanent feature.

"Our conclusion was that the large sum it cost to maintain a broadcasting service could be put to a very much better use by enlarging our news and special feature departments. This," concludes Mr. Howell, "we have done, with gratifying success."

A broadcasting station costs from $50,000 to $100,000 to install. The maintainence expense per year is high, for these broadcasting stations, unfortunately, cannot run themselves. The Detroit *News*, for example, maintains, in addition to the regular operating staff of its station WWJ, a group of trained radio men which it places at the disposal of the public, to give those who wish it, reliable information about radio receiving sets and equipment. That costs money.

T. J. Dillon, Managing Editor of the Minneapolis *Tribune*, considers the question, "Should newspapers broadcast?" in another way. Mr. Dillon tells of the experience the newspaper owners in his city had with radio, and relates how amusingly radio worked to bring the formerly hard and unyielding competitors of Minneapolis and St. Paul around the conference table.

"The Minneapolis *Tribune* entered the broadcasting field in the realization that it was only a temporary advertising activity, the value of which would disappear as soon as broadcasting became more general. Other newspapers in our local field installed broadcasting apparatus, or made connections with stations to which they gave their names. Department stores, electrical companies, and other commercial enterprises were quick to see the advertising possibilities of this novelty, and in a short time it was necessary to organize the directors of these various stations and select a neutral executive officer to portion out the time for each station.

"None of us knew a great deal about radio telephony, and, looking back on the efforts of those days, we will all here admit that they were quite crude, compared to the present-day broadcasting.

"It soon became apparent to the *Tribune* that this competition for the air, and the competition for singers, musicians, bands, etc., would soon reach the point where the *Tribune* would have to assume a very heavy financial burden. In return for this burden, we could hope to get nothing except that intangible and transient commodity known as good will. Then, inasmuch, as this good will would have to be divided more or less equally among our many broadcasting stations, we did not think that our net return would be worth the expense involved.

"The three large newspapers of the Twin Cities evidently came to this conclusion about the same time. The managing editors who had hitherto been cold and uncommunicative competitors, began to get confidential, and even complimentary toward each other. This unnatural condition of inter-office amity deceived none of those interested. It was only a short time until the three gathered together, laid their cards on the table, and frankly asked each other what was the use of a newspaper running a radio.

"The result was the agreement on the part of the three newspapers to withdraw from the field and to lend their support to a private organization that was then planning to install a thoroughly up-to-date station. Simultaneous announcement of this decision drew from the public rather unflattering but fervent commendation.

"The truth of the matter was, that with our lack of experience, we were not giving the public the service and the quality of entertainment they desired, and I think that experience has shown that one or two well-organized stations, operated by a management that would have no other interest, are able to give the public better service than a multitude of stations operated as adjuncts to some other business. This is true, at least, as far as my experience is concerned with the hastily born and short-lived WAAL."

C. W. Kirby, the Radio Editor of the Detroit *News* feels that in spite of the heavy expense in maintaining a good broadcasting station, a solvent and progressive newspaper is justified in maintaining a station. "The newspaper derives no tangible benefit from broadcasting," says Mr. Kirby.

"The Detroit *News* was one of the pioneers in radio broadcasting. Its first set was placed in operation on August 30, 1920. A few months later, its original broadcasting equipment was discarded for the more powerful, more efficient 500-watt station now in use. Our paper and our call letters, WWJ, have become known in every state in the Union, and in countries within 4,500 miles of Detroit through our broadcasting service.

"Good will is about the only return we expect from our station. The circulation department tells us positively that they list no increases in circulation due to our efforts in radio. The advertising department is of the same opinion. The Detroit *News* maintains its broadcasting station as a part of its public service. In addition to the actual broadcasting of entertainment and general items of interest we have a staff of trained radio experts, at the call of the public."

The presence of the newspaper in broadcasting undoubtedly has made the programs more varied and the service to the public greater. One need not go far for a recent example. Out of six stations broadcasting the address of President Coolidge to Congress, three of them were newspaper stations; WFAA, the Dallas *News*; KSD, the St. Louis *Post Dispatch*; and WDAF, the Kansas City *Star*. The newspaper brings its traditional acuteness for "what the public wants" successfully into the broadcasting field.

So, newspaper owners are grouped in two opposing camps. Those who have gracefully retired from the field say, "It isn't worth the money." Those who are still active and healthy participants say, "We shall reap our reward in good will, by helping directly and indirectly to serve the public."

Who is right? Perhaps both. But one of the most interesting side-light on the whole question was given the other day when we asked a radio enthusiast if he thought radio broadcasting helped the newspaper. "Help it?" he questioned and answered in the same breath, "I don't see how radio can avoid doing that very thing. Where I formerly bought one paper, I now buy two and sometimes three, for I don't want to miss any of the programs, near or far!"

The Grid

QUESTIONS AND ANSWERS

The Grid is a Question and Answer Department maintained especially for the radio amateurs. Full answers will be given wherever possible. In answering questions, those of a like nature will be grouped together and answered by one article. Every effort will be made to keep the answers simple and direct, yet fully self-explanatory. Questions should be addressed to Editor, "The Grid," RADIO BROADCAST, Garden City, N. Y.

How to Connect Jacks

I enclose a diagram of a two-stage amplifier. I believe the circuit is correct, but I do not wish to use the amplifier at all times, and so should appreciate your showing me how I can cut out both one stage and the complete amplifier by means of telephone jacks and a plug. Also, please show me how I can do the same thing with the Grimes circuit.

R. U. R., Wilmington, Del.

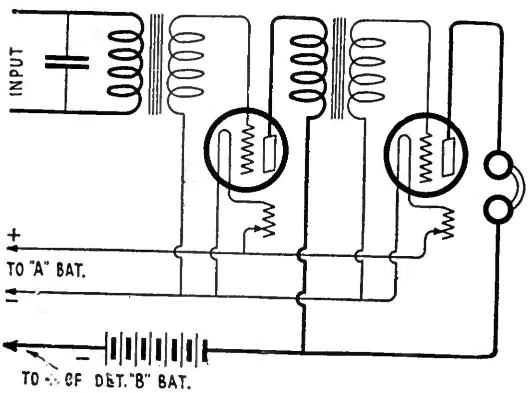


FIG. 1
The circuit submitted to *The Grid*

THIS problem (if it presents sufficient difficulties to be so termed) like many other radio puzzles is merely a matter of a principle involved, and when this is understood, the solution may be applied to many circuits and uses. Jacks are connected in the Grimes circuit in identically the same manner as they are in a straight amplifier. The majority of broadcast enthusiasts complicate radio circuits, and their resulting radio troubles, by insisting on vast differences between circuits, when fundamentally there exists little or no difference. Almost everything the experimenter may learn through the operation of a Grimes or another receiver, can be applied equally well to experiments with a super-heterodyne, etc.

The arbitrary connections for jacks will be better understood if their functioning in a circuit, or just what they accomplish, is first made clear. There are only two kinds of jacks that, for the sake of efficiency and reliability, the GRID recommends to its readers. These are the "open circuit" and the "closed circuit" types. The first two jacks in Fig. 2 are of the closed circuit design, while that in the plate circuit of the third tube is an open circuit jack.

The open circuit jack is used to make a simple connection. When the plug is in, whatever instruments are led to the plug, are in series with the wires leading to the jack. When the plug is out, the instruments are disconnected and the circuit is "open."

The closed circuit jack, which is the more used, is employed where it is desired to disconnect automatically one instrument (say an amplifying transformer) while another instrument (telephone receivers for instance) is plugged in its place. Taking jack two, in Fig. 2, as an illustration: When the plug is removed, as it is in the drawing, the outside prongs close down and make contact with the inside prongs. Thus the transformer is in series with the plate circuit of the first amplifying tube, just as it is in Fig. 1. However, when the phones are plugged in, the plug forces the outer prongs farther apart, until they fail to make connection with the inner ones, and, instead, scrape contact with the plug. The phones are now in exactly the same position as was the transformer primary before the plug was inserted.

Whenever it is desired to cut out amplification by plug-

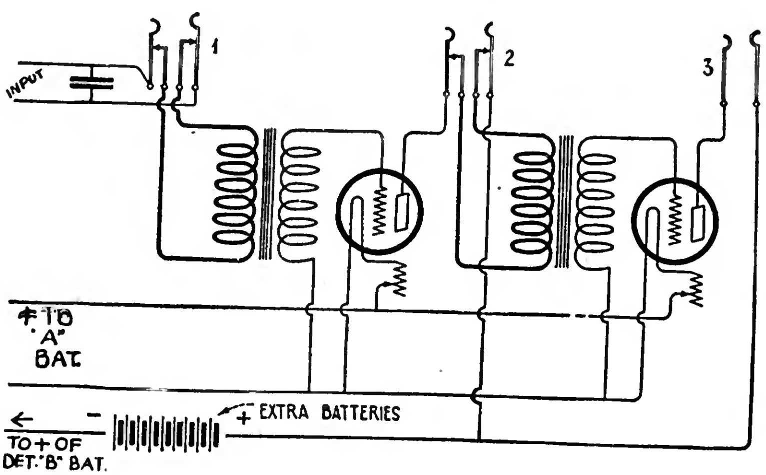


FIG. 2
The circuit of Fig. 1 with jacks added

ging in phones at some preceding tube, it is only necessary to shunt the primary of the transformer for which the phones are going to be substituted, by a closed circuit jack (Fig. 3). Connect the inner prongs to the transformer, and the outside prongs to the original leads in the plate circuit. Make sure that the same lead runs (through the jack) to the same terminal on the transformer as it did before the change was made (assuming, of course, that it was connected rightly in the first place). All soldering paste, acid, and dirt, which will cause noises, should be carefully wiped away from the prongs.

Fig. 1 shows our correspondent's circuit as he submitted it to the GRID, and Fig. 2 is the same circuit with the addition of the jacks.

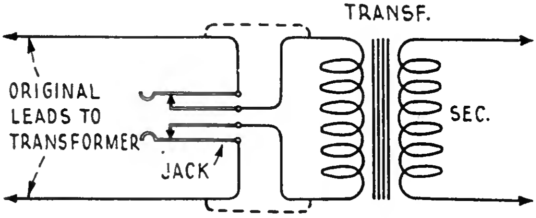


FIG. 3

Jacks may be shunted across any transformer where it may be desired to plug in phones

How To Make A Wave-Trap

I have had much interference from amateur and commercial stations. Would a wave-trap help me? Can I make one, or must it be purchased? What is the theory of its action?

T. O. B., New York City.

THE wave-trap, as its name suggests, is merely a device into which an undesired frequency or wave may be enticed, while the desired wave is passed on to the receiving circuit unimpaired or only slightly affected. Its most simple and common form is a coil of wire shunted by a variable condenser, which is placed in series with the antenna lead to the receiving set, Fig. 4. This forms a resonant circuit, or one which will absorb energy from the wavelength to which it is tuned. Thus if it is tuned to six hundred meters, the wave on which our correspondent doubtless experiences the greatest part of his interference, energy on that wave will be "trapped" and dissipated in the trap circuit, while other waves will pass on to the set.

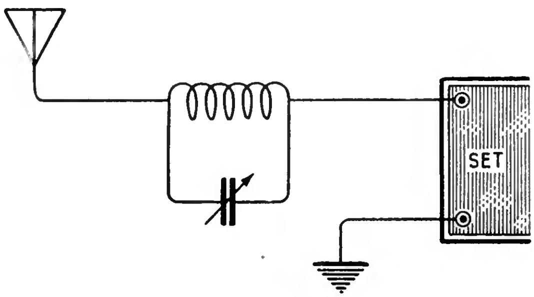


FIG. 4

One method of connecting parts of a "wave-trap"

The coil may be of the lattice-wound variety, about thirty-five turns, or wound to the same number of turns with No. 26 wire on a 3-inch tube. The condenser should be at least a 43-plate variable, and if possible a still larger one (.0015 mfd.). The larger the condenser, the smaller will be the coil, or load on the set, with an additional bypass for the legitimate waves. It is a good idea to reduce the number of turns to the minimum (with full condenser capacity) for absorbing the highest of the undesired waves. This will lessen the reduction in strength of the broadcasting station. The tuning of the wave-trap is rather broad, and it affects signals anywhere from fifty to a hundred meters off its resonance point.

In some cases, particularly in spark interference, the arrangement shown at Fig. 5, is more efficient than that just described, and will probably prove more efficacious in eliminating disturbances from amateur transmitters, though a correctly built and operated receiver should experience little QRM (interference) from such stations. The constants (the coil and condenser) remain the same as for the previous series arrangement, the trap merely being shunted across the antenna and ground rather than in series with the former.

If the interference is confined to commercial traffic on six hundred meters, the 43-plate variable condenser is not necessary, and a 23-plate variable shunted by a .0005 grid condenser, without leak, may be substituted for it.

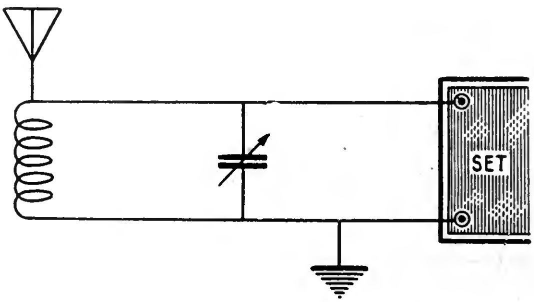


FIG. 5

This arrangement is more efficient in cutting out spark interference than that of Fig. 4

Bank Winding

What is "bank winding"? I see it mentioned very often as an efficient form of inductance, but no one is able to describe it or instruct me as to the method of winding.

W. B., Montreal, Canada.

BANK winding, like the honeycomb and duolateral coils, is a form of inductance in which many turns of wire, or a high inductance, is possible, while the distributed capacity is kept at a minimum. Bank winding, however, can be achieved without special winding forms and apparatus such as is necessary with the variations of the honeycomb.

Distributed capacity is the condenser action between the turns of a winding. It is naturally very high in ordinary multilayer coils in which each successive layer acts as a condenser plate. This capacity, which is virtually shunted across the coil, boosts up the wave and thus limits the inductance in tuning the lower wavelengths, or, more simply, there is an apparent loss due to the fact that the capacity offers a path to the higher frequency currents, which jump from layer to layer, the path of least resistance, rather than pass through the windings.

Bank winding, to an extent, is a method of breaking up

e hook-up

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a multilayer coil into a *series* of distributed capacities; and when condensers are connected in series, which is the effect here achieved, the total capacity is reduced! The method is illustrated by the drawing, Fig. 6, which shows

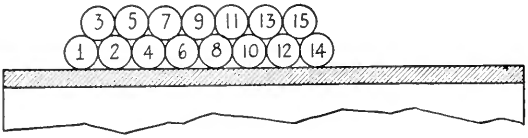

FIG. 6
How the wire is wound on a two-bank coil

a bank-wound primary, and the following table which indicates the exact system of winding the most popular banks. The numerals represent the numbers of the turns.

Two-Bank Coil:

3 5 7 9 11 13 15
1 2 4 6 8 10 12 14

Three-Bank Coil:

6 9 12 15 18
5 4 8 11 14 17
1 2 3 7 10 13 16

Four-Bank Coil:

10 14 18 22
8 9 13 17 21
7 6 5 12 16 20
1 2 3 4 11 15 19

It will be observed that at no time is there any great length of wire between the adjacent turns as is often the case in regular layer windings, such as the following:

15 14 13 12 11 10 9
1 2 3 4 5 6 7 8

—where, between the 1st and 15th turns there may be many feet of wire, *and a voltage equal to that impressed on the coil!* If fifteen hundred volts were applied to this winding, the insulation, were it of ordinary quality, would probably break down between turns one and fifteen, whereas, in a fifteen turn two-bank coil, the potential difference between any adjacent turns, under the same charge, could never exceed two hundred volts! Thus in bank-winding there is little dielectric loss.

R. F. And the Flivver Circuit

I have been using the "Flivver" circuit described in The Grid section of your July number. I have had remarkable results with this set, receiving stations as far away as Schenectady (WGY) through tropical static (when it lets up a little). However, I should like further to improve the set, if possible, by the addition of one stage of radio-frequency amplification and a single step of audio. I should appreciate a diagram if such exists.

Also, in such radio-frequency sets, will you please explain how the received wave perseveres as an alternating current after passing through the first tube, which, so it seems to me, must necessarily rectify it. (Only a one-way current can pass through a tube).

M. E. S., Mexico City.

Radio Broadcast has been experimenting with several possible radio-frequency adaptations to this circuit (Fig. 7) with the idea not so much of increasing the receiving range, but of choking the oscillations to which this set gives rise and which, when admitted to the antenna circuit, cause no small amount of interference in congested radio districts. We are glad to pass on the following data and circuit.

The circuit is shown in Fig. 8, and the right-hand portion enclosed in the dotted lines is the original single-circuit "flivver" receiver (by other names, the Automatic Regenerator, the Colpitts Oscillator, this last being its correct radio designation). The remainder of the circuit comprises the radio-frequency amplifier. A glance at Fig. 8 will indicate an *apparent* addition to the original hook-up in the condenser C2. This, however, is merely a small capacity which compensates for that of the missing antenna. It will be observed that it is connected where the antenna and ground would ordinarily go. This condenser should approximate .00015 mfd., and it may be made up of

FIG. 7
The "Flivver" or Colpitts Oscillator Circuit

two plates of copper or tin foil, one inch wide, overlapping one inch and separated by a piece of waxed paper. It may also be formed from a grid condenser (without leak) by removing two thirds of the foil.

P and S are respectively the primary and secondary of a standard variocoupler. L is a small coil of ten turns of wire wound on a three-inch form, and is often necessary as a partial compensation (C1 also helps) for the grid variometer with which many variocouplers are designed to be used. If it is desired to employ a loop, a coil antenna of the type described in the June Grid may be substituted for S and L.

C1 can be either a .0005 mfd. or a .001 mfd. condenser with a vernier adjustment—the last being preferable. RFT is a standard radio-frequency transformer, one in which maximum amplification (the peak) is at about 425 meters. It will be observed that the secondary is merely substituted for the inductance in the original "flivver" circuit. Hence the operator of the fundamental circuit may, if he desires, build up his own transformer, utilizing his present tuning coil as the secondary. It will merely be necessary to wind over the tuner the same number of turns, minus eight, that are used on the single inductance for the reception of the stations it is desired to amplify. This extra winding forms the primary and it should be shunted with a 23-plate condenser as tentatively shown


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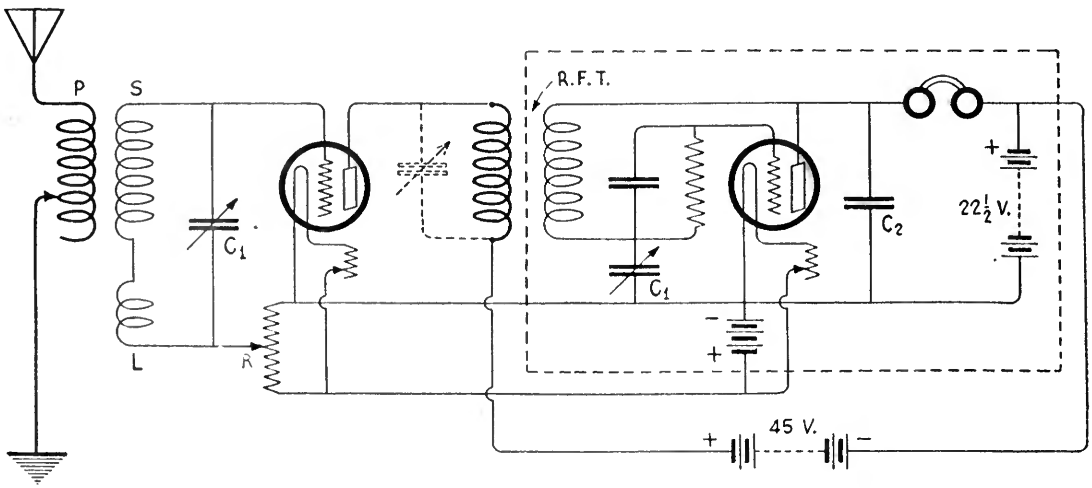


FIG. 8

The dotted lines bound the original Colpitts Oscillator circuit and the radio-frequency amplifier is at the left. Very little alteration in apparatus is necessary to obtain this R. F. amplification

by the dotted lines on the diagram, but which is not required when a standard transformer is used. (Incidentally, employing the arrangement outlined for the home-made primary and secondary, the amplifier is changed to the pure-tuned type, and while adding an additional control, it is, on the whole, the more efficient system.)

The 200- to 400-ohm potentiometer is that usually employed with radio-frequency apparatus. Our readers are familiar with the remainder of the circuit.

The theoretical operation of the amplifier, and the *apparent* lack of rectification in the first tube (viz., the passing on of the radio wave as an alternating current) is of interest to the student reader. It is suggested that he study the article on R. F. amplification published in the August, 1922, issue of RADIO BROADCAST. Several subtleties coincident with this system of amplification are there explained.

The truth is, as our correspondent has suggested by referring to the audion's single-way conductivity, that the radio wave *is* rectified in every tube through which it passes. The alternating currents or radio oscillations which are passed to the succeeding tubes are not the original wave (which of course was effectually blocked by the first tube), but is its amplified duplicate *which is generated in the plate circuit of the tube.* When the grid of the R. F. amplifier is adjusted in a certain way (see the article just mentioned in the August issue) by the potentiometer, the direct plate current will rise and fall in perfect synchronism with and in proportion to the alternations of the incoming wave. The primary of the amplifying transformer is a part of the plate circuit, and it follows that the rise and fall of the plate current, which flows through it, is accompanied by a corresponding rise and fall of the magnetic flux which is set up by the current. (Electricity in motion always "generates" a magnetic field.) This magnetic flux necessarily "cuts" the secondary of the R. F. transformer, and by the law of induction *induces an alternating current therein*—an alternating current of the same wavelength or frequency as the original wave intercepted by the antenna.

It is quite obvious that this arrangement will block the passage of any oscillations generated in the detector circuit back through the R. F. amplifier and out to the antenna—thus eliminating radiation, the greatest objection to this "flivver" circuit.

For the audio amplifier data, our inquirer is referred to the July 1923 issue of RADIO BROADCAST.

WAVELENGTH AND SIZE OF COILS

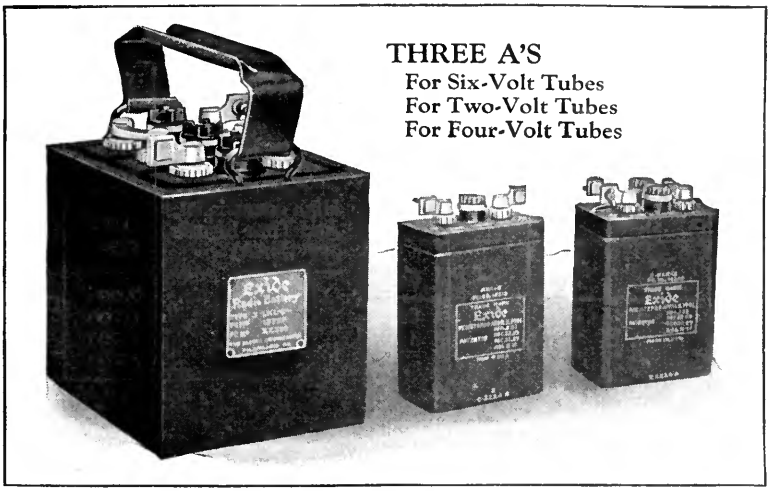
I am sure that many of your readers, in common with myself, have many occasions for winding coils for various wavelengths. Will you please publish a formula for determining the wavelengths of different coils, or, more correctly, the method for designing inductances for different waves?

O. J., New York City.

THERE is, of course, a formula (in fact there are several of them) for determining the required number of turns of wire in a coil for a desired wavelength. However, the application of these formulas is a comparatively difficult task, involving calculations of distributed capacity, spacing, diameter of the coil, inductance, etc., to say nothing of various correction formulas. These are complications that make such formulas useless to any one but the radio engineer, and luckily, they are really unnecessary except when calculations must be made with mathematical precision. An explanation, which would necessarily accompany the publication of these formulas, would be interesting to only a very small percentage of our readers. Such readers interested in the theory of coil design, are referred to *The Wireless Experimenter's Manual,* by E. E. Bucher, where this subject is treated very comprehensively.

For the average radio enthusiast, the correct winding of inductances is much more conveniently described in simple tables, which involve no subsequent mathematical calculations.

Chart 1 is quite self-explanatory, indicating the number of turns, size of winding forms, etc., for primary, secondary, and tickler coils on the wavelengths in which the broadcast enthusiast is most interested. These calculations are *only approximate,* and are based on average values of antenna capacity, etc. In order to secure the indicated wave range,



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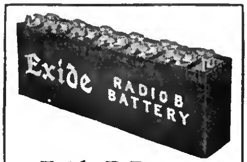

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CHART I

Wavelength Range in Meters	Size of Primary Tube	Size of Secondary tube (or ball)	Turns on Primary	Turns on Secondary	Turns on Tickler
175 to 220 (amateur)	$3\frac{1}{2}''$	$3''$ ball or $2\frac{1}{2}''$ tube	12	30	40
220 to 500 (broadcast)	same	same	40	40	60
350 to 650 (upper broadcast and commercial)	same	same	60	80	80

CHART II

Type of Signal	Wave Range	Primary	Secondary	Tickler
Commercial	450–700	DL75	DL100	DL100
	900–1400	DL100	DL150	DL100
High commercial, And Time Signals (NAA)	1560–2750	DL300	DL300	DL100
Long Wave	8000–15000	DL600	DL750	DL300, 400 or 50
	10000–20000	DL1000	DL1250	DL300, 500 or 60

a .001 mfd. condenser must be shunted across the secondary coil. Sharper tuning and a greater wave range may also be had by using a similar variable condenser in the antenna circuit, with a series-parallel switch, permitting its use in series with the antenna, and in shunt with the primary.

The number of turns in Chart 1 apply equally well to straight windings, honeycombs, or the average spider-web.

If the last division in Chart 1 (No. 3) is used, and the coils tapped, the wave range will include all those given for the smaller coils.

For wavelengths in excess of those covered in the first chart, the reader is referred to Chart No. 2, which spans the higher wavelengths, which can only be attained, practicably, by the use of honeycomb coils (duolaterals).

Chart 3 gives the wavelengths of honeycomb coils used singly, and shunted by .001 mfd. condensers. This data is useful in wavemeter work and in the construction of single circuit tuners *for long wave reception.* The relation between wavelength of a given coil and its number of turns is clearly shown by the charts.

CHART III

It is always a good idea to use the largest possible coi for a given wave. Boosting it up by the addition of a shun capacity is inefficient and results in loss of signal strength

Coil Number	Approximate wave range with .001 shunt condense
DL25	170–375
DL35	200–515
DL50	240–730
DL75	330–1030
DL100	450–1460
DL150	660–2200
DL200	860–2850
DL250	1120–4000
DL300	1340–4800
DL400	1860–6300
DL500	2340–8500
DL600	2940–12000
DL750	3100–15000
DL1000	5700–19000
DL1250	5900–21000
DL1500	7200–25000

Supplemental List of Broadcasting Stations in the United States

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CALL SIGNAL	LOCATION	FREQUENCY (Kilocycles)	WAVE-LENGTH	POWER WATTS
KFLX	Galveston, Texas	1250	240	10
KFLY	Fargo, N. Dak.	1300	231	20
KFLZ	Atlantic. Iowa	1100	273	10
KFMQ	Fayetteville, Arkansas	1140	263	100
KFMR	Sioux City, Iowa	1150	261	50
WABQ	Haverford, Pa.	1150	261	50
WABR	Toledo, Ohio	1110	270	50
WABS	Newark, N. J.	1230	244	50
WABT	Washington, Pa.	1190	252	100
WABU	Camden, N. J.	1330	226	100
WABV	Nashville, Tenn.	1140	263	20
WBR	Butler, Pa.	1050	286	250
WOAR	Kenosha, Wis.	1310	229	50
WWAO	Houghton, Mich.	1230	244	250