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RADIO BROADCAST

May, 1923

V. 3 #1

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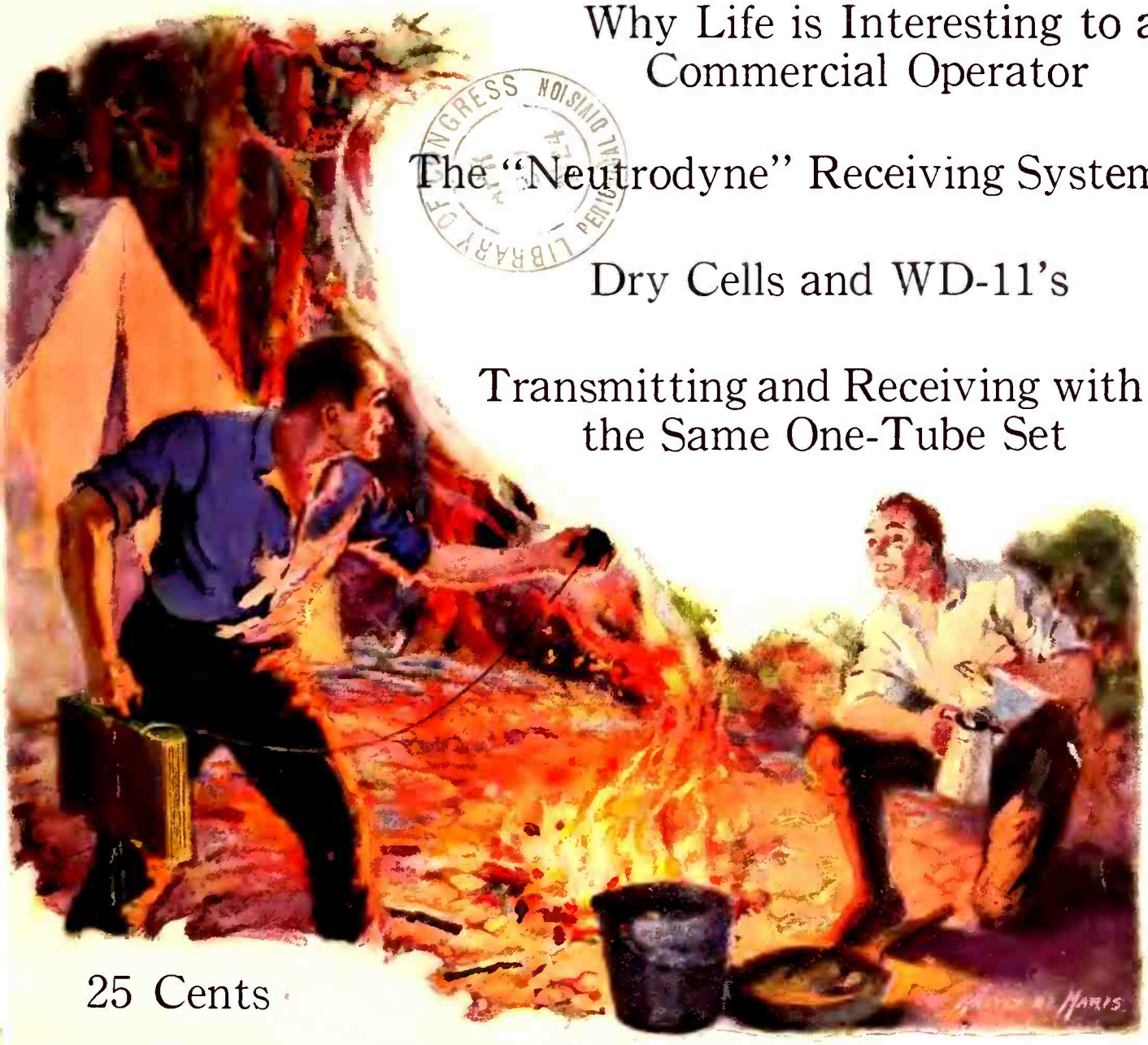

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Radio Broadcast

ARTHUR H. LYNCH, EDITOR

CONTENTS FOR MAY, 1923

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HERBERT C. HOOVER, SECRETARY OF COMMERCE

The White Radio Bill failed at the last session of Congress, but the radio world is now looking to Secretary Hoover to make the best of a bad situation by regulating wavelengths in so far as his present authority allows

RADIO BROADCAST

Vol. 3 No. 1 May, 1923

The March of Radio

WHAT RADIO BROADCAST IS TRYING TO DO

THIS is our first anniversary number. The twelve issues of RADIO BROADCAST which have preceded this represent twelve efforts to give you the very best magazine we could make. It is evident that no uncertain policy, no wavering of ideals, and no subordination to any selfish interest can lead to the highest usefulness of this or any other publication. We believe that you will be interested in a brief statement, at this time, of just what we stand for, what we have been trying to do, and what interests RADIO BROADCAST will continue to serve. We believe:

That the most important function of radio is to make life safe at sea;

That closer and more friendly relations between the United States and other nations can and should be fostered by means of radio communication;

That in broadcasting we have a tremendous force which, properly directed, may be a means of incalculable and universal good; and that every effort should be made to see that this force is fairly and intelligently used for the benefit of the greatest number.

It is our intention to continue a policy which is consistent with these beliefs. First, last, and always, we are for "Better Radio." We make mistakes, but believe that those who do not make mistakes, never make anything. Although you may not always agree with the ideas we express, you can always be sure that we believe what we say and that we make every effort to state the facts clearly and justly.

Much of our present radio development is directly traceable to that group of electrical experts whom we call, for lack of a better name, "amateurs." There are those who would terminate the activities of these experimenters, but in our opinion such a procedure would be not only unjust, it would be folly, for certain of the amateurs' activities are conducive to great benefits to radio.

Concerning broadcasting, this phase of our game is at once the most interesting and popular. Broadcasting has done more to advance radio in the last two or three years than all the efforts of previous years. Of course, there is much to be desired in broadcasting as we find it to-day. We need improved transmission, better programmes, adequate wavelength regulation, fewer high-power broadcasting stations, a more satisfactory distribution of transmitting stations, a reasonable standardization of apparatus. . . .

We have consistently endeavored to promote regulation of a helpful character. As you know, you and we have campaigned together for legislation designed to bring about the changes necessary for better broadcasting.

Thus, you will see that RADIO BROADCAST is, in a sense, not our magazine—it is *yours*. We are but players on a stage, interpreting to the best of our ability for you, our audience, without whom there would be no play.

As the Radio Corporation Sees the Patent Situation

THE following letter from General Harbord, President of the Radio Corporation of America, sets forth the Corporation's views on the radio patent situation. In an editorial in our March issue we called attention to the possible harmful results of what seemed like a tendency on the part of the Corporation toward a monopoly in the production and sale of radio apparatus. Last month, we published an article entitled "Coöperative Competition", which showed how automobile manufacturers found a way out of a situation which seems to us similar in some respects to that now facing the radio industry.

We are glad to publish General Harbord's letter, and we should be glad to publish letters from the companies on the other side of the controversy, for this is perhaps the most important question in the radio field and one on which all radio enthusiasts should have information—and tolerance.

RADIO CORPORATION OF AMERICA,
233 Broadway, New York.
Office of the President

MR. ARTHUR LYNCH,
EDITOR, RADIO BROADCAST.
MY DEAR MR. LYNCH:

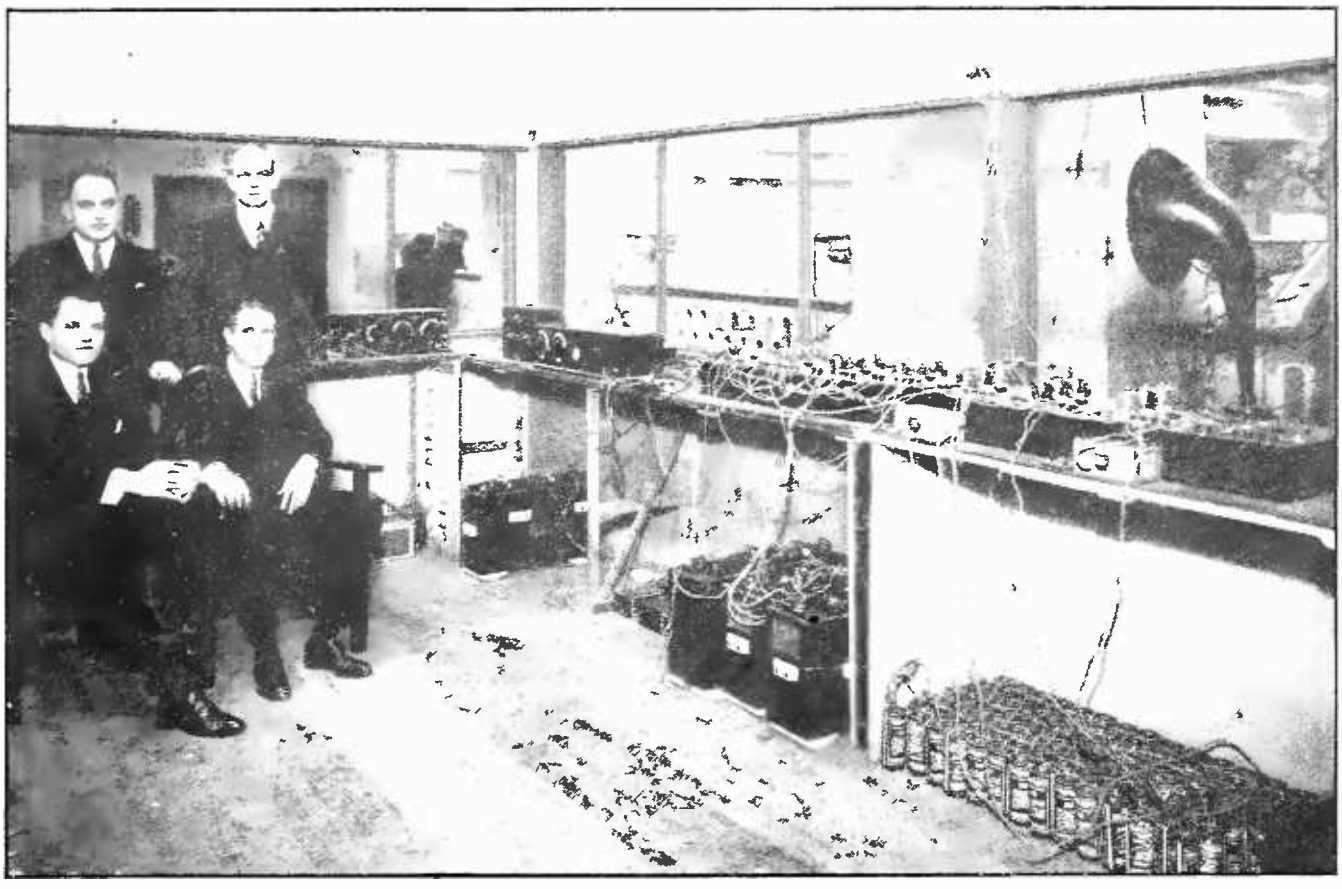
I regret that absence from the City has prevented me from complying with your request transmitted to me by Mr. Stuart Crocker for a statement regarding the plans of the Radio Corporation with reference to the radio patents held by it. I think you will appreciate that it is impracticable in a new art such as radio to make a statement which shall at the same time be prophetic and accurate. Such a statement can only be based on present actual knowledge. It might at any time call for a restatement because of change of conditions. For the present, the best that any company in the radio industry can do is to make month to month decisions.

If I may be permitted a word as to the purposes of the Radio Corporation, I would say that it was organized under the laws of the country for operating a lawful enterprise, for the same object which prompts the launching of any other business institution—service to the public with the hope of a fair return to the stockholders. In addition to this legitimate ambition for material success, the corporation has striven to be of service in a technical and patriotic way. It has aided in the development of radio art, and has furnished the first American owned and controlled means of direct commercial telegraph communication with the principal foreign countries, making the United States the great centre and leading factor in world radio communication. To achieve these ends it has been obliged to coördinate the inventive genius of many individuals. It has made great outlay for research and development work in perfecting its own inventions, and to advance the radio art it has also been considered wise to acquire the inventions of others. In no other way could the various improvements and best features of the numerous inventions—no one of them adequate in itself—which are regarded as requisite to satisfactory radio service, have been assembled and made available for the public in any one line of apparatus. Had the several inventors joined forces, the situation would have been the same under some other organization bearing a different title.

Thus far, the public and a few manufacturers and dealers—some legitimate, but many of them infringers—have profited from the development and production of radio apparatus. The stockholders of this corporation whose money and faith in the patent laws have contributed to the technical achievements largely responsible for progress made have not yet drawn a dollar in profits.

There have been some criticism against the Radio Corporation for bringing suit against various radio manufacturers for the infringement of patents. The cry of monopoly and the charge of oppression of small manufacturers are easily raised, and usually by those to whom the propriety of great exactness of speech does not appeal.

The Radio Corporation had the absolute right to enforce every patent which it owned against every user. It did not, however, adopt this policy, but instead, in keeping with the high ideals which have characterized it since its inception, decided that if an amateur wanted to build his own set for his own amateur use he could do so, and that it would not, until further notice, treat such procedure as an infringement of its patent rights. But there is absolutely no reason why the Radio Corporation, which ought to earn dividends on the shares which it issued to clear this property represented by important patents, and which shares are now owned by over 33,000 stockholders, should allow this property and patents to be recklessly trespassed upon by hundreds of rival manufacturing companies, most of which make no contribution whatever to the art, have made no investment in property patent rights, and merely attempt to reap where others have sown. The Radio Corporation is therefore proceeding to enforce some of its rights by the normal orderly process of suit in the Federal Courts. It is not attempting to create a monopoly; it is attempting to enforce the lawful rights limited in scope and in time which it has been necessary for it to acquire in order that the radio art might go forward. It is as important to the entire radio industry to have these patents judicially



ARMSTRONG'S SUPER-HETERODYNE

In a glorified form, it was one of the features of the radio exposition held in New York. Western Electric loud speakers, each operated from its own power amplifier, were placed in various points in the Grand Central Palace. The plate voltage was supplied by a great number of standard 6-inch dry cells, and about thirty-six vacuum tubes were used. Radio engineers predicted failure for this outfit, which was installed and operated by the Radio Club of America with complete success. Left to right, in the picture, are: L. S. Byers of the Exposition Company; Louis G. Pacent, chairman of the Committee on Papers; George Burghard, President; and Edwin H. Armstrong, Past President of the Radio Club

tested as it is to the Radio Corporation. Not until its validity has been judicially determined is it possible to evaluate the proper royalty basis for a patent. Until this is done, there will be continual confusion, and the radio patent situation in the United States will remain unprofitable to inventors and unsound as far as manufacturers are concerned. We, therefore, have instituted suitable action to reach sound conclusions. We go so far as to believe that all holders of radio patents should do the same thing, if this present complex and disturbing situation is to be clarified.

An infringer of patents has the advantage that he has no patent investment, no research to finance, no responsibility to the art. He can make a thing and sell it; if he makes a dollar profit it belongs to him until the Courts take it away from him, which can only happen after a long litigation. The great concern which has made all this development possible, which has spent millions in clearing the road for American radio has to earn something on what it spent in acquiring that pathway. Enforcement of its patent rights with the Federal Courts will help it to earn that something. If its rights are not as broad as it believes them to be the Courts will say so. In its efforts to test its rights and find out just what they really are and to enforce them the Radio Corporation should have the sympathy of everyone who really wishes the good of the radio art; for if such rights acquired under such circumstances and at such cost are not sustained and enforced, who again will feel justified in taking the risks and making the expenditures that were taken and made when the Radio Corporation was formed?

We must have it clear in our minds that a patent under the constitutional laws of the United States grants to the inventor or to the person to whom he has assigned the patent, the exclusive right of its use. This means that with perfect legality and due regard for the ethics of the situation, the Radio Corporation has such exclusive right to its property in patents. Any one not in agreement with this disagrees with the Constitution of the United States and the laws passed in conformity with it having for a purpose the establishing of patent privileges to inventors and owners of patents.

There has been a suggestion for a coöperative pooling of radio patents in order that all companies can manufacture radio apparatus without fear of patent difficulties. According to the best of my in-

A PRICELESS BOON

To an ordinarily active person who is forced by accident or illness to pass many long hours of inactivity, a broadcast receiving set is a blessing. William Snider, repairman for the Bell Telephone Company, broke both arms and legs in a fall from a pole recently, in Canton, Ohio. Friends among his fellow workers conceived the idea that a radio set might help to pass the tedious hours. Accordingly, a receiver was installed, and the patient was able to keep in touch with the world beyond his hospital window, hearing the concerts every afternoon and evening

formation, no coöperative pooling of patents in any industry has ever been effective until this initial stage has been passed. The pooling arrangement does not take place during the nebulous period under which the developed art passes. Future inventions and developments will probably very greatly change the radio art as we know it to-day.

The future policy of the Radio Corporation regarding patents cannot be more definitely stated at this time. I am glad to give assurance, however, that we intend to be as helpful to the rapid advancement of the radio art as it is within our power to be. The United States should be proud of its position in the development of radio throughout the world. It is with the avowed purpose of maintaining this position that the corporation will always approach the solution of radio problems.

By coincidence, the laws under which we claim our rights are based on the same provision of the United States Constitution which protects your employers in the publishing business, namely, Clause 8 of Article 1. If you should write a scientific work as a result of your years of labor and study, and bring it out at great expense, would you think it a crime or injustice to others who were endeavoring to steal your work that they should be enjoined from doing so for a limited period granted you in which to realize some legitimate profit from your work? That is a similar question to the one which has to be decided by the officers of this corporation, representing over 33,000 stockholders whose motives are impugned by statements in an editorial appearing in the March issue of Radio Broadcast.

I am sure that with this frank statement I can confide in your fairness to the Radio Corporation in the future.

Sincerely yours,

J. G. Harbord

The Effect of Broadcasting on Sermons and Speeches

THE pioneer radio preacher of Pittsburgh, the Rev. Dr. E. J. Van Etten of Calvary Protestant Episcopal Church, gave his opinion recently on the effect which radio might be expected to have on church services. He has probably thought along these lines as much or more than any other churchman,

and has had enough experience in the matter to have reached some interesting conclusions.

We cannot doubt that the radio church service is here to stay, just as is the concert and opera. What will be the effect on the churches themselves of thus spreading their service over a large territory with possibly thousands of listeners? Such an innovation cannot be introduced without having some reaction on the man conducting the service. Some of the churches have a perfectly fixed service routine so that no changes in this respect can be expected; the flexible feature of any church service is the sermon, and the preacher of the sermon. The ritualistic churchman will assert that the personality and ability of the preacher have little to do with the value of a church service, but to the average church-goer the preacher is of paramount importance. Many people go to church "to hear Dr. So-and-So."

Doctor Van Etten, in a recent sermon on this question, said that in his opinion "broadcasting of church services will prove something of a disintegrating force on the church organizations themselves. Only the fittest preachers will survive, and struggling churches will, more or less, go to the wall." This seems like a very sensible conclusion—a preacher of mediocre caliber can hold his congregation only so long as other and more inspiring men are not available. When the congregation can stay at home and hear the wonderful musical service from a metropolitan church, and listen to the words of a superior mind, the small country church with its itinerant pastor is quite likely to suffer.

In his sermon, Doctor Van Etten further stated that "radio religion is not a substitute for public worship. It must become active and not passive." This brings up the question of the effect of radio broadcasting upon church attendance; will many people be content to take their religion from the loud speaker? If we can accept the explanation of the large crowds at the Manhattan Opera House recently, the attendance at church will increase rather than decrease as a result of broadcasting, that is if the service is carried out in an appealing and inspiring manner and if the preacher shows

GATHERING WEATHER REPORTS AT A POWERFUL GERMAN STATION

The reports received from Paris, Warsaw, Christiania, London, and other cities are used to make up the daily forecasts broadcasted from this radio telegraph station located in Berlin

ability and sincerity in his words. In fact, this condition has already been observed following the weekly broadcasting of the Men's Conference at the Bedford Y. M. C. A. in Brooklyn, N. Y.

This idea of forcing the preachers to improve the quality of their sermons leads us to a suggestion for many of our celebrated after-dinner speakers. They don't realize it, of course, but the radio audience is composed of nearly the same individuals every evening, even though those listeners directly in front of them may be different. The professional after-dinner artist has been able to earn his meal ticket rather easily in the past; one set of stories might go for the whole season if he was careful concerning the invitations he accepted. But not so now. We recently heard one of our national figures tell the same stories on three different occasions, all within a week. It's well that he didn't know how many of us had already heard about the marriage of his chauffeur, as it would have taken all the fun out of his narration. It's interesting to know also that some speakers have had to change somewhat the quality of their stories, for they never know who is going to hear them.

The Sunrise and Sunset Barrier to Signals

EVERY careful observer has noticed that the distant stations seem to be erratic in the way they "come in." Some evenings the signal received may be consistently strong, and on others it may fluctuate greatly in strength even during the course of an hour or less.

According to one of our correspondents, certain stations show this fading phenomenon with a remarkable degree of regularity; his observations, which he has sent us, show a striking resemblance to those of Marconi when

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NOTHING LIKE THIS WHEN HE TROD THE QUARTERDECK

England's oldest seadog, the Hon. Sir Edmund Robert Fremantle, Rear Admiral of the United Kingdom since 1901, recently listened to a concert broadcasted from the Eiffel Tower, in the cabin of his old ship, H. M. S. *Impregnable*. Admiral Fremantle entered the Navy in 1849, in the real days of "ships of oak and men of steel," when muzzle-loading cannon lined the decks of tall-masted frigates

that pioneer was first trying to bridge the Atlantic. As any student of radio knows, Marconi found it almost impossible to send his signals across the sunset or sunrise line. When the sun was up in Ireland and not yet up in Newfoundland, the sunrise line was between the two stations and this line seemed to act as a kind of check to the electric waves. The signals acted the same way when the sun had set in Ireland and had not yet set in Newfoundland. This effect is not noticed to any great extent by the long-wave, high-powered stations used for transatlantic service to-day, but with Marconi's shorter-wave, lower-power stations it was a very important factor. The fading of signals noted above is probably similar in nature to the troubles encountered by Marconi.

When two stations are broadcasting with carrier waves within a meter or less of one another they produce a constant singing note in the receiving set, even when this set is not oscillating. (With the rapid increase in number of broadcasting stations this beat note interference becomes very much of a nuisance when reception from distant stations is being attempted.) Our correspondent, who lives about one hundred miles from New York, on listening to the beat note between a New York station and a Chicago station, reports the note just audible when the sun is up in New York City; as soon as the sun sets at his station he observes that the beat note at once increases several times in intensity and that about an hour later, when the sun is setting in Chicago, a remarkable increase in signal strength occurs, the increase not being gradual but occurring very suddenly. This action is so regular, he reports, that he can tell within a minute or two when the sun sets in Chicago!

Several very capable experimenters have been engaged during the past year in making a continuous record of signal strengths from those stations which seem to fade most regularly and we may expect their work soon to give us some reliable data on the fading phenomena.

Transmitting Standard Wavelengths for Calibrating Sets

THE scheme of transmitting standard wavelengths from the Bureau of Standards, which we suggested as possible and advisable in our last issue, has already been inaugurated. The first standard signals were transmitted on March 6th from 11.00 P. M. to 1.15 A. M., this time having been chosen because it was freer from interference than the early part of the evening. Every twenty minutes during this period the wavelength was changed so that, during the two hours, seven standard wavelengths, from 550 meters to 1500 meters, were transmitted. Preliminary tests carried out on January 31st showed the feasibility of the scheme and also convinced the Bureau that it was worth while.

Much of the work of the radio department of the Bureau has to do with calibration of condensers, coils, and wavemeters. These instruments have to be shipped by the owner to the Bureau, tested, and then shipped back; not only is this an unnecessarily expensive procedure but it has been in the past extremely unsatisfactory, as the handling of the instrument by the express employees, subsequent to its calibration, and before the owner received it, many times subjected it to jarring sufficient to make the certification of the Bureau at least doubtful—and that is really as good as no certification at all.

Not only must laboratories have accurate calibration of their apparatus, but every intelligent radio listener would like to have his receiving set calibrated for wavelength, so that, instead of "feeling around" for the signal of a certain station he could at once adjust his set to the wavelength on which the desired station was to transmit and if no signal was heard he would conclude that the station was not on the air. Hence, the average listener welcomed the news that standard wavelengths were being transmitted and hoped that they would soon include the broadcast range.

The calibration signals sent out by the Bureau are continuous-wave signals and can be received only by the heterodyne principle; the local receiver must be made to oscillate by a tickler coil or other means, and the Bureau's call will give the characteristic whistling note signal. By adjusting the receiving set to make the beat note have zero frequency, a point on the variable condenser is obtained, which tunes the set to exactly the frequency the Bureau is broadcasting; this setting is extremely accurate and the set may be calibrated to a fraction of a meter if its construction has been sufficiently well carried out. The tickler coil coupling should be as loose as is possible and still maintain oscillations, otherwise its adjustment will

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LISTENING TO THE GOVERNMENT BROADCAST IN AN ENGLISH HOME

The English experimenter has been going through a stage of development in radio construction familiar to all "old-timers" in this country: working units of all sorts and sizes are placed on a board and wired up regardless of compactness, appearance, and simplicity of operation. The Englishman has done some excellent work in constructing his own equipment, however, and some of the commercial companies produce apparatus that would be hard to beat anywhere

make the calibration of the receiving set less accurate.

As this goes to press, we learn that about April 1st another set of signals, from 300 to 600 meters, is to be broadcasted, and about May 1st another set of from 125 to 300 meters will be sent out. These tests will be repeated periodically so that checks on the accuracy of apparatus many frequently be made.

Considering the small staff engaged in radio work at the Bureau of Standards, and the importance of work like that mentioned above, we have sometimes questioned the judgment shown as to what problems should be studied by the Bureau. The circulars recently issued on the testing of receiving sets, and that on the specifications for dry cells, are, in our opinion, illustrations of work which the Bureau should not attempt; there is so much work of more importance to be done. We believe this broadcasting of standard waves is one of the best services the Bureau has yet done for the radio public, and we expect that the accuracy of the signals will warrant the faith we shall put in them.

Boosting the Box-Office Receipts at the Opera

THE following article, which appeared in the New York *Times* for February 20th, provides an interesting field for speculation as to the coming relations between opera in the opera-house and opera via radio—at home:

RADIO "FANS," DRAWN TO GERMAN OPERA, RECALL THE CROWDS OF HAMMERSTEIN DAYS

Without warning save for such explanations as followed the Manhattan's first "broadcasting" of an opera here two

nights previously, the former Hammerstein Theatre in Thirty-fourth Street was besieged by opera-goers all day yesterday and its lobbies were the scene of a wild but friendly "riot" last night when the Wagnerian Opera Festival began its second week with a packed house for "Die Meistersinger." At first the management was at a loss to account for the crowd, some hundreds of whom had to be turned away for lack of either seats or standing room.

Then it was suggested that the wide public interest had resulted from Saturday's experiment, when a performance of "The Flying Dutchman" had been sent by radio out to a city and suburban population of millions from the Westinghouse plant at Newark, N. J., the music having been conveyed to that place on a wire installed in the Manhattan stage by the Postal Telegraph Company. Influential members of the Metropolitan directorate had likewise heard it and there were those who said the result might change the policy of the older Broadway house, which hitherto had barred the broadcasting of opera by radio.

It would seem that even the Metropolitan Opera Company, with its ordinarily well-filled house, cannot afford to overlook the possibilities in the situation and we hope that the directors will soon reverse their decision not to permit the broadcasting of its performances. For those of us whom distance and expense prevent from going to see the famous operas, now and then, such an announcement would be most welcome.

What is the Range of a Broadcasting Station?

WE HEAR so much nowadays about the remarkable distances covered by broadcasting stations that one may reasonably suppose that the audience of one of the better class stations often numbers tens of thousands. Practically any quiet evening we can hear stations a thousand miles away and we are informed by the National Radio Chamber of Commerce that there are between one and two million receiving sets in the country. Figuring only two or three listeners to a set gives a total radio audience of about five million. If, then, reception over a thousand miles is reasonable, an audience of

LISTENING TO AN OPERA HE HEARD IN 1859

Christian Strohm traveled from Oldes Leben to Weimar, Germany, sixty-four years ago to hear the first presentation of an opera composed by Wagner. This year, he heard on a crystal set the same music, broadcasted from WIP, Philadelphia

a million is not at all impossible, however improbable it may be.

But how many people actually do hear stations one thousand miles away consistently? One of our friends, living in New York City, who has recently bought a modern receiver, confided in us that although he had a set with detector and two steps of audio-frequency amplification, he had never heard stations farther away than Newark, twenty miles distant. He probably isn't the only one who has trouble hearing stations a thousand miles away. The fellows who do hear distant stations do a lot of talking about it but those who have received only within a fifty-mile radius keep quiet when distance records are being discussed.

As a matter of fact, to many listeners-in, there is no particular fascination in spending half the night bringing in the call letters of some distant station, whose programme may be mediocre, when at the same time, a good local station is providing excellent entertainment. Nevertheless, it would be interesting to most of us—whether or not we collect call letters the way some zealots collect autographs or postage-stamps—if one of the popular stations, which has received the thousands of letters which we hear about from the announcers, would plot on a map, for publication, the location of each of these listeners who write in, and so let us know the average distance of the radio audience. We predict it would be well within the thousand-mile limit, even taking into account the fact that the long-distance listeners would be the more likely to write. It would be illuminating to have on record not the number of the *possible* radio audience, but the *actual* number of the audience listening, on a particular evening, to any particular programme.

Atchison, Kansas, Takes Control of Radio

KANSAS is always "doing things," so we are not surprised to hear of a municipal regulation concerning radio, enacted by the commissioners of the city of Atchison. The good people of Atchison evidently need some special supervision, as we are informed that "three hundred aerials were ordered down by the chief engineer of the local lighting company." It seems that the lighting company's poles were being used to hold up the aerials, in spite of the fact that these same poles carried a powerful current at 2300 volts, and 1750 volts is as high as is used in Sing Sing to kill the condemned.

The ordinance passed by the commissioners has to do with the disturbing influence of small boys with spark transmitters. So it was "hereby made unlawful for anybody unnecessarily and electrically to disturb the atmosphere within the city limits of the city of Atchison by any means whatsoever not necessarily incident to the operation of some device, mechanism, or apparatus used and useful in any business, trade, or occupation." Fines and imprisonment are offered to disturbers of the atmosphere.

The city fathers have our approbation and well wishes in their attempt to clear the air of spark sets, but we judge they might have some trouble in sending the offender to jail if he didn't go willingly; a shrewd attorney might show the city was trying to usurp the powers of the Federal Government in the matter; if a certain small boy happened to have a federal license to operate his station we judge he needn't go to prison, no matter how drastic might be the municipal sentence imposed. We have heard of the federal authorities assuming control where the state or municipal machinery had broken down but it seems incongruous to have a small town stepping in to take care of the federal authorities' business.

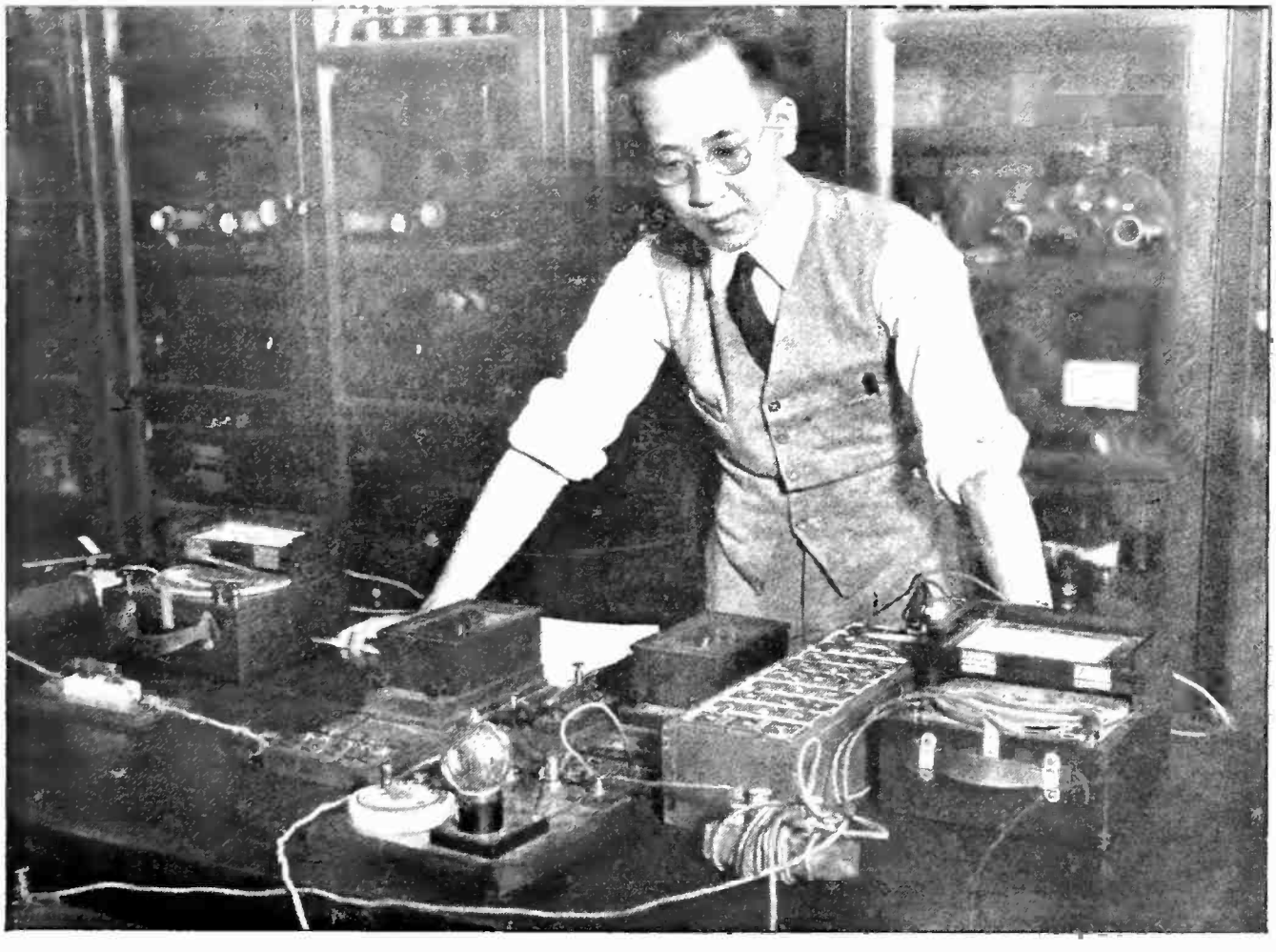
Along this same line we have received some clippings from the *Daily Record* of Kitchener, Ontario, which indicate that our Canadian cousins also can act in radio matters with impetuosity and rashness. While we cannot condone illegal acts, we do sympathize with the Canadians in the situation which preceded their attack. It seems that several amateurs with spark sets had been disturbing the ether around Kitchener to such an extent that reception of distant concerts was apparently impossible for some of the listeners. After a period of controversy the antennas and poles of the offending stations were surreptitiously taken away in the night. Of course, if found the perpetrators may be prosecuted for property damage, as the law prescribes, but they are apparently not advertising their share in the exploit. As for the unfortunate station owners, they are by no means reconciled to their bereavement: to them the proverbial silence of the Sahara is as the noise of many waters compared to the reign of quiet around their spark transmitters.

Will the Entire Nation Listen to the Next President's Inaugural Address?

ONE of the latest developments in broadcasting was demonstrated before a large audience in many sections of the United States on the evening of February 14th. The event was one of the features of the annual convention of the American Institute of Electrical Engineers, held in New York City.

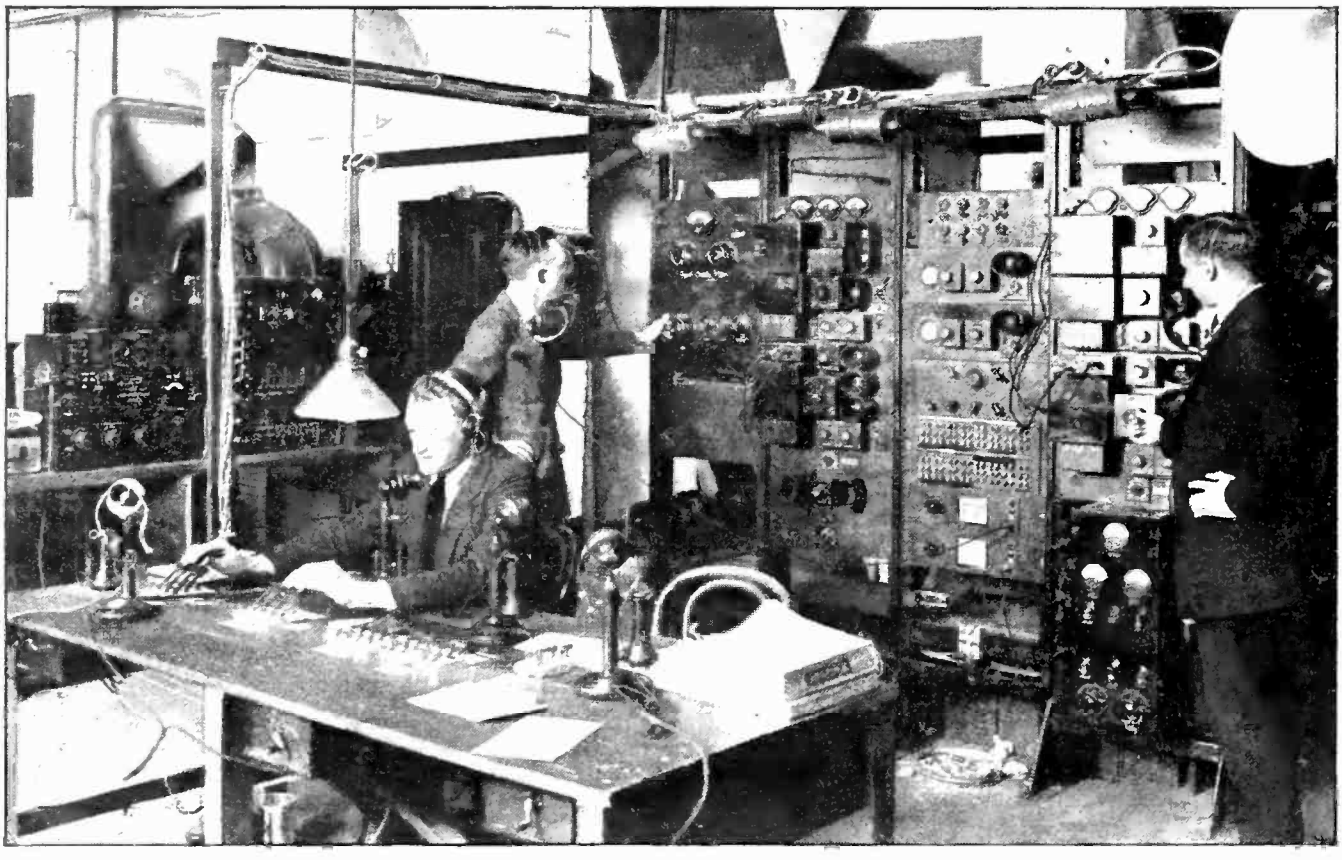
An audience of several hundred people in the Engineering Societies Building, in New York, and another similar audience in Kimball Hall, Chicago, were able to enjoy an illustrated lecture by the same speaker simultaneously. Both auditoriums were joined by a long-distance telephone line, at each end of which two complete "public address" systems were attached, permitting a speaker at either place to address the two audiences simultaneously, though he spoke in a comparatively low voice. Stereopticons and duplicate sets of slides were provided and the audience at both ends of the line had no difficulty in following the entire lecture. A second lecture, delivered in Chicago, was heard in a similar manner in both cities. It gave the listeners an uncanny feeling to hear, at the end of the lecture, the applause of first one audience and then the other.

But even this wonderful demonstration of the practicability of joining audiences in various parts of our country by a two-way communication system was not enough to satisfy the American Telephone & Telegraph Company, who arranged it. An additional tap was taken off the wire connecting New York and Chicago and by a delicate manipulation of the circuits, enough current was drawn into the company's broadcasting station, WEAF, in New York City, to actuate the modulating system at that station. In this manner, the listening audience became much larger than the visible audience. Enthusiastic reports from many parts of the country were received.



A CHINESE STUDENT DETERMINING TUBE CHARACTERISTICS AT COLUMBIA UNIVERSITY, N. Y.

Mr. Shu S. Man, a graduate of Hong Kong University, came from China to do advanced research work in this country. He is here seen testing the amplification characteristics of a vacuum tube under various plate and grid voltages



OPERATORS IN THE CONTROL ROOM

Located in the Engineering Societies Building, New York City, keeping the wires between New York and Chicago working at their best for the audiences, in both cities, some nine hundred miles apart

Picture to yourself a man in his living room in Chicago listening to a lecturer in his own city, the reproduction of the voice coming to him after a trip by wire to New York and by ether back to Chicago in less time than one's thoughts can follow the process. This will give you a slight idea of the possibilities of such a means of communication. It is quite likely that, for the first time in the history of our country, the next President's inaugural address will be heard in every state and most of the larger cities by a similar arrangement of telephone lines used in conjunction with broadcasting stations and receiving outfits equipped with loud speakers.

Twelve More Men Owe their Lives to Radio

THE five-masted schooner *Santino* was recently put to the lowly task of carrying coal. She was built during the war when any respectable ship was at a premium, but in the after-the-war slump it was found that coal cargoes from Norfolk to New England were as much as she could hope to do. On her second trip from Norfolk in this work she struck bad weather south of Nantucket Light and her seams opened up. The war work in the shipping yards apparently wasn't always very well done. To make her plight worse, her pumps broke down (the men who put them in were probably paid too much) and she was soon in a sinking condition. The twelve men who manned her were rescued with the help of radio; and the same signals which called the rescuing vessel called the Coast Guard cutter *Acushnet*, to salvage the vessel and her cargo or to destroy the wreck.

Radio Sets are Contraband in China

IT SEEMS that one political faction of China is afraid that radio may be too powerful a weapon in the hands of the opposition, and accordingly, broadcasting apparatus, such as we use here, has been put on the taboo list in China. An ambitious American firm announced that it intended to inaugurate a broadcasting service in China, but evidently changed its mind when the customs commissioner at Shanghai gave out the information that all such apparatus would be seized as contraband of war.

★ Protecting Our Readers ★

DURING the unprecedented demand for receiving apparatus—especially broadcast receivers—last year and again during the present peak of business, there has been, and there now is, a grand opportunity for unprincipled and uninformed petty capitalists to enter the radio business and, as they themselves express it, "make a clean-up." Such a clean-up is usually accompanied by a large loss on the part of the victims, who, in the effort to purchase a radio outfit and finding all the standard lines depleted, are cajoled into purchasing what has come to be called "bootleg" merchandise.

Just as long as the world rolls on, we are going to find people in business who believe it is easier or preferable to earn their livelihood among the folks of whom Barnum said, "One is born every minute" than in legitimate enterprise. And there will ever be those gullible people who will part with their shekels to the tune of a suave talker's eulogies on the merits of apparatus that proves to be practically worthless.

Our advertising department has adopted a plan which may save readers of RADIO BROADCAST from any such loss. This is the plan they have outlined:

We are to place a star in the advertising space of manufacturing companies whose material we know can be absolutely relied upon to do what is claimed for it. We are taking it upon ourselves to assure our readers that material purchased from advertising carrying our star is sold with the assurance that if its performance is not as represented in the advertising, it may be returned for credit. *Products of the best quality may be advertised without being starred, but this is only because they have not actually been tested by* RADIO BROADCAST. It goes without saying that advertisements of inferior products will find no place whatever in the magazine.

We cannot undertake a general endorsement of the merchandise handled by jobbing or mail order houses, although we are quite confident that our readers may look for fair dealing from any of those who advertise with us. In most instances the equipment handled by these houses, however, is already endorsed in the manufacturer's own advertisements.

RADIO BROADCAST is the product of one of the largest publishing houses in the country —Doubleday, Page & Company. *Country Life, The World's Work, The Garden Magazine, The Health Builder* and *Short Stories* are among the periodicals it publishes in its own plant at Garden City, N. Y. It is the largest publishing house in the radio magazine business, and is in a position to accept or refuse the advertising of any product which it believes to be unjustly represented.

Naturally, a plan of this nature is of great benefit to our advertisers, for it enables the readers of RADIO BROADCAST to buy with confidence. This, in turn, is helpful to our advertising department, for reputable concerns appreciate that being represented in a reliable periodical is a substantial asset to them. By the performance of this service, we are in a position to cement even more solidly the friendly feeling we already enjoy among our readers.

J. H. M.

AN ENGLISH INVESTIGATOR OF OUR BROADCASTING SITUATION

Mr. A. P. M. Fleming, C. B. E., England's representative at the international convention of the Institute of Electrical Engineers at Niagara Falls said: "One of the things we have learned (from the experience of the United States) is to avoid the establishment of innumerable broadcasting stations with no plan of coöperation between them"

A Single-Tube Loop Set in a Brief-Case

A Receiver That Weighs Six Pounds, *Including Everything*, and Offers the Opportunity for Interesting Experiments on Trips and Vacations. The Average Enthusiast Will Find It Neither Difficult Nor Expensive to Construct

By WALTER VAN B. ROBERTS
Princeton University

We have seen and laughed at all manner of freak radio outfits which were supposed to be portable and supposed to work, but have refrained from describing them because they seemed to us impractical and sometimes very misleading.

But the set described in this article has several characteristics which seem to put it in a class by itself: it is very light, very small, inexpensive to make, simple to operate—*and it works!* Can you imagine the uncanny feeling that comes over one who holds a complete outfit—batteries, aerial, etc.—in a brief-case, with nothing attached to it but the phones and "nothing up his sleeve," and hears the voice at a station more than three hundred miles away? In trying out Mr. Roberts' receiver, which we borrowed from him and took into the country to test, this very thing occurred: out here on Long Island, we heard Pittsburgh. Our cover, this month, illustrates one entirely practicable use for this outfit.—THE EDITOR.

MANY so-called portable sets of spectacularly small dimensions have been given publicity from time to time, but most of them either require something extra in the way of an aerial, or receive only from stations very close by; and if vacuum tubes and batteries are used, the outfit is likely to be too heavy to be conveniently portable.

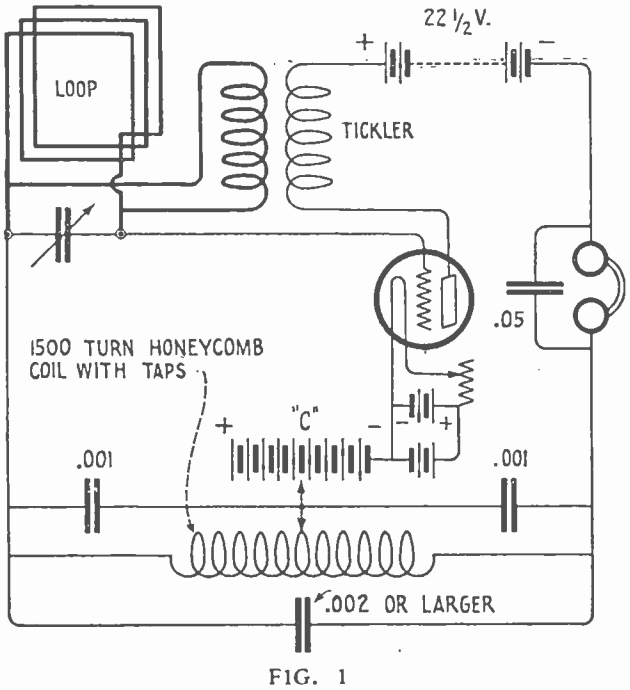


FIG. 1
The circuit which Mr. Roberts uses

An example of this is a portable outfit described not long ago in the radio section of a New York newspaper: the set gave very good results on local stations and even brought in such distant stations as Havana, Cuba, and Ft. Worth, Texas, on favorable nights. But, although it was not bulky (measuring only 11 x 22 x 5 inches over all), it weighed twenty pounds, and hence began to feel pretty heavy after being carried any distance by hand.

Recently, however, there has been perfected a small tube, the Radiotron UV-199, a sample of which was lent to the writer by the General Electric Company for experimental purposes, that requires only 60 milliamperes at 3 volts to light its filament. The UV-199 tube has not yet been put on sale, but it will probably be available soon. The WD-11 tube will operate in this circuit, although it draws more current from the A battery and takes a C-battery voltage of about 4.5. This power can be supplied by flashlight cells. The interest shown in the "suit-case" set mentioned above indicated that it would be worth while to design a set of "brief-case" size weighing about six pounds and capable of giving good clear daytime reception of stations 25 to 50 miles away.

The photograph shows the first model, a one-tube, super-regenerative loop outfit which is rather crude but which does what it was designed to do, and, in addition, has given better

results than expected with distant stations on favorable nights. The farthest stations heard so far from New York are Chicago, Kansas City and Davenport, Iowa. These are very faint, and although quite clear at times, are mentioned only to give an idea of the "freak" range of the set. Of course, as in the case of all unusually long-range reception, the "freak" part is the great distance that the waves travel sometimes without becoming too weak to detect. The receiver itself will not pick up any weaker signals at night than in the daytime; but longer distances are possible simply because the signals themselves are stronger.

IT'S ALL HERE

Set, batteries, and phone are within the box (9½ x 13½ x 3 inches). A 23-turn loop is wound around the outside

In describing the operation of the circuit shown in Fig. 1, an understanding of the principle of super-regeneration will be assumed.* The two features in which this circuit differs from the usual single-tube super-regenerator are the use of a plain Hartley interruption frequency circuit using only one large honeycomb coil, and the C battery so poled as to make the grid positive. When the tickler coil is moved away from the grid coil so that there is no tendency to oscillate at radio frequency, the grid and plate potentials will be approximately represented by the curves of Fig. 2. The plate potential is seen to oscillate about the horizontal line representing the value of the battery voltage between plate and filament, while the grid potential varies about the C battery voltage between the grid and filament.

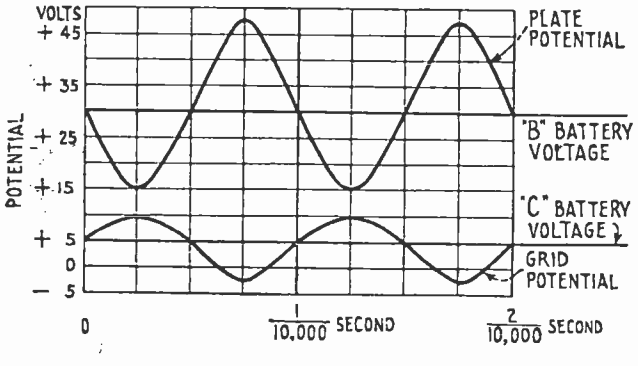


FIG. 2

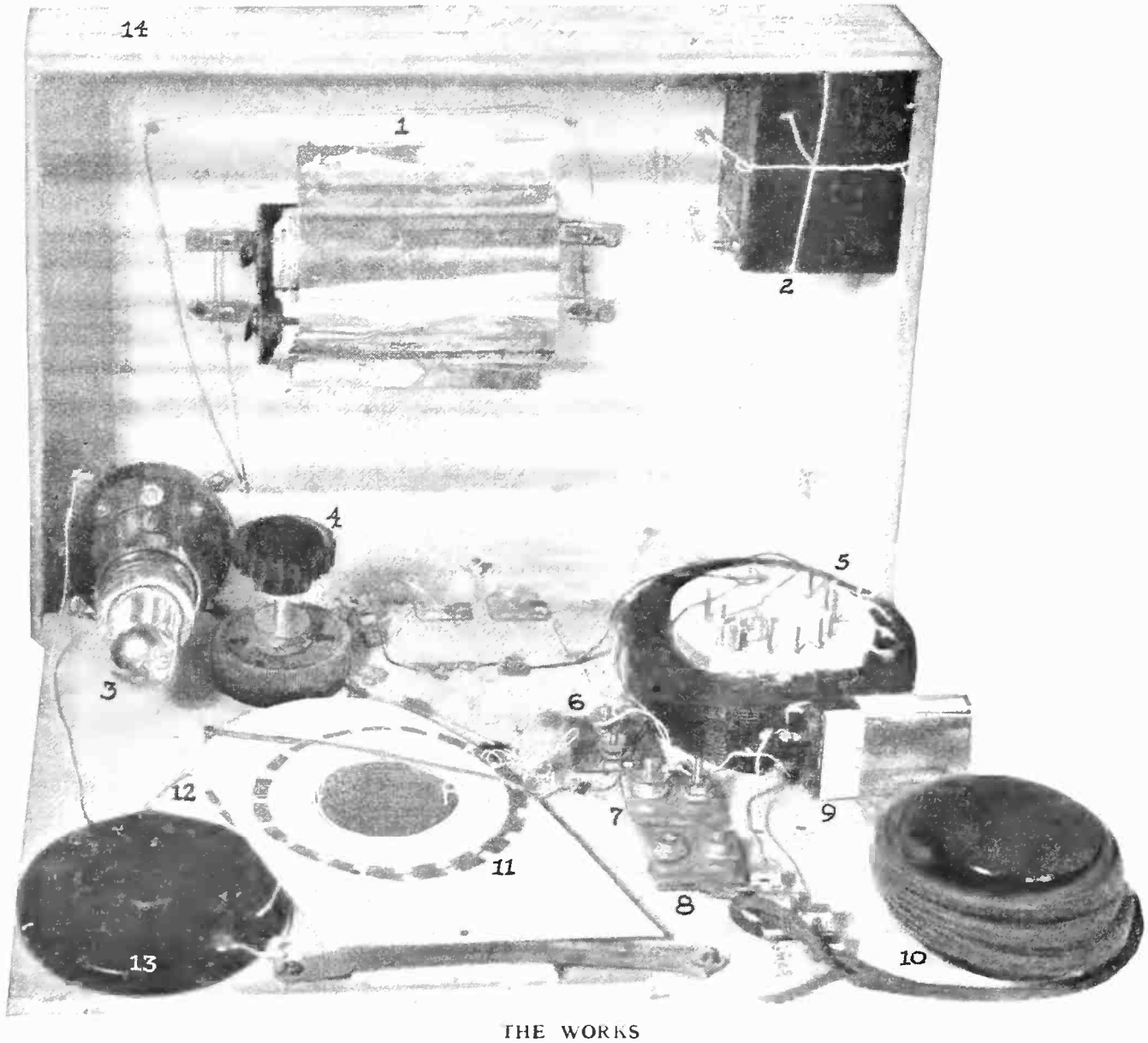
Now it can easily be shown by experiment that in a simple regenerative circuit using a small value of B battery, oscillations can be made to occur more readily if the value of the B battery is increased, while conversely, they start less readily if the plate potential (the B battery) is decreased. Another experiment shows that oscillations occur less readily if the potential of the grid is made positive (by putting in a C Battery) than if the grid potential is kept near zero. These two facts are enough to explain the operation of this super-regenerator. For it can be seen from Fig. 2 that at the time when the plate potential is at its lowest value the grid potential is at its greatest positive value. We have just found that both these conditions are unfavorable to the occurrence of oscillations in the radio-frequency circuit, and hence if the tickler is not brought up too much, radio-frequency oscillations will die out rather than build up during this time. On the other hand, when the plate potential is at its highest value we have the grid potential down near zero; (see Fig. 2) and as both these conditions are favorable, oscillations will start up in the radio-frequency circuit and will have built up to a value proportional to the strength of the signal picked up by the loop when choked off

*Fortunately, however, it is not necessary to know all this to build and operate the kind of set which Mr. Roberts describes.—THE EDITOR.

by the recurrence of the unfavorable condition mentioned above.

The reason that the radio-frequency oscillations die out during the unfavorable period is that the grid is then highly positive and attracts a large number of electrons from the filament, and the energy expended in doing this is supplied by the radio-frequency oscillations which thus quickly give up all their energy, or "die out." This will explain the use of the positive C battery for tubes whose filaments give off so few electrons that the grid must be kept more positive in order to attract equal numbers and hence produce the proper "damping" effect. Another reason for using the positive C battery is that it prevents the grid from ever becoming very strongly negative. For making the grid several volts negative is equivalent to reducing the B battery a good many volts, which we cannot afford to do when we have already cut down the B battery to one small $22\frac{1}{2}$-volt block for the sake of compactness and lightness. The unusual location of the C battery is for the purpose of making it act not only on the grid, but also in the plate circuit, on the principle that "every little helps."

Referring to Fig. 1, the parts include a loop, containing 23 turns of No. 24 D. C. C. wire, wound round the outside of the case ($9\frac{1}{2}$ x $13\frac{1}{2}$ x 3 inches. It might be better to devise a



THE WORKS

The layout shown here may be altered considerably, since there is plenty of surplus room in the case. The numbers indicate the units used as follows: 1, 4 flashlight cells for A battery, in series-parallel; 2, $22\frac{1}{2}$-volt B battery; 3, UV-199 bulb and socket; 4, rheostat; 5, honeycomb coil of 1500 turns; 6 and 7, by-pass condensers each of .001 capacity; 8, condenser in interrupter circuit, .002 mfd.; 9, phone by-pass condenser, .05 mfd; 10, phone, any type will do; 11, tickler coil; 12, grid coil; 13, Dubilier "Variodon" (or any other small condenser); loop, 23 turns of No. 24 wire

means of supporting these wires *inside* the cabinet); a tickler and a grid coil, wound on spider-web forms 2" inner diameter and $3\frac{1}{2}$" diameter including teeth. 19 teeth are used and No. 28 D. C. C. wire is wound over three, then under three, etc., which gives three times as many turns on the same length of tooth as the ordinary spider-web winding. The wire is wound on fairly tight and up to within about an eighth of an inch of the ends of the teeth.

The variable condenser has to be compact. The one now in use by the writer is a Dubilier .0005 mfd. A Connecticut condenser will also go in the box.

The .001 and .002 mfd. condensers are Micadons. None of these values is critical, the first two being merely radio-frequency by-passes while the third determines the interruption frequency.

The 1500-turn honeycomb coil has to be tapped at several places in order to determine the best place. If the wire from the inside of the coil is the one connected to the grid, then the proper tap will be about one third the way from the inner edge to the outer edge of the coil. As the taps are very easy to make by prying up the wire slightly and soldering small wires on, it will be well worth while to make at least six taps near this point so as to find the best by experiment.

A single Baldwin receiver without head band is used. The phone by-pass condenser is a Federal (price fifty cents). One of large capacity is used in order to by-pass the interruption frequency. The B battery is a single small $22\frac{1}{2}$-volt block, and the A battery consists of four flashlight cells in series-parallel, giving three volts and lasting longer than only two cells.

An improvement in operation will be possible when a sufficiently small rheostat of 25 ohms or more can be obtained, so that $4\frac{1}{2}$ volts of A battery can be used (three flashlight cells), and as the battery runs down the resistance can be cut out. Fig. 3 shows the circuit in its recommended form. A sufficient positive potential for the grid of a Radiotron UV-199 is obtained by using the positive side of the A battery as shown.

In operating the set only two adjustments are required. The condenser is turned to the proper point while the tickler is kept just close enough to maintain the hissing sound characteristic of super-regeneration. When the tickler is brought too close the whole thing suddenly goes "dead." If you then withdraw

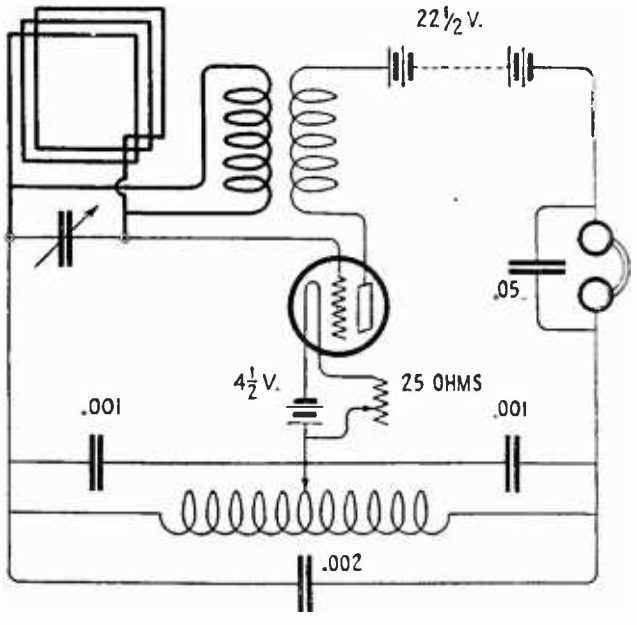


FIG. 3

This is the circuit which Mr. Roberts recommends. The arrangement in Fig. 1, however, is better for WD-11 tubes.

the tickler somewhat and touch the grid with your finger, the interruption frequency will start up again. The proper tap on the 1500 turn coil need not be changed after it is once found. It should not be so near the grid end as to let the advance of the tickler kill the interruption frequency too easily, nor so far from the grid end that the furthest advance of the tickler will not produce the proper hissing.

No claim is laid to any great ingenuity in space saving, so that the arrangement of parts will not be dwelt upon except to note that putting some of the parts in the box and some on the hinged panel makes available considerably more area, for parts that are not very high, than mounting them directly on the panel. It is probable that by careful designing the dimensions could be reduced to about $2\frac{1}{2}$ x 9 x 10 inches, although it would probably be difficult to reduce the weight much below the present six pounds.

Such a set as this should be of value to those who want to be able to catch weather reports or time signals or special features once in a while, but who do not use radio enough to warrant the trouble of aerial and ground installations, or the expense and house room of an ordinary loop set. And it will perhaps interest also those who want to be able to carry a complete receiver—containing within the four walls of a small thin box everything including phones and batteries—from one place to another. With it, they can listen from an auto or boat, for instance, or at a camp—in fact, wherever their vacation-time travels may take them.

Confessions of an Unmade Man

"Beware!" Cries This Miserable Wretch as He Goes Under for the Third Time

By R. O. JASPERSON

A YEAR ago I was a sober, respected citizen, loved of my family, welcome in the homes of my friends. I paid my bills promptly, kept my walks clean in winter and my lawn mowed in summer. In short I was, as you might say, a substantial member of that class of citizens who are the bone and sinew of our nation.

Look at me to-day. I am no longer sober. Once I could pass by where the deadly stuff is sold and never bat an eye. To-day, alas, my feet carry me into the open doors where temptation lurks. I am no longer master of myself. Gone is the respected citizen. No longer do my friends welcome me; they shun me. My family is disgusted with me, my bills are unpaid, my walks are not shoveled, and my position is in danger.

GONE IS THE RESPECTED CITIZEN

Once I could pass by where the deadly stuff is sold and never bat an eye. To-day, alas, my feet carry me into the open doors where temptation lurks: I am no longer strong enough to "take it or leave it alone"

My downfall has been rapid. A week before Christmas, little did I dream that such a change could take place. When I first heard the seductive whisper of the tempter and I yielded, knowing full well the fate that had overtaken my friends, I felt I was strong enough to "take it or leave it alone."

That was at Christmas time. I shall always look back upon that happy season as the beginning of my ruin.

You see, it was like this. A friend, yes it was a friend who started me on the downward path, asked me to go with him to a place where they sell radio parts and sets. He had just been paid and there was a gleam in his eye. He hadn't bought so much as a piece of spaghetti for three days and I could see that it was useless to attempt to restrain him.

So I went with him. It was not a gilded den, but in spite of the crudeness of the furnishings, they had the stuff to sell. There it lay exposed to the greedy eyes of the poor wretches who were spending their hard earned cash for "parts."

My friend ordered a variable condenser for himself and knowing that I didn't indulge, asked the bart—I mean the clerk—to show me a "set," just a cheap little set costing $10, while he poured tempting words into my ear.

"You can get WJZ, and KDKA, and WOR with this set." Now I'm telling you. Just think of it, all those beautiful concerts, speeches, and think of the prize fights, "blow for blow"—those were his exact words—and last night I got Cuba . . . "

"Cuba, did you say, Cuba . . . ?"

"Yes, I got Cuba, but you understand, not on this set. No, I've got honeycomb coils and two stages of radio and two of audio, and next week I'm going to get a loud speaker."

I might have known from his raving how bad they get when once they fall, but I was heedless.

"Blow for blow." Those words kept ringing through my head. "Concerts" and every-

thing. Only $10. WJZ, WGY, KDKA . . . .

Gentle reader, I blush to tell it, but the temptation was too great. I struggled, but struggled in vain. I bought the little $10 set, but with the strong resolution that it would be all. I would show them I could take it or leave it alone.

I don't think my good wife realized how she contributed to my failure to stick to my resolution to be strictly temperate. As I look back, I see how her suggestion that it would be nice if we could both listen in at the same time led to my future excesses. I bought an extra pair of phones, a little matter of $7, and a few nights later when company came to listen to our radio set, wife suggested we ought to have one of those horns so everybody could listen.

THE OFFICE BOY AND I ARE COMPANIONS IN CRIME

We sneak off to the seclusion of the stock room to exchange hook-ups. Once the office boy's opinions on any subject were of no interest to me. Now I eagerly seek his advice

I threw caution to the winds and proceeded to read all the magazines I could get on the subject. My favorite daily newspaper did not publish enough radio information so I changed to one that must be owned by some fiend judging from the amount of space devoted to the subject. All the magazines except those dealing with radio lie unopened and unread upon my library table.

Before prohibition when a fellow indulged, it was hiccups. Now it is hook-ups. My pockets are full of them. I bought a book on hook-ups and with the words of friend wife ringing in my ears, I sought more volume, I craved distance, I yearned for selectivity.

From the maze of hook-ups I selected one that looked modest and easy to master. I bought the parts, some of the parts, I should say, and abandoned myself to the seductive undertaking.

My noon hours were spent in radio shops whither I went to get information about grid leaks and variometers. Always I bought more parts.

The office boy, also an addict, discovered my secret. The size and shape of the many packages I brought in each day betrayed me. He recognized them and one day came to me with a hook-up and asked my opinion. It was a subtle thing to do. Now, the office boy and I sneak off to the seclusion of the stock room to exchange hook-ups. We are companions in crime. Once the office boy's opinions on any subject were of no interest to me. Now I eagerly seek his advice.

Even without taking time to eat lunch, I find I have difficulty in getting back to the office at noon. The office boy is helping me buy parts. Yesterday he knew where he could get tubes at half price. I drew my last dollars out of the bank and dispatched him post haste to get three of them.

Next week I must get a certain battery. The grocer and butcher will have to wait. I must have that battery.

Where will it end? It can't go on. If I knew of a cure I would take it. I have tried to limit myself to a definite sum weekly, but resolutions are of no avail. My will power is gone. Money means nothing to me except a means of gratifying my consuming craving for parts.

There ought to be a law against exposing radio parts for sale. It is putting temptation into the way of the slave to radio. No effort is made to screen the shops where radio addicts congregate. The traffic goes on openly in full view of the young and impressionable.

Even mere boys are among the worst cases. I have seen mere babes of no more than nine or ten rush wildly into a radio shop and demand three honeycomb coils and a vernier rheostat,

throwing the money madly at the clerk and dashing away with the parts clasped to their eager breasts. It's a sad commentary on our American institutions. When you protest, the sad eyed clerk simply smiles and says, "We might as well take it from the children. If they don't spend it, their fathers will."

The other day I saw a well dressed man sitting in a radio shop in deep thought. His clothes were still in fairly good shape, although I felt that he had seen better days. He looked up as I passed and he must have recognized in me a kindred spirit, for he said, "I simply can't make it out. Nobody seems to be able to help me."

"Perhaps I can," I said, for I felt sorry for him.

Then he told me his story. "I have been addicted to the habit two years. I have built twenty sets and used every kind of hook-up from a crystal to a five-tube set with indoor aerial. I have spent most of my money and I thought I was through, but a few nights ago I was adjusting my variable grid leak when the darn set spoke up as I never heard it before. I tried laying a screw driver across the terminal and the knob, and it fairly shouted. I cut a piece of zinc about the size of the screw driver and it worked still better. Then I began to experiment, cutting larger and larger pieces of zinc, each time getting the tone louder and clearer. Then I ran out of zinc until I remembered an old zinc bathtub over on the dump. I got that and was bringing it home when my wife introduced me to a gentleman who she said was to take care of me. He's out there now, see him? He's waiting for me to come out and take me back to the sanitarium. Well, I don't care, only I wish someone would tell me what made my set speak up like that."

I was unnerved. I realized what I was coming to. A few short weeks ago, all unmindful of danger, I embarked upon my career of debauchery and now I am without hope. All about me I see the bright, promising young men who will soon be like myself, ruined.

Go west, young man, go west—but no, it's as bad out there as it is here. But, at least, stop before it is too late. When temptation comes, and you have once given way to it, remember there is no cure.

Why do I pen these words? I would spare you the sight that met my eyes last night. Finding I needed a couple of binding posts, I stole out of the house to a low radio shop around the corner which keeps open all night. There was the usual crowd of men and boys, but what especially pained me was the sight of an unshaven man leaning heavily over a show case studying the display of "parts." Tugging at his arm was a wan little girl who was singing a song I had heard many years before, "Father, dear father, come home with me now, the clock in the steeple strikes one." But the man shoved her away with a muttered curse.

It was too much. I resolved to devote myself to saving others from the fate that had overtaken me. May these lines help.....

Radio as a Rent Inducement

By ALLISON EURAY

AN ENTERPRISING real estate firm in St. Louis, Mo. has conceived the idea of equipping each one of the fifty-four apartments in the Garden Court Apartments, located at 5330 Delmar boulevard, with a loud speaker (operated from a central receiving station), as an extra inducement for the renting of them. No charge is made for the radio service which goes in with the rent.

The apartment house has a central receiving station with an outside aerial, and in each apartment there is a loud speaker which the tenant can connect or disconnect with a plug.

In a trial recently held, the receiving station has "picked up" Kansas City, Atlanta, Pittsburg, Waco, and other Texas points. However, information as to how the situation will be handled, when a half-dozen of the tenants get to arguing with the landlord as to which station is to be listened in on, has not been divulged.

The "Ham" Set of an Old Ship Operator

Amateur Station 2ABM, at New Rochelle, N. Y., Resembles a Commercial Station in Many Ways. Remote Control is One of Its Outstanding Features

By ZEH BOUCK

Many a fellow has taken up radio to enable him to have a taste of travel and adventure. Several years later, when he has settled down, he often finds that he cannot keep his hand off a key or the receivers off his ears. The kinks learned as commercial operators are being used by amateurs like Mr. Parsons in home stations throughout the country.—THE EDITOR.

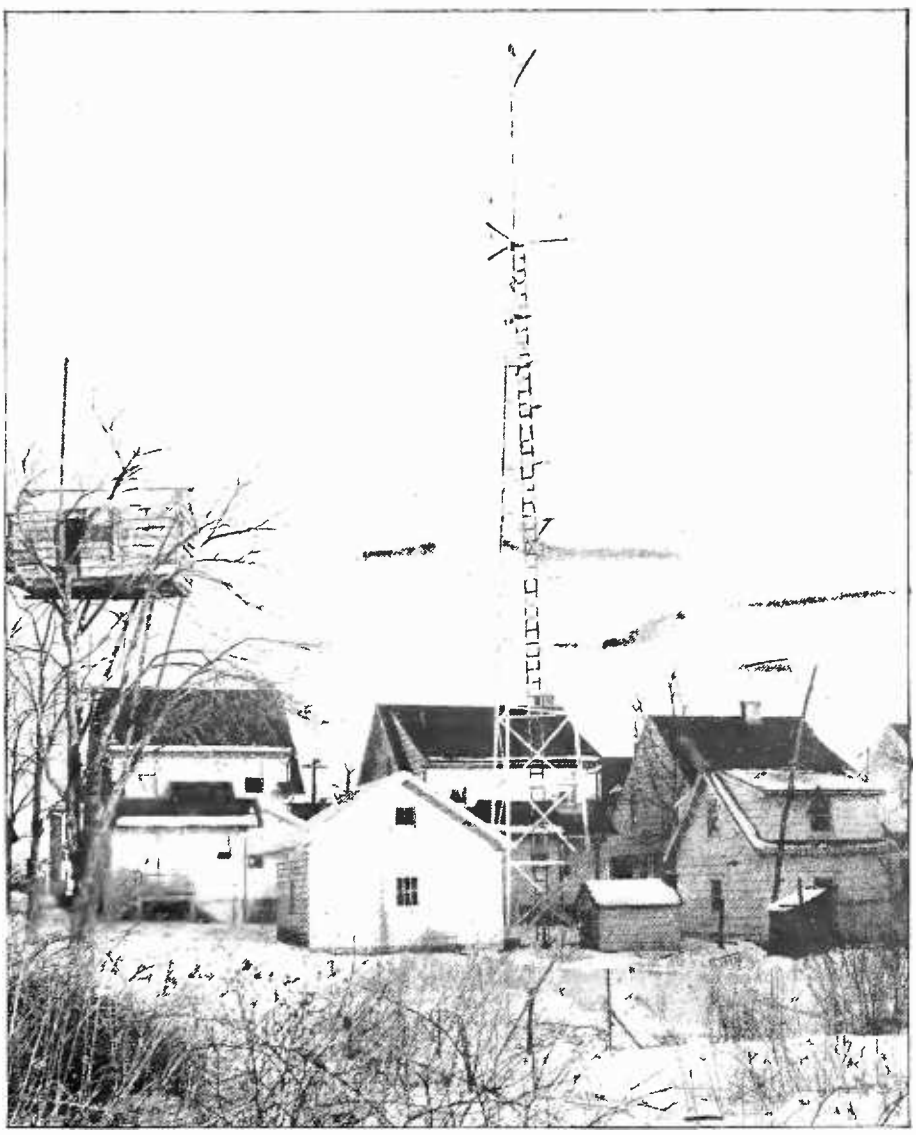
SOME weeks ago, two elderly gentlemen, both broadcast enthusiasts, were standing at a corner in New Rochelle, N. Y., exchanging the time of day and, incidentally, their achievements in radio telephone reception. A short distance away, rising high above neighboring buildings, was a wireless tower, which, catching the eye of one of the gentlemen, caused him to exclaim:

"Great Scott! That's some tower. The chap who owns that must have a wonderful station!"

The second man snorted disgustedly. He had experienced some interference, which, rightly or wrongly, he blamed on that particular station. "Good station nothing!" he replied. "Why, he's only an amateur."

The gentleman who spoke so vehemently knew little about amateurs, in general or in particular, and nothing about the equipment of the station in question.

This tower is visible many blocks away, and is, perhaps, the most spectacular adjunct to station 2ABM, owned and operated by Mr. Fred Parsons. The huge framework is built one quarter of two by two-inch spruce, and three quarters of the resourcefulness and ingenuity of the amateur. It is all the more amazing when it is considered that it went up almost entirely at night and without plans except for



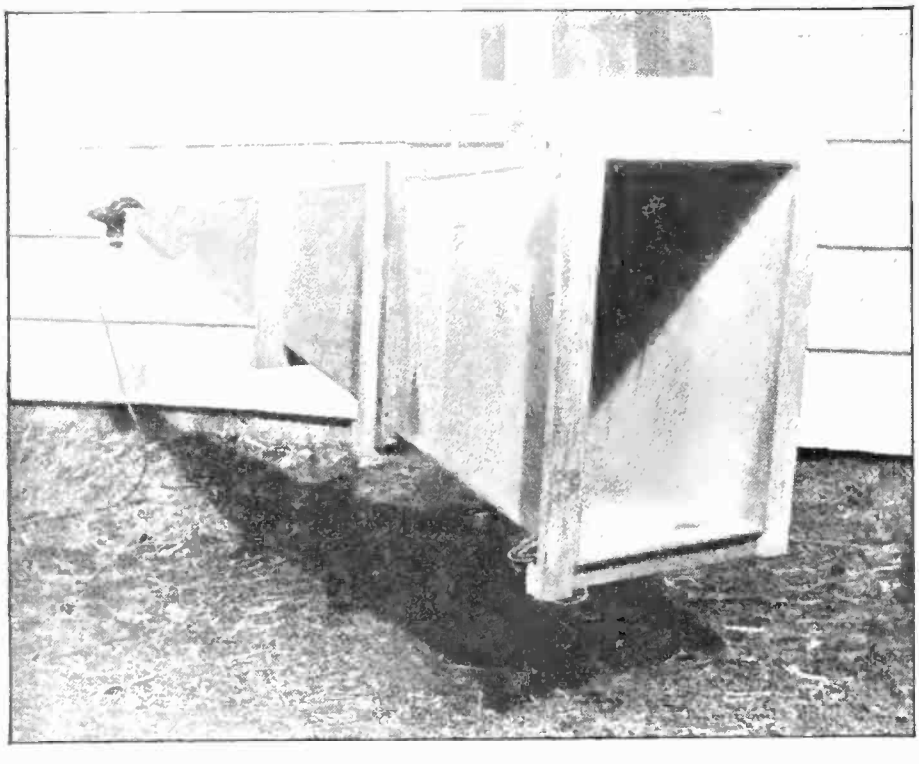
THE 100-FOOT TOWER AT 2ABM

the pre-determination that the base should be an equilateral triangle with twelve foot sides, and that it should taper so that the top, seventy-five feet high, would form a smaller triangle three feet on a side. The number and positions of the crosspieces were also approximately calculated. The tower was built up from the unreënforced earth, the foundations being laid after the framework was completed! These consist of several thousand pounds of concrete poured into three holes dug around the base to which the uprights are anchored. The tower, though practically self-supporting, is additionally safeguarded against strong winds by guy wires. The mast on the top of the tower rises twenty-five feet above the platform, giving a total height of one hundred feet.

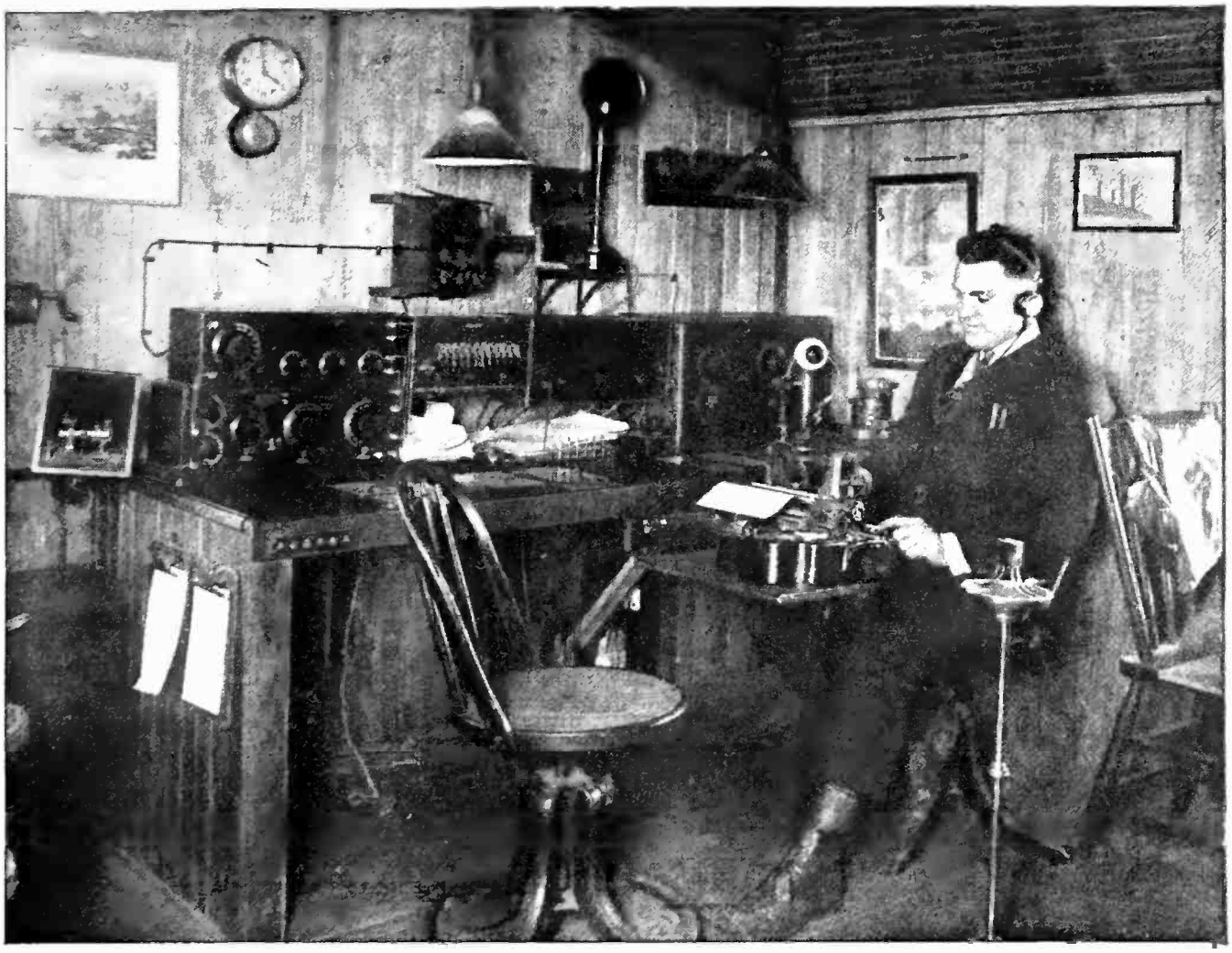
The transmitting antenna consists of four wires which fall almost vertically from the top mast to the roof of the shack, which reduces the actual lead-in to a few feet, and forms an aerial of the most efficient radiating type (vertical).

The outdoor loud-speaker shown below is operated from the power amplifier, which was especially constructed for the rebroadcasting on sound waves of special events, such as prize fights, election returns and the World Series baseball games. It is built entirely of wood, five feet long with a three-foot square "bell." The standard Western Electric loud-speaker unit clamps to the rear end. Elevated on the antenna tower, this mammoth loud-talker can be heard over a mile away, and clearly understood at half that distance.

The station proper occupies the top floor of the garage shown at the base of the tower in the first illustration. Like the majority of efficient stations, the apparatus is, for the greater part, operated by remote control. The operating table, from which the functioning of the receiver and transmitter is controlled, is shown on the opposite page. Various high-current circuits are opened and closed by relays operated by the bank of keys on the panel of the left centre cabinet. Among the operations effected from this board are stopping and starting the rotary spark gap, closing the power line to the transmitting transformer, transferring the key from the wireless to the land-line sounder, and operating the N A A light, which flashes from an illuminated wall map with the dots of the time signals. This last is accomplished by adjusting the grid bias on the final stage of power amplification, so that the plate consumption of the tube, when quiescent, is zero, while the signals from Arlington will so unbalance the circuit, that the bulb will draw some fifty milliamperes. This is sufficient to actuate an especially designed high-resistance relay which closes a local battery circuit to the lamp. (This device could well be applied to tape recording instruments to facilitate the deciphering of code, as well as other interesting experiments in telemechanics. It might be necessary to reverse the connections to the secondary of the last amplifying transformer, in order that the grid be charged positively. The plate voltage should be above two hundred, preferably three hundred and fifty, and the grid bias on



THIS OUTDOOR LOUD SPEAKER CAN BE HEARD A MILE AWAY
Special events such as election returns, play-by-play ball games and blow-by- blow prize fights are re-broadcasted on sound waves, the loud speaker being hoisted up on the antenna tower



MR. FRED PARSONS, 2ABM, AT HIS STATION IN NEW ROCHELLE, N. Y.

some tubes may be as high as one hundred volts. A five-watt power tube should be used in the last step.)

To the extreme left in the picture of the operating room (above) is a land-line instrument, for Mr. Parsons is an old timer whose experience dates back to the days of Morse. The receiver to the left is a Paragon RA-10, with antenna series condenser, and detector and two steps mounted directly above. Two aerials are used individually for reception and transmission, the switch above the control-box disconnecting the single-wire receiving antenna from the set, protecting the delicate instruments from high potential surges. The cabinet to the centre right, originally a detector-amplifier for the honeycomb long-wave receiver next to it, is now common to both sets, a plug and jack arrangement permitting various changes of input and output. The telephone is an extension to that installed in the living quarters, which, however, is used only when a red signal light does not indicate that the receiver is removed on the house phone. Similar red and green lights, at different parts of the station, indicate the functioning of various circuits. On the side of the operating table, arranged according to the practice of commercial stations, are in-and-out-going message blanks, 2ABM being an official relay station, covering a wide territory between the Mississippi and the Atlantic Ocean. The typewriter further facilitates and systematizes the handling of traffic.

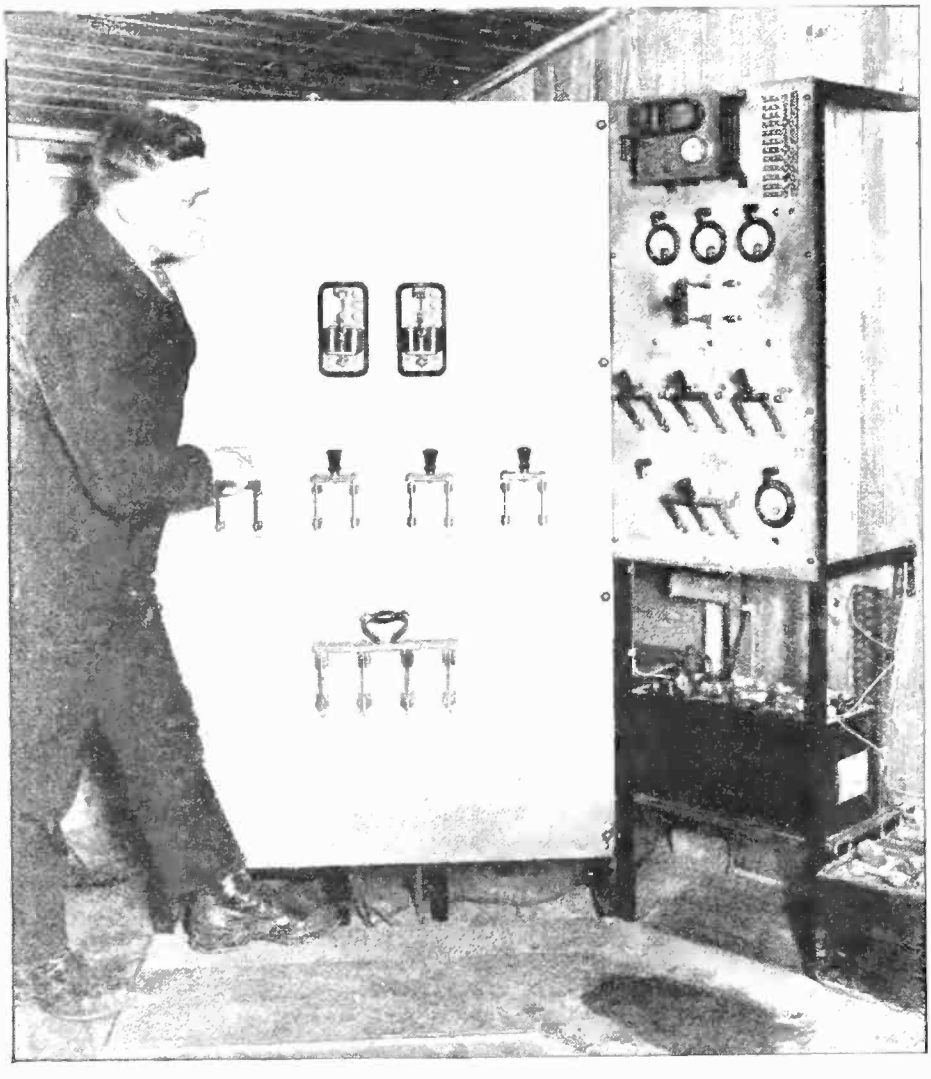
The photo on page 27 shows the receiving high-voltage equipment and the connection rack similar to that in station 2FZ which was described in last month's RADIO BROADCAST. Below the land-line telegraph instrument is the B battery box with the side removed, showing the battery high-voltage arrangement, which consists, for the greater part, of flashlight batteries. This system has an advantage over the block battery in that the dead units, with

their material resistance, may be cut out of circuit.

The stove, reminiscent of the snowbound shacks of Marconi and Fessenden in the pioneer days, is a useful piece of apparatus on cold winter nights, and is worthy of its position in the foreground of the picture.

The panel just to the left of the stove-pipe is the high-voltage switchboard for the power amplifier, which is fed at three hundred and fifty volts from a dynamotor suspended in back of the panel. The dynamotor is operated from the storage batteries shown in the picture below, and the output is perfectly filtered, or the commutator hum smoothed out, by condensers and choke coils. Between the uprights of the connection rack are relays forming part of the remote control system.

In the picture below, the power and battery-charging switch-boards are shown, respectively, from left to right. The power board was purposely constructed with adequate space for expansion. The relays in the upper portion close the circuits to the power transformer and rotary spark gap, a double operation controlled by a single relay, while the other functions as a key, following the dots and dashes of the light Morse instrument on the operating table. Another addition to the remote control system which will be effected in the near future, is a time element relay, which, operating independently of the rotary starting relay, will close the circuit to the transformer a few seconds after the starting key is depressed. This will make it impossible to transmit until sufficient time has elapsed for the spark gap to gain a safe operating speed, a precaution that is hoped will lessen the regularity with which condensers are blown at this station. The four-pole switch cuts off all power to the shack, including lights.

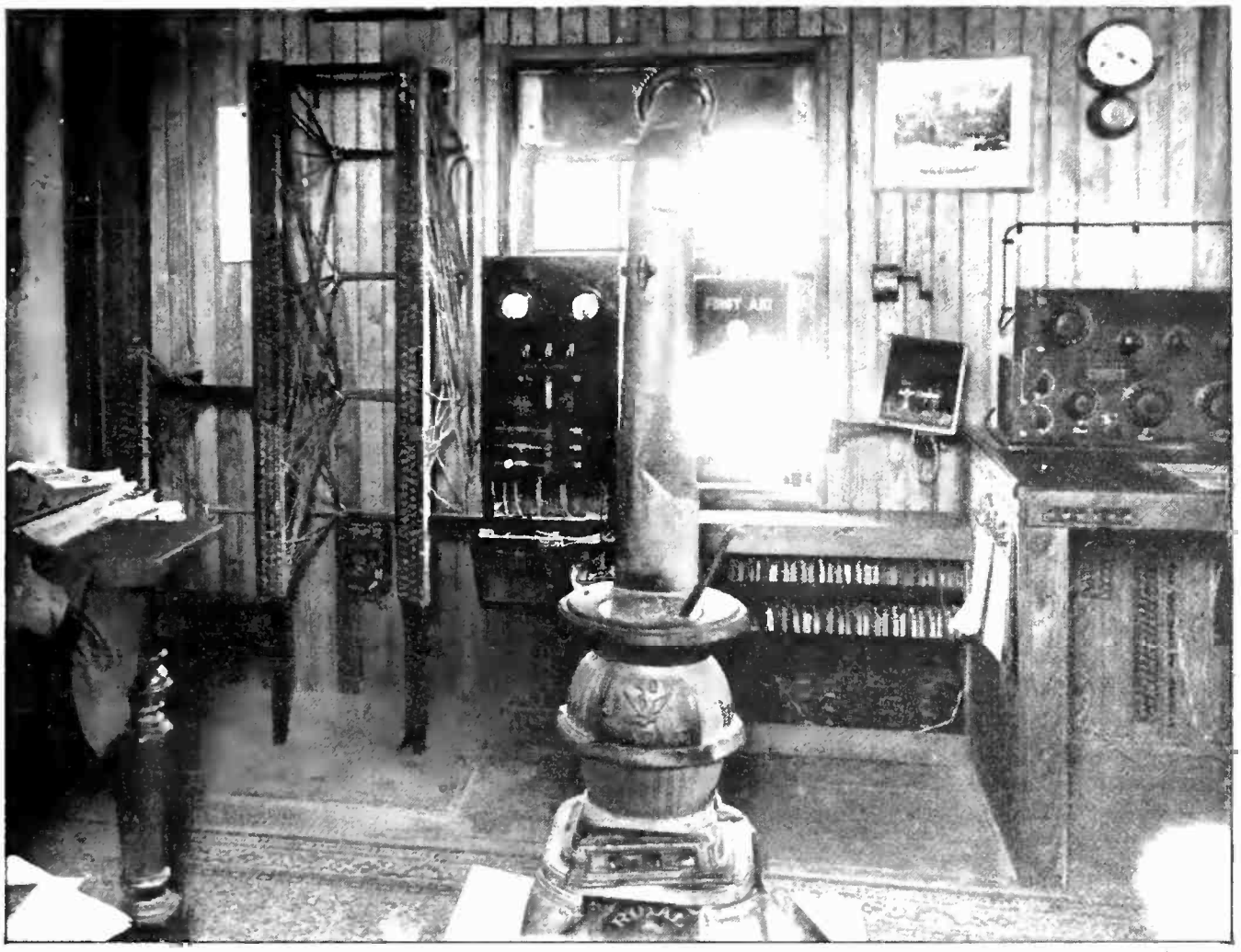


MR. PARSONS AT THE POWER SWITCHBOARD

The charging panel consists of the necessary switches controlling the charge and discharge of the various batteries, meters registering voltage and current, necessary fuses, and the magnetic rectifier at the top of the panel.

The transmitter, as has been implied, is a spark set, Mr. Parsons being true to the old days that are symbolized in a booming gap. The transformer, an open core affair, is partially of home construction, it being a combination of the secondary of an eight-inch spark-coil slipped over a primary wound to consume one K. W. The secondary potential, judging from the spark and blown condensers, is in the neighborhood of fifty thousand volts. The transmitter is mounted in an especially constructed cupboard, the door of which is flush with the wall, an arrangement that effectually silences the roar of the gap.

Following the nation-wide custom of the genuine amateur, in deference to



ANOTHER VIEW OF THE OPERATING ROOM

Showing the connection rack (at left), and the high-voltage B battery supply (at right of stove) consisting mainly of flashlight batteries. On cold winter nights the stove is as important a piece of apparatus as any in the room

the BCL (broadcast listener), the transmitter at station 2ABM is silent between seven and ten thirty P. M., excepting when operation is justified by some unusual necessity.

From the ship's clock on the wall to the port holes with which the windows are being replaced, the shack at 2ABM is reminiscent of the commercial experience that goes into the make-up of many amateurs.

Mr. Parsons operated many years ago on the *Pole Star* plying between Portland, Maine, and New York. Irving Vermilyea, one of the oldest of the old-timers, was his companion operator on the run. However, the radio careers of these gentlemen, as far as the *Pole Star* is concerned, were terminated somewhat abruptly in 1909, by an altercation between the wireless operators and the captain. The disagreement, whatever it was, came to a head on the homeward trip and Sparks, first and second, determined to sever connections between themselves and the good ship *Pole Star* when they reached New York. After leaving the *Pole Star*, Mr. Parsons forsook the commercial game, and returned to his amateur station, then, long before the days of radio legislation, working on eight hundred meters. However, the lure of the profession was not dampened with Mr. Vermilyea, who, following it for a time on sea, and then on land, rose high in the game. Shortly before the war he was superintendent of the old South Wellfleet station, and is now manager of the transatlantic station at Marion, Massachusetts. But his greatest boast (if honest and deserved self-appreciation can be called a boast) is not of his commercial achievements, or even his peer of present day amateur stations, 1ZE, but goes far back to the days preceding the *Pole Star*, when he was, without a dissenting claim, one of the first amateurs in the world!

Vermilyea's first stations, when he signed

"VN," were the inevitable outcome of his immortal private telegraph line, that ran, with as much system as the streets of Greenwich Village, about the city of Mt. Vernon. There were forty or fifty "subscribers." Juice for the line was originally furnished from some hundreds of gravity cells in VN's cellar; and at regular meetings of the "subscribers," the hat was passed, soliciting funds for the purchase of copper sulphate. Things finally came to such a pass that the accumulation of glassware and blue vitriol was appalling, and it was then that the audacity and resourcefulness that made and kept VN an amateur came to his rescue. Inspired one morning, he ran what was apparently a telephone line from his house to a bona fide pole; and from there, in a perfect imitation of the genuine article, it continued for some blocks, or until what VN considered was a safe distance from headquarters. Finally it crossed to a pole supporting the power feed to the Mount Vernon trolley line! Carefully hidden in a puttied up crack, it tapped the five hundred and fifty volts, and for five years the miniature Western Union was amply supplied with current. It is not on record that the tax for copper sulphate was discontinued.

The Tuning Troubles of Messrs. Gallagher and Shean

(With Apologies to those Famous Men)

As Sprung on the Second District Amateurs at Their Recent Annual Banquet

By A. G. CLARK, 2 C N T
Of the RIDGEWOOD RADIO CLUB

Oh Mister Gallagher, Oh Mister Gallagher,
I was listening on the radio last night,
But an amateur quite near seemed to like to interfere,
So I'm going to kick and have him closed up tight.
Oh Mister Shean, Oh Mister Shean,
In the radio game I see you're pretty green;
As they say in gay Paree, what an animal you'd be——
What, an air-hog, Mister Gallagher?
No, a jackass, Mister Shean!

Oh Mister Gallagher, Oh Mister Gallagher,
Now I don't see why you put the blame on me,
Everywhere I turn my knob I can hear the noisy slob,
So it's not my fault at all as you can see.
Oh Mister Shean, Oh Mister Shean,
You are up against a problem what I mean,
But there's something you can get that will cut him out you bet——
An injunction, Mister Gallagher?
No, a tuner, Mister Shean!

Oh Mister Gallagher, Oh Mister Gallagher,
Interference is no more I hear them boast,
Cause a guy named Schnell has said that the old zink spark is dead——
When the tube came in the spark gave up the ghost.
Oh Mister Shean, Oh Mister Shean,
I can't get the situation through my bean,
I must ask Sir Conan Doyle for when I burn the midnight oil——
You hear spirits, Mister Gallagher?
No—spark sets, Mister Shean!

Oh Mister Gallagher, Oh Mister Gallagher,
Station 20M is just a mile away,
I can recognize his call but can't tune him out at all,
Though he's on two hundred sharp I hear them say.
Oh Mister Shean, Oh Mister Shean,
If you hear him high and low and in between,
That "200" is a fraud, why he's on "180 broad!"
Is that lawful, Mister Gallagher?
No, it's awful, Mister Shean!

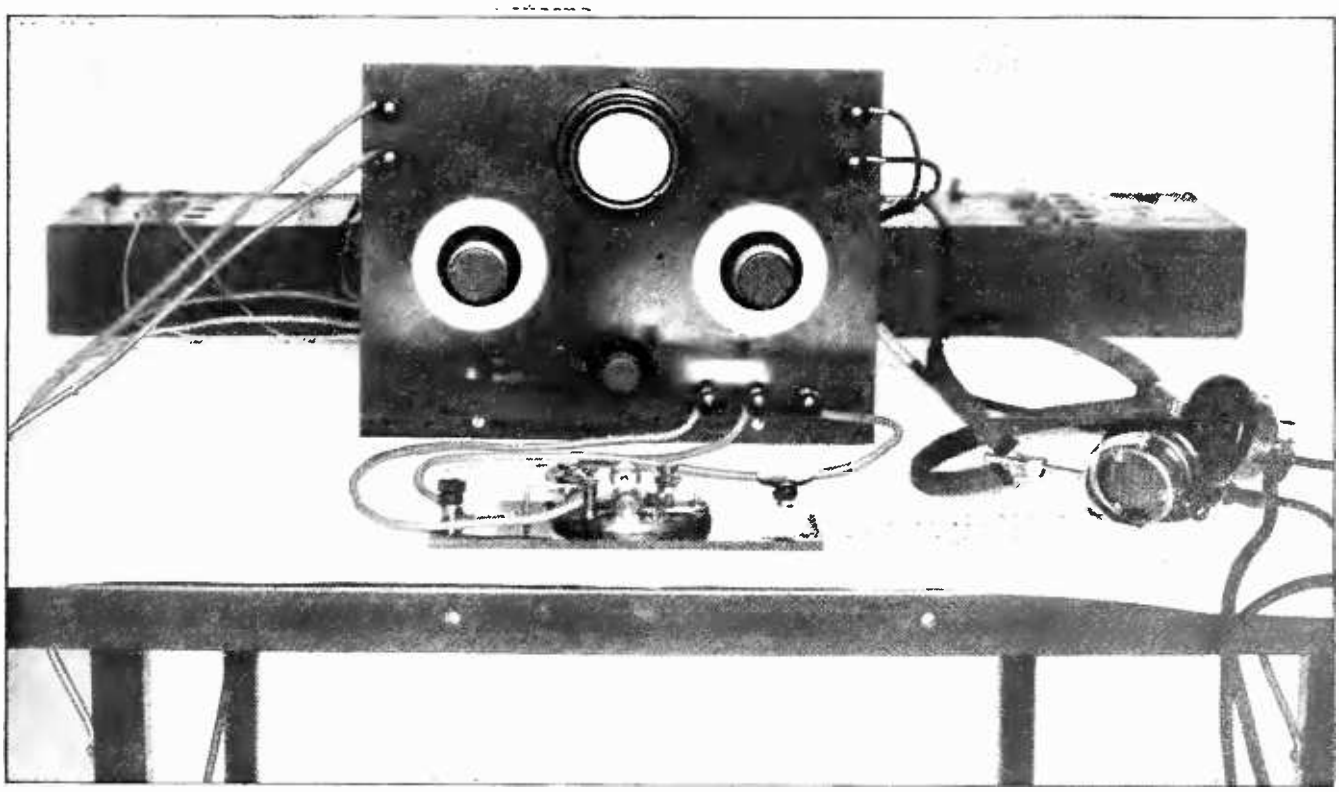
Transmitting and Receiving with the Same One-Tube Set

By FREDERIC W. PROCTER

THERE has been a need among radio enthusiasts for a combined transmitter and receiver of low power that could be placed, complete, in a single cabinet of medium size, and easily carried about. Until now, few instruments of this type has been placed at the amateur's disposal, and it is likely that the one here described will appeal, because of its extreme simplicity, to those who desire a transmitting and receiving set combined in one unit.

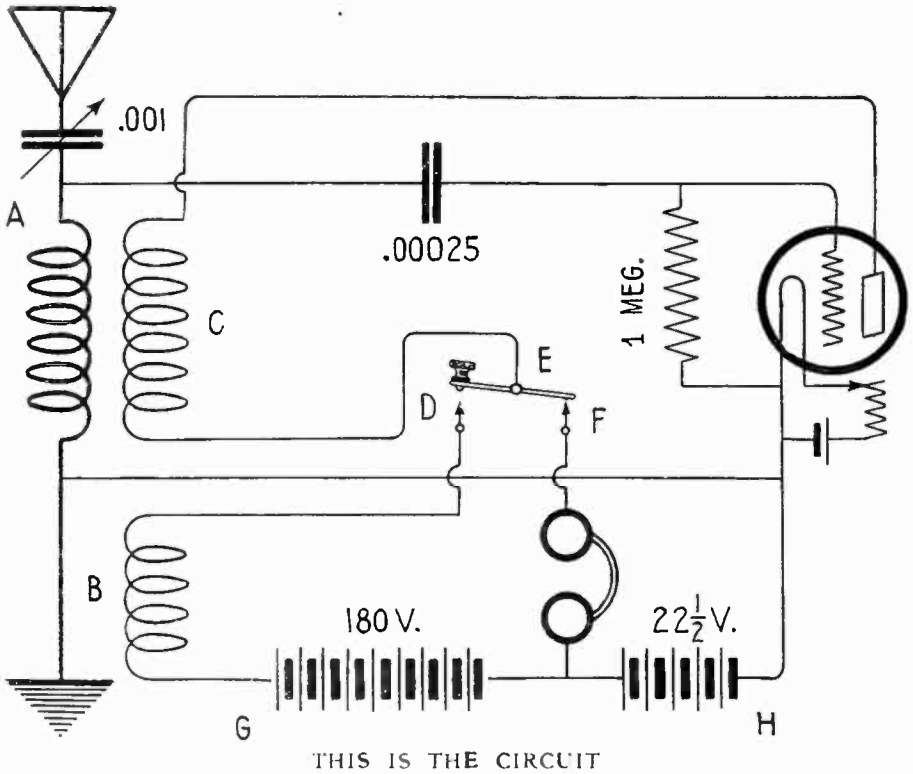
In this instrument, a single tube is used for both sending (telegraphy) and receiving (telegraphy or speech), and it is advisable to secure a tube that does not need too critical an adjustment of the filament when receiving, as it would be impossible to obtain satisfactory results in a circuit in which the change from transmission to reception depends only on the position of a telegraph key. This key must have two contacts, making it possible to operate in two circuits, since in the up or off position it must make contact to close the receiving circuit and in the down position form the dots and dashes of the code. The placing of the key in this combined circuit is unique and makes possible the dual work performed. It will be seen from the following explanation that when the key is in the up position, during code transmission, the circuit is held open for reception. Another advantage of this circuit is that *once the operator has tuned the receiver to the station with which he desires to communicate, the transmitter is also sharply tuned on approximately the same wave.*

If the reader will follow the wiring diagram



MR. PROCTER'S ONE-TUBE TRANSMITTER-RECEIVER

Showing the third key contact, with its binding post at the left end of the key base board. The left-hand dial controls the 43-plate condenser. The other large dial controls the secondary of the variocoupler, and the filament rheostat is mounted in the centre of the panel below the milliameter



THIS IS THE CIRCUIT

Which is used in Mr. Procter's set. A, is the primary of the variocoupler made with a special winding, B; C, tickler coil; D, key contact used for transmitting; E, converted ordinary telegraph key; F, key contact for closing the receiving circuit; G, B battery for transmitting; H, B battery for receiving

closely while reading the description of the circuit, he should have no trouble in understanding the working principle of the system and afterward constructing the set itself.

The receiver is of the well known single-circuit type, and gives the necessary sharpness of tuning with a minimum of adjustments. A variable condenser of .001 mfd. capacity is placed in series with an inductance and the antenna, and due to its large range of capacity it provides a wavelength variation of between 175 and 400 meters, with an antenna of average size. The experiment of placing a vernier in parallel across the plates of this condenser was tried to determine the advisability of leaving it permanently in the circuit, but while the vernier increased the sharpness of tuning to some extent, it was not considered necessary to make it a fixture. The most satisfactory inductance unit that can be used in this circuit is a vario-coupler similar to the Baldwin type, as this instrument is particularly adapted to the needs of the set. It is necessary to make a slight change in the stator winding, to give a special plate inductance required in the transmitting circuit. At the tenth turn from the bottom cut the stator winding and remove two turns, fastening the ends in holes drilled in the tubes. This divides the stator into two sections, the larger of which is used as the antenna tuning inductance, while the smaller is connected between one terminal of the rotor and the auxiliary source of plate potential used for transmission. This is used in series with the rotor or the tickler coil in the transmitting circuit, and its close inductive relation to the tuning inductance insures a state of oscillation when the telegraph key is depressed. For the benefit of those who may prefer to make their own variocoupler, it is advised that No. 20 B. & S. or a larger wire be used for the stator winding if good results are to be obtained.

In considering the grid condenser and grid leak, it is advised that a mica condenser of .00025 mfd. capacity be employed. The amateur may prefer to make this condenser variable and in some instances a variable capacity may be of some aid if the builder is experimenting with different makes of tubes. The grid leak should be of one megohm resistance at the most, since the impulses received are relatively weak, while the transmitted impulses, being generated locally, are relatively high.

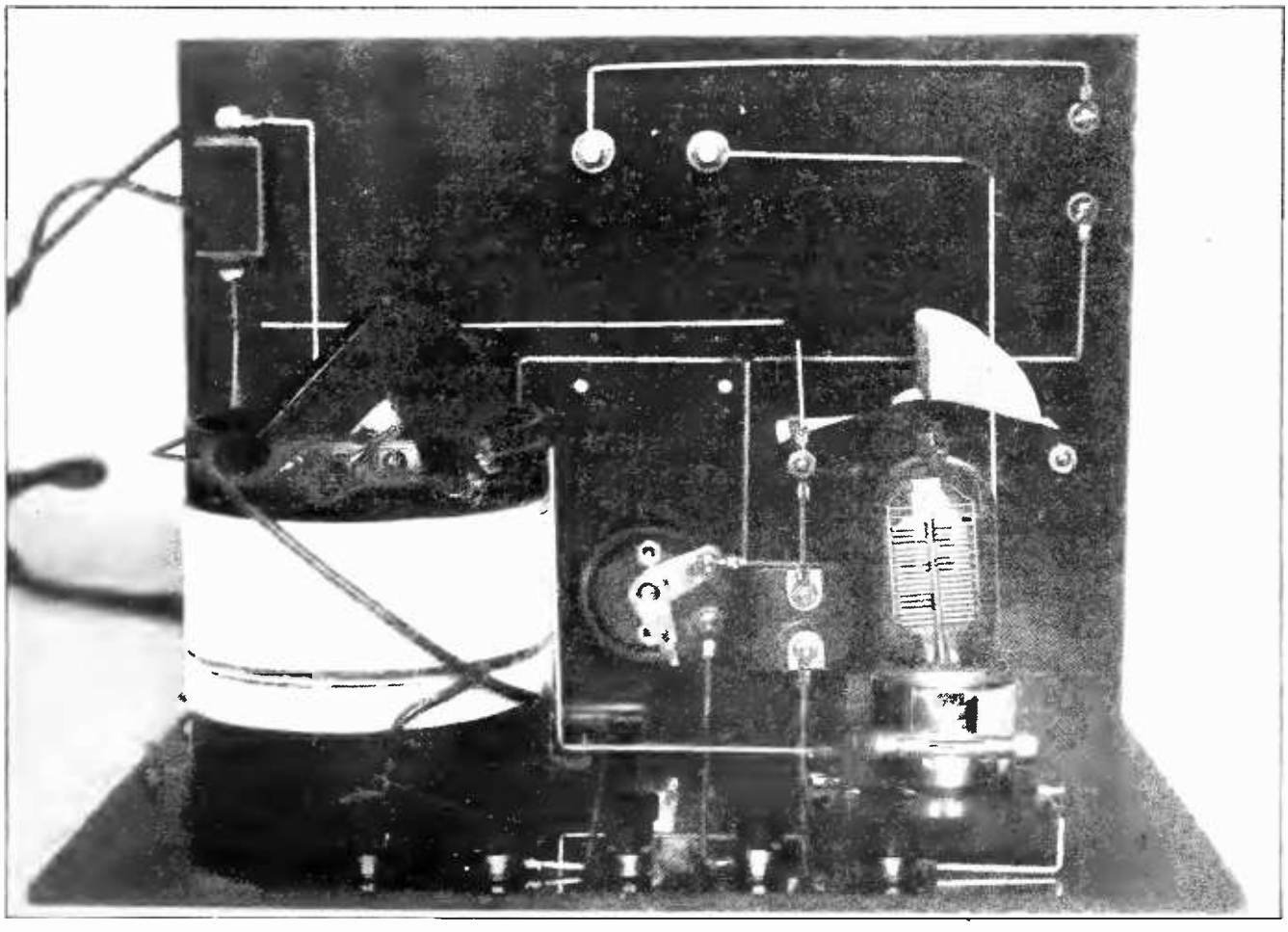
The problem of selecting the right vacuum tube for this circuit is one that brings up many points for discussion, since the tube to be used must be one that will cover a wide range of work. It must not only give good service as a detector but must also be capable of taking a fairly high plate potential to give a strong output for transmission. For the set described, the Western Electric tube or V.T.1 was selected, since its filament adjustment is not critical and its insulation permits the use of plate potentials up to 200 volts. Much valuable knowledge pertaining to the functioning of various tubes can be acquired through trying them out in this circuit.

Next comes the problem of choosing the source of plate potential. B batteries have their advantages, giving a constant source of cur-

rent without the variations in potential common in other forms of plate current supply. Moreover, since no excessive voltage is required for this circuit, a few 45-volt B batteries are all that are necessary. They are to be found in any receiving station and can be purchased at a comparatively low cost. For the amateur who is making his initial attempt at transmission, this method should have a great appeal.

Another method—the use of a small dynamotor or motor generator—will be found satisfactory by those who already have one in their station, if it does not give too high an output for the tube used. It must be remembered that in this circuit the plate current for reception and the plate current for transmission will be in series when the key is depressed, and the plate of the tube will receive the sum of both potentials. Therefore, care should be taken not to overlook the fact that an additional $22\frac{1}{2}$ or 45 volts will be added to the voltage of the motor generator or other source of plate current being used. In purchasing the motor-generator or dynamotor, it is strongly advised that one of standard and reputable make be selected, since a cheap one is likely to be a constant source of annoyance and disappointment. It should have a large number of commutator segments for otherwise a most unpleasant generator hum will be heard in the receiving station. A dynamotor which supplies both filament and plate current will not possess the usual advantages in the case at hand, since it would necessitate the running of the machine to keep the tube lighted for receiving. The possibility of using house lighting current will have to be dwelt upon in a more lengthy manner than the two former methods.

First, 110 D. C. may be directly connected to the set. This system gives exactly the same results as those obtained by the use of B batteries, except that the potential often varies, dropping below 110 volts and rising again, if some excessive load has been placed on the house lighting circuit. This drop will



THERE IS NOTHING VERY COMPLICATED ABOUT THE SET

The tube in the picture, a Western Electric VT-1, has been found very satisfactory for the double function of transmitting and receiving; but other "hard" bulbs may be employed, especially where short distances are to be covered

naturally have an effect on the transmission in progress if the signals at the receiving station are weak, for a troublesome fading will be noted. If the current is sure to be constant this system can be recommended and good C. W. transmission will take place.

Where 110 A. C. is available, it may be used in several different ways.

The first of these is direct connection from the line to the set. The advantage of this system is that the quality of the signal transmitted makes reception possible over short distances with a crystal detector or some other non-oscillatory receiver, since the transmitted wave will be broken up by the set ceasing to oscillate during one alternation. The disadvantage of this system is that if sixty-cycle A. C. current is used, the transmitted note would be low and unpleasant to the listener.

If desired, the alternating current may be connected through a transformer to increase the voltage applied to the plate. This would still give an interrupted wave of very low tone, although the higher plate potential would increase the radiation.

The alternating current can also be rectified. One drawback of this system is the expense involved, but by use of a rectifying device the frequency of the current is doubled, giving a 120-cycle note at the receiving end. This note is much more pleasant to listen to, and allows the operator to use more speed in transmission, since the note is clear and the dots and dashes are sharply defined.

The use to which the transmitter is to be put will determine whether a filter should be employed. A filter may consist of a choke coil, large capacity condenser or a combination of both. The filter serves to smooth out the ripple in the 120-cycle current, permitting transmission on a continuous wave instead of a damped wave. The ingenious experimenter should be able, when using A. C. current, a rectifier and a filter, to put in two double-pole-double-throw knife switches around his filtering system, permitting the use of either straight or modulated C. W. (continuous-wave) transmission at will. The use of either of these forms is a matter of preference, or will depend on the character of the work to be done. For the amateur who desires to use his set for field work, it will be found that B batteries are the most convenient source of plate current. For use in a permanent station, several makes of storage B batteries can be obtained and if the station has a battery charger included in its equipment they will be found satisfactory, although for field work the dry battery excels. After reviewing the different methods of obtaining plate current that have just been outlined, it is up to the builder of the set to choose the method which he considers the best adapted to his needs.

As mentioned above, the key must operate in two circuits, the receiving and the transmitting. By using one of the key contacts in both circuits, it is necessary to add only one more contact. First, the key should be mounted on a bakelite or wood base and a hole drilled one-eighth of an inch directly back of the end of the the key arm in the base. A machine screw should then be raised up through this hole and held in place by a nut. Then remove the nuts from the key adjustment in the rear of the arm and fasten on a small piece of strip brass which will extend out in the rear of the arm and make contact with the machine screw. Then replace the adjustment nuts to hold this strip in place, and the key conversion is complete.

It will be seen that when the key is in the up position the brass strip and screw make the contact in the receiving circuit, while in the down position the key contacts close the transmitting circuit.

It was not the author's intention to tell exactly how to build this set part by part, but rather to describe the circuit and explain the use of each instrument involved. Every experi-

How to Get Your Transmitting Licenses

If you wish to transmit, you must have two licenses, one certifying you as an operator, the other for your station. You must be able to receive at least ten words a minute (five letters or characters to the word), and must comply with certain other requirements explained in the Government pamphlet: "Radio Communication Laws of the United States." It is advisable to obtain this pamphlet, as it gives a list of places where examinations are held and other information either necessary or helpful to the prospective operator. It may be had from the Superintenent of Documents, Government Printing Office, Washington, D. C. Price, 15 cents a copy.

menter prefers to build his set in an entirely different manner from any one else, some preferring to mount the instruments on a board, while others are partial to the cabinet arrangement. The set illustrated was built by the author and Walter H. Bullock, to whom a large amount of credit must be given for his aid and suggestions which helped the author prepare this article.

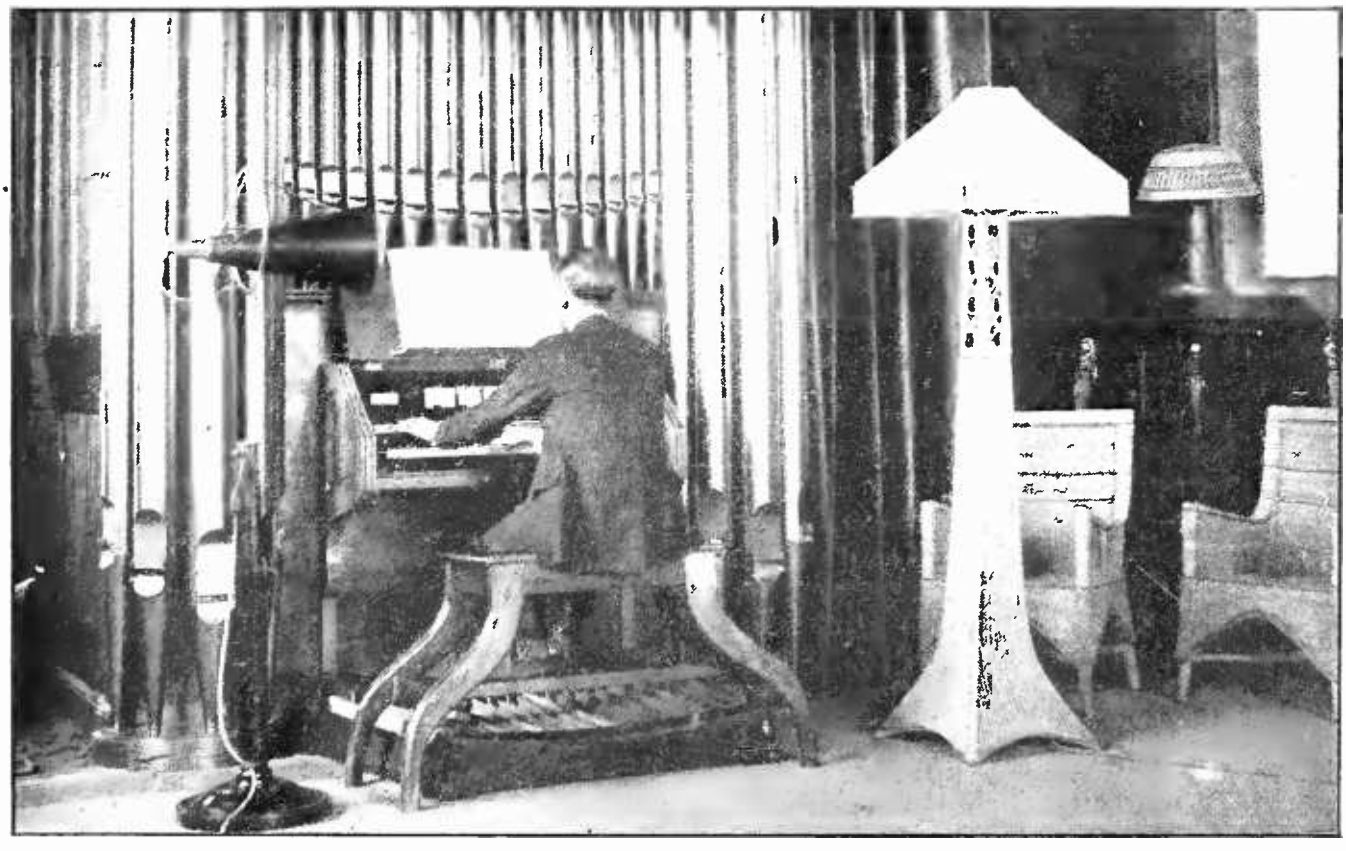
So far, a distance of eleven miles has been covered on transmission from the centre of New York City up into the Bronx under very unfavorable conditions, and signals have been received from a broadcasting station in Chicago (700 miles). These distances exceed anything expected at the time the set was designed. It is hoped that many of you will derive pleasure and knowledge from this circuit and may do the kind of work with it that will make you feel that the time used in constructing the set was well spent.

Have You Heard These Stations Yet?

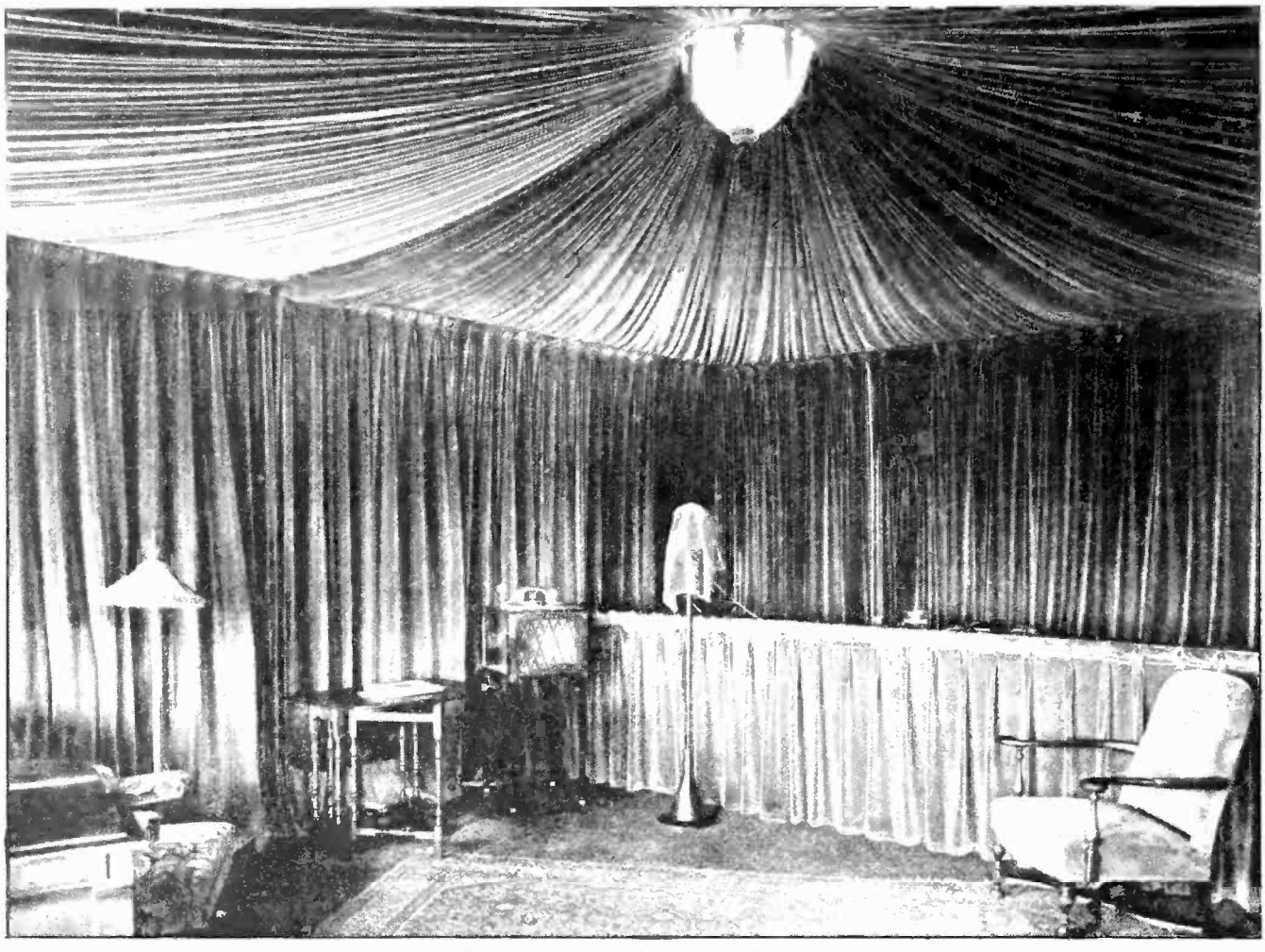
CKAC in Montreal, WGR in Buffalo, N. Y., and WGY in Schenectady, N. Y., are Broadcasting Excellent Musical Programmes. Their Wavelengths are 430, 400 and 400 Meters, Respectively

UP IN Montreal, Canada, there is a French newspaper called "*La Presse,*" which has installed a broadcasting station that is unusual in several respects. One man, Mr. J. N. Carter, performs alone the various duties of announcer, manager and operator. This he is able to do by reason of the special type of broadcasting equipment which, although the station is a powerful one, is simple in operation. No motor generators are used, the alternating current supply from the city being passed through two giant rectifier tubes to supply the required voltages.

CKAC has a splendid pipe organ of its own,

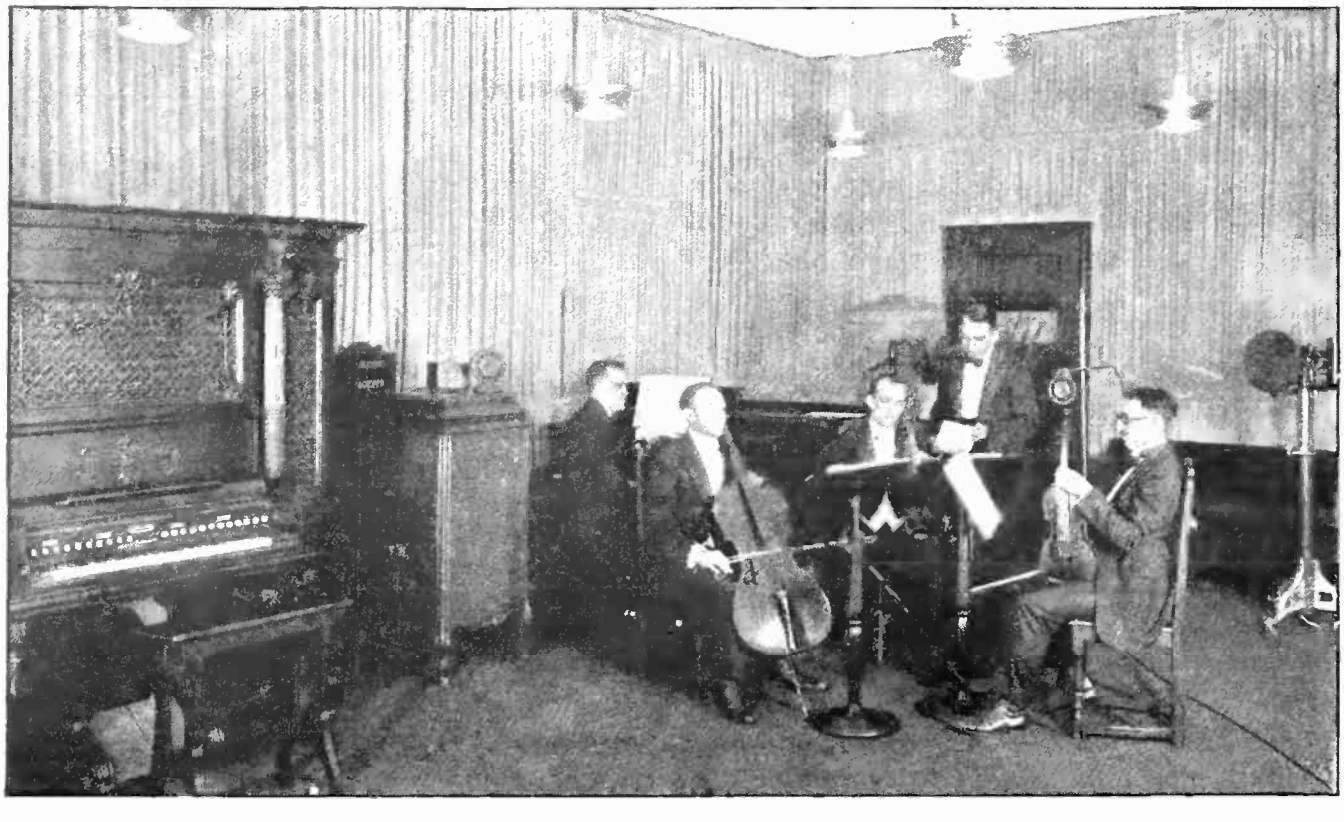


THE ORGAN AT CKAC
Station of the French newspaper, *La Presse*, in Montreal



A CORNER OF WGR, BUFFALO, N. Y.

WGY'S ORCHESTRA AT SCHENECTADY, N. Y.



installed in the studio. The illustration on page 33 shows an organist giving a recital to an audience which undoubtedly contained as many Americans as Canadians. The language of music is, of course, universal, but the announcements at CKAC are made in both French and English, and the programmes, also, are given sometimes in one tongue, sometimes in the other. To tune in this Montreal station, you must "go up" to 430 meters.

The Federal Telephone & Telegraph Company has a station in Buffalo, N. Y., known to a large radio audience as WGR—possibly you have heard of it. It has been performing a useful service in transmitting weather and market reports as well as all manner of musical and other entertainment, and is planning to extend its scope to include educational courses of various kinds. The Broadcast Division of the Federal Company expects also to make WGR a public forum for the discussion of matters of national and local interest. As will be seen from the picture on the opposite page, an elaborate system of hangings and floor coverings has been worked out which isolates the studio from all sounds but those desired for broadcasting.

A third station, which is gaining a wide reputation for its musical programmes, is WGY, the station of the General Electric Company at Schenectady, N. Y. It has a powerful transmitting installation and has been heard in every state in the Union and in several foreign countries. The orchestra which is shown in the picture has won the enthusiastic praise of listeners-in from far and near. These five players also supply the music for the light operas, such as Gilbert and Sullivan's "Pirates of Penzance," broadcasted from WGY from time to time.

Supplying Broadcasts Like Gas or Electricity

How the Municipal Receiving Station in Dundee, Michigan, Relays Radio Entertainment to Private Subscribers Over Land Wires

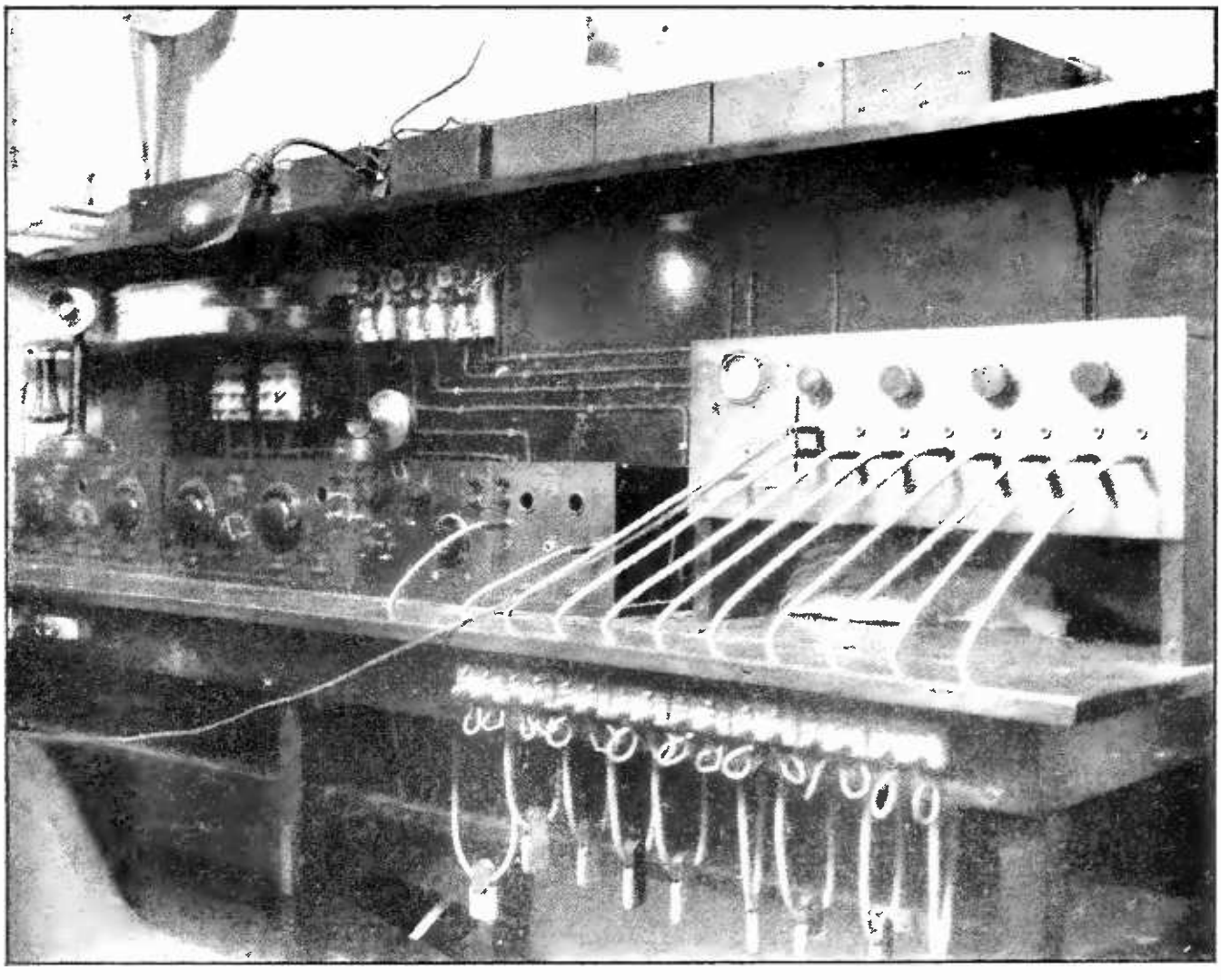
By GRAYSON L. KIRK

RECEIVING conditions in Dundee, Michigan, are unusually good. You don't need any aerial or ground. You don't even have to have a radio set. In fact, you can hear programmes from stations all over the country on nothing but $1.50 a month and a loudspeaker.

Municipal radio is the answer; and Dundee, a little farming village of less than a thousand inhabitants, proudly boasts the first working system of its kind in the United States. This village, named after the Scottish community renowned for its marmalade, is located in the rich farming district of Monroe County, Michigan, along the banks of the River Raisin. There the tired farmer goes in from work, closes a switch, and without any tinkering with instruments may listen to a perfectly tuned concert from almost anywhere in the country. In the pool room on "Main Street," an eager crowd gathers on summer afternoons to listen to Big League scores or Grand Circuit results. In the lobby of the little hotel across the street the college student, agenting for the summer among the farmer folk, may sit of an evening and listen to the radio concerts.

All this is now possible because more than a year ago, Frank W. Gradolph, President of the Farmers' Telephone Company of Dundee, had a vision—a vision whereby his company might render greater service to the town and community. He saw that one of the greatest handicaps to radio receiving was the even slight technical knowledge and expensive instruments necessary for satisfactory operation. And he saw still further the tremendous possibilities that would be opened if these difficulties could be eliminated.

The project at first seemed foolhardy, if not actually impossible. Obviously a central station and receiving apparatus were a necessity. But how could the sound be distributed from such a station without losing any of its tonal



THE RE-BROADCASTING STATION AT DUNDEE, MICHIGAN

Here is where the entertainment for a whole community is tuned in every evening. It is transferred to land wires running to the homes of the various subscribers, who pay $1.50 a month for the service

quality? What sort of wire would be required? Would telephonic interference demand special poles?

These were a few of the problems that beset the originator of the project. He was undaunted, however, and after a stormy session the consent of the board of directors was secured and the work was begun.

First, a powerful receiving set was purchased and installed in the office of the telephone company. Batteries of a special design and extra strength were purchased. Then came the problem of a suitable aerial. The company erected a tall well-braced mast on the roof of their own three-story building and secured permission from the owner of a neighboring building to erect on its roof a similar mast. A customary four-wire antenna was stretched between them and connections were made. It gave splendid results in the little telephone office. Could the sound be distributed all over town satisfactorily?

This problem of distribution proved to be the greatest obstacle the company had to face. At first a few loud speakers were installed in various homes about town and were connected to the central station by means of uninsulated telephone wire strung along on the telephone poles.

The result was discouraging. The sound seemed to have sufficient volume but the tonal quality was ruined. The music was changed into a blaring static-charged discord. The officials decided that the trouble was caused by the interference of the telephone currents and they set about to remedy the difficulty. They tore down the transmission wire and in its place substituted a medium grade of light insulated wire, such as is often used in house wiring.

The results this time were better, but by no

means satisfactory. So, profiting by their experience, the wires were once again torn down, and replaced with a very heavily insulated wire. More than six months had now elapsed since their first experiments, and the directors of the company were beginning to grow impatient. Would it be a success this time or were they again destined to fail?

Giving orders to the operator to open the circuit at a certain time, the officials hurried down to one of the homes that had a Magnavox installation. They waited in suspense; and suddenly there burst from the horn the sound of a voice singing. The tone was full and clear. The reproduction was almost perfect. The experiment was an unqualified success!

News of the success of the venture spread, and within a few days the office was besieged with townspeople clamoring for an installation. The troubles of the company, though, were not yet over, for difficulty in distribution arose almost immediately. As the number of phones or horns was increased the volume of sound steadily decreased, until the results were as unsatisfactory as before.

Various schemes of overcoming the trouble were tried and finally the electricians hit upon the idea of dividing the town into four distribution districts and effecting a quadruple distribution from these four main conduits. As a further aid, more powerful batteries were installed in the central station. Once again the results were satisfactory.

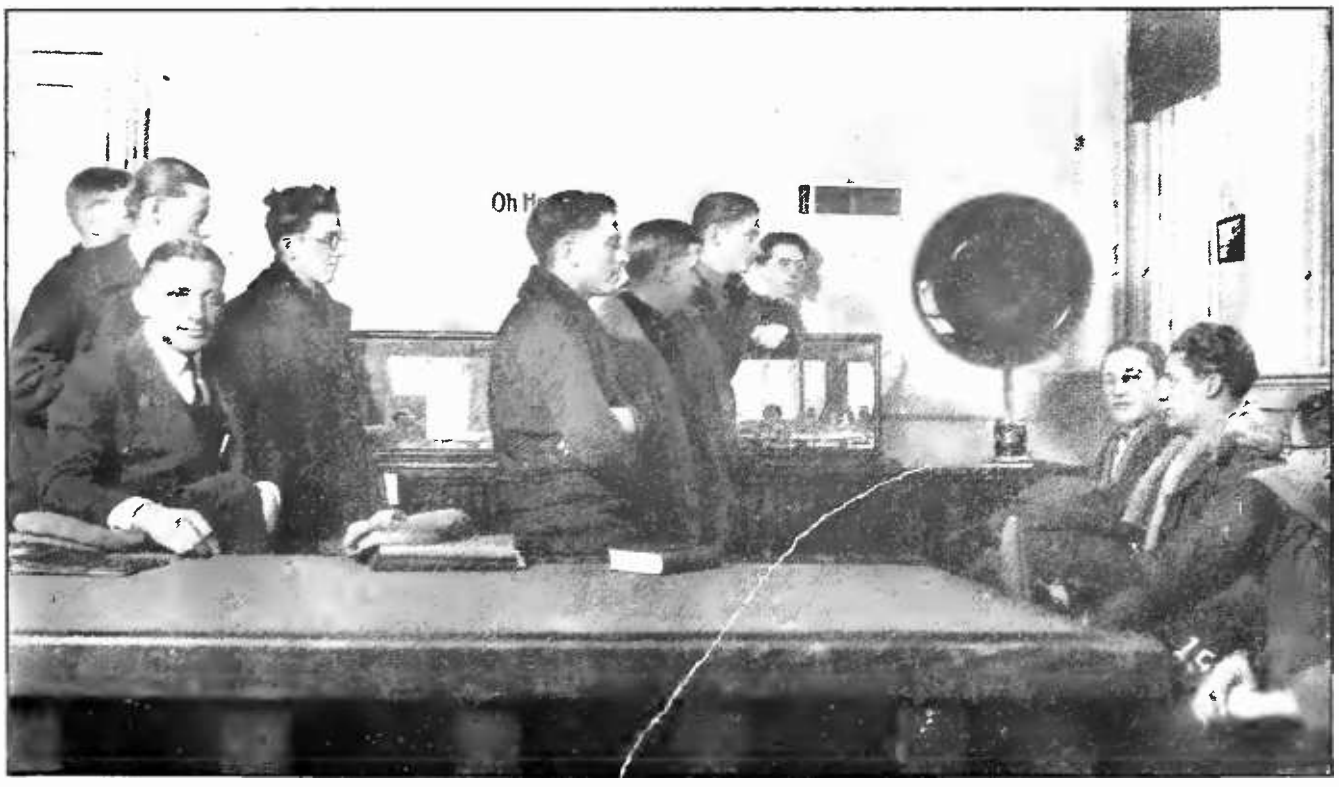
The entire mechanical force of the telephone company was placed on the work of installing and soon practically every home in the village was able to enjoy, without any technical knowledge or expensive receiving outfit, radio concerts and programmes picked up from many parts of the United States by the powerful central station.

F. W. Gradolph, the man who was credited earlier in this story with the original idea and subsequent realization of the project, is a quiet electrician and business man of early middle age, who takes a naïve and pardonable pride in being able to provide this broadcast service at a charge of one dollar and a half a month to each subscriber.

It is the opinion of everyone who has witnessed the successful operation of the Dundee experiment that this community really "has something." Who will say how many Dundees, all over the country, will be adopting this system of municipal radio within the next few years?

THE MUSIC FLOODS THE LOCAL STORE

One drawback to this system of re-broadcasting is that if one subscriber doesn't like the selections provided, he cannot turn a knob and bring in something else. It's a case of take it or leave—the switch open



The "Neutrodyne" Receiving System

Outlining the Hazeltine Method of Securing Radio Frequency Amplification Without Regeneration or Reradiation

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

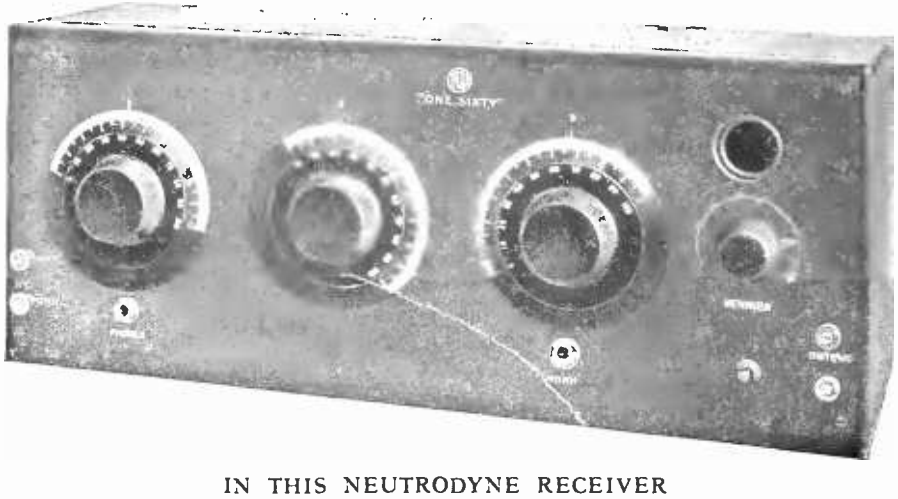
RADIO enthusiasts speak freely of audions, pliotrons, dynatrons, super-regeneration and heterodyne; but now comes a new word—"neutrodyne."

Neutrodyne is the coined name for a revolutionary radio receiver circuit that seemingly achieves the impossible. It neutralizes the capacity coupling of the circuits and allows very efficient radio-frequency amplification even on short wavelengths. In effect, the usual regeneration of the circuit is eliminated by this method of neutralizing the coupling capacities.

On the evening of March 2nd, 1923, Professor L. A. Hazeltine, Professor of Electrical Engineering at Stevens Institute of Technology, Hoboken, N. J., delivered a lecture before a meeting of the Radio Club of America, telling in detail of his work which, extending over a number of years, has resulted in the development of the neutrodyne circuit. The application of this circuit to the problem of radio-frequency amplification is only one of the uses of the neutrodyne principle as developed by Professor Hazeltine.

Briefly reviewing the methods of producing amplification in radio receiver circuits, we find that radio-frequency amplification can be obtained by using three possible methods of coupling one circuit to another, namely, resistance coupling, impedance coupling and transformer coupling. Resistance coupling is possibly desirable when wavelengths above 1,000 meters can be used, but the amplification per stage is not great and the tuning is broad. Impedance-coupled amplifiers when tuned are much more efficient and good results have been obtained from their use. If two or more stages of tuned impedance amplification are employed, however, the sharpness of tuning means very difficult adjustments and as a result cascade amplifiers of this type are not in general use. On the other hand, transformer coupling of amplifier circuits, because it has been standard practice with audio frequency circuits, has always found favor with both professional radio engineers and amateur experimenters as the ideal method of obtaining efficient radio-frequency amplification.

To date, two general devices for transformer-coupled radio-frequency amplifying circuits have been used; those employing air-core transformers and those having iron-core transformers. Circuits using air-cored transformers are extremely sharp in their tuning and the wavelength range of the transformers is necessarily limited. In cascade amplifiers of this type a multiplicity of controls is thus necessary, and very accurate tuning is required for each stage to get good results on the various wavelengths. For some time iron-cored transformers for radio frequency work were thought to be impracticable, due to the enormous eddy-current and hysteresis losses developed in the cores at



IN THIS NEUTRODYNE RECEIVER

All the tuning is done with the three dials. In a test made by RADIO BROADCAST, broadcasting stations over a thousand miles distant were heard on a loud speaker at night

these high frequencies. Later work with iron-cored transformers showed that by using cores made of special, very thin laminations and taking great care in the design and assembly of the transformer, quite satisfactory amplification could be obtained.

Special means were devised to broaden the wavelength band, but even as with air-cored transformers, it was impossible to utilize windings with a step-up ratio. Thus several stages were needed to obtain long distance signals.

As nearly every experimenter will agree, it is exceedingly difficult to hook up, even in the laboratory, either of these types of radio-frequency amplifier circuits and not get oneself into all sorts of trouble. At high frequencies the losses in the insulating materials used, the necessity for making all soldered connections of low resistance, and the very great drawback of the impossibility of eliminating the capacity coupling between the circuit and its various parts, make the problem seem impossible of solution. The matter of capacity coupling is obviously the most important. The capacity of the output circuit to the input circuit between the wiring of the set provides a path for a feed back of energy with the result that the apparatus oscillates. In broadcast reception using this sort of equipment the incoming signals are likely to be distorted, the overtones and undertones being eliminated, and the tuning accompanied by whistles as each carrier wave is crossed. In addition to the capacity coupling between the circuits the inductive coupling of transformers, inductances, etc., is also likely to bring this reaction about.

THE THEORY OF THE NEUTRODYNE

PROFESSOR Hazeltine in his lecture pointed out methods of overcoming, through neutralization, these various capacities between component parts of receiver and amplifier circuits. Theoretically his method may be explained as shown graphically in Fig. 1. We have two circuits, A and B, coupled to each other by a metallic connection C and, in addition, by the coupling capacity D. A magnetomotive force is set up in circuit B because of energy being transferred by the capacity coupling, a voltage and current transfer taking place. This condition in many instances is undesirable and decreases the efficiency of the receiver or amplifier circuit.

To make clear his method of neutralizing this capacity coupling between circuits, Professor Hazeltine explains by the drawing the use

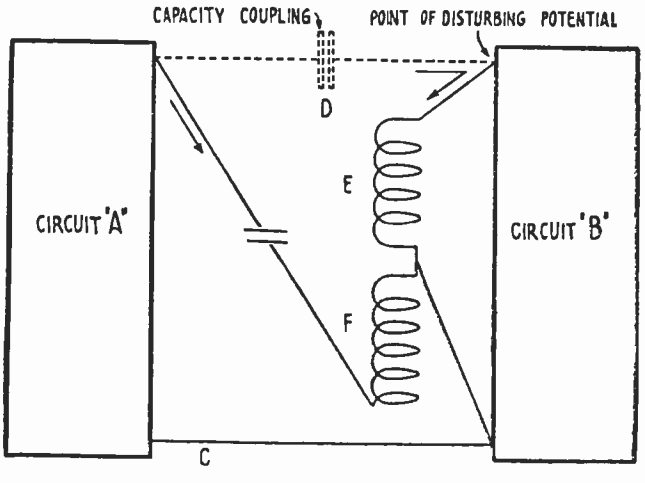


FIG. 1

A theoretical presentation of Prof. Hazeltine's neutralizing scheme

of an inductance tapped in the centre as shown. To the point of the disturbing potential on the circuit B one end of this inductance is connected and the other end is connected to a similar point on circuit A through an adjustable neutralizing capacity. The centre tap of this inductance system is connected to the low potential point of the circuit B. In effect, the path of the voltage and current is as shown by the arrows, with the energy caused by the parasitic capacity coupling D passing down through coil E in one direction and with the current and voltage in the opposite direction through branch F, going into the inductance system as an opposing voltage, thus inductively neutralizing the coupling capacity effect and causing no voltage across the terminals of circuit B.

As applied to radio circuits the drawing of Fig. 2 shows the device adapted to neutralizing the grid-to-plate capacity of vacuum tubes. In this circuit coils E and F are placed respectively in the grid and plate circuits while the centre tap goes to the common filament connection. The grid-plate capacity is shown by dotted lines and the neutralizing capacity is adjusted to offset the grid-plate capacity coupling. It is possible that the inductances E and F might be replaced by the inductances of other units as used in the circuit, as for instance the primary and secondary coils of an air-core radio frequency transformer. Professor Hazeltine showed that the character of these transformers affects the size of the balancing-out neutralizing capacity and that in his system it is possible to utilize transformers with a step-up ratio in the order of one to four and thus reduce the

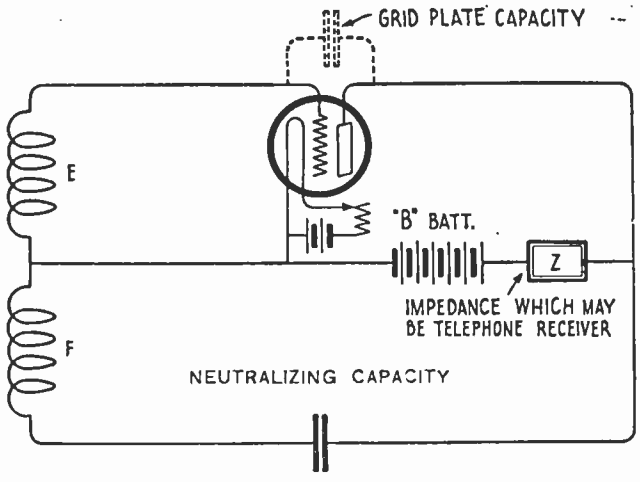


FIG. 2

Applying the neutralizing method to a vacuum tube circuit

capacity of the neutralizing condenser to approximately one or two micro-microfarads.

In both of these explanatory drawings the capacity to be neutralized out or eliminated has been represented by dotted lines as being only a single capacity. In practice this capacity may be made up of a great number of small capacities whose total is balanced out by the neutralizing capacity.

Accompanying illustrations show interior and exterior views of a receiver built by F. A. D. Andrea, Inc., employing the Hazeltine principle in its commercial form. It will be noted that but four controls are used, three of them being tuning controls and the other being the detector tube vernier rheostat. Two stages of tuned radio-frequency amplification, a vacuum-tube detector, and two stages of audio-frequency transformer-coupled amplification is obtained, using only four tubes. One tube does double duty as both audio- and radio-frequency amplifier.

In the interior view the amplifying transformers are shown in the foreground. Three variable air condensers are mounted directly behind them and the transformers assume an angle with respect to each other such that no electro-magnetic coupling exists between them. The variable condensers shown in the wiring diagram in Fig. 4 are placed in parallel with the radio-frequency transformer secondaries, forming closed oscillatory circuits, so that dial settings for these condensers remain practically alike for any given wavelength. The settings of dial one, which is across the secondary of the transformer whose primary is in the open oscillatory antenna circuit, will vary in setting with various sizes of antennas used. With the average antenna, however, it should not vary more than 10° to 12° above or below the settings of dials two and three counting from the left.

The important neutralizing condensers are pictured just above and between the variable condensers and transformer units. It is rather difficult to imagine a variable condenser having so small a capacity as 1 micro-microfarad and with the added advantage of having no connection to its moveable element. Such a condenser can be readily constructed. As shown in the drawing in Fig. 3 it consists of an insulated sleeve in which are inserted two pieces of wire with about $\frac{1}{8}$ inch space between them at the center. A metal tube is adjusted lengthwise outside of the insulating sleeve over the ends of the two wires. The resulting capacity is the series capacity of the metal tube to both wires. After this capacity is adjusted during the testing of the receiver it is sealed, being adjusted carefully for the particular types of vacuum tubes used. The adjustment of these neutralizing capacities is made experimentally by tuning in a strong signal, then turning out the filament of the tube whose capacity is to be matched but leaving the tube in its socket. If the neutralizing capacity is not correct the circuits on each side of the tube will have capacity coupling which will transmit the signals into the receivers. The neutralizing capacity is then adjusted until the signal disappears, then sealed in place. Such a method illustrates that the neutrodyne circuit operates to eliminate the capacity coup-

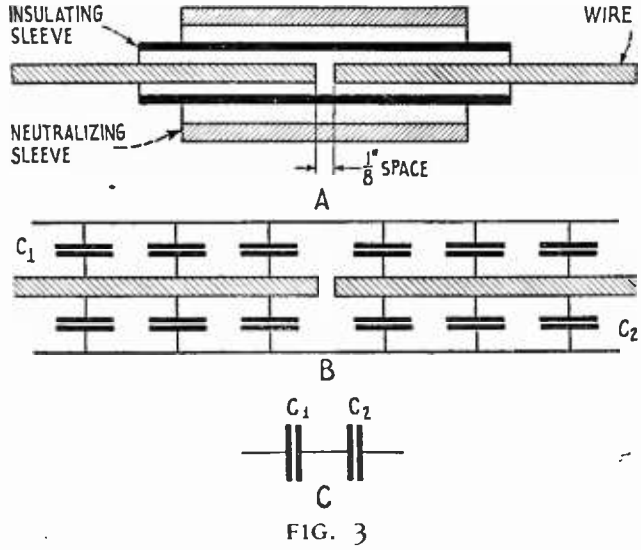


FIG. 3

The arrangement shown in A forms a condenser shown in B. The resultant capacity is the series capacity of the two rods to the neutralizing sleeve

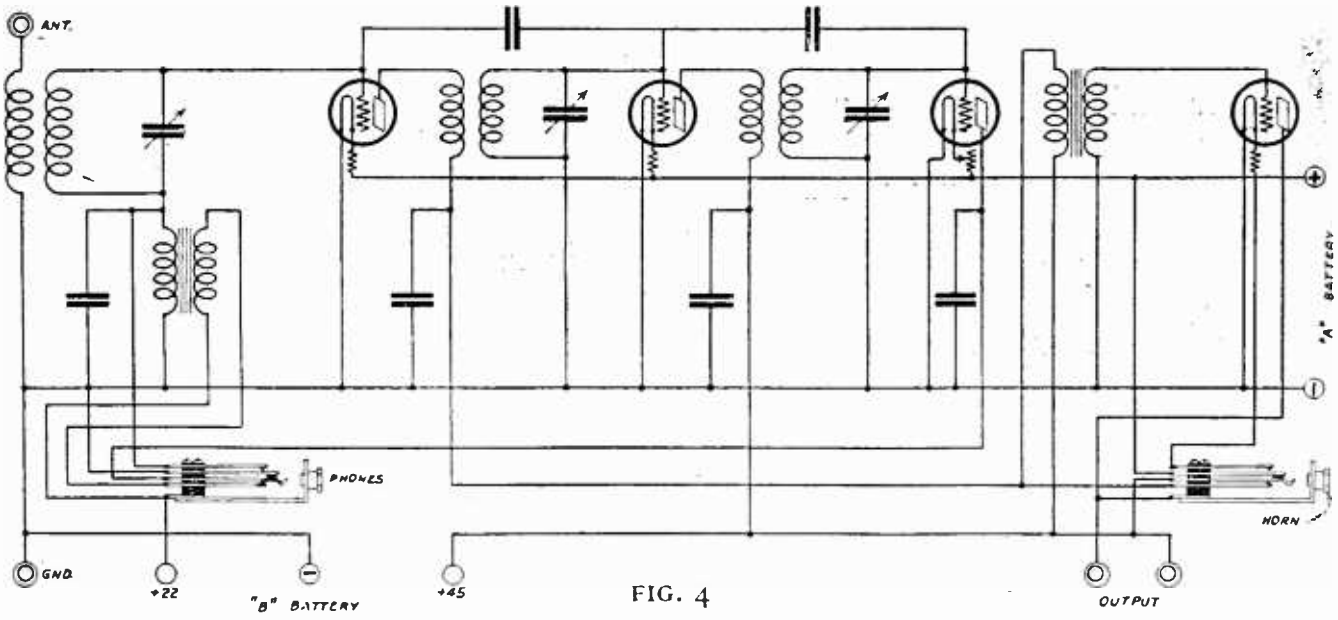


FIG. 4

THE NEUTRODYNE SYSTEM APPLIED TO A RECEIVER FOR GENERAL USE

In which there are three air-core transformers with tuned secondaries. The left hand one functions in the antenna circuit while the other two are used for the tuned R. F. inter-stage coupling transformers

ling and is not just a method for opposing the effects of regeneration, because the adjustment is made while the filament is cold and therefore under conditions when the tube could not regenerate.

With one of these receivers utilizing the neutrodyne circuit and only four vacuum tubes, three of the stations copied from New York City are noted below, together with the dial settings. In this work an indoor antenna was used consisting of about 50 ft. of annunciator wire running along the picture molding.

A glance at the dial setting indicates the sharpness with which tuning may be accomplished.

		Dial 1	Dial 2	Dial 3
KYW	Chicago, Ill.	35	66	66.5
WOO	Philadelphia, Pa.	35.5	67	65
WGM	Atlanta, Ga.	46	74	71.5

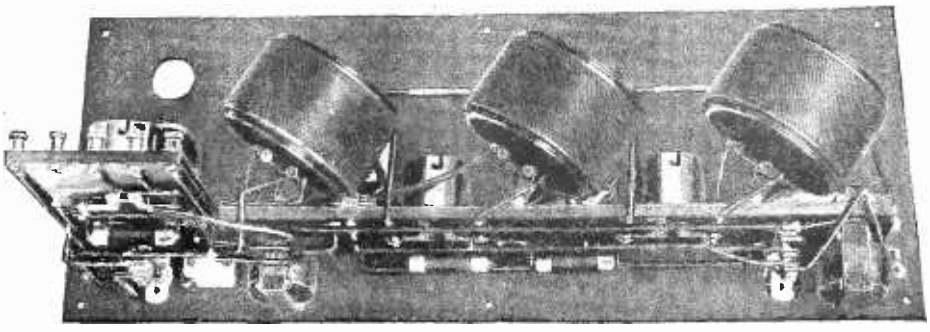
Another advantage of the neutrodyne capacity neutralizing circuit is the fact that it can be used with circuits employing regeneration if desired. This means that amateur C. W. reception can be carried out successfully over very long distances; in fact, several tests made in New York City by amateurs not particularly familiar with the circuit have resulted in reception from every district in the country, stations from the West Coast coming in clearly and with good volume.

From a non-interference point of view the neutrodyne circuit possesses great advantages because it does not re-radiate even when used in connection with regenerative circuits, because it does not allow energy to be fed back into the antenna—in other words, oscillation, if it occurs at all, is confined to the detector circuit.

The selectivity of the receiver is great and yet because no regeneration occurs it is possible for even the novice broadcast listener to adjust the three dials quickly and receive concerts with great clarity. Dial settings for various stations read like football signals, and to be able to have the women folks turn the dials to prearranged settings, throw in the filament switch and pull in broadcasting stations 1500 miles away, is a feat that even some of the older radio "night-hawks" envy.

THE INTERIOR OF THE RECEIVER

Is well planned. Note the angle at which the transformers are mounted to cut out electro-magnetic coupling. The brass sleeves which form the neutralizing condensers may be seen between the transformers



An SOS in the Jungle of Indo-China

By LELAND L. SMITH

How a Distress Call, Flashed from a Remote French Outpost, Brought Airplane Assistance at the Critical Moment in an Uprising of Moi Natives

THE most easterly town on the coast of French Indo-China, Qui Nhon, lies at the door of the wildest hunting country that I have been able to find anything about. When I arrived there, looking for a bit of hunting and literally "a place in the sun" as a relief after campaigning in Siberia, only ten French government officials inhabited the place, but they immediately opened their arms to a former American army officer. While talking to one of them, I was suddenly asked whether I happened to come from Pittsburgh. Being a good Yankee, I replied with a question, asking why of all American cities he had inquired about Pittsburgh.

"Well," the official replied, "I am one of the only two living persons bearing the name of Duquesne, the founder of Pittsburgh; and it is my greatest wish to visit that city."

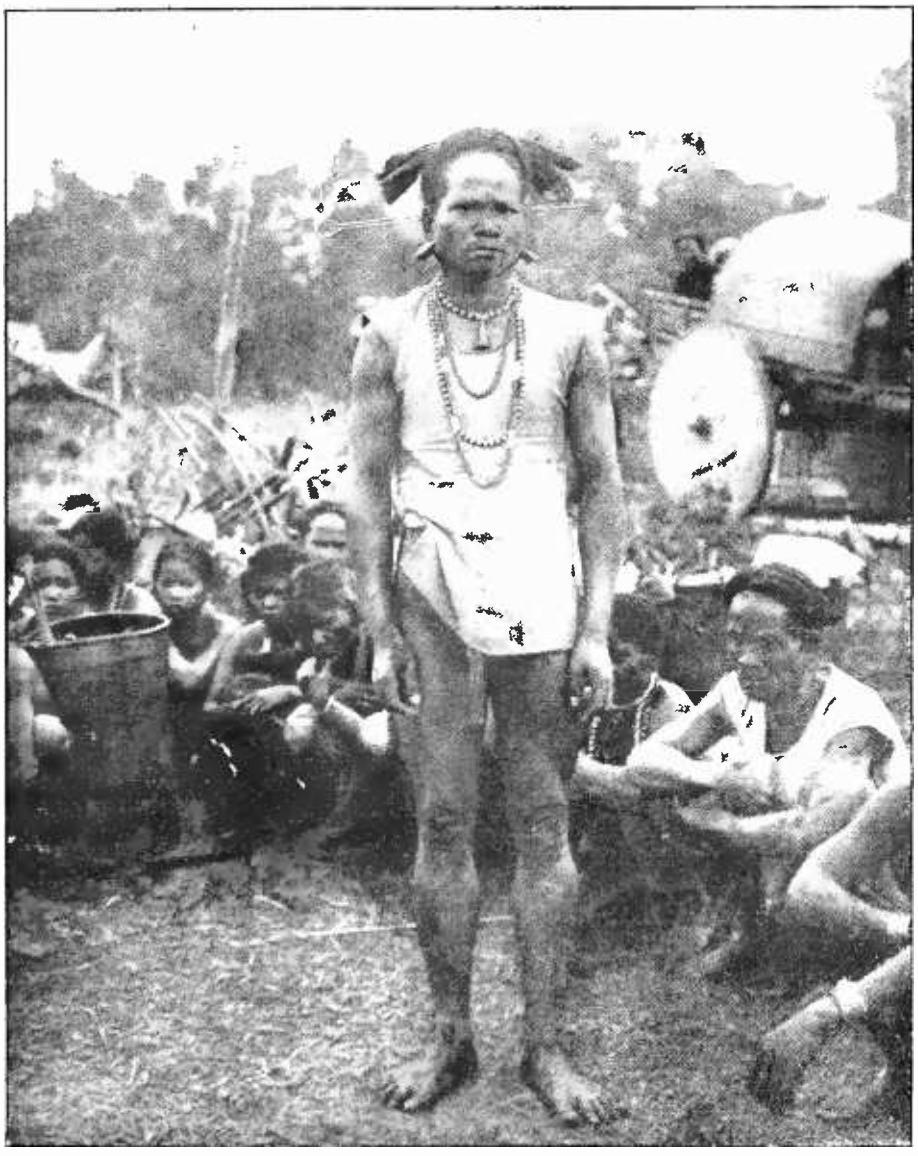
There was something interesting about this man who was keeping up the pioneering history of his family. We became good friends and he gladly gave me all the information that I needed. We had still another thing in common: Mr. Duquesne turned out to be in charge of the government radio station at that point and I had, shortly before leaving Siberia, been transferred to the wireless branch of the Signal Corps. I was naturally delighted when I was invited to visit his plant, which I found to be very modern and large enough to protect the shipping of perhaps the worst bit of typhoon coast in the world.

His stories about the China Sea were thrilling, but what whetted my imagination most was his account of how a tiny French post, lost in the wilds of the Annam mountains, had been saved from annihilation at the hands of the Moi natives by the use of radio. It seemed that the natives of the mountains had yet to be brought under the domination of the French. Military posts were gradually being established in the interior, but slowly, as most of the Colonial troops were still in France and the native Annamite troops were too much of an unknown quantity to undertake the subjugation of the Mois. Directly East of Qui Nhon, 200 kilometers away, was a post called Kon Tum which had no means of communicating with the outside world except radio. Telephone and telegraph wires had been strung several times, but wild elephants had destroyed them as fast as they were laid. Therefore, a field wireless had been installed at the post. An automobile road was in the course of construction but only half was completed, and the rest of the distance to the post had to be made over a jungle trail—impassable after a tropical rain—by ox-carts.

A year before, the natives, who are religious fanatics, had become excited over some fancied wrong to their faith and had attacked the post. Many were killed by machine gun fire but the Mois, in their religious wars, seek death, believing that the supreme sacrifice in battle will render them salvation. The supply of ammunition had run low and the post was soon reduced to a state of starvation. There had been a succession of electrical storms that had temporarily put the field radio set out of commission, and it was only by hard work and good luck that the news of the outbreak was received

"After having spent a rather frigid time in Siberia fighting for democracy," writes Mr. Smith, "I decided to look for a place where I could thaw out. I hunted up a map of the world, and putting my finger on the equator, started searching for the most out-of-the-way, hot place on the globe. My eyes fell on Indo-China, and then and there I decided that Indo-China was the place for me." After reading the following account of his experiences there, we are inclined to think it isn't the place for *any* white man. But the French Colonials make existence in the jungle more endurable and less hazardous by the use of radio at their outposts.—THE EDITOR.

by the Qui Nhon station. It was impossible for relief to arrive immediately and it was doubtful if the handful of men that Qui Nhon could spare would be enough to cope with the situation. The lieutenant in charge of the besieged fort had the idea of calling by radio for two aeroplanes that were stationed at Qui Nhon, as the Mois had always taken to flight upon the one or two occasions that planes had cruised over the country. The weather being favorable, the planes had set out and, upon arriving over the fort, dropped a few bombs and opened up at close range with machine guns. As if by magic, the natives took to their heels and had not bothered the post since. The French had since increased the number of planes on the Annam coast in case of a recurrence of the outbreak. But the machines were never allowed to fly inland often enough for the Mois to get accustomed to them.



THIS MOI CHIEF THREW HIS VICTIMS TO THE ELEPHANTS

Lieutenant Gobert would have suffered this death, had not the author been successful in summoning French army planes by radio. The long double piece of wire in the chief's hair was originally part of some European cooking utensil. Note the large wheel on the native cart. Wheels of jungle carts are never greased in Indo-China, as the ear-splitting shrieks they make serve to keep tigers and leopards at a safe distance

I was very much interested in the story and inquired whether it would be possible for me to visit the post, and whether I could obtain any big game such as tiger and elephant at the same time. I was told that Qui Nhon communicated with the post twice a day and if I would be at the station on the following morning at seven I could ask as many questions as I desired. It was finally arranged that I should go to the camp and participate in a hunt for a man-eating tiger that had been ravaging the neighboring Moi tribe. So, on the following day, I set out for the jungle post, loaded with equipment and supplies that the French officials had given me or recommended.

The first 100 kilometers were quickly covered by automobile over a road that led directly into the mountains and through dense jungles. Then I was bundled into an ox-cart and plunged into the dark country away from the white man's land.

A man who has never seen a real jungle cannot even guess at its denseness, or its vivid color. For hours at a time, it seemed, the bamboo "brousse," as the French call it, hid the sight of the sky, its long, curving stalks closing like a net over the thin trail. Flowering vines hung from the branches like Japanese filmy curtains. The solemn oxen, that carried me jerkily over the rough road, ruthlessly tore down the colored strands and munched the most exquisite orchids. Monkeys followed overhead, chattering and making a terrific

racket. Gay-plumed parrots, noble peacocks, deer, and wild boar were encountered continually. As the heat was terrific, the oxen were rested at every creek and I was able to peer into the jungle at close range. The length of my nose was about as far as I could get, and I thought to myself that Siberia and the Bolsheviki had been less dangerous than this new kind of No Man's Land. My white escort had left me, and four half-naked Annamites and one child had taken possession of me. Their apparent unconcern, however, reassured me.

The cart that was carrying me to Kon Tum had the largest wheels I have ever seen outside of a power house, and when they revolved they made a sound like the singing of every canary that the islands of that name had ever been guilty of exporting. An investigation elicited the fact that wooden hubs, revolving on wooden axles, were sending forth the air splitting shrieks that went echoing away into the jungle. The driver, who spoke an extremely Annamite-French, advised me that the noise was made on purpose as tigers and leopards never attacked a squeaking vehicle. He added that no person would ever get out of the jungle alive in a noiseless cart. From then on, the squeaks became the most beautiful music, and the louder they became the more I liked it.

We arrived at an open space shortly before sunset and preparations were made to spend the night. I had always dreamt of sleeping in a hammock suspended between two palm-trees and it was with a thrill of delight that I started to hang my swinging bed between two royal palms not far from the fire. The entire Annamite contingent protested violently. I was unable to understand why, but resigned myself to my fate and removed my stuff to the covered cart. After an exceedingly Annamite meal, which I could not eat (having seen it cooked), I sat down under the palms and watched the light of the day disappear over the jungle, or rather it seemed that the sombre, tangled forest arose and blotted out the light. Never will I forget the intricate laciness of the bamboo foliage; nor the majesty of the scattered royal palms as they struggled to retain the light a little longer than their less tall companions; or the weird calls that came from the depths of the jungle and were echoed again and again on my spinal cord.

A sharp pain on my wrist brought me to with a start. I naturally grabbed the outraged spot and felt hot blood. Another pain struck me in the neck; it was so sharp that I cried out. The Annamites came running and dragged me from under the palms to the fire. I discovered several black worms about two inches long crawling on me. They fastened their heads upon an object, bringing their tails up to the head, and repeating the operation, they moved along with surprising rapidity. Their backs were kept curved after the manner of an outraged cat and they were extremely painful if your skin was reached; for immediately the worm began the operation of bloating itself with your blood.

"Sangsues! Sangsues!" shouted the natives with amusement; and it was then that I discovered why I could not sleep under trees. The worms were leeches that live on the branches and drop on their prey at night. Their bites are very deep and the blood may run for fifteen minutes before it can be stopped; and the deadly, recurring forest fever often results from them.

With the crack of dawn, we were jolting and rocking again. We left the valley country and began toiling up crooked, mountain roads. The jungle gave way to pine trees, and tall mountains frowned down upon us from all sides. Mile after mile and hour after hour went by without the slightest trace of man. We seemed to be the only people in the world.

As the forenoon lengthened, we reached a great plateau, and in the distance a black spot was pointed out as our objective. Only glimpses of the fort could be seen from time to time through the large pine trees and I was not prepared for the formidable structure that suddenly appeared, dominating a large vacant plain from the top of a knoll. The fort looked for all the world like a copy of the old prints I had seen of the stockade-stronghold of the Pilgrim Fathers at Plymouth. A dry moat surrounded the post. On the inside bank, long pointed posts stuck out at an angle of forty-five degrees. Then came a tall, pointed stockade broken at frequent intervals with enfilading towers. At the corners were tall look-out posts. Bayonets flashed at intervals along the top of the stockade. A French flag hung from a tall pole.

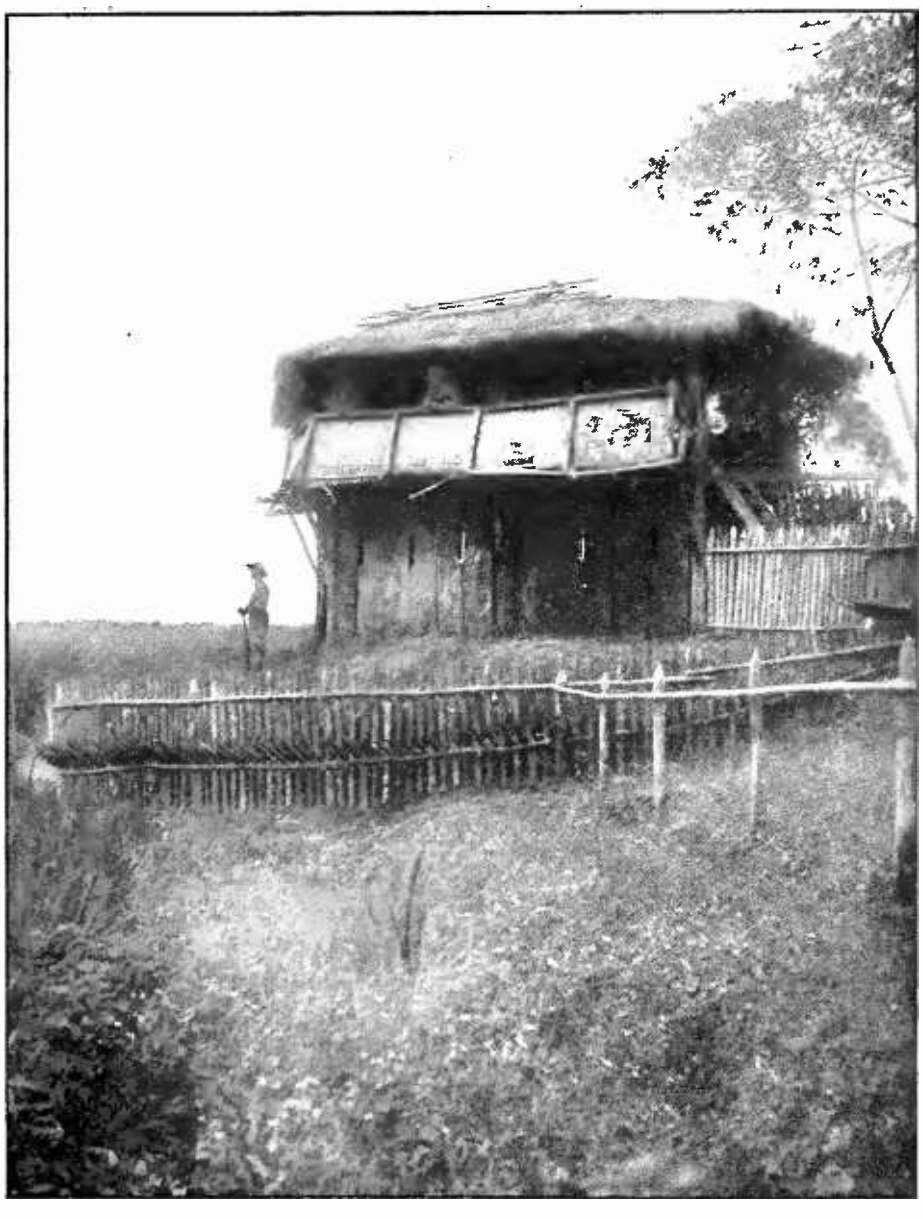
We crossed the open space, which I noticed must have been prepared for aeroplanes and, as we approached, a bugle sounded. A drawbridge was lowered and a French lieutenant

advanced to greet me. A few minutes later, I was in the officers' quarters trying to discover some part of my body that did not ache from the vibrations of the ox cart, and quenching my thirst with one of those long, cold ones that make you think that all has not been in vain.

The lieutenant, Gobert by name, was a slim, medium-sized man bearing the tan that comes only from years of life in the tropics. He was about thirty years old and his plain, khaki uniform did not have the vestige of a decoration, a sharp contrast to the gay bosoms of the Colonial officers I had seen. His eyes had followed mine and a slight blush suffused his face.

"I was one of the few Colonials that understood the Mois and were kept here during the entire war to prevent the natives from being carried away by German propaganda. I am still a lieutenant and have yet my laurels to win."

The lieutenant had spoken frankly and pleasantly. I felt that I was going to like him immensely.



A CORNER OF THE DEFENSES OF KON TUM
Showing the stockade with its sharp-pointed posts, set like bayonets against a possible attack by man or beast

"From what I have already heard about you and the Mois last year, I would say that your laurels have grown into a large-size tree," I hastened to answer.

Lieutenant Gobert laughed, replying: "The Mois are extremely interesting. They have no place in history and have apparently always lived in the mountains of Annam. The fact that they have been uncontaminated by surrounding races is probably due to the fact that the Annamites of the coast think the mountains are the abiding place of the worst devils, and the Mois are certain that sure death lurks on the plains. As a result, the Mois are perhaps the most uncivilized people in the world. But enough of this: it is nearly dinner time."

In going to my quarters, I discovered that the buildings were in the form of a square and could be joined together by inserting sections of stockade, thus presenting a second line of defence. The feudal atmosphere of the place and the Annamite soldiers with their conical hats, long bayonets and vivid red-wrapped leggings above their bare feet thrilled me with delight. I was comfortably quartered and given an orderly. The place was a veritable museum of strange instruments of war, and it was with a sense of regret that I abandoned a bamboo arrow-gun to follow my orderly to the mess quarters. We passed through a charming garden to a large house, evidently of Moi pattern, raised off the ground about ten feet and

having a wide porch running entirely around it. On one side, a snowy white table was already set and the interior of the structure was the most perfect man's lounging room I have ever seen, with huge fire-place, deep chairs, hunting trophies and a riot of velvety skins. It was the only spot in the post that did not breathe war.

Our dinner was delicious, and when, as a climax, a heaping dish of luscious strawberries and cream was brought in, visions of home and Mother flashed before me. I was told that the post was at an altitude of five thousand feet and that temperate zone products flourished on the plateau.

We sat there a long time, watching the afterglow of the tropical sun on the mountain tops, and planning my hunting trip. It was decided that we would take elephants on the following morning and visit the neighboring Moi village where we would arrange for the killing of a buffalo, the building of a "kill" in which to wait for the tiger, and the engaging of a number of Mois to assist us in the proposed hunt. While waiting six or seven days for the slain buffalo to become tender enough to appeal to the delicate senses of a well-brought-up tiger, I was to be initiated into the excitement of electric searchlight hunting at night and the dangerous pastime of shooting elephants.

We were interrupted by a pretty young girl clad only in a colored, native skirt. Her hair stood out at least ten inches all around her head and her eyes were so black that I was startled.

Lieutenant Gobert spoke to her in her native tongue. The girl advanced shyly. After a short conversation, she made me the religious Lai courtesy of Annam and glided noiselessly out of the room, her dark, brown body seeming to fuse into the darkness.

The French officer laughed before making any explanations.

"That was Pocahontas, my Moi wife. Come," said he, rising, "Duquesne will be trying to get us on the radio. Let us go to the operating room and I will tell you the story of Pocahontas on the way."

Once out of the dark garden, the lieutenant continued:

"Most of the time there are only two white officers in a post like this. At the present moment, I have a garrison of only sixty Annamites, since my colleague, Sous-Lieutenant Lancelin, and the rest of the force is fifty kilometers away on some surveying work. Our only communication with this force is by fire. At ten o'clock we will mount the observation tower and look for his signal that all is well. After you have done over six years of this kind of service, with only one leave in France, you will perhaps understand how all of the books in the world will cease to be the companion that nature has intended every man to have.

"The Mois are very tricky; you never know when and how you are going to hurt their feelings. About two years ago, I was unfortunate enough to kill one of their sacred bulls accidently while hunting at night. I was instantly seized and condemned to be thrown to the elephants, which are instructed in the playful art of throwing humans high into the air, catching them on their tusks and then kneeling on what is left after the first operation. This girl you have just seen pleaded with her father, the chief, for clemency—I had previously tried to buy her for a wife—but the old man had refused. So earnest was she in my behalf that the father allowed me to go. A few days later I discovered the little princess hidden in my room: she had run away from her tribe and said that she only wished to serve me as long as I wanted her. I finally struck a bargain with her father, but he swears that he will throw her to the elephants if she ever goes back to him.

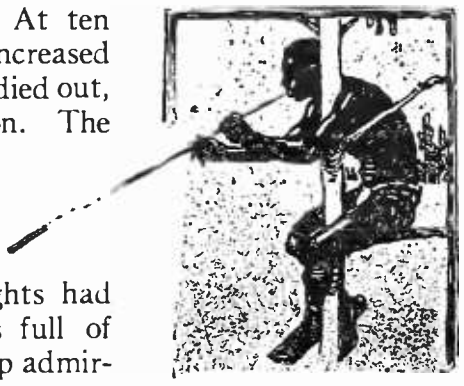
"This all sounds like a fairy tale, but I have grown to love her and wonder what I can do with her and what will become of her when I am transferred home. I call her Pocahontas because Duquesne interested me in American history some time ago and the story of Captain John Smith and the Indian princess seemed to resemble my case somewhat."

As we entered the receiving room, an operator was busy receiving a message. I found that the radio set was a small one, not good for over one hundred and fifty miles under the most favorable conditions, but compact and just the thing for an outpost like Kon Tum. Lieutenant Gobert read me the gist of the message already received. Most of it was world news but Duquesne had slid in the baseball scores sent out by Cavite for my benefit. It was wonder-

ful! Here we were lost in the wilds of Darkest Asia, yet we figured out that the baseball crowds in New York were still on their way home.

When the native had ceased receiving, I asked the lieutenant for permission to send a message to Duquesne. "Pittsburgh—Pittsburgh!" I flashed out over the jungle wastes, experiencing a thrill of pleasure at the snappy crack of the spark. As quick as a flash the reply came back: "Heinz 57."

After a few minutes of exchange of compliments, I reluctantly followed Gobert to the look-out. At ten sharp, a red glow, that increased suddenly and then slowly died out, appeared on the far horizon. The lieutenant touched an electric button and an electric searchlight above us answered the signal. That was all; but the lights had sent a message that was full of meaning. I could not help admiring these men who were consecrating their lives to the demands of their country and carrying out their orders in the midst of a hostile country that might swallow them up at any moment.



Next morning, shortly after daybreak, Lieutenant Gobert called for me with two large elephants bearing protected baskets. Pocahontas was there also, stroking one of the beasts fondly. She had come to see her master off. Her shyness had disappeared and I was greeted with an expansive smile. There were five armed men in the first basket, not counting the driver, who sat pompously on the elephant's head. We mounted the second elephant and were joined by three more soldiers, making twelve of us altogether. There were enough bayonets sticking out of the baskets to frighten most any creature. The lieutenant gave a few orders, waved good-bye to Pocahontas, and we were off.

"She's a funny girl," Gobert remarked with a smile, having doubtless followed my eyes. "I have given her all kinds of European clothes, but she refuses to wear them, as she says that neither her mother nor her grandmother ever wore anything like them. If she ever sees a white woman, perhaps she will change her mind."

It took me a few minutes to become accustomed to the rather uncomfortable toddle of the elephant, and for a while I had grave fears for my breakfast. After leaving the stronghold, we first crossed the great open space that lay before it. Lieutenant Gobert went on, waving toward the plain:

"The maintenance of this field absolutely free of all plants capable of hindering a plane is my greatest charge, because, if the Mois should suddenly rebel, I count absolutely upon the assistance of planes, as there are no troops available that could get here quick enough in an emergency."

"Have the Mois any firearms?" I inquired.

"No; but they have bamboo guns that shoot extremely dangerous poisoned darts. Also, they are very accurate with blow-guns. They have no fear, wishing to die in war, as it assures them of the favor of the gods. It is no sinecure fighting hundreds of these natives with a few guns and a limited quantity of ammunition that deteriorates more rapidly than it can be replaced in this tropical climate."

"It is very fortunate that you have a radio set," I remarked.

"I should say so; the radio is really our protector. You think that I am isolated now; just think how much more difficult the position of my predecessor was before the days of the radio!"

We had plunged into the forest. Large pine trees lined the roads interspersed by tropical foliage in the low places. The elephants fascinated me as they tore down all the low, hanging limbs that would otherwise have scraped our car. In one place we passed a curious collection of houses surrounded by a high paling of tree trunks. Wicker roofs rose sharply from their narrow bases and met forty feet overhead like the edge of a razor. Colored woods were worked into the roofs in peculiar designs. I was told that each house represented a family vault, some of them containing twenty wrapped bodies; and the strong stockade was to prevent the dead from being consumed by tigers.

Shortly afterward we reached a village of many houses clustered around a large square. They were all made of grass, rested on piles from eight to ten feet from the ground, and had flat sloping roofs. Upon our approach, crowds of naked children, and natives clad only around the centre of the body, swarmed down the lad-

Courtesy of the *French Colonial Digest*

A BIT OF THE COUNTRY WEST OF QUI NHON

Once in the tangle of tropical growth beyond the falls, it is impossible to see more than a few feet in any direction, and it is dark and strangely silent

ders of their houses and curiously inspected us, always keeping at a respectable distance. At the far end of the square was a building of considerable proportions which my conductor announced was the domicile of the Chief. We had hardly time to descend from our elephants before the great man appeared, protected by several extraordinary muscular soldiers armed with spears, grass shields, and bow-guns.

The Chief was dignity itself in a native woven shirt, black towel tied around his head with its ends flapping on either side, several strings of beads around his neck, round pieces of gold in the lobes of his ears, and a long double piece of wire from some European cooking utensil stuck through his twisted hair at a rakish angle.

Lieutenant Gobert addressed him in his own language, presenting him with a package of cigarettes. Not a trace of a smile broke his feature or those of his attendants during the interview. Suddenly he made a signal, turned and entered the house, leaving us to ourselves. Gobert announced that we had been promised a number of Mois but they would have to be paid in advance. At that instant a number of stalwart men advanced. I took out my purse, insisting on paying the necessary costs. Lieutenant Gobert burst into laughter, directing me to offer each native a couple of Indo-China bills. The men took the money, examined it coolly, and handed it back to me. The lieutenant explained that the bills were in payment for their work as guides, but they immediately protested violently, turning on their heels to go away. It was then I realized that money was an unknown article to these simple natives. Lieutenant Gobert produced some pieces of cloth, beads, and brass bracelets which were divided among them. Not even then did they smile. Their stoicism was most disagreeable and I realized what unpleasant folk they would be if aroused.

We were soon again on the march, our Moi guides following after. I was told by Gobert to watch out for the Chief's elephants, as we were soon to pass them. Great snorts greeted us as we came to several strong stockades almost obscured by clouds of dust. I was greeted by one of the strangest and most awful sights of my life. Ten elephants with long, curved tusks, the ends of which had been sharpened by the addition of steel points, were throwing grass manikins into the air and catching them deftly on the ends of their tusks. After doing this several times, they cast what was left of the forms on the ground and trampled them. The elephants were undergoing their daily training.

The forest soon became so dense that we had to dismount our elephants. Gobert superintended the killing of an old buffalo, and a blind was made from where we were to shoot the great cat when he had been attracted by the odor of the dead beast. The huge buffalo, although weighing over two thousand pounds, was chained to a tree to prevent him from being dragged off by the tiger.

The following night we started on our first hunt. Gobert fitted me out with an electric searchlight that was fastened to my hat and connected with some batteries strapped to my belt. I was then given a lecture on eyes: red eyes announced a member of the cat family: if they were small and close together it would be a leopard, but if they were large and far apart it would be a tiger. On the other hand, if the eyes were green, they belonged to a member of the deer family.

Trying to keep this information in my mind, I plunged with Gobert into a jungle path, fol-

lowed by several Mois. I was told to keep my searchlight flashing on the trees to anticipate any lurking panthers while my companion was to cover the ground, since he did not care to run the risk of my killing a sacred bull as had happened before with disastrous results. All of the awful sights I had ever seen paled in the terrible aspect assumed by the snarled, dark, dank jungle that closed in upon us. The hanging vines, apparently brought to life by the flashing searchlights, looked like writhing snakes waiting to clasp us in their clammy embrace. Owls kept me on the jump as their eyes would flash like a match in the night as they flew before us.

Suddenly two lights shone before me and disappeared before I could decide whether they were green or red. Two more followed to the left; and still two more to the right. I brought my rifle to my shoulder but Gobert whispered in my ear that they were deer and not to shoot as it would frighten the big game we were after. I have never seen anything prettier than the lovely animals as they slunk away into the woods after having been momentarily hypnotized by our searchlights.

We came to a branch in the trail and I was told to take the one on the left until it met the other a few hundred yards ahead. I had not followed it long before I came to an open space. I heard a noise, and flashing my light in the direction of the disturbance I found myself looking into a pair of huge eyes. A second later I had fired. There was a terrific crash. I carefully went forward, expecting to see a great tiger stretched out on the ground. Finally, the light revealed my prey. I became transfixed with terror: a huge animal lay before me with several Mois shrieking beside it. Upon seeing me they fled, followed by our own escort, and I was left alone—alone with a dead sacred bull.

A moment later Lieutenant Gobert rushed up. When he saw what had happened, he seemed to turn to stone. Not a word did he utter after his first ejaculation: he stood motionless looking at the bleeding animal before him. I tried to explain how I had been sure that nothing in the world but a tiger could have had such large eyes; how terribly I felt about it. But he heard me not, and I lapsed into silence, my intuition telling me that the consequence of my error would be disastrous. Suddenly he turned on his heel with a curt "Come; we must act quickly."

Without another word I followed him to our elephant and suffered the torments of the damned on our trip home. Gobert smoked one cigarette after another, often not waiting for one to be consumed. The frightful consequences following the killing of a bull two years before flashed though my brain with foreboding vividness. I could think of nothing but being tossed aloft by furious elephants, and of fruitless radio SOS calls.

Upon our arrival at the fort, Gobert led me immediately into the radio room and carefully locked the door. He gave me a pad and pencil, and proceeded to give me directions.

"There is only one thing to do: I must go to the Chief personally and forestall any religious uprising that may follow.

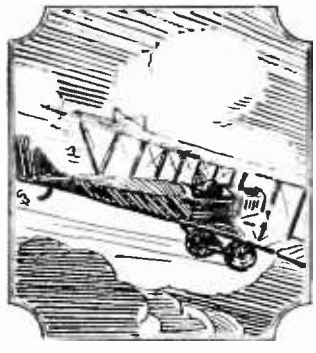
"Nothing of the kind; it is I who must bear the consequences," I interrupted.

"You could do nothing, and besides, you

STRIKING INTO THE DENSEST JUNGLE

A hunting party out after tiger. The journey would be practically impossible on foot, but the lumbering, pitching elephants are excellent mounts for this sort of work—if you are a good sailor

must take charge here until the other detachment can get back. You will at once keep a fire signal going until answered by my lieutenant. Then you will keep at this radio set until you can get Qui Nhon. They do not usually take messages before 7 A.M. but you must call every five minutes all night in the hope that for some reason that God only knows Qui Nhon may be able to pick up your call. You will tell them of what has happened and to send aeroplanes at once, for there is no time to lose. If I don't come back, have the planes bomb the Mois. But in no event open the gates of the fort until the planes or Lieutenant Lancelin arrive."



I protested, warning him of his danger, but was finally convinced that he, knowing the Chief, was the person to go. With a last few directions and a warning not to tell "Pocahontas" where he was or what had happened, he was gone. He was to take one elephant and five armed men, one of which was to drop off the elephant just before entering the Moi camp and return to the fort with news of the party's fate.

A moment later the Annamite radio man came in and we began our frenzied attempt to call Qui Nhon. The soldier was visibly frightened, although he did not know just what had happened, and I felt that the small Annamite garrison would not hold if attacked by the Mois.

Suddenly there was a crash and the sky seemed to split from one end to the other. I was dazed by the light. The heavens opened and a storm of such magnitude as I had never conceived broke upon us. The current had to be turned off and there we sat in total darkness hour after hour, helpless and unable to use the instruments before us. Never have I seen such flashes of lightning, such blasts of wind and rain. The signal soldiers reported that no answer from the surveying party had been seen and the searchlight was now useless. I ordered a number of barrels of crude oil to be set afire as help must be had. The Annamite said that electrical storms sometimes kept up for several days and I trembled when I thought that I might be prevented from soliciting help by radio. It was simply up to Providence, and we kept up our ominous vigil, hoping and praying that the storm would cease at the break of day.

The girl came in to inquire for the lieutenant. I sent her away with some excuse. A few moments later the Annamite called my attention to the East where the first signs of day were struggling through the storm. There came a blow at the door and a torn and water-soaked figure fell into the room. It was Gobert's soldier, who had struggled several miles through the storm and jungle. His condition was pitiful. After a breathing spell, he was able to tell us between gasps of terror and exhaustion that the lieutenant and his soldiers had been seized by the Moi chief. The soldiers were to be thrown to the elephants and the lieutenant, owing to his rank, would receive the more honorable death of being tied to four elephants which would then be driven to the four opposite points of the compass.

A scream followed and Pocahontas, who had been concealed behind the door, rushed into the room. She cried that she had saved Lieutenant Gobert once and she could do it again. According to the custom of her people all executions took place at high noon, and by starting at once she could forestall the event. I told her that I would not allow her to go as her father had vowed to kill her if she ever returned to his camp. The poor girl rushed from the room crying that she would gladly give her life if she could but save the lieutenant. It was necessary to have the girl locked up, and she struggled and shrieked to the very last.

I took up my place at the instrument again. The day broke with a rush, sending the storm away as fast as it had come. It was incredible that such a calm could succeed the crashes and downpour of the night so suddenly. I turned on the current and sent out the call for Qui Nhon, one thing running through my mind again and again—assistance had to arrive before noon. It was an hour before Qui Nhon was scheduled to receive but I prayed that somehow the message would be heard. A half hour went by. And then it was three quarters. My wrist watch showed that there remained barely five hours. I wondered what could be done if I could not get immediate help. It was impossible to rescue Gobert with the small detachment at the post. The poor Annamite was no longer capable of work; he was almost paralyzed with terror and I must admit the situation was affecting my own nerves.

Suddenly there came a buzz in my ears and a moment later I was pounding off the news of our predicament. Then I had to wait for a reply. An hour went by. Only four more hours remained. I cursed the slowness of officialdom. Finally, there came orders to get everything in readiness to receive two aeroplanes that had already started. I announced the news to the nervous Annamites and discipline returned immediately.

Then began the longest wait I have ever known. My eyes went from my watch to the eastern sky. Only two and a half hours remained. Duquesne flashed me words of encouragement. An Annamite rushed in pointing to the sky and words fail to express the joy with which we watched the progress and landing of the planes.

A Captain rushed forward and in a second I had explained the situation. He commanded me to enter his machine, which was a three-seated bomber, and we were off, followed by the small plane armed with a machine-gun, speeding for the Moi village. As we approached it, we could see a crowd in the square. We dropped a bomb which went off with a terrific crash as it struck the earth. The Mois seemed to disappear into thin air. The small plane made a nose dive, spraying the fleeing natives. We exploded another bomb just for effect and then landed, the small plane circling overhead to protect us.

We found Lieutenant Gobert and the Annamites lying in a row, stripped of their clothing and tied to thick bamboo poles. A Moi cart was found and we were soon on our way back to the fort. When we were safely within the walls, the two planes left for Qui Nhon, for the Mois must be kept in fear of them. We were also told that reinforcements were on the way, and were also greeted upon our return by the surveying party that had seen our signal of the night before.

The joy of Pocahontas upon seeing her master was something I shall never forget. Savage though she may have been, she was as brave and devoted as they make them. That night, as Gobert and I communicated with Duquesne, it was with a sense of gratitude that we handled the small radio set. Twice it had saved the life of the lieutenant and his tiny garrison. As for me, I had to return to Qui Nhon contented with my one shoot, for I had so roused the natives that it was impossible to continue the hunt.

Now, as I sit comfortably by my radio set in a staid city of the United States, I cannot help wondering how Gobert and Pocahontas are faring in their fort in the wilds of the Moi country.

COOLING OFF AFTER A TIGER HUNT

Adding Two Steps to Your Aeriola Senior

How the Job is Done, and What the Set Will Do

By JACQUES H. HERTS

THERE must be a great number of radio enthusiasts who started their radio education as I did, with the well known Westinghouse Aeriola Senior, really the first of the WD-11 tube sets. To all of these this description of its reconstruction should prove interesting.

I acquired my Senior last April, and from the first hour that I had it in operation I knew that I had been bitten by the "bug." Results were interesting from the start and after a few months I was listening to half the continent on its single (and then almost unknown) WD-11 dry-cell tube. Being a "bug," I knew that ere long I should want a larger and more powerful set, and my present set is the result.

Several months ago the two-step audio-frequency amplifier to match the Senior made its appearance on the market; but my old Senior was rather shabby looking after its hard summer's work (though it still was reaching out 1,000 miles with regularity), and I didn't like the idea of hooking-up one of these nice, new shiny amplifying units to it, so I decided to use what I could from the Senior and build an addition to it of two stages of audio-frequency amplification, the entire new set to be contained in one cabinet and, of course, to operate entirely on WD-11 tubes.

Not having the necessary equipment to do the work, I drew many plans and had them carried out by a well-known radio construction firm; however, the work is quite simple and could be done at home in a few days (and quite a bit of money could be saved on the job).

The new parts needed and their prices are as follows:

2 WD-11 tubes	$13.00
2 Transformers	10.00
3 Sockets	1.50
3 Rheostats	1.80
3 Jacks	3.00
3 Dials	1.50
1 Variable Condenser	2.50
3 Dry cells	1.00
90 Volts of "B" batteries	5.00
Panel (7x24) and Cabinet	6.00
Sundries—Buss Bar, Spaghetti, Binding posts, etc.	2.00
Total	$47.30

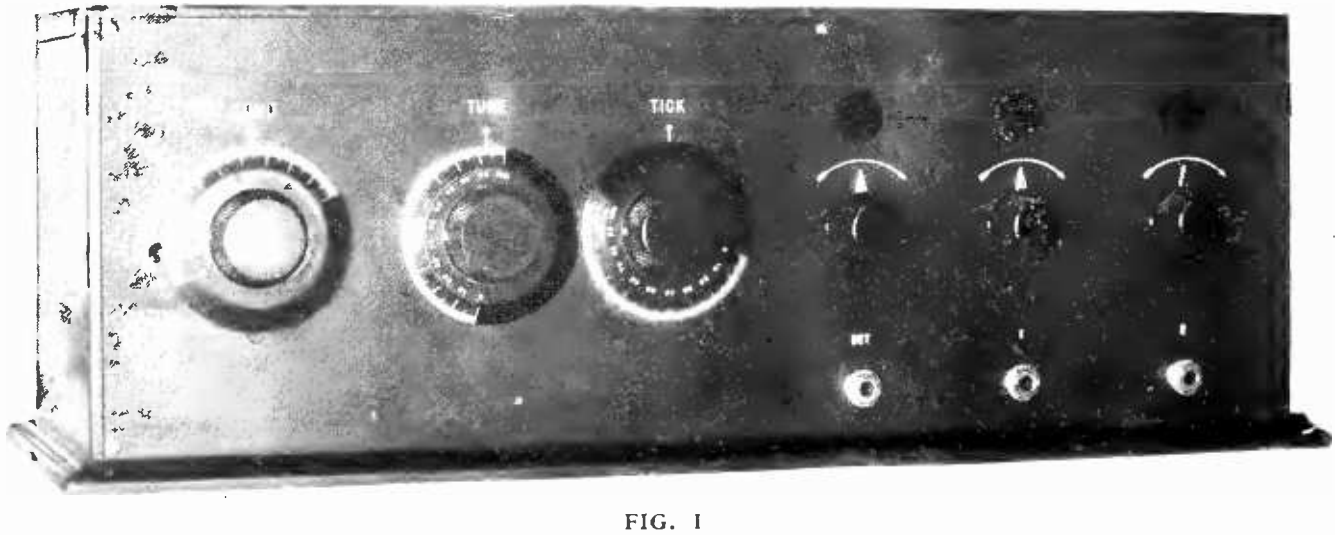


FIG. 1

This is the receiver built according to the author's plan. Everything but the antenna and ground leads and the loud speaker (or phones) is within the cabinet. This receiver is both attractive and practical

The prices given are approximate. If you want to shop around a bit, you can reduce them materially.

You will note that I specify two new tubes,

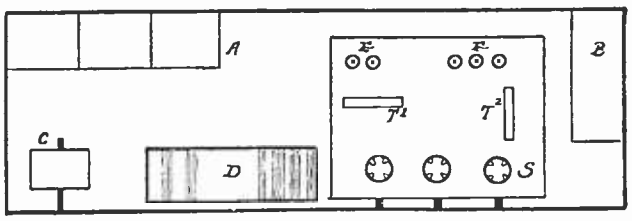


FIG. 2

There is plenty of room within the cabinet for the A and B batteries as well as the tuning and amplifying units. Note that the amplifying transformers are mounted at right angles to each other

assuming that you will use the one that you are using with your Senior, as I did. Three new sockets and rheostats are needed as the ones on the Senior will not be suitable for your new set. Choose dials and rheostats that match up and your new panel will present a neat, professional appearance.

I retained intact the Senior tuning element as I considered that the heart of the circuit, the only addition being the .0005 variable condenser in the antenna circuit instead of the fixed antenna condenser that is provided in the Senior. This gives considerably sharper tuning with better selectivity resulting. That's about all you can use of the Senior with the exception of the phone condenser and grid condenser and leak, but it is enough to form the basis of a very fine piece of apparatus.

I used De Forest transformers and find the results excellent, though that is a matter of personal choice. Nearly any of the standard, well made audio transformers may be used with the WD–11 tube.

Figure 1 shows the panel arrangement. The .0005 condenser is placed at the extreme left, next comes the dial for the main variometer, and next the tickler. You will note that this arrangement reverses that on the Senior. It is done simply by turning the entire tuning element upside down. This will make wiring somewhat easier and is a bit better when you come to tuning the set. To the right of the panel you see the three rheostat knobs with the three jacks underneath for plugging in on signals with either the detector alone or with one or two stages of amplification.

Figure 2 shows the interior arrangement of the parts. I have my three tube sockets, two transformers and all battery binding posts, mounted on a small hard rubber base panel to the right of the tuning elements. I had my cabinet made large enough to hold three standard dry cells, comprising my A battery and one 45-volt B battery, although I find somewhat louder signals may be had by using $67\frac{1}{2}$ or even 90 volts on the plates of the amplifying tubes, so I am using another 45-volt B battery for which there is not room within the cabinet. All connections are inside the cabinet with the

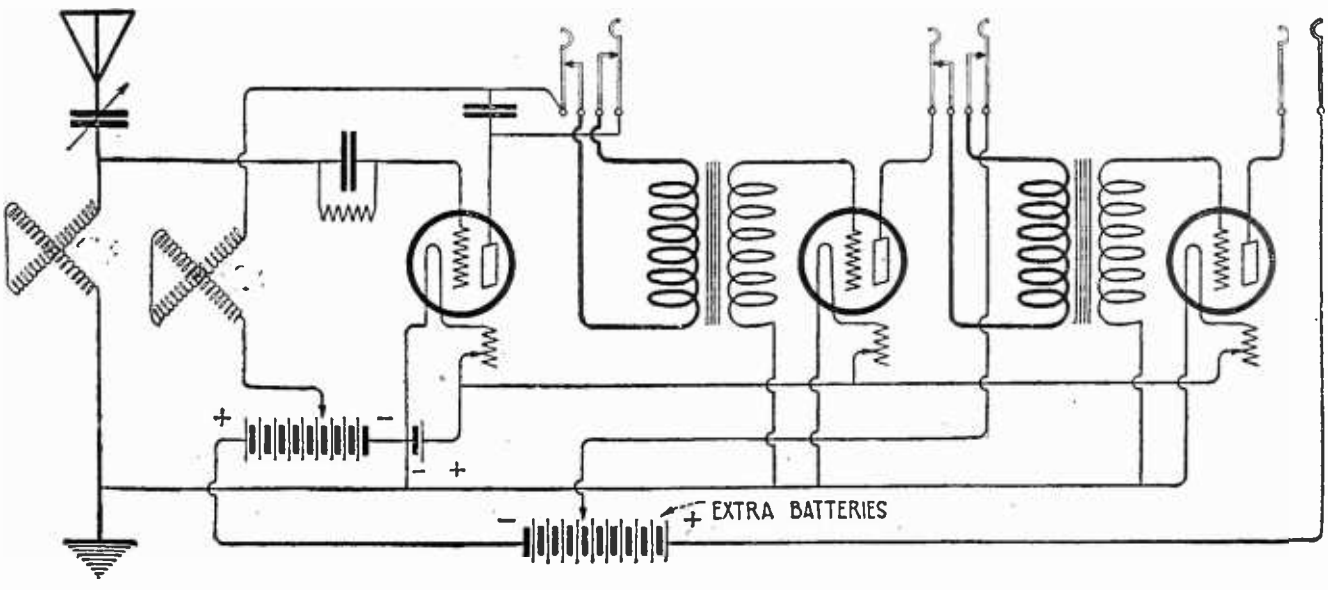


FIG. 3

The two variometers are included in the Aeriola Senior unit itself, and the addition of the variable condenser and amplifying units is clearly shown in this diagram

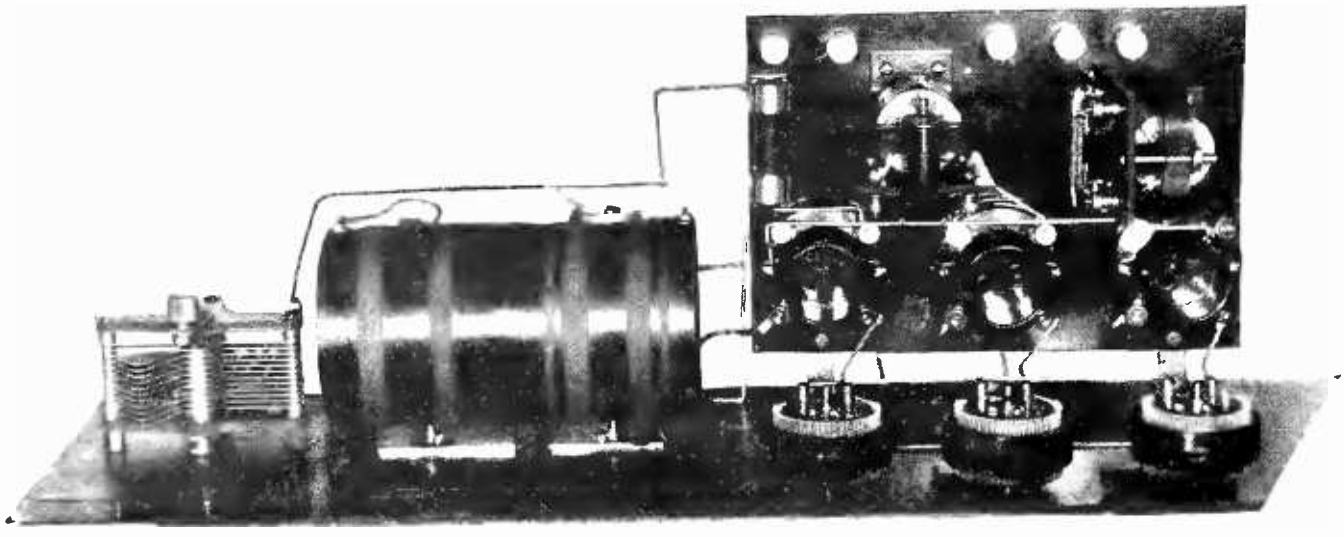


FIG. 4

Here we have the layout of the main and amplifier panels. Notice the shielding, made of sheet metal, on the main panel, and the sturdy brackets used to fasten the two panels together. All the binding posts are located on the amplifier panel

exception of this extra B battery and the silk-covered antenna lead and ground lead. The wiring diagram shown in Fig. 3, together with the panel and arrangement drawings, should enable any one to duplicate this set. So much for how it is done.

Now for what it will do. My outside antenna is a single wire 70 feet long on the top of a seven-story building with the lead-in to my room on the third floor. The ground connection is eight feet long to the cold-water pipe. I also use a loop aerial consisting of 15 turns of Litzendraht wire spaced $\frac{3}{4}''$ between turns on a two-foot loop. I have used a Dubilier socket as an aerial with excellent results.

I list, in the order of their importance to me, the set's various performances:

TONE QUALITY: Excellent, equal to the best phonograph I have ever heard.

SELECTIVITY: I have readily tuned in (from New York) KYW, WWJ, KDKA, and WGY, while either WJZ, WEAF, WHN, or WOR were going full blast.

VOLUME: Set can be heard all over our eight-room apartment. Local stations come in loud enough to work a non-power loud speaker, *using the loop*. This is one feature that appeals to me particularly, as the loop certainly tunes sharp and clean and when the summer season comes again should prove very useful in cutting down the static.

DX: My best distance so far is WBAP at Fort Worth, Tex., 1400 miles, air line. I can probably improve this as I continue to use the set, but do not expect any tremendous increase in range over the Senior. Only the first stage of the audio amplification will be of any value in reaching out after DX stations and this assistance will only be slight.

The advantages of the set are, that the simple tuning of the Senior is retained to a large degree, the added control of the variable condenser does not complicate tuning very much (after a few days you will hardly notice the change), you still have a portable set (no storage batteries), and you have fine tone and ample volume, fine selectivity and good range.

Just one little hint. I found after a few weeks' operation and experiment that a .0005 fixed condenser shunted across the secondary of the second transformer improved the tone quite a bit and did not cut down the volume noticeably.

I have purposely avoided laying down any hard and fast directions or instructions for the construction work. I am merely offering a suggestion of what can be done with an Aeriola Senior and am leaving details to each individual's ingenuity. The next person that attempts the same job will probably hit upon some little wrinkle or improvement that I did not discover.

What Can Be Patented?

By ROGER SHERMAN HOAR, A.B., M.A., LL.B.
Former Assistant Attorney General of Massachusetts

Drawings by THOMAS E. MONROE

NOT every bright idea is patentable, and not every patentable idea can be made use of by its originator. Without any further introduction, let us roll up our sleeves and plunge right into the following welter of words:

U. S. Revised Statutes, Title LX, Sec. 4886. Any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvements thereof not known or used by others in this country before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country before his invention or discovery thereof, or more than two years prior to his application, and not in public use or on sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law, and other due proceeding had, obtain a patent therefor.

That is a mouthful, to chew and digest! But the present chapter will undertake that task. Let us start with a few definitions.

An "art" means some distinct method or process. The word "machine" requires no defining. A "composition of matter" consists in the uniting of two or more ingredients, either chemically or physically, to produce a new and homogeneous mass. A "manufacture" is anything, made by man, which is not a machine, a composition of matter, or a design.

The invention must be new and useful. Novelty consists in the invention not having been used by others in the United States, or patented or described in any printed publication in this or any foreign country. Yet prior knowledge or use abroad, unknown to the inventor, does not prevent the invention from being "new," even if such foreign use was known in this country. This shows that, in spite of the language of the above-quoted statute, prior *knowledge* in this country does not prevent novelty; and we shall see later in this article that even prior *invention* in this country is not necessarily fatal.

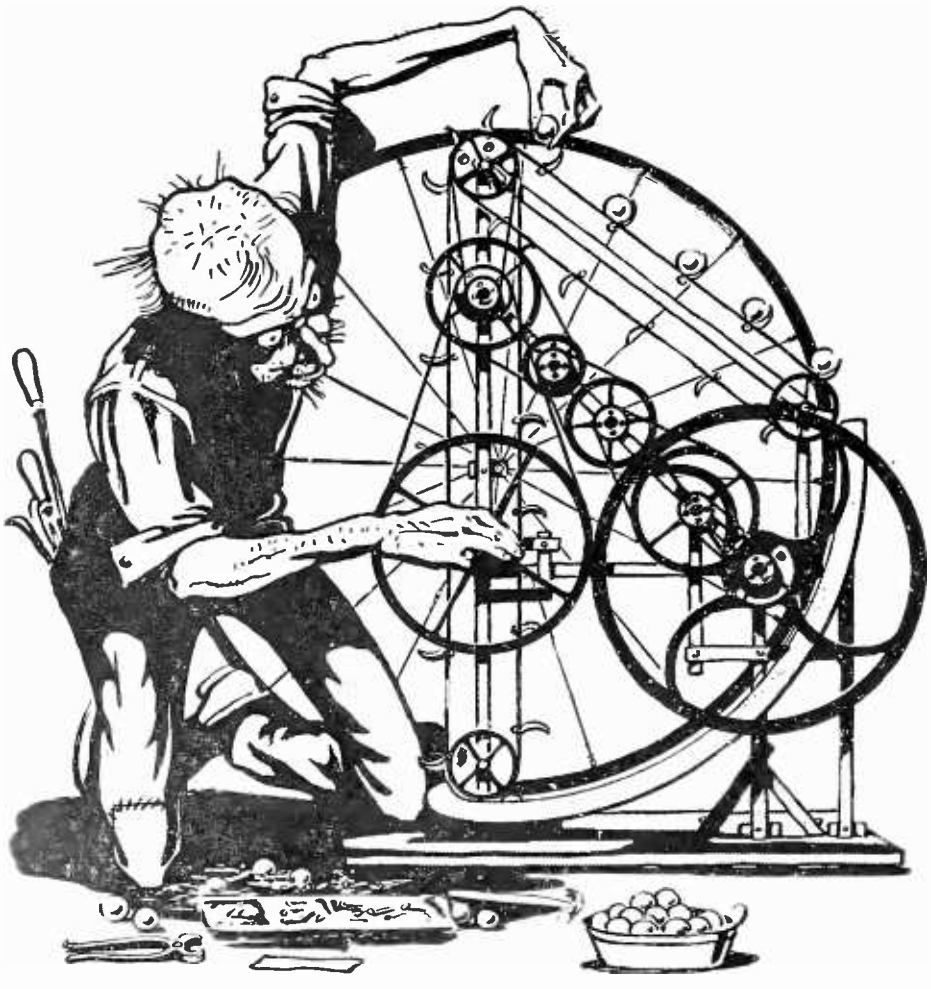
An invention is "useful," if operable, and if not frivolous, nor injurious to morals, health or good order.

The Patent Office has an interesting policy with respect to perpetual-motion machines, which of course are not operable, and hence are not useful, and hence are not patentable. Unfortunately it is impossible, by mere argument, to convince the inventor of perpetual motion that he is on the wrong track. So the Patent Office adds a little inducement to its argument, by sending a personal letter to the poor deluded scientist, offering him his choice of a rejection if he persists, or a return of his filing fee if he will be so good as to withdraw his application. This usually works.

Yet many ideas as weird and wild as perpetual motion are permitted to be patented. I know of one leading patent attorney who has a much-prized collection of some two hundred freak patents of this sort.

If you wish some light humorous reading, I suggest that you look at the *Official Gazette* of the Patent Office each week at your Public Library, or subscribe to it at five dollars a year from the Public Printer, Washington, D. C. In the first place, this magazine is, next to the *Congressional Record*, the leading funny-paper of America. In the second place, it will enable you to keep in touch with the progress which is being made in your own particular line. Some member of every engineering department should certainly be assigned the very entertaining job of reading the "O. G.," which very name is symbolic of the surprised joy he will experience.

But although the examiners of the Patent Office are too busy to head off the scores of absolutely absurd and unworkable devices which issue every year, yet they occasionally balance the record by rejecting some perfectly workable one. "If this be treason, make the most of it," as Patrick Henry once said. For example, a certain aiming device for big guns, which was developed during the late War, was thrice turned down by them with much sarcastic comment, in spite of the fact that it had been tested and approved by the



"INVENTION CONSISTS IN THE CONCEPTION OF A FUNCTION
And the selection of means whereby the function can be operatively carried out"

Coast Artillery Board, the Field Artillery Board, the Chief Orientation Officer of the A. E. F., etc., etc., and had won an official U. S. Army contest to determine the most accurate device of its class. Yet the patent examiners thrice ruled, in the face of this evidence, that this machine could not possibly work!

Reverting to the subject of patentability, we find that there is an important legal distinction between "combinations" (which are patentable) and "aggregations" (which are not). Suppose your invention consists in putting together two or three already-known elements. The mere combining of old machine parts, each operating in the old way, and accomplishing the old result, is an aggregation, and hence unpatentable; whereas, if a new result be produced by the joint action of the elements, and if such result be not the mere adding together of the contributions of the separate elements, then there exists a patentable combination. Ask yourself: Is the function of the whole equal to, or greater than, the sum of the functions of the parts? If equal to, then we have mere aggregation. If greater than, then we have combination. In other words, a patentable combination violates that fundamental axiom of geometry: "The whole is equal to the sum of its parts."

Furthermore, a mere idea is not patentable; there must also be the means for utilizing it practically. Newly discovered laws of nature are not patentable; invention consists, not in discovering them, but rather in applying them to useful objects. A good definition from a very recent court decision is: "Invention consists in the conception of a function, and the selection of means whereby the function can be operatively carried out."

Novelty and utility alone are not enough to make an idea patentable, but there must also be invention. That is to say, the inventor must have displayed more ingenuity than could be expected of the average skilled person, when confronted with the same situation. It is not necessary, however, for the inventor to understand *why* his device works, provided he understands and explains *how* it works.

Mere simplicity of the device does not negative invention; but rather is often evidence of the very highest inventive genius. On the other hand, mere complexity or multiplicity of parts is no proof of invention. Redhoeffer's famous perpetual-motion machine attracted no popular attention until he added a lot of gears and buzzing ratchets, when it at once became a nine-day wonder; but all this noisy machinery didn't get him anywhere with the Patent Office. A certain gear company has an advertising machine consisting of about a thousand of their products, all intermeshing and actually running; certainly ingenious, and involving great mechanical skill, but by no means patentable.

A few further sorts of improvements which

are not patentable are: superior form or finish; a more extended application of an old idea; enlarging or strengthening; changing proportions; duplication of parts; changing the location of parts; substitution of equivalent materials; or substituting, for some part, a mechanical equivalent which performs the same functions in substantially the same way, thereby accomplishing substantially the same result. Mechanical devices are "equivalents" when any skilled and experienced workman would know that they would produce the same results.

The omission of a part and of its function is not invention; but the omission of a part, with a rearrangement of the remaining parts, so as to perform the same results, *is* invention. So likewise is the substitution of a single part to perform the functions of two or more former parts.

The best way to determine the patentability of your invention is to have some attorney make a search of the prior art in the files of the Patent Office at Washington. This will cost you at least twenty or thirty dollars, but any search costing less than this will not be worth even what you pay for it.

Thus it will be just as cheap for you to prepare a regular patent application and file it with a twenty-dollar fee, and then let the Patent Office make your search for you. If the search shows that your invention has been anticipated, it will have cost you no more than a search made by an attorney. If, however, the result of the search is favorable, your patent will already be on its way to allowance without further expense.

But, before doing even this, you can easily make a *sort* of search, which may be productive of great results at practically no cost. Copy the patent dates from a few machines of your own class. Look up the inventor's name and patent number under these dates in the bound volumes of the *Official Gazette* in the Public Library. If any of these inventions are at all like yours, send ten cents apiece, with the name, date and number, to Mentzel & Sterzer, 919 Washington Loan & Trust Bldg., Washington, D. C., requesting copies of these patents, and a list of the patents which were cited against each, while pending. Enclose an extra dollar per patent, for this latter information. When they reply, send ten cents apiece for copies of the citations, etc., until finally you will have collected, at nominal cost, enough prior art to show you just where you stand. I always use this method.

You will save a lot of bother by using government coupons to order your copies. Such coupons can be purchased of the Patent Office in books of twenty for $2.00, or one hundred for $10.00.

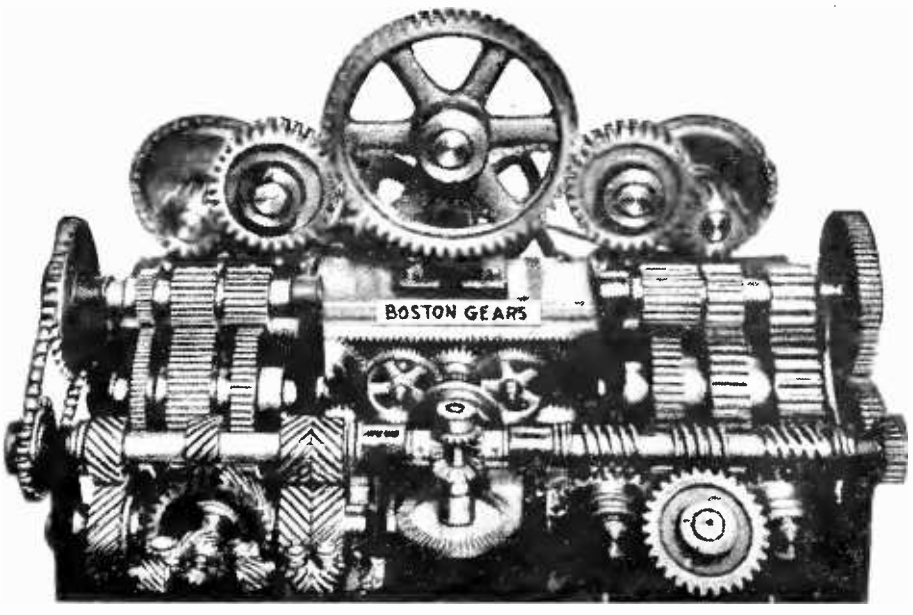
Let us now consider how an invention can lapse. An inventor forfeits his invention by two years' public use or sale in America (by himself or others) prior to his applying for a patent; or by abandonment.

A single public use is sufficient. The knowledge or consent of the inventor is immaterial. But mere experimental use, even if public, is not a bar; and the Courts are very liberal in construing a use to be experimental.

A single sale is sufficient. Merely placing on sale the completed machine is sufficient, even if no sales result. But it is allowable to sell a very expensive *experimental* machine, without this barring your patent.

An inventor can likewise forfeit his invention by abandonment, as will be described in the next article.

Reverting to the language of the statute, you



INGENIOUS, BUT NOT PATENTABLE

A collection of various kinds of products manufactured by a gear company. The gears actually run, but the machine serves no useful purpose

EVEN IF NO SALES RESULT
An inventor forfeits his invention by placing on sale his completed machine for two years prior to his applying for a patent

will see that only the inventor or discoverer is entitled to a patent in the United States. The manufacturer or first importer cannot get a patent here, although a different rule prevails in some foreign countries.

You will also see that the invention must not have been previously known or used by others. This amounts to the same thing as the statement to which the inventor must subscribe in his official oath: namely, that he is the original and sole inventor. Just what do these words mean? Strange as it may seem, they have two entirely distinct meanings, according as to whether the *real* first inventor does, or does not, apply for a patent. This is a vital distinction, and may well be the determining factor in deciding whether or not to apply for a patent.

Let me illustrate this point by the imaginary case of a certain type of desk invented by Smith. Suppose that Robinson, several months later than Smith, independently conceives of exactly the same invention.

Case 1. Suppose that both Smith and Robinson apply for patents. An interference is declared in the Patent Office, and each is required to produce evidence as to the date of conception of his invention, and the dates of such subsequent acts as have been performed by him in completing, adapting, and perfecting it, and in putting it into use. Such dates usually include the dates of (a) conception, (b) first drawing, (c) first written description, (d) first disclosure to others, (e) first full-size machine, (f) first successful operation, and (g) first sale; also the extent of use. But, although the date of conception is the really important thing, it is very hard to prove a conception earlier than the date of first disclosure. Furthermore, the conception, drawing, description, and even disclosure are of no avail unless the invention was diligently reduced to practice, i. e., either built or embodied in a patent application. Reduction to practice will be discussed more at length in the next article.

Case 2. Suppose Robinson, the later inventor, applies for, and secures, a patent. Smith tries to manufacture. Robinson sues Smith for infringement. Smith defends on the ground that Robinson was not the original and first inventor, a defense specifically allowed by statute. But the Courts have cut down this defense by limiting the admissible evidence. Thus Smith must prove an actual successful use of the machine, or a sale or full published description, prior to Robinson's mere conception. Even proof of models and unpublished drawings will be of no avail to Smith.

Both cases show the importance of the real first inventor speedily applying for a patent, if he wishes to retain the right to manufacture his own device.

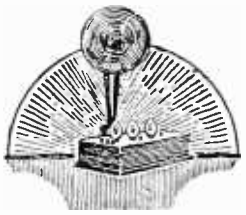
Let us now consider the perplexing question of joint inventors. If several persons work together devising a new piece of apparatus, which of them should be included in the application for a patent? This is not a mere formal question, but is very important, for a patent issued to two parties is invalid if one of them is the sole inventor, and a patent issued to only one of two joint inventors is likewise void.

This is particularly important in interferences where the true facts are almost certain to be brought out in the course of proving the date of invention. It is impossible either to add or to strike out an inventor by amendment; and so, because of including too many or too few names, the application is apt to be disregarded, and priority awarded to inventors who, although later, have nevertheless been more careful in this particular.

Above all, do not include the name of your

chief engineer, out of mere courtesy, as a joint-inventor, nor the name of your draughtsman or mechanic. I have known patents to be declared void for each of these causes.

If different improvements on the same machine are invented by each of several inventors separately without consultation with the other, then each must patent his own contribution separately. But mutual suggestions and improvements constitute a joint invention, even if the contribution made by each is distinct and separate.



Thus when a claim covers a series of steps or a number of elements in a combination, the invention may be joint, even if some of the steps or elements were contributed by one inventor alone.

On the other hand, the suggestion of some features by another than the patentee will not invalidate the patent, if the final result represents the patentee's own combination of these suggestions with ideas of his own.

In view of this, it may be desirable to patent a device in the name of the last contributor; and this is perfectly allowable if the device with his last contribution would be patentable as an improvement over the device as it stood just before this contribution.

Lack of mechanical skill, and the consequent employment of another to work out the details of your invention, do not prevent you from being the sole inventor.

In the absence of an express agreement between the joint owners of a patent, either of the owners can make, use, and sell the invention, or grant to others the right to do so, without regard to the proportionate interest which the parties may own, and without liability to his co-owners to share his profits with them.

As between patent attorney and client, any suggestions of the attorney inure to the benefit of the client. In a recent case the lawyer claimed to have made a certain invention before his client came to him with the same idea; but the Court awarded the patent to the client. This illustrates the need of care in choosing an honest lawyer, a point which will be further discussed in the fourth article.

In the absence of an express agreement, an employer has no right to the inventions of an employee, even though the device was built, tested, and patented at the employer's expense, and even though the employee was hired expressly to invent, in which latter case, however, the Company would have an implied license to make, use, and sell devices embodying the inventions. And in any event, if the invention was applicable to the employer's business, he would have a right to use the device in his own shops.

Accordingly it is customary for employers to insist that technical employees shall agree in writing to assign all inventions made during their employment; and such agreements have always been sustained by the Courts.

An agreement to assign *all* future inventions, is void; but, with a time limit or even a limit to a certain class of inventions, it is perfectly valid. Yet everyone will tell you that there must be a time limit too, even in the latter case.

In my old home town, the noble redskins frequently sell a piece of land and still think that they own it. This results in the same piece of land being sold several times in succession. and yet still being claimed by its original Indian owner, to the great joy of some local lawyer. Hence the expression "Indian Giver." Somewhat the same idea frequently prevails among inventors, so let me state in closing that, if you sell a patent, it is *gone*, and even *you* can't manufacture your own device any more.

This is the second of a series of four articles dealing with patents. The first, "What Good is a Patent?" appeared last month, and Mr. Hoar's third article, entitled "Protecting Your Invention," will be published in RADIO BROADCAST *for June.*—THE EDITOR.

LISTENING TO A BROADCASTING PROGRAM—
This is said to be the first hotel in America to equip its—
guests may listen when they wish to, but are not disturbed—

—AT THE HOTEL BELLEVUE, SAN FRANCISCO
—dining-room with radio. By using individual phones, the
—by a loud speaker when they prefer to talk—or eat!

A Radio Code With Eleven Million Variations

By S. R. WINTERS

WHEN the battleship fleets of the Atlantic and Pacific engaged in maneuvers in the vicinity of the Panama Canal, in March, there was in operation for the first time under service conditions an apparatus for transmitting radiotelegraph messages in a code capable of 11,881,376 variations. The invention, the work of Edward H. Hebern of Oakland, California, is said to be the only one in the world by which wireless communications can be sent by a code system that is automatically deciphered and is clothed in absolute secrecy. A reward of $5,000, offered to the Department of Justice many months ago, contingent upon its ability to decipher a message thus transmitted, has not been redeemed.

This machine, for which more than seventy patents have been issued or are pending in all countries of the world, functions in conjunction with a small, changeable wheel known as the "key wheel" or "code wheel." A statistical wizard in California has computed the possible changes to which one code wheel is subject as approaching the staggering figures—40,303,146,321,064,147,046,400,000. Be that as it may, this tiny wheel, weighing barely twelve ounces, contains a multiplicity of abbreviated electric wires—twenty-six, to be exact. In either side of this wheel are also twenty-six apertures, with an equal number in the rim.

Each key on the typewriter-like keyboard is wired in combination with other letters and they are responsive to a slight pressure of any of the letter keys, each of the latter being energized by an electro-magnet. The entire apparatus is electrically operated, the arrangement of the complicated wiring containing the secret of the instrument. A dry battery, half the size of one's hand, is sufficient to operate the machine for about two hours. The model on demonstration in Washington, D. C., employs a No. 750 Tungsten battery. As a matter of fact, any source of electricity is capable of operating this mechanism—a six-volt automobile battery, dry cells, or direct or alternating current from a 110-volt home or office circuit. The standard code machine, however, is equipped for operation with alternating current, contact being made with a 110-volt circuit, which is "stepped down" to twenty volts by a transformer within the stand of the apparatus. If direct current is to be used, a special transformer is supplied for reducing the strength of the electric energy.

The operator who desires to transmit wireless messages according to this code system writes what he has to say in plain English on the keyboard. The code wheel on the sending device transforms the words into a jumble of letters, so to speak, for conveyance through the ether by radio. Both the sending and receiving units of this machine are combined, the entire outfit weighing barely twenty-five pounds and being less bulky than a typewriter.

The unit for the reception of the radiotelegraph communications records the words in code just as they were sent. However, the message is mechanically decoded before it is actually put down on paper by the receiving operator, who manipulates a keyboard according to the letters spelled out on an electrically-illuminated alphabet-board identical in arrangement with his keyboard. For the sake of convenience in transmission and as an extra precaution for insuring secrecy, the sending mechanism automatically prints the code in groups of five letters, and the decoding unit, at the wireless receiving station, converts these five-letter groups back into understandable English words.

The operator of the code receiving unit maintains on a rack in front of him a number of these spools or code wheels which correspond in wiring to similar wheels at the transmitting point. The operator who is to decode the message needs to know on which key letter the opposite wheel was set in order that he may set his wheel at the same key letter to start decoding. This is necessary since a wheel set at any one of the twenty-six key letters causes

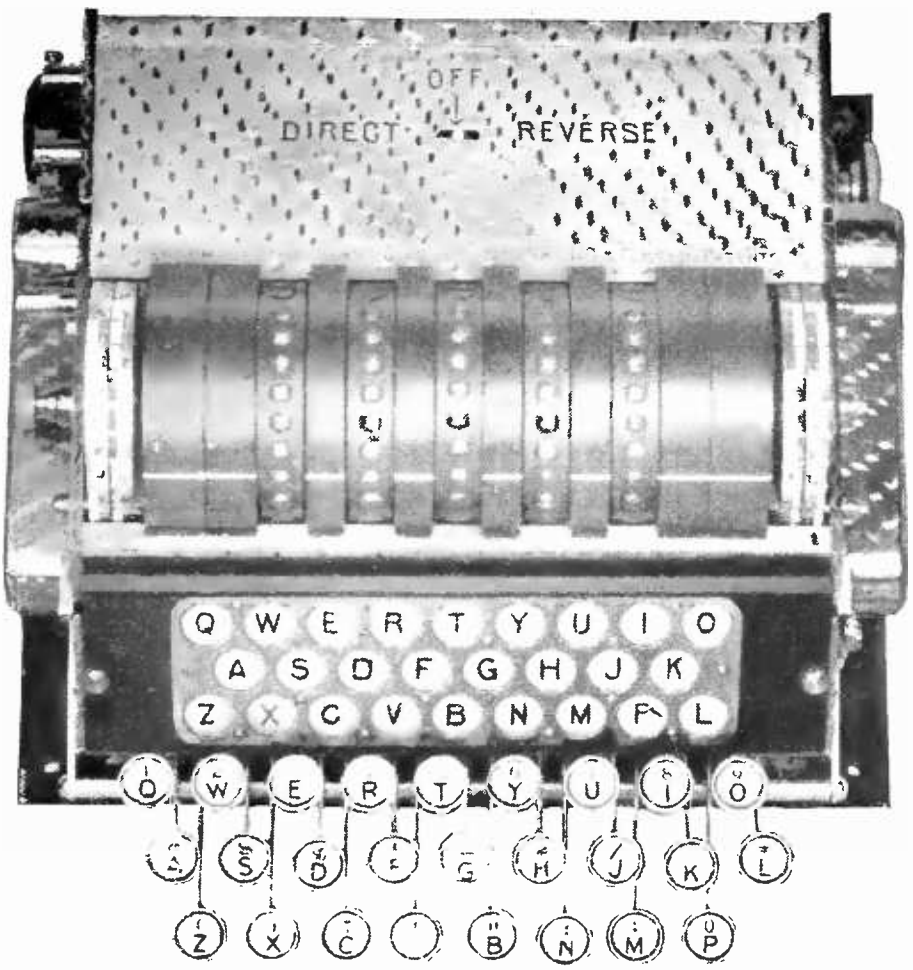
the machine to write an entirely different code. Therefore, it is important either to print the key letter on which a code wheel starts coding as the first letter of the message, or to have it understood in advance what key letter will be used. Differently expressed, letters common to two wheels are first sent, which affords a "key" to the receiving operator to insert into his machine the similarly electrically-wired code wheel from his rack. That is, only two wheels that have electric wiring in common will function together.

The so-called "Hebern Electric-Super Code," to quote the inventor, "is merely the application of the electric current in certain combinations, which causes the machine at the receiving end to reproduce in understandable words an apparently meaningless, yet systematic, jumble of words sent out by the operator of the sending machine. Neither the sending nor the receiving operator knows the letters that are going through the air; that is the secret of the machine, or rather the secret of the two little, electrically synchronized wheels, a dozen of which can be carried in a man's coat pocket. The machine without the wheel is useless; the wheel without the machine is nothing but a little metal bobbin.

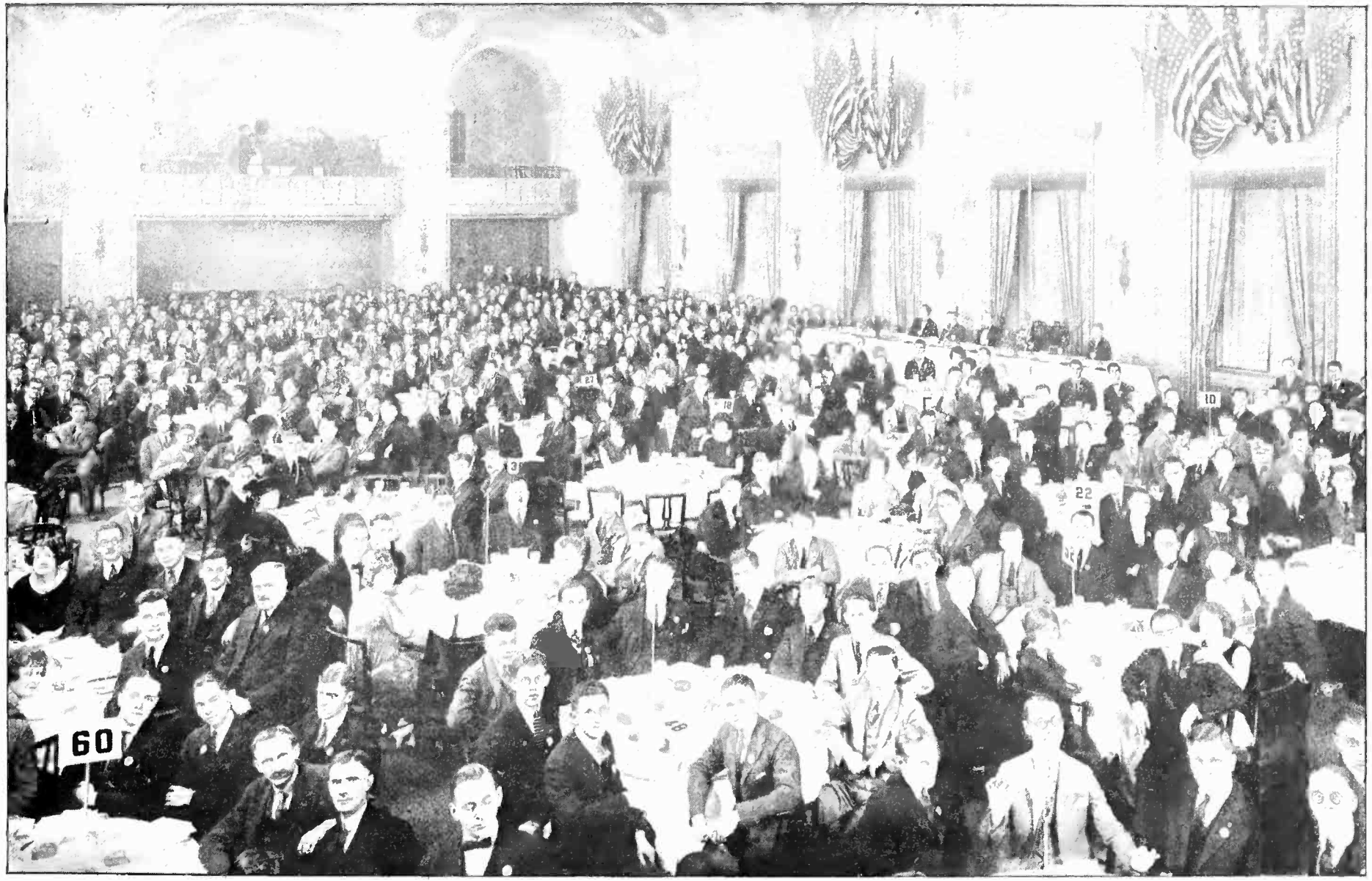
"To solve any one message sent out between any two of these machines and plucked from the air by wireless instruments, would require exactly 11,881,376 experiments, and it would require all the time of a staff of code experts for 100 years to make these experiments."

The "Hebern Electric-Super Code" is built in two units, one design being applicable to the service of the United States Government in times of war or peace, and the other provided with a typewriter and adaptable to commercial purposes. It is understood that the inventor will not sell these machines, but will lease them to interested parties. The machine is only about 8 by 10 inches in dimensions and may be carried from place to place in a small case.

The protection of documents issued by banks, such as travelers' checks, drafts, cashiers' checks; the transmission of important business papers between banks or other commercial firms, and as a means of preventing forgery, are among the suggestions advanced for the application of this wonder-working mechanism to peace times. Somebody has stated that code messages sent during the Civil War have not yet been deciphered. Even as late as the World War the imperfection of code systems was realized when during the naval engagement off Jutland the code system was abandoned after a trial of one hour and messages received during that brief sixty minutes were not deciphered for days thereafter. The use of radio and the invention here described may solve the problem of the United States in the event of future wars, when a secret and yet readily understandable code system is a pressing need.



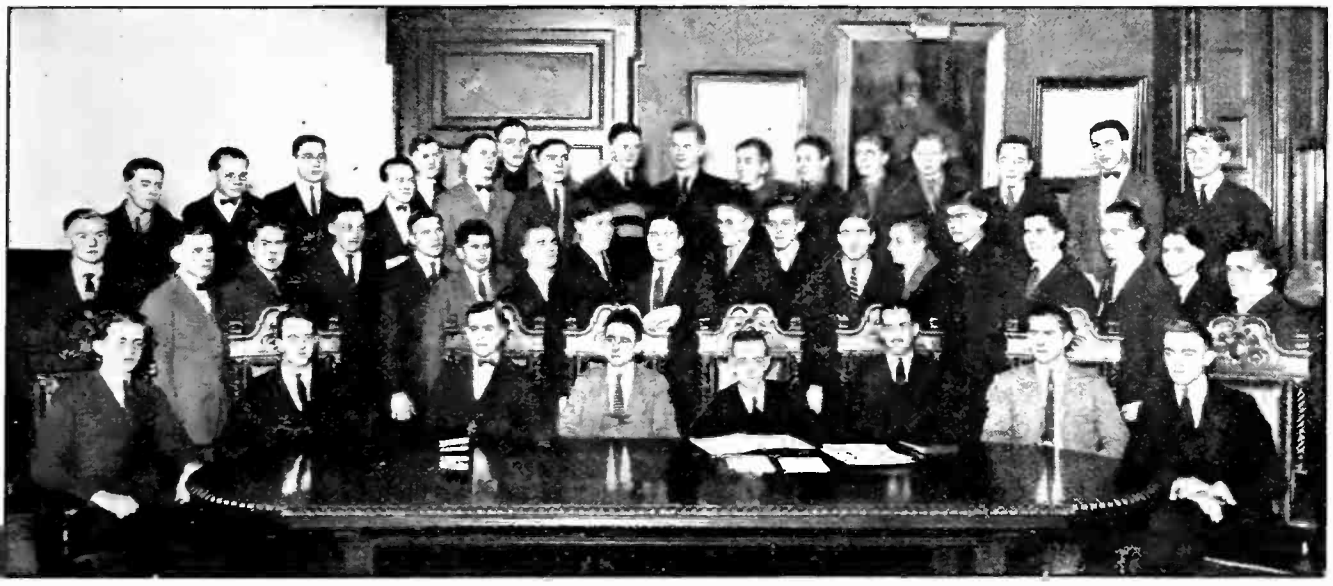
THE HEBERN ELECTRIC-SUPER CODE MACHINE



THE 2ND DISTRICT AMATEURS' 1923 BANQUET AT THE HOTEL PENNSYLVANIA, NEW YORK CITY

Among the notables from "Hamdom" were Hiram Percy Maxim, Paul F. Godley, K. B. Warner and many of the amateurs whose signals had been received in Europe. Two of them had accomplished this feat with ten-watt transmitters

Among the "Hams"



OFFICERS AND MEMBERS OF THE MILWAUKEE AMATEURS' RADIO CLUB

Beer may have put Milwaukee on the map, but this organization is doing its best to keep it there. Founded in 1917, the Club has had a steady growth, and its "ham-fest", technical lectures, spirited debates, and operating activities have evidenced a high degree of interest and enthusiasm among the forty-odd members, Meetings are held weekly, at which visitors and prospective members are welcome, and the Club is always ready to help the newcomer by teaching him the code and enlarging his acquaintance among radio amateurs

AMATEURS TAKING THE CODE TEST AT THE HOTEL PENNSYLVANIA, NEW YORK

This receiving contest, held to determine the fastest operator in the Second District, is an important feature at each annual convention

All Boy Scouts, Attention!

RADIO BROADCAST announces a contest, starting now and ending July 31, 1923, to determine WHAT BOY SCOUT TROOP HAS DONE OR IS DOING THE MOST WITH RADIO.

Prizes for Winning Articles

FIRST PRIZE: CROSLEY MODEL X 4-TUBE RECEIVER.

This receiver, which may be used with dry-cell tubes if desired, consists of detector, one stage of tuned radio-frequency and two stages of audio-frequency amplification. (Advertised in RADIO BROADCAST).

SECOND PRIZE: MUSIC MASTER LOUD SPEAKER.

This is the new loud speaker, made by the General Radio Corporation. (A picture and description of it appear in the advertising pages of RADIO BROADCAST).

THIRD PRIZE: THREE WD-11 VACUUM TUBES.

The WD-11 is the well-known dry-cell tube manufactured for the Radio Corporation. (Filament voltage 1.5, plate voltage 22½—45).

A YEAR'S SUBSCRIPTION TO "RADIO BROADCAST" will be given as prizes for the ten next best contributions in this contest.

These prizes will be awarded to troops, not to individuals, although any troop may delegate one of its members to prepare the story.

Rules of the Contest

1. *Articles must be true accounts of radio with relation to your particular troop: what you have done, or are doing, or both.*
2. *Every article must be written by a Scout or by more than one Scout belonging to one troop.*
3. *Articles should be between 500 and 1000 words long.*
4. *Good photographs to illustrate the article will count 50% in judging contributions.*
5. *Typewritten manuscript, double-spaced, is desired, though not required.*
6. *Address contributions to Scout Contest, Radio Broadcast, Doubleday, Page & Company, Garden City, N.Y.*

Scouts have done splendid work in maintaining communication by radio in time of floods and disaster, in copying and spreading the market reports transmitted by the government Farm Bureaus, in training themselves along mechanical and electrical lines, and, in short, in using radio as a part of scout work in a way consistent with the best traditions of scouting. What have you to tell of your troop's past or present activities? Get your scribes and photographers under way with that story which will put in a strong bid for first prize. How would a receiver with three stages of amplification go in your troop?

Beginning with the July number of RADIO BROADCAST, *the best articles will be published. The winners will be announced in the September number, and unless the three best articles have been previously published, they will appear in that issue.*

Wanted—Information on Railroad Radio

The Committee on Application of Radio to Moving Trains of the Association of Railway Electrical Engineers desires to communicate with any one who can give information regarding actual experiments in radio reception or transmission to or from a moving train.

Kindly communicate with the Chairman of the Committee,

Mr. P. S. Westcott,
Assistant Car-Lighting Engineer,
Chicago, Milwaukee & St. Paul Ry. Company,
West Milwaukee Shops, Milwaukee, Wisconsin

Why Life is Interesting to a Commercial Operator

Amusement, Experience and Education Come in Daily Doses to the Sea-Going Radioist, as this True Story of Three Trips on a Passenger Vessel Discloses

By A. HENRY

CAN you imagine being eighteen years old and having sailed as Chief Radio Operator and sending out an SOS and being rescued and written up in your home-town paper without noticing that the size of your hat was entirely too small? If you can't you will never appreciate my feelings for the week following my return from my first trip to sea. If, on the other hand, you can imagine the self-sufficiency such a series of events is likely to leave in their wake, you can understand my air castles.

And what is more, my pockets were well lined with real shekels and it was anything but difficult to engage the company of ladies fair, who, but a short month before would have refused my invitations with alacrity if not disdain. Few among them can resist the possibilities of association with a front page head-liner. Probably because news in our town was scarce at the time, much space was devoted to somewhat extravagant stories of my heroic deeds upon the sea. Because there was really nothing much for me to tell reporters, they spun great yarns about modesty in the usual way. But, you may wonder why you are told of these very natural and uninteresting details, and my only excuse is that I would like you to have some faint idea of my feelings upon being called upon the carpet in the holy of holies over which the Superintendent presided. You see, a week of pampering had almost completely altered my viewpoint of life and the satisfaction of being the centre of attraction in a small town was an entirely new and not unpleasant sensation.

I was waiting in the "static room", which, a few years ago, was the ante-chamber to the offices of the Marconi Wireless Telegraph Company of America, where incoming and outgoing radio men gathered and swapped stories of true and imaginary escapades in foreign lands, while waiting a summons to appear before the Superintendent for assignment, re-assignment, or—the "gate." Just above the door leading into that gentleman's private office a buzzer hung from a screw, and it was connected by a wire system running into the "Super's" office, the repair department and the radio instructor's office. The gentry in charge of affairs found this means of communicating between their offices quite valuable; and the buzzer also served to call the desired operators to the desk of the "Super."

Even the older operators who gathered in this ante-chamber had accepted me into their midst, for in order to impress them, I had told a rather laudatory story of my shipwreck experience in a casual manner designed to conceal the exaggeration. As one operator who had just returned from Yucatan and Vera Cruz on the *Esperanza* of the Ward Line, finished a tale concerning the embarrassing situations he encountered in attempting a courtship with a lady whose language he could not savvy and the mirth of his auditors was reaching a climax, the buzzer above the door grunted the symbols which spelled my name and with a

Life on the Ocean Wave

This is the third of a series of articles dealing with Radio Operating As a Career. The first article of the series appeared in our March number.

These stories are true and are actually chapters from the life of the author himself, who has been through the mill.

Next month, Mr. Henry is going to tell of his experiences on a private yacht which kept him in Mexico for five months. Among other interesting incidents he describes an attack upon the yacht by Mexicans, who attempted to put the radio equipment out of business by doing away with the operator.—THE EDITOR.

knowing wink I left the group and went into the office.

On reaching a point just in front of the boss's desk, I stopped and maintained a respectful silence until he had finished the very serious and laborious task of affixing his signature to a letter. Without looking up he proceeded to talk to me and read over another letter simultaneously. At least here was a man who was not very much concerned with my heroic exploit of a few weeks ago, and if his attitude was a little disconcerting, his remarks were even more so.

"Henry," he said, "you are to be promoted—". Following a slight pause, he looked up and a partial smile crossed his face, but he became serious and most matter-of-fact as he proceeded. "Yes, we're satisfied with your work and I'm going to assign you to a passenger vessel. You are to sail the day after to-morrow at three. Here's your assignment."

I was greatly pleased and said so and was about to withdraw when he cleared his throat and, after a certain amount of hemming and hawing, told me that my promotion was from a tug to a passenger vessel but my short time in the company's service did not warrant an increase in salary. Further explanation disclosed the fact that my youth would not permit my assignment as chief operator, but my salary would stand without reduction despite my sailing as junior. By the time he had finished I knew that he had outgeneralled me in a very thorough manner and I made a rather embarrassed departure. Since then I have often wondered why that suave gentleman wasted his time in a position such as his, when he could have made a fortune selling oil stock or gold bricks.

At any rate I was assigned to one of the Clyde Line steamers which plied between New York, Charleston, S. C., and Jacksonville, Fla. The day before we sailed I took my bags over, handed my assignment to the Chief Officer because the Captain was not aboard, and met the chief operator. He seemed a good sort but he was one of those uncommunicative fellows who mind their own business and show no desire to have any but strictly business relations with subordinates. He proved to be a very reasonable and just fellow—but he gave me a pain. We shared an inside room in the after section of the saloon deck just above the propeller and hard by the men's wash-room. Steamship companies are always very solicitous for the comfort of the radio men that way. They know that the vibration is a sleep producer and that it is very interesting and entertaining on rough nights to hear the slamming of the wash-room door as landlubbers rush from their bunks in a never ending procession.

The radio shack was on the promenade deck just abaft the main stack and directly above the galley. We never suffered from the cold, especially when we got below Hatteras and the tropical calms settled upon us. We were saved the anxiety caused by not knowing what to expect on the menu, for the appetizing aroma of onion soup and similar delicacies was ever present in our little cabin.

Radio shacks are not large as a rule—ours was particularly small and must have been laid out by a past master at space conservation. There was a place for everything and one thing out of its place crowded the room beyond comprehension.

In addition to the radio equipment there was a typewriter and a multigraphing machine, used to prepare the radio news section of the little magazine we sold each day. And my chief, who happened to be a camera fiend, had a goodly store of film, printing paper, various chemicals in powder and liquid form, a red lantern and the usual coterie of trays, paper clips, etc. There was hardly room for us to sit down in comfort. There was no room at all for the radio equipment I brought along, so I made no reference to it, although I knew it would have improved the outfit greatly.

On sailing day I found a vantage point in the vicinity of the gang-plank and was agreeably surprised to note the number of attractive young ladies who made their way aboard. A feeling of superiority pervaded me and I paced the deck like a pouter pigeon, in an effort to engage the attention of some of the attractive maidens, but none of them seemed to heed me in the least, for how were they to know that I held the important post of Junior Radio Officer? I had no uniform and must have appeared to be one of those individuals who imagines that he is entirely sea-broken after a ferryboat ride or a sail in some yacht belonging to a friend twice removed.

Some of the ladies strolled about the deck and I went into the radio shack and acted as I

thought a sophisticated operator would act. For the benefit of several gentlemen who made it their business to stop at my door and ask questions, I unsheathed a bundle of technical terms, designed to fill them with awe, but when one of the group asked some questions that indicated quite plainly that his knowledge of radio was greater than my own, I recalled an important engagement elsewhere and closed shop to visit our sleeping quarters.

HARDLY IN KEEPING WITH MY AUGUST POSITION AS RADIO OFFICER
Was my job of hawking the magazines we printed, at a dime a copy

Here I found my chief laying out his uniform on my bunk and making ready to try a little slumber in his own. Assured that he would not bother me for a while I made my way back to the operating room, swung the door wide open, removed my coat and started the motor-generator. Its hum attracted a few people, so I disconnected the aerial lead and began manipulating the key while the heavy spark boomed in its chamber. A crowd soon gathered outside the door, though I pretended to pay no attention. I made various adjustments and exercised all the meters, shut down the set and turned around to answer any questions which might be forthcoming.

A young lady, evidently with her mother, beamed upon me and asked about the wonders of wireless. She was most attractive and we chatted for some time and became quite friendly, though we had not reached the point where an exchange of names takes place. Here, indeed, was a stroke of rare luck. I made use of every device I could recall learning from the old-timers in the static room and my progress was so satisfactory that I was wondering how best to invite her to visit the shack occasionally on the trip south.

Suddenly there was a blood-curdling racket on the deck and it seemed to be coming in our direction. A colored porter bawled "All Ashore's Goin' Ashore" and accompanied himself by lambasting a metal tom-tom. My visitors dispersed and the attractive young lady thanked me for my kindness and departed. I took a position near the gang-plank and by the time that porter finished his parade most of the attractive ladies had made their way down the gang-plank and were waving tear-bedewed handkerchiefs to departing mothers, fathers, etc. Most of those remaining aboard seemed to be possessed of husbands and as we pulled out into the stream I resigned myself to my work and tried to forget the alluring possibilities of feminine companionship which had loomed up during the past hour.

As we left the dock I reported to the Sea Gate Station and was advised that there were no messages on hand for me, so I strolled around the deck a few times, stopping here and there to have a chat with the passengers. A group of young folks attracted my attention and I spent some little while discussing all manner of important events such as the time made in races at a college athletic meet and the possibility of bad weather after passing Scotland Lightship.

We sailed at three and it was not long before dinner time rolled around. My chief relieved me and I found my way into the main dining saloon, where some of the passengers had already gathered, and a rattle of dishes in the pantry proclaimed that service had started. A Negro

THE RADIO MAN'S DINNER TABLE IS LIKELY TO BE GRACED BY A COSMOPOLITAN GROUP
Consisting of a spoiled society bud, the heavily bejeweled wife of a newly 'arrived" pawn-broker, an English remittance man, and a lady who is "well-known in society." Often the peace of mind of everyone present is upset by the ill-bred youngster whose mother is more attentive to the men aboard than to her child

waiter whose smile disclosed two lines of ivory and gold ushered me to a seat, which was reserved for me. It was at a table some little distance from the Captain's, so I felt quite at home.

It is unlikely that any place in the world, even a railroad station, permits the study of so many different kinds of people as a steamship. One finds gentlemen who can eat peas only if served with mashed potatoes and who imagine that their discourses upon the latest scientific discoveries are amazingly interesting to their co-voyagers. One is likely as not to find at his table the wife of a newly "arrived" pawnbroker, heavily bejewelled and master of gestures accompanied by knife and fork; an English "remittance man" on his way to parts unknown; a society matron, whose dwindling fortune makes it increasingly difficult for her to keep up the pace her position demands, while very much in evidence is one of those ill-bred youngsters who delights in spilling soup without regard to the direction it takes by yanking the table-cloth in a hair-raising fashion.

Following the evening meal among just such company I was to relieve my chief while he ate his dinner and, following that, I would retire until *one o'clock* the next morning. From one to eight was my section of the night watch and there was quite a bit of work to be attended to. Among other things it was necessary to print the radio section for the magazine we sold. The Chief copied the press reports from one of the coast stations and typed them while he was on duty. Our typewriter was provided with a duplicating ribbon, so it was but necessary for me to put the original in a duplicating machine and draw off as many copies as we estimated could be sold.

If there was any brass to shine or similar work to be done, the night watch was the time to do it, for it was difficult to remain awake. The monotony, however, could be broken by

an occasional trip to the officers' mess where coffee and stale sandwiches could be found.

In the morning the chief had his breakfast and then relieved me. When my breakfast was finished I took an armful of magazines and hawked them about the deck at a dime a copy. Being associate editor, reporter, printer and newsboy was interesting but it was hardly in keeping with the august position of the Radio Officer, and I began to cast about for a better selling system. By appointing young ladies to the positions of reporter, subscription and circulation manager, society reporter, etc., we were able to sell more copies with less effort and still maintain our dignity. Thus, instead of retiring at ten-thirty or eleven, it was possible for me to get to bed by nine or nine-thirty, though by that hour the extreme desire for sleep usually had passed and the few winks before lunch time amounted to little or nothing.

After we had been out two days on my first trip on this vessel, I happened to be in the lounge one afternoon, chatting with one of the "society editors," who was a very comely girl of some eighteen or twenty years. I was assisting her to dispose of a box of chocolates, when the Captain came in. Seeing us, he smiled and sat down with us, helping himself to the chocolates. Most of his remarks were addressed to the lady and he seemed to be enjoying himself quite well. As he was about to withdraw he invited us—I was included by a half-hearted attempt at politeness—to visit the pilot house where we could see the navigating instruments. He asked me if I was bound for Charleston or Jacksonville, and seemed somewhat nonplussed at my reply that I was going to both places and then back to New York. Somehow or another the subject of wireless was brought up and he passed some disparaging remarks about the system in general and operators in particular.

"Well, Captain," said the pretty society editor, "this young man must be somewhat different from most operators and I know you must like him."

"What's he got to do with it?"

And he had no sooner asked the question than his face began to go through a series of contortions as it dawned upon him that I was his junior operator. He departed before his wrath escaped, but it was not more than a few minutes later that a quartermaster told me of the Captain's desire to see me in his cabin.

Followed a lecture about ship's discipline during which it became very clear to me that none of my duties included the entertainment of the lady passengers—that task seemed to have been meted out exclusively to the Captain. Among other things, it was essential that I procure a uniform at once in order that the Captain might not again mistake me for a passenger and become the least bit friendly. Finally, my Chief was informed of my transgressions and advised to put my case in the hands of the superintendent upon our return to New York. Captains, as a rule, are strange that way. In their own opinion they are past masters at entertaining the ladies; but a radio shack has wonderfully romantic possibilities if properly engineered.

In this particular instance the "old man" made the mistake of inviting the young lady and her mother to lunch with him in his cabin and during the luncheon pointed out the folly of having anything to do with wireless operators. From his description, we were a bad lot and no fit company for young ladies. The result was that he finished his luncheon alone and we had a word for word report of the proceedings, which the ladies believed would make most interesting reading in our paper. That, of course, was out of the question.

Nothing of great moment happened before we arrived at Charleston, where my Chief took me in tow to point out the places of historic interest. A classmate of mine, who was on his way to Miami with his mother, came aboard and there was another lady in his party. As soon as we left the dock he brought her around to the radio shack and they had all sorts of good things to eat with them. A few minutes later our society editor arrived upon the scene and we had a very jolly little party.

It was but a step to the smoking room and we could have all sorts of pop. There were pickles and olives and ham and saltines and raspberry soda and the usual accessories for a college girl's dormitory escapade. Four of us were inside the room, one seated on the table; one on top of the tuner; one in the only chair and one on the door sill. Papers containing various edibles were strewn about wherever they could be pushed out of the way. One of the girls had a harmonica and she played some popular airs while we all sang or whistled or hummed. I was "on watch" and therefore could not

remove the headphones and dancing was out of the question in our little shack.

We had just finished the refrain of a popular musical number, executed with great gusto and stamping of feet, and were making another attack upon the food when the room was suddenly darkened. I lowered the pop bottle and was more than delighted to see the jolly old Captain standing in the doorway. He was delighted, too, for it seems that our singing had reached him, while he vainly sought slumber.

My guests were dispersed and the wrath of the master again descended upon my unholy head. I was a young fool—a pest—an insubordinate jackass—and a few other things uttered in sub-audible tones.

Next day we arrived in Jacksonville and my newly made friends kindly invited me to visit them, which I felt at perfect liberty to do. There were no "watches" to stand and I did not put in my appearance aboard ship until a few hours before sailing. I had met the Captain, however, in the dining room of the Windsor Hotel and though he said nothing, he gave me a wicked look.

IT WAS AT LEAST A UNIFORM

You see, one of the officers mentioned that the captain was a regular guest at the Windsor by courtesy of the management. Tales had been spun in the static room of similar arrangements extended to radio men in other ports. After a certain amount of argument, it was possible to convince the manager that we could direct a great number of guests to his establishment in return for a room with bath. This was indeed an achievement and a certain satisfaction was felt when we could ask correspondents to write us in care of the hotel. Well do I remember how astonished some of the passengers would be to find that we lived in a hotel while ashore. And the letters written on the hotel stationery sent to friends at home were designed to create an impression of progress in the world of commerce.

Upon arriving in New York, I felt rather doubtful about putting in an appearance at the office, but funds were not running very high and a few dollars would relieve some of the strain, so I fared forth. Quite to my surprise the Senior had turned in a favorable report with the single exception that the Captain objected to my sailing again without a uniform.

For the next three days I spent most of my spare time searching for a uniform at my price, but it was not to be had and the Superintendent was satisfied to have me make another trip provided I purchased a uniform cap. This I did, but the Captain was less easily satisfied and insisted that I could not leave on the third trip ununiformed, so once again my time in New York was spent hunting for proper raiment.

Eventually I was able to procure a suit from the Superintendent himself, who had undertaken to dispose of it for another operator. After he had seen to it that my shekels were delivered safely into his hand he informed me that the fellow who had previously owned the outfit had joined the angels following a contagious disease, but he assured me that the perfect fumigation through which the suit had passed made it quite unlikely that I would go and do likewise.

Broadcast Receiving Contest!

Any Number of Tubes—Any Kind of Receiver

THE LONG-DISTANCE RECEIVING CONTEST, to determine who has done the best with ANY NUMBER OF TUBES AND ANY TYPE OF RECEIVER, is well under way. The drawbridge will be hauled up at sunset on May 31st, however, and after that even the most imposing-looking contributions will have to be left outside the portcullis. A great many of them will probably gallop through in a cloud of dust at the last minute—but that is dangerous business, and we advise you not to try it. Read through the Eight Commandments below, roll up your sleeves, and go to it.

The Four Prizes

First Prize: DE FOREST D-7 REFLEX LOOP RECEIVER

This receiver, described in RADIO BROADCAST for February (page 297), is the latest product of the De Forest Company: it makes three amplifying tubes and a crystal detector do the work of six tubes. The loop antenna aids in selectivity because of its directional properties. An ordinary antenna and ground may be used, however, if desired. Recently, a man in Brooklyn, N. Y. heard a broadcasting station in Seattle, Wash., with one of these sets.

Second Prize: GREBE TUNED RADIO-FREQUENCY AMPLIFIER, TYPE "RORN"

Illustrated on page 352, RADIO BROADCAST for February. This amplifier, which has a wavelength range of from 150 to 3000 meters, may be used with any form of home-made or bought receiver. It is the most recent development of a company widely known for the excellence in design and workmanship of its products.

Third Prize: Choice of

THREE OF THE NEW RADIOTRON UV-201-A AMPLIFIER TUBES (6 volts, $\frac{1}{4}$ of an ampere), or

THREE AERIOTRON WD-11 DRY CELL TUBES ($1\frac{1}{2}$ volts, $\frac{1}{4}$ of an ampere).

Fourth Prize: TIMMONS LOUD-SPEAKER UNIT

This unit, which may be connected directly to the output of your amplifier, has a diaphragm adjustable for sounds of different intensities, and when used with two stages of amplification reproduces broadcasted programs about as loud as the music from the average phonograph.

Rules of the Contest

1. *You should list all broadcasting stations 150 or more miles away from the receiving point, which you have heard distinctly (announcement of location as well as of call letters.)*
2. *Measure distances accurately, and give aggregate mileage. (This is the sum of all the distances, each station counted once, but two or more stations in the same city being counted separately.) An aggregate mileage of less than 15,000 miles will not be considered.*
3. *Manuscripts should include the following: description of set, directions or advice for constructing and operating it; any "wrinkles" or makeshifts which you have used to advantage; photograph of your apparatus; circuit diagram; in general, anything you have to tell that will make your story more interesting and helpful. Manuscripts should not be longer than 2000 words. Typewritten reports preferred.*
4. *Data should be arranged in three columns, under the headings: call letters, location, distance.*
5. *For material used, a liberal rate will be paid.*
6. *In judging contributions, the quality and interest of photographs, text, and drawings, and the originality and general effectiveness of the apparatus described, will have greater weight than the list of stations heard, although a long list of distant stations will distinctly help.*
7. *The Contest begins now and closes May 31st, 1923.*
8. *Address: Receiving Contest, RADIO BROADCAST, Doubleday, Page & Co., Garden City, N.Y.*

Six-Inch Dry Cells and WD-11 Tubes

By E. E. HORINE
National Carbon Company, Inc.

FOR more than twenty-five years the six-inch dry cell has been a popular source of small amounts of electrical energy. It is convenient, compact, safe, and reliable. It is in such universal demand for a wide variety of purposes that it has become a staple article of commerce all over the country. It may be purchased for a small sum in any city, town, or village, and at most country cross-roads stores.

With such a cheap, convenient, reliable source of energy almost universally available, it is natural that designers of receiving vacuum tubes should bend their efforts toward the development of a tube which would be so economical of current that dry cells could be used for heating the filaments.

Since the Westinghouse Company brought out the WD-11 dry cell tube its use has become increasingly popular. There is no doubt that it is one of the most important forward steps made in receiving apparatus during the past few years. It has actually made radio a source of pleasure, information, and instruction for many who would never have availed themselves of it otherwise.

The satisfaction derived from a receiver employing one or more of these tubes depends in no small measure upon a suitable filament current supply. With this in mind we asked Mr. E. E. Horine, of the National Carbon Company, who has directed a great deal of research work in the application of dry cells to radio, to prepare this helpful data for our readers on this important subject.—THE EDITOR.

The WD-11 tube is the first among these tubes to have been developed and placed on the market. These dry cell tubes are proving popular, and deservedly so, for they are the means of bringing radio to rural sections where storage battery charging is a real problem. They also have a strong appeal for the city dweller, who, although surrounded by cheap current and storage battery charging stations, welcomes relief from the relatively large investment for a storage battery and its attendant bother. Dry battery tubes bid fair eventually to replace all storage battery receiving tubes; so a study of the characteristics of dry cells is of particular interest to the radio enthusiast.

The dry cell is inherently an intermittent service cell. That is, it must be given opportunity to recuperate between periods of service in order to use it most economically. More work can be obtained from a dry cell by operating it intermittently than by drawing current from it continuously. Practically all radio receiving sets are operated for a few hours each day, standing idle the rest of the time, which is an ideal arrangement from a dry battery standpoint.

The uses to which dry cells are put are so numerous, and the demands made upon them are so diversified, that it has been necessary to develop a number of different types of cells, each especially suited for some particular class of service. In addition to these so-called "single-purpose" cells, there has also been developed the "general-purpose" cell, designed to cover a number of uses. This latter is the cell with which the public is most familiar, and is the one usually sold over the counter to the retail trade. It is generally used for motor ignition, bell ringing, annunciator systems, and lately for heating the filaments of vacuum tubes. Our discussion of dry battery characteristics refers only to this general-purpose battery.

When a radio enthusiast purchases a number of dry cells for his set, all he wishes to know about them is how much electrical energy he is getting for his money. However, he does not couch his inquiry in this style: he merely asks "How long will they last?" This is a reasonable and proper question, and on the face of it, a simple one. Yet, of all the questions he might have asked about dry cells, this is perhaps one of the most difficult to answer, the main reason being that the amount of service, measured in hours, obtainable from a dry cell, depends largely on the unknown

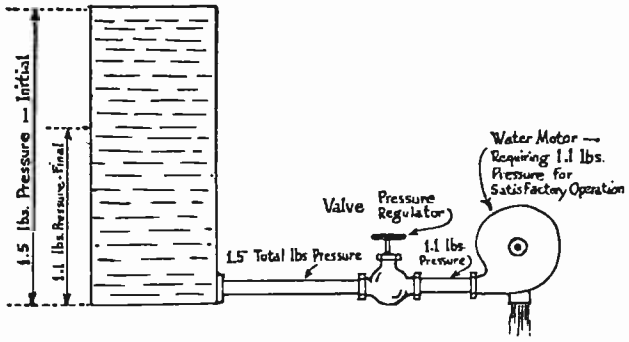


FIG. 1

factor of just how the cell is to be used. All the manufacturer can do is to see to it that his product contains the maximum amount of electrical energy when it leaves his hands. There his control over the cells ceases, and from that point on, the amount of service obtainable from them is strictly up to the user. In the hands of different people, identical cells will deliver widely divergent amounts of service.

If the exact conditions of service are known, it is quite easy to predict just how many hours of useful work may be obtained from an average dry cell. But conditions of service vary, even in radio work, and the best that can be done is to state how many hours of service should be obtained under certain different conditions.

In many ways, a dry cell may be compared to a tank of water. In Fig. 1 such a tank is shown connected to a water motor. The motor is so designed that it will not work if the water pressure falls below 1.1 pounds per square inch. The height of the tank is such that the resultant pressure when full is 1.5 pounds per square inch. To control the pressure applied to the motor, a valve which varies the resistance to the flow of water is inserted in the line between the tank and the motor.

As water is drawn from the tank, the level of water falls, and the pressure drops. After a certain definite amount of water has been withdrawn, the pressure reaches 1.1 pounds per square inch, following which the motor will fail to function due to lack of sufficient pressure. If the operator of this device fails to regulate the valve properly, so that at times the pressure on the motor is in excess of 1.1 pounds per square inch, the water will be drained out of the tank more rapidly, and the length of service down to the final 1.1 pounds, will be materially reduced.

The conditions in Fig. 2 are the same as in Fig. 1, except that here we are dealing with a flow of electrical energy instead of water. The dry cell is the container of electrical energy. This energy is held under a pressure of 1.5 volts. The proper operating pressure for the WD-11 tube is 1.1 volts. The rheostat serves as a voltage regulator, and if properly manipulated, maintains the voltage on the tube constant at 1.1 volts.

As energy is drawn from the cell, the voltage gradually drops, and this decrease in voltage must be compensated for by adjusting the rheostat. Eventually the cell voltage falls to 1.1 volts, after which satisfactory operation will not be obtained, because it is no longer strong enough to heat the tube filament to a point where sufficient electron emission occurs. The lowest voltage at which a dry cell can satisfactorily supply current to any device is called the cut-off voltage. This figure varies for different electrical devices, and has a marked influence on the amount of service obtainable from a dry cell.

To obtain the desired characteristics, the designers of the WD-11 tube found it advisable to choose 1.1 volts as the operating voltage. This means a cut-off voltage of 1.1 volts for the dry cell used with it.

The current taken by the WD-11 tube at 1.1 volts is about one quarter ampere. Curve A, Fig. 3 shows the number of hours of service obtainable from a six-inch dry cell, delivering one quarter ampere, two hours per day, to various cut-off voltages. This curve, as well as others presented in this article, is the result of a large number of tests on several leading makes of general-purpose dry cells, and represents the average performance of the various makes, rather that the individual performance of any one make. These curves therefore show what the user may reasonably

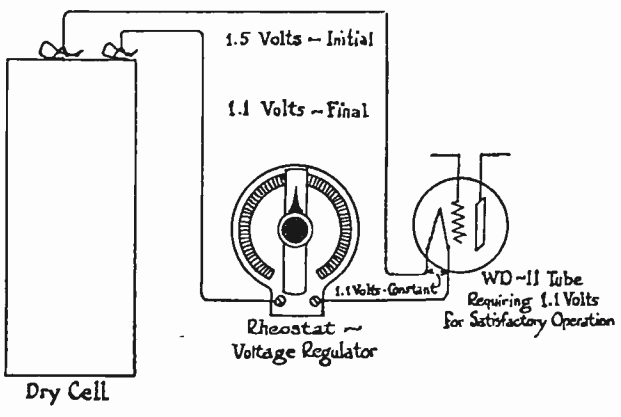


FIG. 2

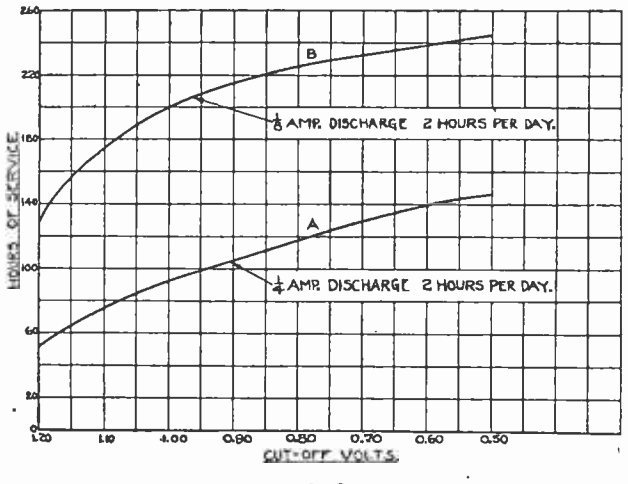


FIG. 3

By comparing curves A and B, the economy of using two dry cells in parallel (curve B) for each tube becomes apparent

expect from any dry cell of reliable manufacture, provided he uses it properly.

By exhausting the cell down to a cut-off of 1.1 volts, at the rate of one quarter ampere, two hours per day, the amount of service obtainable is approximately 75 hours.

Curve B, Fig. 3, shows the amount of service obtainable from a six-inch dry cell when delivering one eighth ampere two hours per day. This is the condition prevailing when two cells connected in multiple (zinc to zinc and carbon to carbon) are used to operate one WD-11 tube. Here the total current of one quarter ampere is divided between the two cells, so that the discharge from each is one eighth ampere. Under these conditions, the amount of service obtainable from the two cells is approximately 175 hours, or at the rate of $87\frac{1}{2}$ hours per cell, instead of 75 hours when only one cell is used. It is therefore more economical to use two cells per tube than one cell per tube.

Fig. 4 shows the effect on service life of various rates of discharge. This curve was obtained by operating cells two hours per day to a cut-off of 1.1 volts at different currents. At discharges of one quarter ampere, the service life is 75 hours. At one eighth ampere, it is 175 hours, and at one twelfth ampere, it is 258 hours.

These discharge rates correspond to the use of one, two or three cells for each WD-11 tube in the set. The service for one cell is 75 hours; for two cells, $87\frac{1}{2}$ hours per cell; and for three cells, 86 hours per cell. This shows that while it is more economical to use two cells per tube than one cell, no further increase in economy is obtained by using more than two cells per tube.

Still another factor affecting the service life of dry cells is the average number of hours the cells are used each day. In radio reception, this is an extremely variable factor, and no one knows just how many hours per day the average set is used. It probably lies between two and three hours a day, although individual cases will vary considerably from this figure.

The curves in Fig. 5 serve to show how different periods of use affect the service life of dry cells. Curve A is for one quarter ampere to a cut-off of 1.1 volts, and curve B is for one eighth ampere to the same cut-off point.

It will be observed from a study of Curve B that when the periods of use are below $1\frac{1}{2}$ or 2 hours per day, the service life is slightly reduced. This is due to the natural depreciation which takes place in all dry cells when not in use. On the other hand, when the service periods are greater than three hours a day, the number of hours of useful life is again decreased, due to the lack of sufficient time between periods of use for complete recuperation. Between these two extremes is a point where maximum service will be obtained, and in this case, it is somewhere between two and three hours per day. For each current discharge, there is always this point of maximum service, but it is different for each current. For one quarter ampere discharge, maximum service will be obtained by using the cells between one half and one hour per day.

This further emphasizes the advisability of using two dry cells for each WD-11 tube in the set. When this is done, maximum service is obtained by operating the set two or three hours per day, and in all probability,

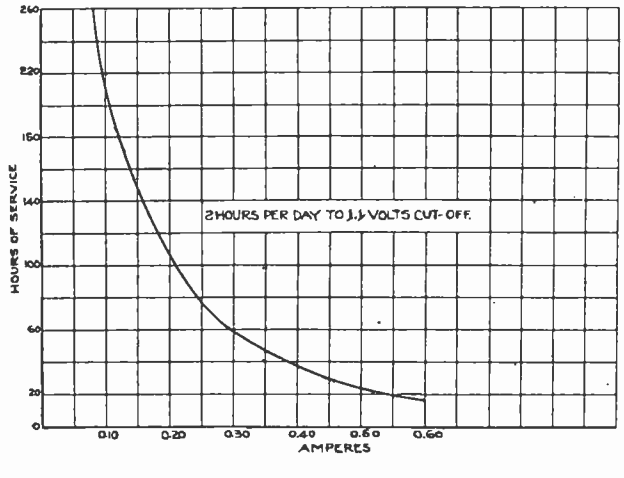


FIG. 4

It is evident that the less current you take from a dry cell the longer its life will be. However, it will deteriorate of its own accord from too little use, as shown in Fig. 5

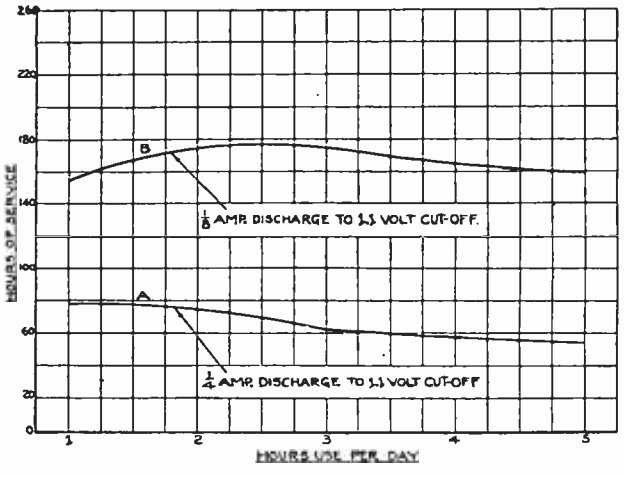


FIG. 5

Different periods of service may be expected where the amperage and the hours of service per day vary. By properly proportioning your cells to meet the demands of your particular service, you may secure the greatest life for your A battery at the least expenditure

this figure comes nearest to average conditions of use.

The age of a dry cell when put into use has some influence on the amount of service which can be obtained from it. The slow depreciation going on in all idle dry cells, has the effect of reducing the useful service life. However, in well-made cells, this depreciation factor does not become appreciable for many months. The date given in the curves, Figs. 3 to 5 apply to dry cells not more than six months old. The possibility of a purchaser securing a dry cell more than six months old is extremely remote, if he confines his purchases to cells of well-known, reliable make, for such cells enjoy a wide sale and consequently the dealer's stock turns over rapidly, insuring fresh cells always on hand.

Let us assume that the average user has purchased two standard six-inch dry cells for his WD-11 tube which he uses between two and three hours daily. Under these conditions he should obtain 175 hours of service from the battery, but he sometimes fails to do this by a considerable margin. On first thought he is apt to blame the dry cells. In the vast majority of cases this is unjust, because cells made by reliable manufacturers are not only carefully constructed, but are constantly inspected during process of manufacture and carefully tested before shipment. The chances for defective cells getting into the hands of the user are practically zero. The failure to get adequate service is usually caused by the user himself. Just what does the operator do that shortens the life of his cells?

He may fail to adjust his filament rheostat properly. Suppose, in adjusting his rheostat, the operator obtains a current of 0.28 ampere instead of 0.25 ampere. This is easily possible, for the average operator has no means of accurately determining the filament current. By doing just this one little thing, he reduces the service life of his dry cells 25 hours, as shown in Figure. 4.

Some filament rheostats are responsible for decreased service life of dry cells. It may seem a far cry from a filament rheostat to dry battery life, but in reality the two are closely associated.

The construction of certain rheostats is such that it is impossible to cut out all the resistance. With the indicator at the "all out" position, there still remains a small amount of resistance in the circuit, which prevents the full battery voltage from reaching the tube. This voltage drop is always present, and means that the cut-off voltage of the cell must be greater than the tube voltage by an amount equal to the drop through the fixed resistance. Even if this resistance is so small as to cause a drop of only .05 volt, this will reduce the service life of the cells ten or twelve hours.

The resistance of the wires used to connect the battery to the tubes has a similar effect. Resistance measurement of typical installations have been made, and in some cases, the resultant voltage drop has been found to be as much as 1 volt. This immediately raises the cut-off point from 1.1 to 1.2 volts, with a corresponding decrease in battery service life of 45 hours.

To get maximum service from six-inch dry cells in connection with WD-11 tubes, the following should be observed:

Obtain fresh cells by purchasing those of reliable manufacture which enjoy a large sale.

Use two cells connected in multiple for each tube in the radio receiving set.

Never subject the tube to a voltage in excess of its rating, that is, 1.1 volts.

Install the battery so that there will be the minimum resistance in the leads between it and the tubes. Locate the battery as close as possible to the tubes, and use heavy wires for connections.

Revised List of U. S. and Canadian Broadcasting Stations

This list includes all commercial broadcasting stations in the United States licensed up to March 18, 1923. *denotes stations that were deleted up to that date. The Canadian list, comprising 59 stations, includes all that were licensed before February 21, 1923. Additional lists, with deletions, are printed every month in RADIO BROADCAST.

KACY	Western Union College	Le Mars, Iowa
KAD	Y. M. C. A.	Denver, Colo.
KDKA	Westinghouse Electric & Mfg. Co.	East Pittsburgh, Pa.
KDN	Meyberg Co., Leo J.	San Francisco, Calif.
KDPM	Westinghouse Elect. & Mfg. Co.	Cleveland, Ohio.
KDPT	Southern Electrical Co.	San Diego, Calif.
KDYL	Telegram Publishing Co.	Salt Lake City, Utah
KDYM	Savoy Theatre	San Diego, Calif.
KDYN	Great Western Radio Corp	Redwood City, Calif.
*KDYO	Carlson & Simpson	San Diego, Calif.
KDYQ	Oregon Institute of Technology	Portland, Oreg.
*KDYR	Pasadena Star-News Pub. Co.	Pasadena, Cal.
KDYS	The Tribune, Inc.	Great Falls, Mont.
KDYV	Cope & Cornwell Co.	Salt Lake City, Utah
KDYW	Smith, Hughes & Co.	Phoenix, Ariz.
KDYX	Star-Bulletin Pub. Co.	Honolulu, T. H.
KDZA	Arizona Daily Star	Tucson, Ariz.
KDZB	Frank E. Siefert	Bakersfield, Calif.
KDZE	The Rhodes Co.	Seattle, Wash.
KDZF	Automobile Club of So. Calif.	Los Angeles, Calif.
KDZG	Cyrus Peiree & Co.	San Francisco, Calif.
KDZH	Fresno Evening Herald	Fresno, Calif.
KDZI	Electric Supply Co.	Wenatchee, Wash.
KDZK	Nevada Machinery & Electric Co.	Reno, Nev.
KDZL	Rocky Mountain Radio Corp.	Ogden, Utah
KDZM	E. A. Hollingworth	Centralia, Wash.
*KDZP	Newbery Elect. Corp.	Los Angeles, Cal.
KDZQ	William D. Pyle	Denver, Colo.
KDZR	Bellingham Publishing Co.	Bellingham, Wash.
KDZT	Seattle Radio Assn.	Seattle, Wash.
KDZU	Western Radio Corporation	Denver, Colo.
*KDZW	Claude W. Gerdes	San Francisco, Calif.
KDZX	Glad Tidings Tabernacle	San Francisco, Calif.
KDZZ	Kinney Bros. & Sipprell	Everett, Wash.
KFAB	Pacific Radiofone Co.	Portland, Oreg.
*KFAC	Glendale Daily Press	Glendale Calif.
KFAD	McArthur Bros. Mercantile Co.	Phoenix, Ariz.
KFAE	State College of Washington	Pullman, Wash.
KFAF	Western Radio Corp.	Denver, Colo.
KFAJ	University of Colorado	Boulder, Colo.
KFAN	Electric Shop	Moscow, Idaho
KFAP	Standard Publishing Co.	Butte, Mont.
KFAQ	City of San Jose	San Jose, Calif.
KFAR	Olesen, O. K.	Hollywood, Calif.
KFAS	Reno Motor Supply Co.	Reno, Nev.
KFAT	Donohue, Dr. S. T.	Eugene, Oregon
KFAU	Independent School District of Boise City	Boise, Idaho
KFAV	Cooke & Chapman	Venice, Calif.
KFAW	Radio Den, The	Santa Ana, Calif.
KFAY	Virgin Milling Co., W. J.	Central Point, Oreg.
KFAZ	Weatherell, C. H.	Readley, Calif.
*KFBA	Ramey & Bryant Radio Co.	Lewiston, Idaho
KFBB	Buttrey & Co., F. A.	Havre, Mont.
KFBC	Azbill, W. K.	San Diego, Calif.
KFBD	Welsh, Clarence V.	Hanford, Calif.
KFBE	Horn, Reuben H.	San Luis Obispo, Calif.
KFBF	Smith, F. H.	Butte, Mont.
KFBG	First Presbyterian Church	Tacoma, Wash.
*KFBJ	Boise Radio Supply Co.	Boise, Idaho
KFBK	Kimball-Upson Co.	Sacramento, Calif.
KFBL	Leese Bros.	Everett, Wash.
*KFBM	Cook & Foster	Astoria, Ore.
*KFBN	Borch Radio Corp.	Oakland, Cal.
*KFBQ	Savage Elect. Co.	Prescott, Ariz.
KFBS	Gas & Elect. Supply Co.	Trinidad, Colo.
KFBU	Thomas, Bishop N. S.	Laramie, Wyoming
KFBV	Clarence O. Ford	Colorado Springs, Colo.
*KFC	Northern Radio & Electric Co.	Seattle, Wash.
KFCB	Nielsen Radio Supply Co.	Phoenix, Ariz.
KFCC	Auto Supply Co.	Wallace, Idaho
KFCD	Salem Elect. Co.	Salem, Oregon
KFCF	Frank A. Moore	Walla Walla, Wash.
KFCH	Electric Service Station	Billings, Mont.
KFCK	Colorado Springs Radio Co.	Colorado Springs, Colo.
KFCL	Los Angeles Union Stock Yards	Los Angeles, Calif.
KFCM	Richmond Radio Shop	Richmond, Calif.
KFCP	Flygare, Ralph W.	Ogden, Utah
KFCQ	Motor Service Station	Casper, Wyoming
KFCV	Mahaffey, Jr., Fred	Houston, Texas
KFCY	Western Union College	Le Mars, Iowa
KFCZ	Omaha Central High School	Omaha, Neb.
KFDA	Adler's Music Store	Baker, Oregon
KFDB	Mercantile Trust Co. of California	San Francisco, Cal.
KFDC	Radio Supply Co.	Spokane, Wash.
KFDD	St. Michael's Cathedral	Boise, Idaho
KFDF	Wyoming Radio Corp.	Casper, Wyoming
KFDH	University of Arizona	Tucson, Ariz.
KFDJ	Oregon Agricultural College	Corvallis, Oregon
KFDL	Knight-Campbell Music Co.	Denver, Colo.
KFDO	Cutting, H. Everett,	Bozeman, Mont.
KFDP	Hawkeye Radio & Supply Co.	Des Moines, Iowa
KFDR	Bullock's Hardware & Sporting Goods	York, Neb.
KFDU	Nebraska Radio Elect. Co.	Lincoln, Neb.
KFDV	Gilbrech & Stinson	Fayetteville, Ark
KFDY	South Dakota State College	Brookings, S. D.
KFDZ	Harry O. Iverson	Minneapolis, Minn.
KFEB	The City of Taft	Taft, Calif.
KFEC	Meir & Frank Co.	Portland, Oregon
*KFED	Billings Polytechnic Institute	Polytechnic, Mont.
KFEJ	Guy Greason	Tacoma, Wash.
KFEL	Winner Radio Corp.	Denver, Colo.
KFEP	Radio Equipment Co.	Denver, Colo.
KFEQ	Scroggin, J. L.	Oak, Neb.
KFER	Auto Electric Service Co., Inc.	Fort Dodge, Iowa
KFEV	Radio Electric Shop	Douglas, Wyoming
KFFA	Dr. R. O. Shelton	San Diego, Calif.
KFFJ	Jenkins Furniture Co.	Boise, Idaho
KFFQ	Marksheffel Motor Co.	Colorado Springs, Colo.
KFFV	Graceland College	Lamoni, Iowa
KFGB	Loewenthal Bros.	Pueblo, Colo.
KFGF	Buchanan Stevens & Co.	Mt. Vernon, Wash.
KFGG	Astoria Budget	Astoria, Oregon
KFGH	Leland Stanford Jr. Univ.	Stanford University, Calif.
KFHB	P. L. Boardwell	Hood River, Ore.
KFHJ	Fallon Company	Santa Barbara, Calif.
KFI	Anthony, Earle C., Inc.	Los Angeles, Calif.
KFU	Precision Shop, The	Gridley, Calif.
KFV	Foster-Bradbury Radio Store	Yakima, Wash.
KFZ	Doerr-Mitchell Electrical Co.	Spokane, Wash.
KGB	Mullins, Electric Co., Wm. A.	Tacoma, Wash.
KGC	Electric Lighting Supply Co.	Hollywood, Calif.
*KGF	Pomona Fixture & Wiring Co.	Pomona, Calif.
KGG	Hallock & Watson Radio Service	Portland, Ore.
KGN	Northwestern Radio Mfg. Co.	Portland, Ore.
KGO	Altadena Radio Laboratory	Altadena, Calif.
KGU	Mulrony, Marion A.	Honolulu, Hawaii
KGW	Portland Oregonian	Portland, Oregon
KGY	St. Martins College (Rev. S. Ruty)	Lacey, Wash.
KHD	Aldrich Marble & Granite Co.	Colorado Springs, Colo.
KHJ	Kierulff & Co., C. R.	Los Angeles, Calif.
KHQ	Wasmer, Louis	Seattle, Wash.
*KJC	Standard Radio Co.	Los Angeles, Calif.
KJJ	Radio Shop, The	Sunnyvale, Calif.
KJQ	Gould, C. O.	Stockton, Calif.
KJR	Kraft, Vincent I.	Seattle, Wash.
KJS	Bible Institute of Los Angeles	Los Angeles, Calif.
KLB	Dunn & Co., J. J.	Pasadena, Calif.
KLN	Noggle Electric Works	Monterey, Calif.
KLP	Kennedy Co., Colin B.	Los Altos, Calif.
KLS	Warner Brothers	Oakland, Calif.
KLX	Tribune Publishing Co.	Oakland, Calif.
KLZ	Reynolds Radio Co.	Denver, Colorado
KMC	Lindsay, Weathereill & Co.	Reedley, Calif.
KMI	San Joaquin Light & Power Corporation	Fresno, Calif.
KNJ	Roswell Public Service Co.	Roswell, N. Mex.
KNN	Bullock's	Los Angeles, Calif.
KMO	Love Electric Co.	Tacoma, Wash.
KNR	Beacon Light Co.	Los Angeles, Calif.
KNT	North Coast Products Co.	Aberdeen, Wash.
KNV	Radio Supply Co.	Los Angeles, Calif.
KNX	Electric Lighting Supply Co.	Los Angeles, Calif.
KOA	Young Men's Christian Association	Denver, Colo.
KOB	New Mexico College of Agriculture and Mechanical Arts	State College, N. Mex.
KOE	Spokane Chronicle	Spokane, Wash.
KOG	Western Radio Electric Co.	Los Angeles, Calif.
KON	Holzwasser Inc.	Dan Diego, Calif.
KOP	Detroit Police Dept.	Detroit, Michigan
KOQ	Modesto Evening News	Modesto, Calif.
KPO	Hale Bros,. Inc.	San Francisco, Calif.
KQI	University of California	Berkeley, Calif.

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. The letter containing the questions should have the full name and address of the writer and also his station call letter, if he has one. Names, however, will not be published.

Operating Loud-Speakers at a Distance

Please tell me how many loud-speakers (say Magnavoxes) could be worked off a two-stage audio-frequency set—and is there any limitation to the distance they could be placed from the set, as in neighbors' houses (the receiving set being in one house, and the others having the loud-speakers operated from the same set?)

W. H. M., Miami, Arizona.

THEORETICALLY, any number of loud-speakers may be operated in series from one set, if the impedance and voltage are corrected and the signal on a single loud-speaker is strong. Practically, it should not be difficult to operate a dozen or so in this manner.

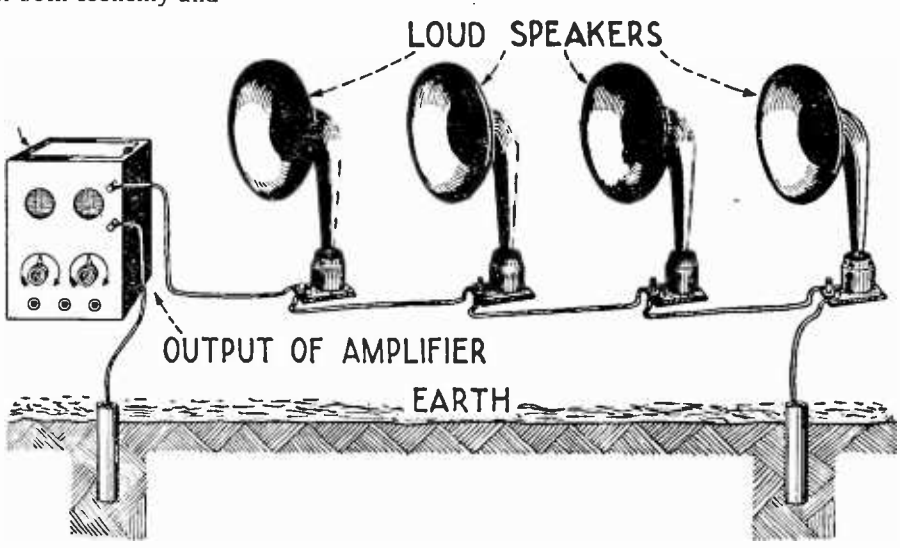
However, there are much more definite limits, imposed principally by capacity effects, on the distance which such loud-speakers may be operated from the receiving apparatus. The leads running to the loud-speaker are virtually a shunt capacity, and the loss in signal strength is comparable to that occasioned by shunting too large a condenser across the telephone receivers. In some cases the capacity may cause distortion, though in the majority of loud-speakers, this would be counteracted by the inductance in the loud-speaker windings. The undesirable effects of capacity may be somewhat reduced by employing a single wire with a ground return.

If Magnavoxes are used, it is suggested that a separate six-volt battery be located in the immediate vicinity of each Magnavox to excite its field.

For use in neighboring houses, assuming the total length of wire to be less than eight hundred feet, the problem is not a difficult one. In consideration of both economy and simplicity, we suggest using loud-speakers having permanent fields, such as the Western Electric (without power amplifier.) They should be connected in series, Figure 1, using well insulated wire of size number twenty-four or larger, with a final return through the ground. As the wire carries a comparatively high voltage, it should be carefully insulated wherever braced or supported. Forty to a hundred additional volts should be used on the *final step* of amplification.

For farther distances, or a greater multiplicity of loud talkers, it would be best to distribute the signals from the *first step* of the receiver, and equip each loud-talker with a separate one-step amplifier using individual A and B batteries. The auxiliary apparatus would, of course, be housed under the same roof as the loud-speaker itself. (Care should be taken in running the lines for such an installation, that the wires are not closely parallel to lighting or power leads, for all induced disturbances will be amplified.) With this arrangement, Magnavoxes may be conveniently used, the externally excited fields being supplied from the amplifier A batteries.

By elaborating on this latter system, it should be practical to equip the houses of an entire village with loud-talkers operated from a single well located receiver. However, before undertaking such a venture, it would be well to consult a telephone expert, and finally to do the actual installing under his supervision.



Tuned Circuits

What relation has the wavelength to which the plate variometer is tuned, to the intercepted wavelength?

Can regeneration be controlled in the ultra-audion circuit?

What would be the advantage of using both a tickler and tuned plate circuit simultaneously?

L. U., Bellefontaine, Ohio.

THE wavelength of the plate circuit in a variometer regenerative set is tuned by means of the plate variometer to within a few meters of the wave of the received signal. The degree of regeneration increases as the resonance point in approached, until, just before the plate circuit is perfectly tuned, the bulb oscillates, a condi-

(*Continued on page 86*)

KQL	Kluge, Arno A.	Los Angeles, Calif.
KQP	Apple City Radio Club	Hood River,, Ore.
KQT	Electric Power & Appliance Co.	Yakima, Wash.
KQV	Doubleday-Hill Electrical Co.	Pittsburgh, Pa.
KQW	Herrold, Charles D.	San Jose, Calif.
KQY	Stubbs Electric Co.	Portland, Ore.
KRE	Maxwell Electric Co.	Berkeley, Calif.
KSC	Hael & Co.	San Jose, Calif.
KSD	Post Dispatch	St. Louis, Mo.
KSL	Emporium, The	San Francisco, Calif.
KSS	Prest & Dean Radio Research Laboratory	Long Beach, Calif.
KTW	First Presbyterian Church	Seattle, Wash.
KUO	The Examiner Printing Co.	San Francisco, Calf.
KUS	City Dye Works & Laundry Co.	Los Angeles, Calif.
KUY	Coast Radio Company	El Monte, Calif.
*KVQ	Hobrecht, J. C.	Sacramento, Calif.
KWG	Portable Wireless Telephone Co.	Stockton, Calif.
KWH	Los Angeles Examiner	Los Angeles, Calif.
KXD	Herald Publishing Co.	Modesto, Calif.
KXS	Braun Corporation	Los Angeles, Calif.
*KYF	Thearle Music Co.	San Diego, Calif.
KGY	Hawley, Willard P., Jr.	Portland, Ore.
KYI	Alfred Harrell	Bakersfield, Calif.
KYJ	Meyberg Co., Leo J.	Los Angeles, Calif
KYQ	Electric Shop	Honolulu, Hawai
KYW	Westinghouse Electric & Mfg. Co	Chicago, Ill.
*KYY	Radio Telephone Shop, The	San Francisco, Calif.
KZC	Public Market & Department Stores Co.	Seattle, Wash.
KZI	Cooper, Irving S.	Los Angeles, Calif
KZM	Allen, Preston, D.	Oakland, Calif.
KZN	Deseret News	Salt Lake City, Utah
KZV	Wenatchee Battery & Motor Co.	Wenatchee, Wash.
*KZY	Atlantic-Pacific Radio Supplies Co.	Oakland, Calif
KUO	Examiner Printing Co.	San Francisco, Calif.
NAA	U. S. Government	Arlington, Md.
NOF	U. S. Navy	Anacostia, Md.
WAAB	Jensen, Valdemar	New Orleans, La.
WAAC	Tulane University of Louisiana	New Orleans, La.
WAAD	Ohio Mechanics Institute	Cincinnati, Ohio
WAAE	St. Louis Chamber of Commerce	St. Louis, Mo.
WAAF	Union Stock Yards & Transit Co.	Chicago, Illinois
*WAAG	Elliott Electric Co.	Shreveport, La.
WAAH	Commonwealth Electric Co.	St. Paul, Minn.
WAAJ	Eastern Radio Institute	Boston, Mass.
WAAK	Gimbel Brothers	Milwaukee, Wisc.
WAAL	Minnesota Tribune Co.	Minneapolis, Minn.
WAAM	Nelson Co., I. R.	Newark, N. J.
WAAN	University of Missouri	Columbia, Mo.
*WAAO	Radio Service Co.	Charleston, W. Va.
WAAP	Taylor, Otto W.	Wichita, Kansas
WAAQ	New England Motor Sales Co.	Greenwich, Conn.
*WAAR	Groves-Thornton Hardware Co.	Huntington, W. Va.
WAAS	Georgia Radio Co.	Decatur, Ga.
*WAAV	Athens Radio Co.	Athens, O.
WAAW	Omaha Grain Exchange	Omaha, Neb.
WAAY	Yahrling-Raynor Piano Co.	Youngstown, O.
WAAZ	Hollister-Miller Motor Co.	Emporia, Kansas
WAH	Midland Refining Co.	El Dorado, Kansas
*WAAX	Radio Service Corp.	Crofton, Pa.
WAJV	Indian Pipe Wire Corp.	Princeton, Ind.
WBA	Marshall-Gerkin Co.	Toledo, Ohio.
WBAA	Purdue University	West Lafayette, Ind.
*WBAB	Potter, Andrew J.	Syracuse, N. Y.
WBAD	Sterling Electric Co. & Journal Printing Co.	Minneapolis, Minn.
WBAE	Bradley Polytechnic Institute	Peoria, Ill.
WBAFG	Middleton, Fred M.	Morestown, N. J.
WBAG	Diamond State Fibre Co.	Bridgeport, Pa.
WBAH	Dayton Co.	Minneapolis, Minn.
WBAJ	Marshall, Gerkin Co.	Toledo, O.
WBAM	Rennysen, T. B.	New Orleans, La.
WBAN	Wireless Phone Corporation	Paterson, N. J.
WBAO	Millikin University	Decatur, Ill.
WBAP	The Star Telegram	Fort Worth, Texas
WBAU	Republican Publishing Co.	Hamilton, Ohio
WBAV	Erner & Hopkins Co.	Columbus, Ohio
WBAW	Marietta College	Marietta, Ohio
WBAX	John H. Stenger, Jr.	Wilkes-Barre, Pa.
WBAY	Amer. Tel. & Tel. Co.	New York, N. Y.
WBL	T. & H. Radio Co.	Anthony, Kansas
WBS	May (Inc.) D. W.	Newark, N. J.
WBT	Southern Radio Corporation	Charlotte, N. C.
WBU	City of Chicago	Chicago, Ill.
WBZ	Westinghouse Electric & Mfg. Co	Springfield, Mass.
WCAB	Newburgh News Printing & Pub. Co.	Newburgh, N. Y.
WCAC	John Fink Jewelry Co.	Fort Smith, Ark.
WCAD	St. Lawrence University	Canton, Ohio
WCAE	Kaufmann & Baer Co.	Pittsburg, Pa.
WCAF	Michigan Limehouse & Chemical Co.	Rodgers, Mich.
WCAG	Daily States Publishing Co.	New Orleans, La.
WCAH	Entrekin Electric Co.	Columbus, O
WCAJ	Nebraska Wesleyan University	University Place, Neb.
WCAK	Alfred P. Daniel	Houston, Tex.
WCAL	St. Olaf College	Northfield, Minn.
WCAM	Villanova College	Villanova, Pa.
WCAN	Southeastern Radio Telephone Co.	Jacksonville, Fla.
WCAO	Sanders & Stayman Co.	Baltimore, Md.
WCAP	Central Radio Service	Decatur, Ill.
*WCAQ	Tri-State Radio Mfg. & Supply Co	Defiance. Ohio
WCAR	Alamo Radio Electric Co.	San Antonio, Tex.
WCAS	William Hood Dunwoody Industrial Institute	Minneapolis, Minn.
WCAT	S. Dakota State School of Mines	Rapid City, S. Dak.
WCAU	Philadelphia Radiophone Co.	Philadelphia, Pa.
WCAV	J. C. Dice Electric Co.	Little Rock, Ark.
WCAX	University of Vermont	Burlington, Vt.
WCAY	Kesselmen O'Drescoll Co.	Milwaukee, Wis.
*WCAZ	Compton, Robert	Carthage, Ill.
WCE	Findley Electric Co.	Minneapolis, Minn.
*WCJ	Gilbert Co., A. C.	New Haven, Conn.
WCK	Stix-Baer-Fuller	St. Louis, Mo.
WCM	University of Texas	Austin, Texas
WCN	Clark University	Worcester, Mass.
WCX	Detroit Free Press	Detroit, Mich.
WDAC	Illinois Watch Co.	Springfield, Ill.
WDAD	Central Kansas Radio Supply	Lindsberg, Kan.
WDAE	Tampa Daily Times	Tampa, Fla.
WDAF	Kansas City Star	Kansas City, Mo.
WDAH	Mine & Smelter Supply Co.	El Paso, Tex.
WDAI	Hughes Electrical Corp.	Syracuse, N. Y.
WDAJ	Atlanta & West Point R. R. Co.,	College Park, Ga.
WDAK	The Courant	Hartford, Conn.
WDAL	Florida Times Union	Jacksonville, Fla.
WDAM	Weston Electric Co.	New York, N. Y.
*WDAN	Glenwood Radio Corp.	Shreveport, La.
WDAO	Automotive Electric Co.	Dallas, Texas
WDAP	Drake Hotel	Chicago, Ill.
*WDAQ	Hartman-Riker Electric Machine Co.	Brownsville, Pa.
*WDAR	Lit Bros.	Philadelphia, Pa.
WDAS	Samuel W. Waite	Worcester, Mass.
WDAU	Slocum & Kilburn	New Bedford, Mass.
*WDAV	Muskogee Daily Phoenix	Muskogee, Okla.
WDAX	First National Bank	Centerville, Iowa
WDAY	Kenneth M. Hance	Fargo, N. D.
WDM	Church of the Covenant	Washington, D. C.
WDT	Ship Owners Radio Service	New York, N. Y.
*WDV	Yeiser, John O., Jr.	Omaha, Nebraska
WDW	Radio Construction & Electric Co.	Washington, D. C.
*WDY	Radio Corp. of America	Roselle, Park, N. J.
WDZ	Bush, James L.	Tuscola, Ill.
WEAA	Fallain & Lathrop.	Flint, Mich.
WEAB	Standard Radio Equipment Co.	Fort Dodge, Ia.
WEAC	Baines Electric Service Co.	Terre Haute, Ind.
WEAD	Northwest Kansas Radio Sup. Co.	Atwood, Kans.
WEAE	Virginia Polytechnic Institute	Blacksburg, Va.
WEAF	American Tel. & Tel. Co.	New York, N. Y.
WEAG	Nichols-Hineline-Bassett	Edgewood, R. I.
WEAH	Wichita Board of Trade & Landers Radio Co.	Wichita, Kans.
WEAI	Cornell University	Ithaca, N. Y.
WEAJ	University of South Dakota	Vermillion, S. D.
WEAK	Julius B. Abercrombie	St. Joseph, Mo.
WEAM	Borough of North Plainfield	North Plainfield, N. J.
WEAN	Shepard Co.	Providence, R. I.
WEAO	Ohio State University	Columbus, Ohio
WEAP	Mobile Radio Co.	Mobile, Ala.
WEAQ	Young Men's Christian Association.	Berlin, N. H.
WEAR	Baltimore American & News Pub. Co.	Baltimore, Md.
WEAS	Hecht Co.	Washington, D. C.
WEAT	John J. Fogarty	Tampa, Fla.
WEAU	Davidson Bros. Co.	Sioux City, Iowa
WEAV	Sheridan Electric Service Co.	Rushville, Neb.
WEAW	Arrow Radio Lab.	Anderson, Ind.
WEAX	T. J. M. Daly	Little Rock, Ark.
WEAY	Will Horwitz, Jr.	Houston, Tex.
WEAZ	Donald Redmond	Waterloo, Iowa
WEB	Benwood Co.	St. Louis, Mo.
WEH	Midland Refining Co.	Tulsa, Okla.
WEV	Hurlburt-Still Electrical Co.	Houston, Tex.
WEW	St. Louis University	St. Louis, Mo.
WFAA	A. H. Belo & Co.	Dallas, Tex.
WFAB	Carl F. Woese	Syracuse, N. Y.
WFAC	Superior Radio Co.	Superior, Wis.
WFAD	Watson Weldon Motor Supply Co.	Salina, Kan.
WFAF	H. C. Spratley Co.	Poughkeepsie, N. Y.
WFAG	Radio Engineering Laboratory	Waterford, N. Y.
WFAH	Electric Supply Co.	Port Arthur, Tex.
WFAJ	Hi-Grade Wireless Instrument Co.	Asheville, N. C.
WFAK	Domestic Electric Co.	Brentwood, Mo.
WFAL	Houston Chronicle Publishing Co.	Houston, Tex.
WFAM	Times Publishing Co.	St. Cloud, Minn.
WFAN	Hutchinson Electric Service Co.	Hutchinson, Minn.
WFAP	Brown's Business College	Peoria, Ill.
WFAQ	Missouri Wesleyan College & Cameron Radio Co.	Cameron, Mo.
*WFAR	Hall & Stubbs	Stanford, Me.
WFAS	United Radio Corporation	Fort Wayne, Ind.
WFAT	Daily Argus Leader	Sioux Falls, S. Dak.
WFAU	Lewis, Edwin C., Inc.	Boston, Mass.
WFAV	University of Nebraska	Lincoln, Neb.
WFAW	Miami Daily Metropolis	Miami, Fla.
WFAX	Kent, Arthur L.	Binghamton, N. Y.
WFAY	Daniels Radio Supply Co.	Independence, Kan.
WFAZ	South Carolina Radio Shop	Charleston, S. C.
WFI	Strawbridge & Clothier	Philadelphia, Pa.
*WFO	Rike-Kumler Co.	Dayton, Ohio
WFY	Cosradio Co.	Wichita, Kansas
WGAB	QRV Radio Co.	Houston, Tex.
WGAC	Orpheum Radio Stores Co.	Brooklyn, N. Y.
WGAD	Spanish-American School of Radio Telegraphy	Ensenada, Porto Rico

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2.—7 x 9 x $\frac{1}{8}$
3.—7 x 12 x $\frac{1}{8}$
4.—7 x 18 x $\frac{3}{16}$
5.—9 x 14 x $\frac{3}{16}$
6.—7 x 21 x $\frac{3}{16}$
7.—12 x 14 x $\frac{3}{16}$

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★ Tested and approved by RADIO BROADCAST ★

WGAF	Goller Radio Service	Tulsa, Okla.
WGAH	New Haven Elect. Co.	New Haven, Conn.
WGAI	Southern Equipment Co.	San Antonio, Tex.
WGAJ	Gass, W. H.	Shenandoah, Iowa
WGAK	Macon Electric Co.	Macon, Ga.
WGAL	Lancaster Electric Supply & Const. Co.	Lancaster, Pa.
WGAM	Orangeburg Radio Equipment Co.	Orangeburg, S. C.
WGAN	Lloyd, Cecil E.	Pensacola, Fla.
WGAQ	Patterson, W. G.	Shreveport, La.
WGAR	South American	Fort Smith, Ark.
*WGAS	Ray—Di—Co. Organization	Chicago, Illinois
WGAT	American Legion, Dept. of Nebraska	Lincoln, Neb.
WGAU	Limb, Marcus G.	Wooster, Ohio
WGAV	B. H. Radio Co.	Savannah, Ga.
WGAW	Albright, Ernest Co.	Philadelphia, Pa.
WGAX	Radio Elect. Co.	Washington, O.
WGAY	North Western Radio Co., Inc.	Madison, Wis.
WGAZ	South Bend Tribune	South Bend, Ind.
WGF	Register & Tribune, The	Des Moines, Iowa
WGH	Montgomery Light & Power Co.	Montgomery, Ala.
WGI	American Radio & Research Corporation	Medford Hillside, Mass.
WGL	Howlett, Thomas, F. J.	Philadelphia, Pa.
WGM	Atlanta Constitution	Atlanta, Ga.
WGR	Federal Telephone & Telegraph Co.	Buffalo, N. Y.
WGU	Fair, The	Chicago, Ill.
WGV	Interstate Electric Co.	New Orleans, La.
WGY	General Electric Co.	Schenectady, N. Y.
WHAA	State University of Iowa	Iowa City, Iowa
WHAB	Thompson, Clark W.	Galveston, Texas
WHAC	Cole Bros., Electric Co.	Waterloo, Iowa
WHAD	Marquette University	Milwaukee, Wis.
WHAE	Automotive Electric Serv. Co.	Sioux City, Iowa
*WHAF	Radio Electric Co.	Pittsburgh, Pa.
WHAG	University of Cincinnati	Cincinnati, O.
WHAH	Griffin, John T.	Joplin, Mo.
WHAI	Radio Equipment & Mfg. Co.	Davenport, Iowa
WHAJ	Bluefield Daily Telegraph	Bluefield, W. Va.
WHAK	Roberts Hardware Co.	Clarksburg, W. Va.
WHAL	Phillips, Jeffery & Derby	Lansing, Mich.
WHAM	University of Rochester	Rochester, N. Y.
WHAN	Southwestern Radio Co.	Wichita, Kan.
WHAO	Hill, F. A.	Savannah, Ga.
WHAP	Otta, Dewey L.	Decatur, Ill.
WHAQ	Semmes Motor Co.	Washington, D. C.
WHAR	Paramount Radio & Electric Co.	Atlantic City, N. J.
WHAS	Courier Journal & Louisville Times	Louisville, Ky.
WHAT	Yale Democrat & Yale Telephone Co.	Yale, Okla.
WHAU	Corinth Radio Supply Co.	Corinth, Miss.
WHAV	Wilmington Electrical Specialty Co.	Wilmington, Del.
WHAW	Pierce Elect. Co.	Tampa, Fla.
WHAX	Holyoke Street Ry. Co.	Holyoke, Mass.
WHAY	Huntington Press	Huntington, Ind.
WHAZ	Rensselaer Polytechnic Institute	Troy, N. Y.
WHA	University of Wisconsin	Madison, Wis.
WHB	Sweeney School Co.	Kansas City, Mo.
WHD	West Virginia University	Morgantown, W. Va.
WHK	Cox, Warren R.	Cleveland, O.
WHN	Ridgewood Times Printing & Publishing Co.	Ridgewood, N. Y.
WHQ	Rochester Times Union	Rochester, N. Y.
WHU	Duck Co., William B.	Toledo, Ohio
*WHW	Seeley, Stuart, W.	East Lansing, Mich.
WHX	Iowa Radio Corporation	Des Moines, Iowa
*WIAA	Waupaca Civic & Commerce Assn.	Waupaca, Wis.
WIAB	Joslyn Automobile Co.	Rockford, Ill.
WIAC	Galveston Tribune	Galveston, Texas
WIAD	Ocean City Yacht Club	Ocean City, N. J.
WIAE	Zimmerman, Mrs. Robert E.	Venton, Iowa
WIAF	De Cortin, Gustav A.	New Orleans, La.
WIAG	Matthews Elect. Supply Co.	Birmingham, Ala.
WIAH	Continental Radio Mfg. Co.	Newton, Iowa
WIAI	Heers Stores Co.	Springfield, Mo.
WIAJ	Fox River Valley Radio Supply Co.	Neenah, Wis.
WIAK	Journal Stockman, The	Omaha, Neb.
WIAL	Standard Radio Service Co.	Norwood, Ohio
WIAN	Chronicle & News Pub. Co.	Allentown, Pa.
WIAO	School of Engineering of Milwaukee & Wisconsin News	Milwaukee, Wis.
WIAP	Radio Development Corp.	Springfield, Mass.
WIAQ	Chronicle Publishing Co.	Marion, Ind.
WIAR	Rudy & Sons, J. A.	Paducah, Ky.
WIAS	Burlington Hawk Eye—Home Electric Co.	Burlington, Iowa
WIAT	Noel, Leon T.	Tarkio, Mo.
WIAU	American Trust & Savings Bank	Le Mars, Iowa
WIAV	New York Radio Laboratories	Binghamton, N. Y.
WIAW	Saginaw Radio & Elect. Co.	Saginaw, Mich.
*WIAX	Capital Radio Co.	Lincoln, Nebr.
WIAY	Woodward & Lothrop	Washington, D. C.
WIAZ	Electric Supply Sales Co.	Miami, Fla.
WIK	K. & L. Electric Co.	McKeesport, Pa.
WIL	Continental Electric Supply Co.	Washington, D. C.
WIP	Gimbel Brothers	Philadelphia, Pa.
WIZ	Cino Radio Mfg. Co.	Cincinnati, O.
WJAB	American Radio Co.	Lincoln, Neb.
*WJAC	Redell Co., The	Joplin, Mo.
WJAD	Jackson's Radio Eng. Lab.	Waco, Texas
*WJAE	Texas Radio Syndicate	San Antonio, Texas
WJAG	Huse Publishing Co.	Norfolk, Neb.
*WJAH	Central Park Amusement Co.	Rockford, Ill.
WJAJ	Y. M. C. A.	Dayton, O.
WJAK	White Radio Laboratory	Stockdale, O.
*WJAL	Victor Radio Corp.	Portland, Me.
WJAM	D. M. Perham	Cedar Rapids, Iowa
WJAN	Peoria Star & Peoria Radio Sales Co.	Peoria, Ill.
WJAP	Kelly Duluth Co.	Duluth, Minn.
WJAR	Outlet Co., The	Providence, R. I.
WSAS	Capper Publications	Topeka, Kans.
WJAT	Kelley-Vawter Jewelry Co.	Marshall, Mo.
*WJAV	Yankton College	Yankton, S. D.
WJAX	Union Trust Co.	Cleveland, O.
WJAZ	Chicago Radio Lab.	Chicago, Ill.
WJD	Howe, Richard H.	Granville, Ohio
WJH	White & Boyer Co.	Washington, D. C.
*WJK	Service Radio Equipment Co.	Toledo, Ohio
WJT	Electric Equipment Co.	Erie, Pa.
WJX	DeForest Radio Telephone & Telegraph Co.	New York, N. Y.
WJZ	Westinghouse Electric & Mg. Co.	Newark, N. J.
WKA	Landans Music & Jewelry Co.	Wilkes-Barre, Pa.
WKAA	Paar, H. F. & Republican Times	Cedar Rapids, Iowa
WKAC	Star Publishing Co.	Lincoln, Neb.
*WKAD	Looff, Charles	East Providence, R. I.
WKAF	W. S. Radio Supply Co.	Wichita Falls, Texas
*WKAG	Bruce, M. D., Edwin T.	Louisville, Ky.
WKAH	Planet Radio Co.	West Palm Beach, Fla.
WKAJ	Fargo Plumbing & Heating Co.	Fargo, N. D.
WKAK	Okfuskee County News	Okemah, Okla.
WKAL	Gray & Gray	Orange, Tex.
*WKAM	Hastings Daily Tribune	Hastings, Neb.
WKAN	Alabama Radio Mfg. Co.	Montgomery, Ala.
WKAP	Flint,Dutee Wilcox	Cranston, R. I.
WKAQ	Radio Corp. of Porto Rico	San Juan, P. R.
WKAR	Michigan Agri. College	East Lansing, Mich.
WKAS	Lines Music Co., L. E.	Soringfield, Mo.
WKAT	Frankfort Morning Times	Frankfort, Ind.
WKAV	Laconia Radio Club	Laconia, N. H.
WKAW	Turner Cycle Co.	Beloit, Wis.
WKAX	Macfarlane, William A.	Bridgeport, Conn.
WKAY	Brenau College	Gainesville, Ga.
*WKAZ	Landau's Music & Jewelry Co.	Wilkes-Barre, Pa.
WKC	Zamoiski Co., Joseph M.	Baltimore, Md.
WKN	Riechman-Crosby Co.	Memphis, Tenn.
WKY	Oklahoma Radio Shop	Oklahoma City, Okla.
WLAB	Grossman, George F.	Carrollton, Mo.
WLAC	North Carolina State College	Raleigh, N. C.
*WLAD	Arvanette Radio Supply Co.	Hastings, Neb.
*WLAF	Johnson Radio Co.	Lincoln, Neb.
WLAG	Cutting & Washington Radio Corp.	Minneapolis, Minn.
WLAH	Woodworth, Samuel	Syracuse N. Y.
WLAJ	Waco Electric Supply Co.	Waco, Texas
WLAK	Vermont Farm Machine Co.	Bellows Falls, Vt.
WLAL	Tulsa Radio Co.	Tulsa, Okla.
WLAM	Morrow Radio Co.	Springfield, O.
WLAN	Putnam Hardware Co.	Houlton, Me.
*WLAO	Anthracite Radio Shop	Scranton, Pa.
WLAP	Jordon, W. V.	Louisville, Ky.
WLAQ	Shilling, A. E.	Kalamazoo, Mich.
*WLAR	Mickel Music Co.	Marshalltown, Iowa
WLAS	Hutchinson Grain Radio Co.	Hutchinson, Kansas
WLAT	Bosch Co., Chas. G.	Burlington, Iowa
WLAV	Electric Shoo Inc.	Pensacola, Fla.
WLAW	New York Police Dept.	New York, N. Y.
WLAX	Greencastle Community Broadcasting Station	Greencastle, Ind.
WLAY	Northern Commercial Co. of Alaska	Fairbanks, Alaska
WLAZ	Hutton & Jones Elect. Co.	Warren, O.
WLB	University of Minnesota	Minneapolis, Minn.
WLDO	Anthracite Radio Shop	Scranton, Pa.
WLK	Hamilton Manufacturing Co.	Indianapolis, Ind.
WLW	Crosley Manufacturing Co.	Cincinnati, O.
WMA	Arrow Radio Laboratories	Anderson, Ind.
WMAB	Radio Supply Co.	Oklahoma City, Okla.
WMAC	Page, F. Edward	Cazenovia, N. Y.
WMAD	Atchinson County Mail	Rockport, Mo.
WMAF	Round Hills Radio Corp.	Dartmouth, Mass.
WMAG	The Tucker Electric Co.	Liberal, Kansas
WMAH	General Supply Co.	Lincoln, Neb.
WMAJ	Drovers Telegram Co.	Kansas City, Mo.
WMAK	Norton Laboratories	Lockport, N. Y.
WMAL	Trenton Hardware Co.	Trenton, N. J.
WMAM	Beaumont Radio Equipment Co.	Beaumont, Tex.
WMAN	Broad Street Baptist Church	Columbus, O.
WMAP	Utility Battery Service	Easton, Pa.
WMAQ	The Fair Corp. & The Chicago Daily News	Chicago, Ill.
WMAR	Waterloo Electrical Supply Co.	Waterloo, Iowa
WMAT	Paramount Radio Corp.	Duluth, Minn.
WMAU	Louisiana State Fair Ass'n	Shreveport, La.
WMAV	Alamaba Polytechnic Inst.	Auburn, Alabama
WMAW	Wahpeton Electric Co.	Wahpeton, N. D.
WMAX	K. & K. Radio Supply Co.	Ann Arbor, Mich.
WMAY	Kings Highway Presb. Church	St. Louis, Mo.
WMAZ	Mercer University	Macon, Ga.
WMB	Auburn Electrical Co.	Auburn, Me.
*WMC	Columbia Radio Co.	Youngstown, O.
WMC	Commercial Publishing Co.	Memphis, Tenn.
WMH	Precision Equipment Co.	Cincinnati, Ohio
WMU	Doubleday-Hill Electrical Co.	Washington, D. C.
WNAB	Park City Daily News	Bowling Green, Ky.
WNAC	Shepard Stores	Boston, Mass.
WNAD	Oklahoma Radio Eng. Co.	Norman, Okla.

Is your battery always fully charged and fit?

Is it always toned up for best results, whenever friends happen in—throughout every concert?

Keep it at full strength and prolong its life—the simple, easy, inexpensive Tungar way.

Tungar—the go-between from house-lighting circuit to storage battery—attaches wherever there is a lamp or convenience outlet.

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Tungar Battery Charger. Operates on Alternating Current.
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Special attachment for charging 12 or 24 cell "B" Storage Battery —$3.00 —fits either size Tungar.

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Tungar

BATTERY CHARGER

A GENERAL ELECTRIC PRODUCT

35A—96C

★ Tested and approved by RADIO BROADCAST ★

*WNAF	Enid Radio Distributing Co.	Enid, Okla.
*WNAG	Rathert Radio & Elect. Co.	Cresco, Iowa
*WNAH	Wilkes-Barre Radio Repair Shop	Wilkes-Barre, Pa.
*WNAJ	Benson Co.	Chicago, Ill.
WNAL	Rockwell, R. J.	Omaha, Neb.
WNAM	Ideal Apparatus Co.	Evansville, Ind.
WNAN	Syracuse Radio Tel. Co.	Syracuse, N. Y.
WNAP	Wittenberg College	Springfield, O.
WNAQ	Charleston Radio Electric Co.	Charleston, S. C.
WNAR	C. C. Rhodes	Butler, Mo.
WNAS	Texas Radio Corp.	Austin, Texas
WNAT	Lenning Bros. Co.	Philadelphia, Pa.
WNAV	People's Telep. & Teleg. Co.	Knoxville, Tenn.
WNAW	Peninsular Radio Club	Fort Monroe, Va.
WNAX	Dakota Radio Apparatus Co.	Yankton, S. Dak.
WNAY	Ship Owners Radio Service	Baltimore, Md.
WNJ	Shotton Radio Manufacturing Co.	Albany, N. Y.
WNO	Wireless Telephone Co. of Hudson County, N. J.	Jersey City, N. J.
WOAA	Hardy, Dr. Walter	Ardmore, Okla.
WOAB	Valley Radio	Grand Forks, N. D.
WOAC	Maus Radio Co.	Lima, O.
WOAD	Whitall Elect. Co.	Waterbury, Conn.
WOAE	Medland College	Fremont, Neb.
WOAF	Tyler Commercial College	Tyler, Tex.
WOAG	Apollo Theatre	Belvedere, Ill.
WOAH	Palmetto Radio Corp.	Charleston, S. C.
WOAI	Southern Equipment Co.	San Antonio, Texas
WOAJ	Ervins Electrical Co.	Parsons, Kans.
WOAK	Collins Hardware Co.	Frankfort, Ky.
WOAL	William E. Woods	Webster Grove, Mo.
WOAM	Arthur F. Breisch (temporary-1 day)	Bethlehem, Pa.
WOAN	Vaughn Conservatory of Music	Lawrenceburg, Tenn.
WOAO	Lyradion Mfg. Co.	Mishawaka, Ind.
WOAP	Kalamazoo College	Kalamazoo, Mich.
WOAQ	Portsmouth Radio Ass'n	Portsmouth, Va.
WOAR	Henry P. Lundskow	Kenosha, Wis.
WOAS	Bailey's Radio Shop	Middletown, Conn.
WOAT	Boyd Martell Hamp	Wilmington, Del.
WOAU	Sowder Bolling Piano Company	Evansville, Ind.
WOAV	Penn. National Guard	Erie, Pa.
WOAW	Woodmen of the World	Omaha, Neb.
WOAX	Franklyn J. Wolff	Trenton, N. J.
WOAY	John M. Wilder	Birmingham, Ala.
WOAZ	Penick Hughes Co.	Stanford, Texas
WOC	Palmer School of Chiropractic	Davenport, Iowa
*WOE	Buckeye Radio Service Co.	Akron, Ohio
*WOH	Hatfield Electric Co.	Indianapolis, Ind.
WOI	Iowa State College	Ames, Iowa
WOK	Pine Bluff Co.	Pine Bluff, Ark.
WOO	Wanamaker, John	Philadelphia, Pa.
WOQ	Western Radio Co.	Kansas City, Mo.
WOR	Bamberger & Co., L.	Newark, N. J.
WOS	Missouri State Marketing Bureau	Jefferson City, Mo.
WOU	Metropolitan Utilities District	Omaha, Neb.
WOZ	Palladium Printing Co.	Richmond, Ind.
WPA	Fort Worth Record	Fort Worth, Texas.
WPAB	Penn. State College	State College, Pa.
WPAC	Donaldson Radio Co.	Okmulgee, Okla.
WPAD	W. A. Wieboldt & Co.	Chicago, Ill.
WPAF	Peterson's Radio Co.	Council Bluffs, Iowa
WPAG	Central Radio Co., Inc.	Independence, Mo.
WPAH	Wisconsin Dept. of Markets	Waupaca, Wis.
WPAJ	Doolittle Radio Corporation	New Haven, Conn.
WPAK	North Dakota Agricultural College	N. D.
WPAL	Superior Radio & Tel. Equipment Co.	Columbus, Ohio
WPAM	Auerbach & Guettel	Topeka, Kans.
*WPAN	Levy Bros. Dry Goods Co.	Houston, Texas
WPAP	Theodore S. Phillips	Winchester, Ky.
WPAQ	General Sales & Engr. Co.	Frostburg, Md.
WPAR	R. A. Ward	Beloit, Kan.
WPAS	J. & M. Electric Co.	Amsterdam, N. Y.
WPAT	Saint Patrick's Cathedral	El Paso, Texas
WPAU	Concordia College	Moorhead, Minn.
WPAV	Tinetti & Sons. Paul	Laurium, Mich.
WPAW	Radio Installation Co., Inc.	Wilmington, Del.
WPAX	S—W Radio Co.	Thomasville, Ga.
WPAY	Bangor Radio Laboratory	Bangor, Maine
WPAZ	Koch, Dr. John R.	Charleston, W. Va.
WPB	Newspapers Printing Co.	Pittsburgh, Pa.
*WPE	Central Radio Co.	Kansas City, Mo.
WPG	Nushawg Poultry Farm	New Lebanon, O.
WPI	Electric Supply Co.	Clearfield, Pa.
*WPJ	St. Joseph's College	Philadelphia, Pa.
WPL	Fergus Electric Co.	Zanesville, O.
WPM	Williams, Thomas L.	Washington, D. C.
WPO	United Equipment Co.	Memphis, Tenn.
WQAA	Horace A. Beele, Jr.	Parkersburg, Pa.
WQAB	Southwest Missouri State Teachers' College	Springfield, Mo.
WQAC	Gish, E. B.	Amarillo, Texas
WQAD	Whitall Electric Co.	Waterbury, Conn.
WQAE	Moore Radio News Station	Springfield, Vt.
WQAF	Sandusky Register	Sandusky, O.
WQAH	Brock-Anderson Elect. Eng. Co.	Lexington, Ky.
WQAJ	Ann Arbor Times News	Ann Arbor, Mich.
WQAK	Appel-Higley Electric Co.	Dubuque, Iowa
WQAL	Cole County Tel. & Tel. Co.	Mattoon, Ill.
WQAM	Electrical Equipment Co.	Miami, Fla.
WQAN	Scranton Times	Scranton, Pa.
WQAO	Calvary Baptist Church	New York, N. Y.
WQAQ	West Texas Radio Co.	Abilene, Texas
WQAR	Press Publishing Co.	Muncie, Ind.
WQAS	Prince-Walter Co.	Lowell, Mass.
WQAT	Radio Equipment Corp.	Westhampton, Va.
WQAV	Huntington & Guerry, Inc.	Greenville, S. C.
WQAW	Catholic University of America	Washington, D. C.
WQAX	S—W Radio Co., J. R. Shumate, Jr.	Thomasville, Ga.
WQAY	Gaston Music & Furniture Co.	Hastings, Neb.
WQX	Walter A. Kushe	Chicago, Ill.
WRAA	Rice Institute	Houston, Tex.
WRAB	Savannah Board of Public Education	Savannah, Ga.
WRAC	State Normal School	Mayville, N. D.
WRAD	Taylor Radio Shop	Marion, Kan.
WRAH	Stanley N. Read	Providence, R. I.
WRAJ	Pickering Co., M. H.	Pittsburgh, Pa.
WRAM	Lombard College	Galesburg, Ill.
WRAN	Black Hawk Electric Company	Waterloo, Iowa
WRAO	Radio Service Co.	St. Louis, Mo.
WRAR	Jacob C. Thomas	David City, Neb.
WRAU	Amarillo Daily News	Amarillo, Tex.
WRAV	Antioch College	Yellow Springs, O.
WRAY	Radio Sales Corp.	Scranton, Pa.
WRK	Doran Brothers Electrical Co.	Hamilton, O.
WRL	Union College	Schenectady, N. Y.
WRM	University of Illinois	Urbana, Illinois
WRP	Federal Institute of Radio Telegraphy	Camden, N. J.
WRR	City of Dallas	Dallas, Tex.
WRW	Tarrytown Radio Research Laboratory	Tarrytown, N. Y.
WSAA	Sprague, B. S. Elect. Co.	Marietta, O.
WSAB	Southeast Missouri State Teachers' College	Cape Girardeau, Mo.
WSAC	Clemson Agricultural College	Clemson College, S. C.
WSAH	Leonard, A. G., Jr.	Chicago, Ill.
WSAJ	Grove City College	Grove City, Pa.
WSAL	Franklin Elect. Co.	Brookville, Ind.
WSAS	State of Nebraska	Lincoln, Neb.
WSAT	The Plainview Electric Co.	Plainview, Texas
WSAV	Radio Construction Co.	Houston, Texas
WSB	Atlanta Journal	Atlanta, Ga.
WSL	J. & M. Electric Co.	Utica, N. Y.
*WSN	Ship Owners Radio Service	Norfolk, Va.
WSV	Hunter, L. M. & G. L. Carrington	Little Rock, Ark.
*WSX	Erie Radio Co.	Erie, Pa.
WSY	Alabama Power Co.	Birmingham, Ala.
WSZ	Marshall-Gerkin Co.	Toledo, O.
WTAC	Penn. Traffic Co.	Johnstown, Pa.
WTAS	Carpenter, George D.,	Elgin, Ill.
WTAU	Ruegy Battery & Electric Co.	Tecumseh, Neb.
WTAW	Agricultural & Mechanical College of Texas	College Station, Texas
WTG	Kansas State Agricultural College	Manhattan, Kan.
WTK	Paris Radio Electric Co.	Paris, Tex.
WTP	McBridge, George M.	Bay City, Mich.
WWAC	Sanger Bros.	Waco, Texas
WWAD	Wright & Wright, Inc.	Philadelphia, Pa.
WWAH	General Supply Co.	Lincoln, Neb.
WWAX	Worman Bros.	Laredo, Tex.
WWAY	Marigold Gardens	Chicago, Ill.
WWB	Daily News Printing Co.	Canton, O.
WWI	Ford Motor Co.	Dearborn, Mich.
WWJ	Detroit News	Detroit, Mich.
WWL	Loyola University	New Orleans, La.
WWT	McCarthy Bros. & Ford	Buffalo, N. Y.
WWZ	Wanamaker, John	New York, N. Y.
CFAC	Radio Corp. of Calgary, Ltd.,	Calgary, Alberta
CFCA	Star Pub. and Printing Co.	Toronto, Ontario
CFCB	Marconi Wireless Telegraph Co. of Canada, Ltd.	Vancouver, B. C.
CFCD	Canadian Westinghouse Co., Ltd.	Winnipeg, Manitoba
CFCE	Marconi W. T. Co. of Canada	Halifax, N. S.
CFCF	Marconi W. T. Co. of Canada, Ltd.	Montreal, Quebec
CFCH	Abitibi Power and Paper Co., Ltd.	Iroquois Falls, Ontario
CFCI	Motor Products Corp.	Walkersville, Ontario
CFCN	W. W. Grant Radio, Ltd.	Calgary, Alberta
CFCX	The London Advertiser	London, Ontario
CFPC	International Radio Development Co.	Fort Frances, Ontario
CFTC	The Bell Telephone Co. of Canada	Toronto, Ontario
CFUC	University of Montreal	Montreal, Quebec
CFVC	Roy Russell Brown	Courtenay, British Columbia
CFYC	Victor Wentworth Odium	Vancouver, B. C.
CFZC	Canadian Westinghouse Co., Ltd.	Montreal, Quebec
CHAC	Radio Engineers, Ltd.	Nova Scotia, Halifax
CHBC	The Albertan Publishing Co.	Calgary, Alberta
CHCA	Radio Corp. of Vancouver, Ltd.	Vancouver, B. C.
CHCB	Marconi W. T. Co. of Canada, Ltd.	Toronto, Ontario
CHCC	Canadian Westinghouse Co., Ltd.	Edmonton, Alberta
CHCF	Radio Corp. of Winnipeg, Ltd.	Winnipeg, Manitoba
CHCQ	The Western Radio Co., Ltd.	Calgary, Alberta
CHCS	London Radio Shoppe	London, Ontario
CHCX	B. L. Silver	Montreal, Quebec
CHCZ	The Globe Printing Co.	Toronto, Ontario
CHFC	John Millen & Sons, Ltd.	Toronto, Ontario
CHIC	Canadian Westinghouse Co., Ltd.	Hamilton, Ontario
CHOC	Canadian Westinghouse Co., Ltd.	Vancouver, B. C.
CHVC	Metropolitan Motors, Ltd.	Toronto, Ontario
CHXC	J. R. Booth, Jr.	Ottawa, Ontario
CHYC	Northern Electric Co.	Montreal, Quebec
CJBC	Dupuis Freres	Montreal, Quebec

3 Letters! and they will be interesting to every — radio user.

HUDSON MOTOR CAR COMPANY OF N.Y.
INCORPORATED
DISTRIBUTORS OF
HUDSON AND ESSEX MOTOR CARS
1423 REDFORD AVE.
BROOKLYN

November 23rd, 1922

Acme Apparatus Company
Cambridge, Mass.

Gentlemen::—

It will possibly be of interest to you to know that with the aid of your radio Frequency Transformers R2, R3 and R4, I have built an ideal set. This set brings in PWX, Havana, as clear as a bell any time that I care to hear him. I have also reached other stations that I never knew existed. Last night I hooked up 3 Transformers in place of yours, and with the stations that I received there was enough howls and yells to make one think that all Hell was let loose at once, so put the old Acme's back and the loud speaker started to give out some real music. This set has given such satisfaction that I simply couldn't refrain from writing you to let you know that you have satisfied at least one Radio Bug. However, I might add that I am using a loop antenna and my tuner consists of only 2 Variable condensers, one 43 plate and one 3 plate hooked right across the loop outlet.

Please do not think that this is the first set I have ever seen and that my enthusiasm is running away with me. I have owned a . . . . a step and a . . . . and have also built numerous other sets, but this Acme Radio Frequency Transformer sure has the world licked.

Very truly yours,
Hudson Motor Car Company of N. Y., Inc.

John M Craig

Service Manager

ACME APPARATUS COMPANY
TRANSFORMER AND RADIO ENGINEERS AND MANUFACTURERS
186 MASSACHUSETTS AVENUE
CAMBRIDGE 39, MASS., U.S.A.

Mr. John M. Craig
510 St. Marks Avenue
Brooklyn, N. Y.

December 7th, 1922

Dear Sir:—

We wish to thank you for your letter of November 23rd and would like to know if you would be willing to allow us to use this as a testimonial either with or without vour name.

We worked for practically nine months before putting a radio frequency amplifying transformer on the market and it is exceedingly gratifying to receive such letters as yours as a reward for this endeavor.

Yours very truly,
ACME APPARATUS COMPANY

G M Bertram

Per Chief Engineer

HUDSON MOTOR CAR COMPANY OF N.Y.
INCORPORATED
DISTRIBUTORS OF
HUDSON AND ESSEX MOTOR CARS
1423 REDFORD AVE.
BROOKLYN

Mr. G. E. M. Bertram
186 Massachusetts Ave.,
Cambridge, Mass.

December 8th, 1922

Dear Sir:—

Your letter of the 7th instant came to hand this morning, and in reply would say that you are at liberty to use my letter of November 23rd, in any way you desire, with or without my name. I might add that I know of four sets copied from mine that are giving results equal to mine.

On Wednesday evening I had a transmission engineer from the New York Telephone Company out to my homc and believe me he was the most surprised man I have seen in some time. Without having ever seen my set, in twenty minutes he tuned in PWX, WOC, WBAP, WSB and several near stations. What pleased him especially was that he could tune in the 200 meter stations as well as the 400 meter boys.

Very truly yours,
Hudson Motor Car Company of N. Y., Inc.

John M Craig

JMC:N
510 St. Marks Avenue
Brooklyn, N. Y.

Service Manager

YOU can purchase all Acme Transformers at radio stores. If your dealer does not carry them, we will see that you are taken care of. Leaflets describing hook-ups for various Acme Transformers will be sent on request.

THE ACME APPARATUS COMPANY
(Pioneer transformer and radio engineers and manufacturers.)
CAMBRIDGE, MASS., U. S. A.

New York — 1270 Broadway
Chicago — 184 W. Washington Street

ACME ★ ~ for amplification

★ Tested and approved by RADIO BROADCAST ★

CJCA	The Edmonton Journal, Ltd.,	Edmonton, Alberta	
CJCB	James Gordon Bennett	Nelson, British Columbia	
CJCD	T. Eaton Co., Ltd.	Toronto, Ontario	
CJCE	Vancouver Sun Radiotelephones, Ltd.	Vancouver, B. C.	
CJCF	News Record, Ltd.	Kitchener, Ontario	
CJCG	Manitoba Free Press Co., Ltd.	Winnipeg, Manitoba	
CJCH	The United Farmers of Ontario	Toronto, Ontario	
CJCI	McLean, Holt & Co., Ltd.	St. John, New Brunswick	
CJCN	Simons Agnew & Co.	Toronto, Ontario	
CJCS	Eastern Tel. and Tel. Co., Ltd.	Halifax, Nova Scotia	
CJCY	Edmund Taylor	Calgary, Alberta	
CJGC	London Free Press Printing Co., Ltd.	London, Ontario	
CJNC	Tribune Newspaper Co., Ltd.	Winnipeg, Manitoba	
CJSC	The Evening Telegram	Toronto, Ontario	
CKAC	La Presse Publishing Co.	Montreal, Quebec	
CKCB	T. Eaton Co., Ltd.	Winnipeg, Manitoba	
CKCD	Vancouver Daily Province	Vancouver, B. C.	
CKCE	Canadian Independent Tel. Co., Ltd.	Toronto, Ontario	
CKCK	Leader Publishing Co., Ltd.,	Regina, Saskatchewan	
CKCR	Jones Electric Radio Co.	St. John, New Brunswick	
CKCS	The Bell Telephone Co. of Canada	Montreal, Quebec	
CKCZ	Canadian Westinghouse Co., Ltd.	Toronto, Ontario	
CKKC	Radio Equipment and Supply Co.	Toronto, Ontario	
CKOC	The Wentworth Radio Supply Co.	Hamilton, Ontario	
CKQC	Radio Supply Co. of London	London, Ontario	
CKZC	Salton Radio Engineering Co.	Winnipeg, Manitoba	

THE GRID

(*Continued from page 79*)

tion seldom desirable in receiving other than continuous wave signals.

However, as the grid or secondary circuit is of course in resonance with the primary, the set is theoretically more efficient when the plate circuit is likewise in perfect tune with the received wave, i.e., each and every circuit is coöperating to make the most of the energy picked up by the antenna. As before explained, it is impracticable to realize this condition often (except in super-regeneration) due to the circuit falling into an oscillating state; but the experienced operator effects a compromise by slightly lowering the filament, and continuing to tune the plate circuit toward resonance. A happy medium resulting in the loudest signals may be thus achieved, when the plate circuit is almost resonant, and the detector filament lowered *just enough to prevent oscillations without impairing the efficiency of the tube.* Needless to say, the life of the bulb is prolonged by this finesse.

The phenomena of tickler and variometer regeneration were explained in detail in the December GRID.

Regeneration in the De Forest ultra-audion circuit can be controlled, but to a lesser degree than is possible in variometer and tickler circuits. Control is principally effected by the coupling condenser between the plate and filament. In many cases the oscillations may be rendered less critical by varying the grid leak, grid condenser, filament rheostat or a B battery potentiometer.

Whatever advantage exists in a circuit combining both tickler and variometer regeneration is counteracted by the critical and unstable operation. However, some amateurs, familiar with the idiosyncrasies of the circuit, have experienced phenomenal results using a three coil (primary, secondary and tickler) honeycomb set, with variometers in the grid and plate circuits.

A very effective combination of tuned plate and tickler feed-back can be easily secured by shunting the tickler coil (a half dozen or so turns under the normal size) by a twenty-three plate variable condenser.

ARTIFICIAL STRAYS

We are troubled here with a Cotterell dust precipitating plant at the smelter, and so far it has been impossible to use a receiver on account of the Cotterell making more noise than the incoming signals. However, I think, perhaps, that a radio-frequency outfit may work through this. What are your ideas?

—W. H. M., MIAMI, ARIZONA.

DUST precipitating arrangements, as well as those for the elimination of heavy factory smoke, operate on the principle of the electrical attraction and repulsion of charged conductors on small particles, such as dust and carbon (smoke). Many achieve this effect by means of high potentials which, continually breaking down in the process of charging the microscopic matter, set up radio waves. Nearby X-ray and high-frequency apparatus causes similar QRM (interference), as well as do radio-frequency machines for the cultivation of plants and gardens. These last consist primarily of an antenna suspended over a ground (the area under cultivation) and create such an atmospheric disturbance that they have attracted government attention. It is contended by some that the agricultural enterprise is no other than a radio station transmitting without a license, and should be prosecuted as such!

Radio-frequency amplification will doubtless be helpful in almost every case, and in many instances will eliminate such artificial static.

If the disturbance is of audio frequency, due to powerful induction, and inductively coupled receiver (one having primary and secondary, with no metallic circuit between the audion and the antenna system) will help matters, and radio-frequency amplification, which is nothing more than additional couplers, will silence the last undesired crash.

If the interference is in the form of a wireless wave, the solution is more difficult, and next to impossible when the predominant wave of the interfering signal is that which it is desired to receive. There is generally a certain frequency (or wave) in all radio oscillations which carries most of the power. However, due to broadness of the wave (or proximity of the station, in which case oscillations are forced on almost any frequency) the signals, though loudest at the resonant or predominant point, will be heard on more than one degree of the tuning scale. This resonant point may be determined by merely tuning over the range of the set, and noting where the signals are of the greatest intensity. If this wavelength is other than that which it is desired to receive, radio-frequency amplification will help matters, each step acting as a filter, passing and amplifying the genuine signal, but descriminating against the pirateering stray.

Engineers might consider this matter, and design dust precipitating and similar apparatus, so that the emitted wave is predominantly of a non-interfering frequency.

The wireless world is beginning to appreciate the possibilities of radio frequency!