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v. 2 #1

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Radio Broadcast

ARTHUR H. LYNCH, EDITOR

CONTENTS FOR NOVEMBER, 1922

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"Treasures of gold and jade" said Lao Tzu, "deserve a proper dwelling!"
"Grebe Radio is now housed in a manner befitting its excellence"
Doctor Wu

IN THE SHADOW OF THE STATUE OF LIBERTY

The U. S. Army Station at Fort Wood, N. Y., which broadcasts radio instruction and entertainment

RADIO BROADCAST

Vol. 2 No. 1 November, 1922

The March of Radio

TOO MANY COOKS ARE SPOILING OUR BROTH

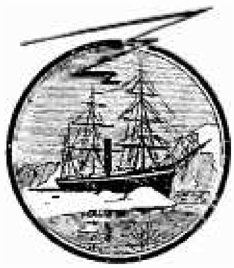
EVERY month sees a remarkable growth in the number of stations licensed for radio broadcasting. This might be taken as a sign of the healthy growth of the new art, but a little reflection seems to point to the opposite conclusion. Apparently, a broadcasting license is to be had for the asking. The question now arises: Is this encouragement of broadcasting stations the policy which will make for the best development of radio and its appreciation by the listening public? It seems to us that a curb should be put upon the licensing of broadcasting stations or there will soon be country-wide troubles of the kind which recently occurred near New York—conflicts between the various stations for the most desirable hours and the resulting interference of signals between the several stations, which made listening-in no pleasure.

There are at present nearly 500 licensed broadcasting stations in the United States, and this list is being augmented each week; in one week recently there were 26 new licenses issued. Probably the majority of these stations are being operated by manufacturers and dealers, but many are controlled by the press. It looks as if we shall soon have 1000 licensed stations, which means that it is about time to inquire how many of them will be operated in such a fashion as to increase the interest of the public in radio and how many of them will merely send out advertising noise.

A radio enthusiast from the Middle South recently related, in reply to our inquiry as to the progress of radio in his vicinity, with much disgust and vehemence the nuisances he and his fellow amateurs had been forced to put up with. They had all worked hard to perfect their sets so as to get some of the better transmitting stations. Frequently two or three of them worked together, combining their supply of tubes and accessories, and in this way they had been able to get radio concerts from some of the stations three hundred miles distant. But a few months previous to our inquiry a small local newspaper, sensing the possible advertising value of a broadcasting station, had obtained a license and had put into operation a set which the local radio fans declared to be "simply rotten." And this newspaper station runs when it wants to, on exactly the same wavelength as the good stations to which the amateurs had been accustomed to listen. "It has killed interest in the game around R——," said the Southerner.

Now, with the rapid increase in the number of stations, isn't this situation going to be duplicated elsewhere? And isn't the progress of radio and the interest of the public going to suffer seriously as a result? It seems almost certain, for it must be remembered that all broadcasting licenses are as yet being issued with permission to transmit only on 360 meters. Every one of these stations which is within a reasonable distance of the listener will tune in at about the same adjustment of the receiving set.

Lost in the mazes of Congressional procedure there is a radio bill, introduced in the House more than three months ago by Mr. White. This bill was intended by its framers to obviate the interference which, we firmly believe, is sure to occur soon. It gives Secretary Hoover more power over the control of radio than does the older radio law of 1912 and if the bill should be passed, the broadcasting situation might be remedied at once, by assigning to the various stations which are close enough to interfere, widely different wavelengths. If this had been done in the case of the Southern town already referred to, skilled amateurs with well-built sets could have listened to their distant "good" stations without any interference from the local newspaper. This station might then have poured out its advertising propaganda into an ether channel to which no sets within its range were tuned.



This reapportionment of wavelengths would evidently react to improve the quality of the broadcasting stations. Suppose that one station, with poor transmission, sends out a wretched programme on, say, 325 meters, and another in the same neighborhood sends out an excellent one on 375 meters.

With the usual broadcast procedure the announcers at both stations would, at the end of the programme, ask for comments and suggestions from the listeners. No one would have been listening on 325 meters, so no suggestions would be received and the owner of the station would soon find out that his signals were being sent to "deaf" radio sets, sets which had purposely shut out his message. He would then have to improve his station or stop transmitting.

In the re-apportionment, the longer wavelengths assigned to broadcasting should be given to the more powerful metropolitan stations, those which can afford better talent for their programmes. More power can be radiated on the longer wavelengths than on the shorter ones, so the shorter ones should be kept for the small radio jobbers and newspapers, whose programmes will generally be only of local interest.

A CASE IN POINT

IN OUR last issue we made comment on the advisability of installing emergency antennas on board vessels and also suggested that airplanes could utilize emergency aerials, carried by a balloon or kite, to help them out of difficulties in case of forced landing in sparsely settled territory. Scarcely was the ink dry when there came the report of a plane being forced to land—because of engine trouble, in a remote region—and the aviator having to walk twenty miles to the nearest place where help could be obtained.

As the number of airplanes increases—and the increase will undoubtedly be rapid during the next few years—there will be a correspondingly growing demand for dependable means of communication in case of necessity.

A twenty-mile walk sufficed in this case, but the next time it may be farther and over more difficult terrain; or it may be impossible. Unless the radio apparatus was seriously damaged, it would surely have been able to summon help with a kite or balloon-flown antenna and so have minimized the danger which was present in this instance.

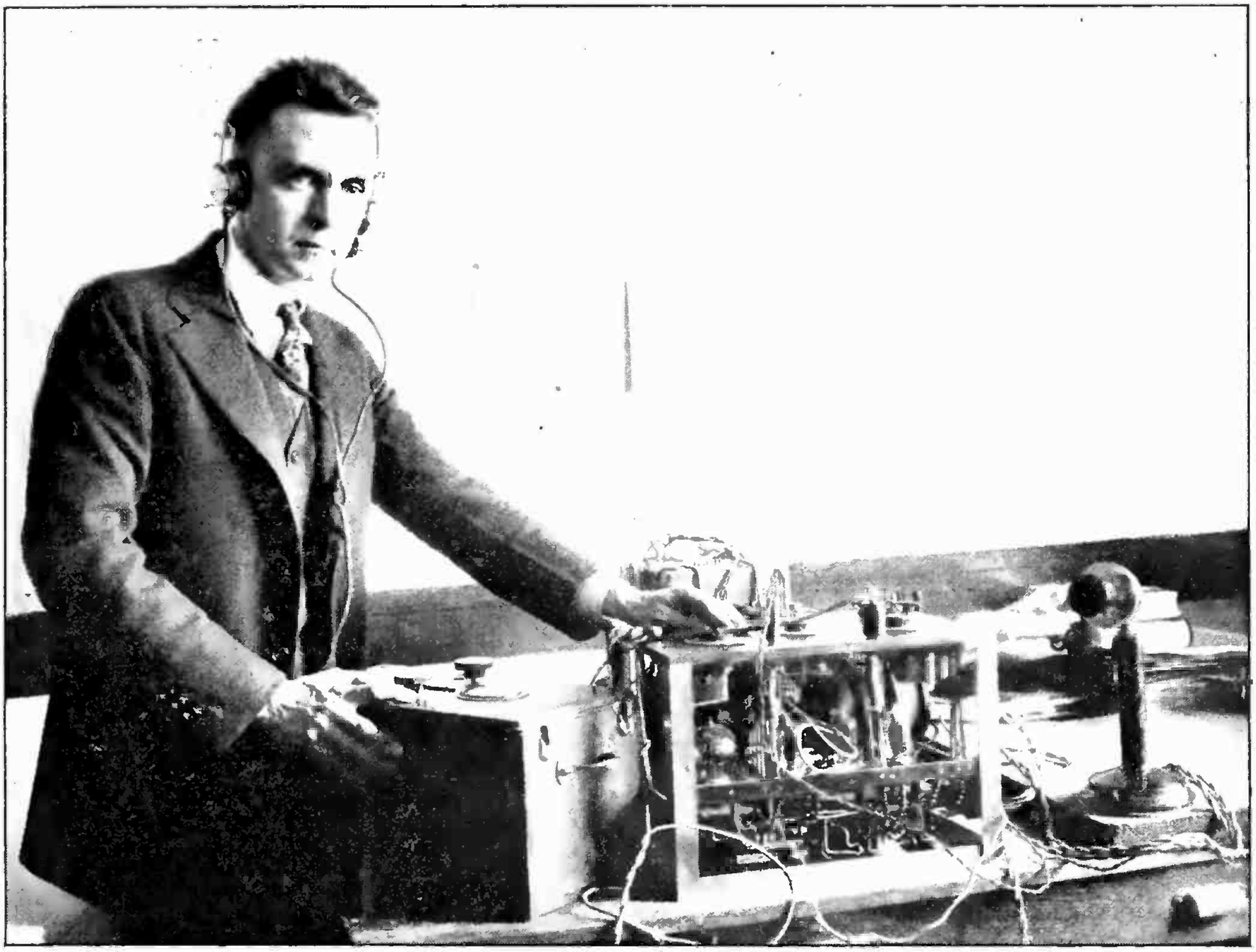
SECRET RADIO

RUMORS are continually indicating that secret radio, or super-radio, as someone has styled it, is soon to appear. Although our present knowledge of radio leads us to believe that this is practically impossible, we have seen sufficient recent development along spectacular lines to retain an open mind on such a question as this.

There are various lines along which such a development might take place, but it is very likely that our guess as to the direction from which it will come will prove wrong. Marconi's recent demonstration showed us that short-wave radio is quite possible and practical, and this is secret, to a certain extent, when compared to the present radio. The directional short-wave communication would eliminate all listeners except those quite close to the line joining the sending and listening stations; thus if the stations were 100 miles apart only those listeners in a band between the stations, perhaps 10 miles wide, could overhear the conversation. Of course this would not give a great deal of secrecy, but compared to the present scheme, which permits every one within 100 miles of the transmitting station to hear as well as does the intended listener, the 10 mile band would be quite exclusive communication.

Another likely development may use two waves for transmission instead of one, and the style of modulation be such that a receiving set must be properly tuned to both of these waves at the same time to get intelligible conversation. It would be extremely difficult for an undesired listener to eavesdrop by properly adjusting his set for the complex tuning condition, and, if necessary, the transmitting station could use a series of these double wave-bands, after notifying the *bona fide* listener by code letter or otherwise of the new combination to which he was going to shift. This double-wave scheme may never be allowed, however, as it "uses up" two channels in the ether and so will cause twice as much interference as at present. Which heaven forbid!

Another possible scheme, used to some extent during the war, is to record the signal which it is desired to communicate at ordinary speed on a phonograph disc or similar device, taking perhaps five minutes to make the complete record. The disc may then be used to excite the transmitting set, but it is run at, say, ten times normal speed, so that any one listening would get nothing but a few seconds of unintelligible blur. The listening station for which the message is intended, however, would, at the proper time, employ an automatic recording machine running at a rapid speed and let its receiving circuit make a record on the disc. The disc is then used to reproduce the message intelligibly by "playing" it through the phonograph at one tenth the speed it had while recording the received signal. This scheme is evidently of no use for secrecy in ordinary conversation as it takes too long.



© Harris & Ewing

R. D. DUNCAN, JR.
Demonstrating the Superphone, credited as a system capable of secret radio communication

BETTER RADIO EQUIPMENT FOR OUR SUBMARINES

SINCE the war, the radio experts employed by the Navy have been at work on the improvement of sets for submarines; and the

Navy Department has announced that when these new sets are installed, the reliable range of radio communication for our submarines should be more than 200 miles in the daytime. It is the belief of the naval authorities that these new radio outfits will put our submarine force at least on a par with that of any other nation in so far as radio is concerned.

The new sets are the outcome of experimental development by experts employed by the Navy, whereas the sets previously in use were designed and built by commercial concerns. But little new apparatus was required for the assembly of the new sets as most of the material which enters into the construction was already in Navy stores or in existing sets; it is estimated that if the new equipment had been purchased from a commercial concern it would have cost at least $5500 a set, but as it is, the outlay will be only about $500 a set, thus showing a "paper" saving of about $300,000, as 59 of the new sets are being built.

"SCIENCE COMES TO YOU ONLY THROUGH YOUR FINGERS"

HOW well we remember, from our high-school days, the "shopwork" which was given as a special course by the physics teacher to those students in his courses who showed special aptitude. Although the equipment was poor and insufficient, it seemed that an understanding of physics came to us more rapidly when talking and working with the instructor in the shop than by any amount of home study. In fact, we are inclined to believe a well-known physics teacher who said "Science comes to you only through your fingers." To be sure, shop and laboratory work can never compensate for lack of mental concentration such as is required for the solution of problems and analysis of theorems, but the interest of the student in a subject is absolutely necessary before useful concentration is possible, and this interest, this desire to know, constitutes the lasting benefits derived from shop and laboratory work.

Thirty years ago the instructor in shop courses was rather nonplussed to find jobs for his student workers. We well remember the glass-plate electric machines which took so many afternoons to build and which had practically no use after they were built. Of course we discovered that it was difficult to glue glass plates to wood without having them crack and experience taught us how to drill holes properly in the glass plates, but how much more we learned when allowed to build a small dynamo! It worked—and we could light small lamps with it and charge the storage batteries which we also built in the shop. This generator gave us more appreciation of Faraday's laws than any amount of study and lecture.

Boys' high school shop and manual training courses are probably helping their choice of a career even more than a generation ago, not only because of the excellent equipment now general in our better schools, but because of the more fascinating work which it is now possible to carry out. The present interest in radio and the comparative ease with which apparatus can be built makes the work of the manual training instructor much pleasanter and more absorbing than in earlier days. The boys we know to-day are actually anxious for the shop periods to arrive.

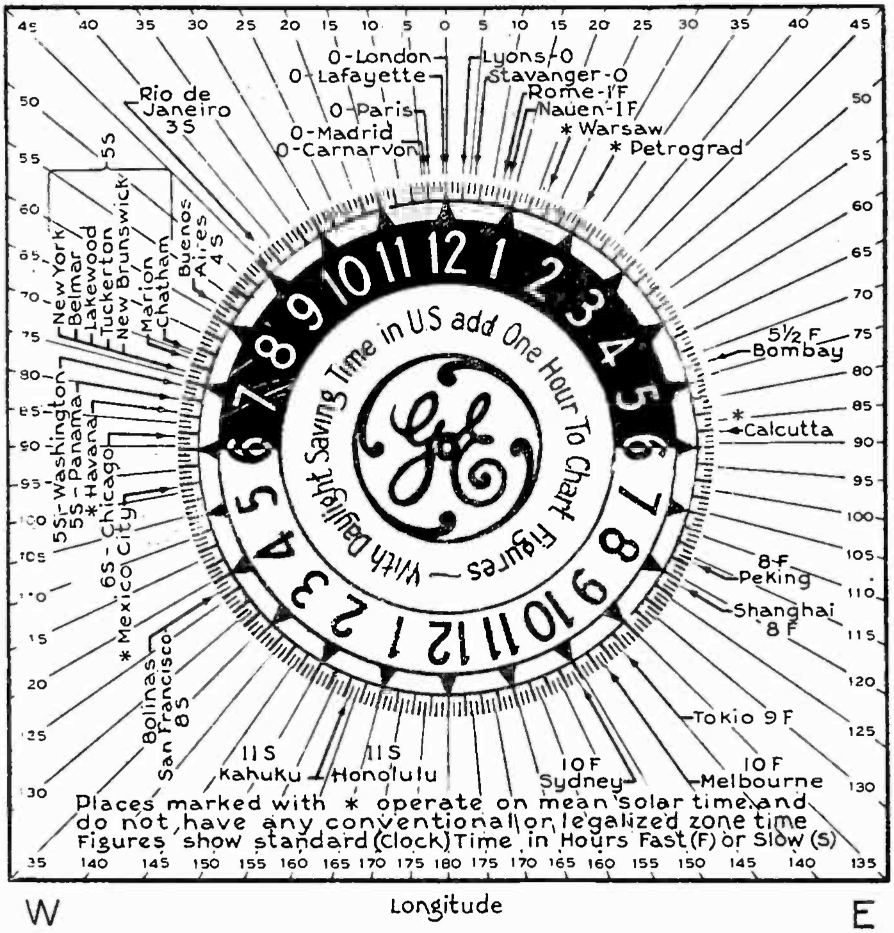
To make a radio set which will work, and work well, is a great incentive for any boy to-day—especially as his parents are probably almost as eager as he is to have it completed, so he can set it up at home. Not only is it possible to teach him to saw straight and hit a nail square and use a lathe in making the radio set, but, during the construction of the apparatus, information as to how the thing works will be eagerly sought by the student from his instructor—information which would have to be forced on him if presented in the course of ordinary classroom exercises.

SENDING AND RECEIVING ON A TYPEWRITER

THE achievements of radio have already been so remarkable that scarcely any announcement of new uses can surprise us. By the most delicate and complicated relays, radio serves to guide a battleship in maneuvers, it utilizes the thousandth part of a watt of power to control accurately the output of a generator supplying hundreds of kilowatts to the antenna, and it utilizes the swing of a clock pendulum to send out time signals over all the earth's surface.

Being necessarily in the habit of admitting practically anything as possible, we are ready to accept the report issuing from Washington that recent Naval Air Service experiments have shown it possible to utilize the "teletype" in radio communication. Two typewriters, of special construction and operation, are used in such a manner that the operator at the transmitting station, instead of manipulating the ordinary telegraph key to send out code signals, sends with the typewriter keyboard just as though he were actually typewriting. Pressing the *a* key of the machine, for example, makes the radio transmitter send letter *a* in code. At the receiving station this code *a* acts on a set of selective relays in such a way that the *a* of the receiving typewriter is depressed and written just as though the receiving operator himself had struck the key. Thus, as the transmitting operator works his typewriter keyboard, a typewritten copy of the message is automatically made at the receiving station. The teletype, as the automatic typewriter is called, has been used on land lines for several years so that its application to radio was expected and was sure to occur when sufficient research had eliminated the troubles first encountered. This new departure in radio will make for more reliability in transmitting orders, according to the Navy Department, as it does away, to a large degree, with the possibility of operator's errors. So far, the teletype has proved successful from plane to ground over a distance of several miles, and the reverse operation, from ground to plane, will probably soon follow.

WORLD TIME CHART



Courtesy of General Electric Co.

If you mount this chart on a piece of cardboard and cut around the outside circle with a sharp knife and run a pin through the center to form an axle, you may tell the hour in any of the places indicated for a given hour in any other place

BROADCASTING HEALTH

ONE possibility in radio broadcasting which has not been developed nearly as much as is warranted by its importance, is the dissemination of information regarding health; not, for example, the municipal arrangements for guarding against epidemics, but timely personal advice such as a good family physician gives. How many people suffer unnecessarily from severe colds at certain times of the year! How many people go off on vacations and attempt such an extraordinary programme of exercising that they come back to their everyday occupation not refreshed, but thoroughly "played out"—what an eloquent phrase, that is!—after their vacation. And how many people get indigestion by eating too rapidly and exercising violently right after eating!

Everybody knows that these habits are to be avoided, but it needs more than knowledge to alter the ordinary man's method of living; he generally persists in a certain course until a visit to the doctor, or possibly the hospital, convinces him that he should have brought his habits of living into conformity with the dictates of common sense. If there were periodic radio talks on health and healthy living by reputable physicians, a real good might be accomplished. A physician can help us more by preventive measures when we are well than curative measures after we are "down and out"; yet we practically never consult a physician until we are forced to do so by illness.

In recommending brief talks along this line we feel that those who arrange the programmes must be ever careful that only recognized authorities be allowed to address the radio audience.

RADIO'S RELIABILITY

CONSIDERING the pride with which we, as a nation, point out our radio achievements, it seems strange that in crucial tests, radio should occasionally so lamentably fail. When the N. C. planes were preparing for their remarkable trip across the Atlantic, we were informed that the radio equipment aboard was of the very best type, that the radio personnel was the most capable the Navy could command, and that the range of transmission and reception was several hundred miles. We stationed destroyers, fitted with powerful radio equipment, every few miles along the route—yet the planes were soon "lost" as far as radio was concerned, when they should never have been more than perhaps fifty miles from a destroyer! And now we read of the recent trip of the army airship C-2 making a carefully planned trip from Aberdeen, Md., to New York and back, and as far as radio was concerned, she was apparently lost soon after leaving the ground—trouble with the apparatus prevented communication with land, although the ship was only a few hundred feet high.

Incidentally, this trip was made with a hydrogen filled balloon, the same kind as has on two recent occasions caused such a large loss of life. We are informed that the purpose of the trip was to show the practicability of night flying. In this respect the trip was successful. But how successful would it have been had it been necessary to make a forced landing, and had the bag come in contact with high voltage wires—or had it been fired by atmospheric discharges?

Of course, since no lives were lost and the army was not deprived of some of its most skilled personnel, the question may seem out of order, but we do wonder where was the explosion-proof helium about which we boasted so much a short time ago—the helium taken out of that other ill-fated dirigible and stored in tanks under strict guard, while our skilled and valuable officers and men, in carrying out tests which the good of the service seems to demand, go aloft through lightning storms and over electric wires under thousands of cubic feet of dangerous gas.

J. H. M.

THE REMAINS OF THE "ROMA"

America can ill afford to lose her most skilful birdmen and none but the most skilful are charged with the flying of our huge dirigibles. Non-explosive gas and efficient radio can greatly reduce the hazards of air navigation

© Wide World Photos

Phoning Home from Mid-Ocean

How the Problem of Simultaneous Radiophone Transmission and Reception Was Solved Aboard the S. S. *America*, and Reliable Communication Routed Direct from a Land Radio Station to Telephone Subscribers. An Indication of a Home-to-Stateroom Telephone Service that May Soon Be Generally Applied

By G. HAROLD PORTER
General Superintendent, Marine Dept., Radio Corporation of America

WHEN the steamship *America* sailed from New York on April 15th, 1922, destined for her usual brief visit to European ports, little did the public realize the significance attached to this particular trip. To a group of eminent engineers this was more important than the maiden trip of the big vessel, for her radio cabin held certain secrets that were close to their hearts.

The combined efforts of these men, representing the Radio Corporation of America, the General Electric Company, the American Telephone and Telegraph Company, and the Western Electric Company, have been focused for some time on the problem of establishing a shipboard radio telephone exchange. This, they intended, should provide the interchange of intelligence at sea, on a limited scale, with the same facility with which present land telephones handle the communications of our nation.

The realization of this plan in the form of a practical working radio service between ships on the high seas and land stations would provide a communication system differing radically from that which is now in universal use. Manifold problems would find their solution in the successful conclusion of this venture which, since the very birth of radio, has been the subject of untiring study.

In the wake of progress, it is natural that we should find methods of the past superseded by the ever increasing products of advanced research. Radio is no exception. The principal undesirable feature of present-day radio systems, which the engineers working on the *America's* installation sought to supplant, was the switch employed for changing from the sending to the receiving conditions and *vice versa*.

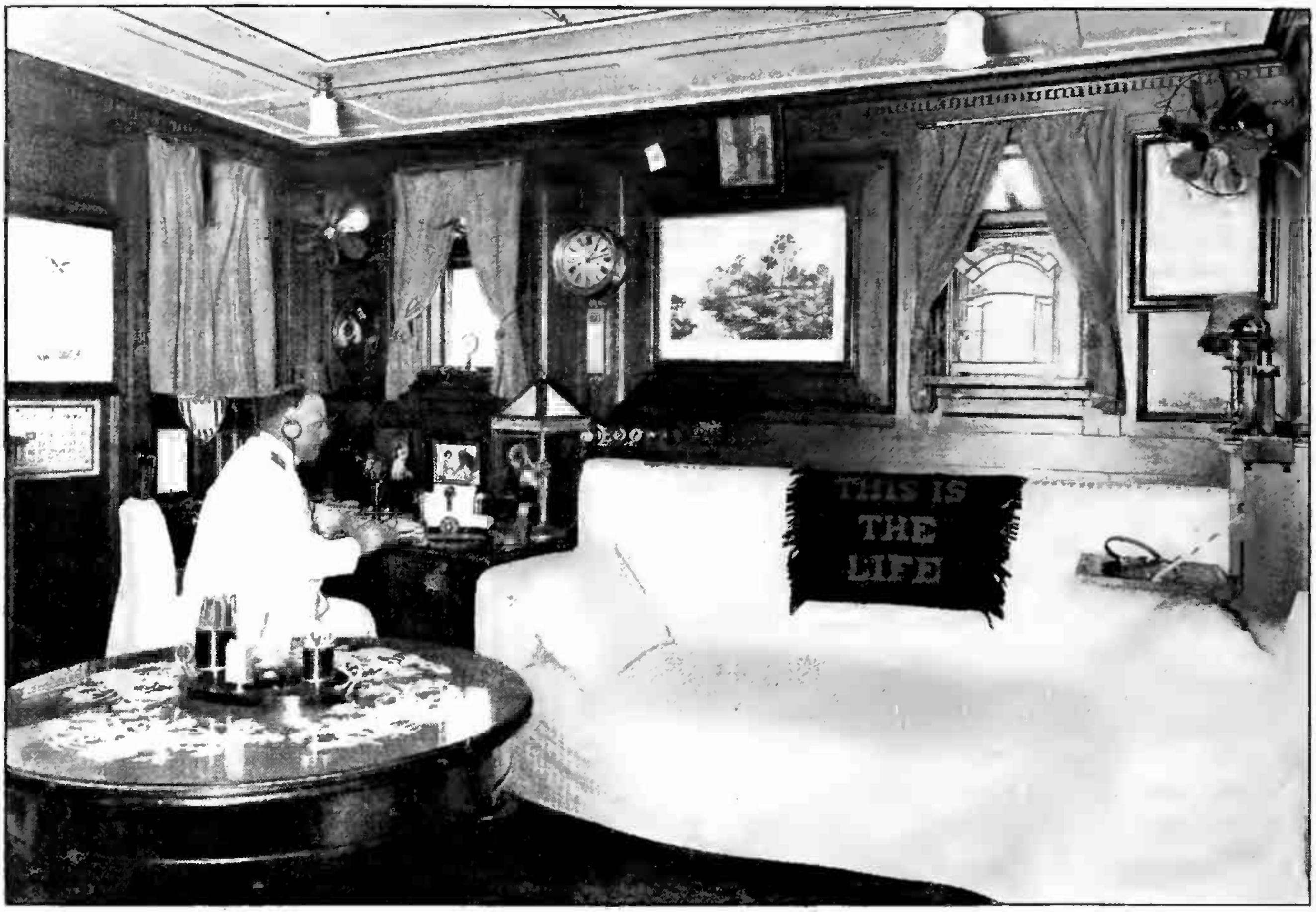
It is almost universal practice in radio telephone communication to-day to use a "send-receive" switch to connect the antenna to either the transmitting outfit or the receiving set, depending on which one is to be used. At the end of each transmitted message, the operator always makes a conventional signal indicating to the receiving operator that each must throw the send-receive switch to its opposite position. Of course, the interchange of thought would be far more rapid with a system permitting either participant of the conversation to interrupt the other instantaneously. This would avoid the loss of continuity in a conversation and the calls for "repeats" now frequently encountered.

Undoubtedly the greatest need for this duplex or two-way radio telephony is the installation of it in such a way that the public may avail themselves of it. Inexperienced persons could not be expected to operate a send-receive switch at the proper moment, and, accordingly, some substitute had to be found.

To the novice, the development of the wireless telephone so that it could be used as, and in connection with, the ordinary wire telephone, presents no particular difficulties; but to the trained engineer, the details and obstacles encountered are endless. Supported by the resources of some of the country's foremost research laboratories, months of painstaking efforts and measurements of the greatest precision were required before such a system was ready for trial.

SENDING AND RECEIVING AT THE SAME TIME ON THE SAME ANTENNA

THE engineers who worked on this system were concerned with carrying on two operations at the same time: the first, detecting the incoming antenna current and transforming it into speech, and the second, permitting the voice currents aboard the *America* to advance from the antenna into space, as waves, reaching



PHONING HOME FROM MID-OCEAN

Captain Rind of the S. S. *America* has been heard phoning home by nearly every amateur from Maine to Florida

a distant operator on shore or aboard another vessel. How to extricate the exceedingly feeble receiving current from the antenna system while the transmitter is driving enormous power into the antenna *at the same time* was the problem that had to be faced.

THE "TRAP" CIRCUIT

THE transmitted energy has a wavelength which differs from that of the received energy. The antenna forms the common path for both waves. Two branch electrical circuits connected at the end of the highway have different wavelengths. The received signal proceeds along the antenna until it reaches the junction point, where it branches off to the path which is tuned to accommodate it and then enters the amplifier. The transmitter supplies energy to the same antenna along the other path which, because of the difference in tuning, does not materially interfere with the incoming signals. While the two currents of different wavelengths exist in the antenna simultaneously, each has a special function; the feeble current energizes the receiving set and amplifier, and the transmitting energy flows through its proper path to the antenna and travels through space to be absorbed by the distant receiving station.

To make sure that the transmitter does not drive any current into the associated receiving set and thus establish interference to reception, "electrical constriction" is placed in the lead which branches from the main antenna to the receiving set. This so-called "trap" functions as a sentinel at the receiver connecting point, permitting only the feeble incoming currents from the antenna to flow along to the receiver, but which resists any attempt of the transmitter to feed its powerful energy back into the delicate receiver.

This trap circuit is not a new idea by any means, for one of its modifications is used in transcontinental telephony. It is, to explain briefly, a path composed of a group of inductances and condensers, designed and assembled so that their combination will permit only waves of approximately a given frequency to pass through. Since wavelength is a function of frequency, the filter may be designed for almost any band of wavelengths and it is only necessary to have the transmitting wavelength of sufficient difference from the receiving wavelength to be resisted by this trap or filter.

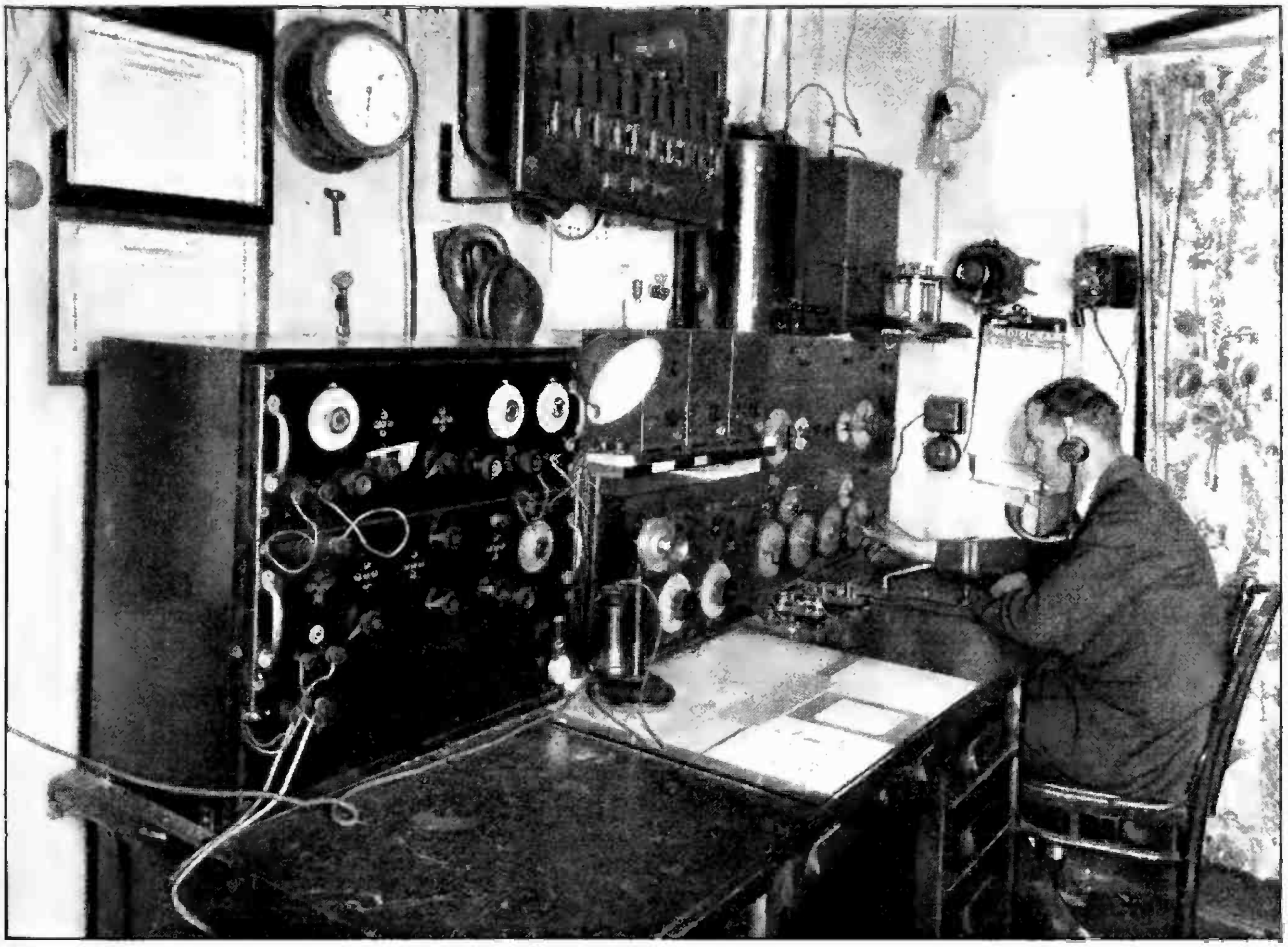
Obviously, this arrangement provides a substitute for the send-receive switch, as the operator may speak into his transmitter and control the powerful antenna currents while he listens to the feeble signals arriving at his receiving set.

He may thus be interrupted while speaking by the man at the distant station who may wish him to repeat part of his message. Thus, interchange of thought is as instantaneous as with the ordinary land telephone.

This method was given a series of preliminary tests before the installation was finally made on the S. S. *America*. That it was the proper method of procedure was then well established. The tests aboard the ship were made as a means of determining the commercial worth of the system, and the accuracy with which this work was performed was well demonstrated by the remarkably successful trials at sea. On her first and subsequent voyages and under normal atmospheric conditions, reliable telephone communication with the shore was established while the ship was more than 1,600 miles from New York. Both Captain Rind of the *America* and the shore operator reported the speech to be perfectly intelligible at all times during many conversations which they held while the ship was in mid-ocean. Incidentally, many amateurs located on the Atlantic seaboard listened-in and were thrilled by these remarkable experiments.

SHORE APPLICATION

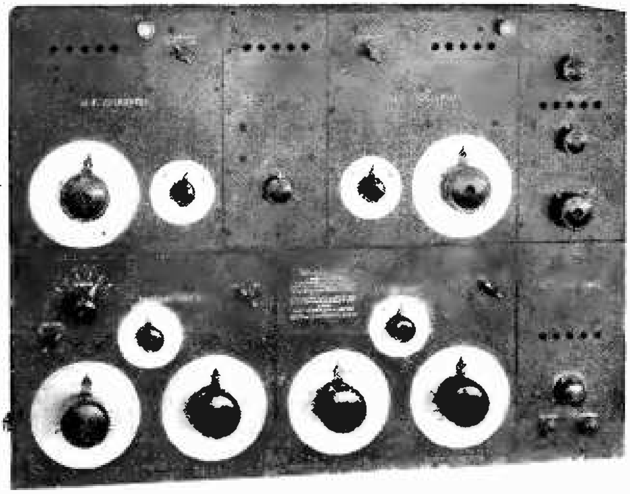
THE duplex system was now an accomplished fact, but why should its application be limited to the service of the Captain of the *America* and the operator at the shore station? To render the maximum amount of service, the "ether line" between the *America* and the shore must be linked up with the regular wire telephone systems of the country, so that a business man, for instance, located any-



THE RADIO ROOM ON THE S. S. "AMERICA"
Through the complex circuits in this room incoming and outgoing voice currents pass simultaneously

where in the United States, might use his ordinary desk telephone to converse with one of his associates who might be on the *America* several hundred miles out at sea. This arrangement accordingly was made.

The shore station, where the radio and land lines were linked together, is located at Deal



THE CONTROL PANEL OF THE "AMERICA'S" RECEIVER

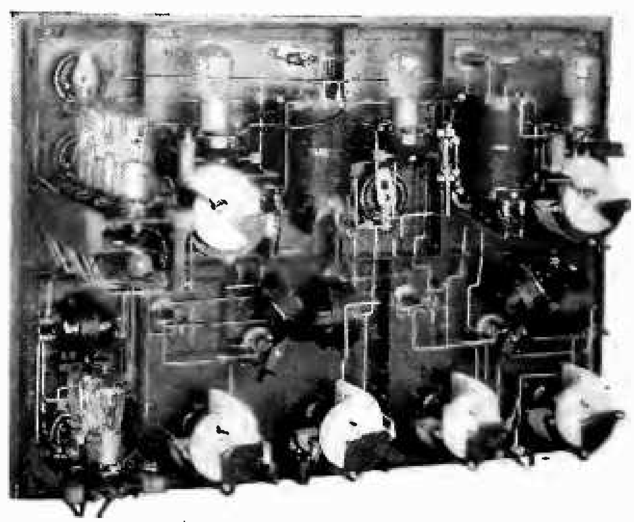
Beach, New Jersey. It is operated by the Western Electric Company, and is connected by a toll line to a telephone switchboard of the American Telephone and Telegraph Company in New York City. By means of this connection, communication could be carried on from a ship to any point reached by the regular wire telephone system. When it is desired to place a call for a party on shore, the customary practice used for a toll call in wire telephony is followed. A regular desk telephone was installed in Captain Rind's quarters on the *America*. When he desired to talk to someone on shore, he called the ship's radio operator by pressing a button on his desk. The operator answered and, after ascertaining the telephone number or name of the party desired on shore, established comunication with Deal Beach. The operator at Deal Beach transferred the call to the New York toll line, completing the circuit between the *America* and the switchboard operator at New York, so that both operators could exchange information regarding the call. In placing a call for a party on shore, the standard practice used for a toll call in wire telephony is followed. When New York had the party at that end, the ship operator called Captain Rind and he conversed from his extension in the same manner as one would over any telephone system.

The equipment is, of course, not limited to a single telephone instrument on board the ship. An extension may be installed in every stateroom if desired.

When the *America* was 2,586 miles out of New York, a call was received from the S. S. *Westland*, asking medical advice for a sick member of the crew. The telephone was turned over to the ship's doctor who prescribed treatment for the patient. A great number of similar cases are on record indicating the tremendous possibilities of the radio telephone at sea.

On his recent visit to the United States. Marconi inspected the installation on the S. S. *America*. He stated that the now famous duplex system employed so effectively on every trip of the steamship was a tribute to splendid efforts of American radio engineers.

From the foregoing, it will be seen that combined radio and wire telephony, proved highly satisfactory in the case of the first experimental set installed on the *America*. It must not be inferred, however, that the immediate step is to equip all vessels which at present carry radio telegraph apparatus with this latest telephone system. This happy condition may not come about for some time, because there are still certain scientific engineering and traffic problems to be solved. Also the International Radio Convention and our own government must take note of the development



INTERIOR OF THE "AMERICA'S" RECEIVER

of wireless telephony and allocate suitable wavelengths. For purposes of a special nature, such as ship movements. medical and other urgent service, where the radio telegraph is not sufficiently direct. the radio telephone will be especially valuable.

Do Brains or Dollars Operate Your Set?

By W. H. WORRELL

THERE is more than one kind of person who likes to operate a radio set; there are, to be exact, two kinds. The first of these recognizes in radio a fad which he would feel ashamed not to appear interested in; he does what he does because it is "done." Radio to him is also an easy means of entertainment, and a source of free music—especially jazz. Where the music comes from doesn't concern him much, if it is only strong enough—regardless of weather conditions—and always on draught. He wants to be able to turn a spigot and just let 'er pour forth.

In short, such a man isn't a very good sport. He is the kind that generally doesn't like fishing unless he can get a boy to hang the worms on his hook and take off the fish. He would prefer catching bullheads to tempting trout, and might ask his dealer to guarantee the effectiveness of his tackle. He will not survive the first summer of static, nor the first week of experimenting with his receiving set. He will discover that radio is a game, in which a certain amount of patience and skill are demanded, and that a vacuum tube is more like a violin than a victrola.

The other type of person is fascinated by radio as by anything that seems to be above or beyond common experience, and that, while apparently contradicting common sense, invites investigation and stimulates imagination. He seizes upon the apparently supernatural, or at least the unusual, as affording a change from the regularity of nature and of average human experience; yet he does so with the intent of rendering it some day both natural and familiar. It interests him intensely to discover new wonders and then to try to solve their mysteries. His unconscious purpose is to render space and time, and all that limits and thwarts human existence, as completely amenable to the will of man as in a fairy tale. This is the real radio devotee, whether he is a lawyer spending his evenings in the attic with his home-made set, or a boy tuning in at midnight for the signals of some distant comrade.

The fascination of radio lies in its atmosphere of magic, which is the accomplishment of something out of all proportion to the means employed, or in seeming contradiction to natural laws and common experience. It lies also in the uncanny way in which time and distance—the natural obstacles to quick interchange of thought between human beings—are reduced almost to insignificance.

Distance separates us from people and things. To reach them requires time. During the transition from one scene to another we ourselves are changed by the intervening time with its experiences. To some extent we may travel by telephone almost instantly to the presence of a friend at a given house in a distant city; but by radio we may, on a good night, pay flying visits to a dozen places between Schenectady, Detroit, and Atlanta.

When we learn a little more about radio it appears to be the transmission and reception of pure form, without substance. And isn't it amazing to think that this form, this exchange of thought, is constantly passing about us—*passing through us—from countless transmitting stations, at this very instant!* We possess no human faculty which can make us aware of this—but with sensitive enough instruments all this flow of ideas could be reduced to significant sound. At present, a tiny fraction of it—on a still winter night we may be inclined to think it is a big fraction!—can be made available for us by the intelligent use of such instruments as we may possess. All the fascination of a link between the physical and the spiritual is here, and it is far from easy to rid ourselves of the feeling that we are at the threshold of fundamental truths which have baffled humanity throughout the centuries.

Simple Bulb Transmitters

By ZEH BOUCK

IT IS probable that many people who have installed receiving sets during the past year are not content merely to listen-in, but are considering the possibility of simple, short-range transmitting sets. The use of the air for the amateur, however, is definitely limited. The government is becoming more discriminating in issuing licenses, and the citizen operator himself is apt to resent the intrusion of a novice unfamiliar with amateur tradition and ethics.

This article is intended to help those who, now laboring under the opprobrium of "concert fans," desire to follow up the possibilities of amateur radio on the transmitting side of the change-over switch.

> The numerous letters from our readers requesting further details of "A Compact, Portable Wireless Set," described in our May issue, indicate that many broadcast enthusiasts would like to transmit, if transimtting did not involve too much trouble and expense.
>
> Accordingly, we shall publish articles from time to time describing simple sending outfits. Some of them may be made by altering a few connections in your present receiving set. Others may be operated from the current taken from a lamp socket—replacing the "A" and "B" batteries entirely.
>
> The author of this article tells in a clear-cut way how a single tube transmitter may be made and operated.—THE EDITORS.

Except for laboratory experiments, one of which is described in this article, *transmission cannot legally be effected without two government licenses: one licensing the station, and the second certifying the individual as an operator.*

The technical knowledge required in the examination for a first-grade amateur license is not very exacting. Radio inspectors are predisposed to license applicants whose diagrams indicate that their prospective stations are bulb or undamped transmitters.

APPLICANT FOR LICENSE MUST LEARN CODE, BUT IT IS WELL WORTH WHILE

CODE is another matter, and is generally the bugbear of the would-be operator. Sometimes it takes two or three months to gain a safe margin over the ten-words-a-minute speed stipulated by the government. The only solution lies in attacking the problem systematically. If the determined experimenter will persistently copy the high-wave arc and alternator stations (many of which transmit very slowly), occasionally breaking the monotony with a weather forecast from NAA (Arlington. After 10 P. M. Eastern Standard Time), the average period for learning code will be more than halved. Once the code is acquired, the experimenter is no longer a dilettante—he is an operator, and he will find that a great new field of interest is open to him. The person who turns the knobs only to receive music, who can make nothing out of the code signals which fill the ether—well, he doesn't know what he is missing!

WHAT HAPPENS WHEN WE SEND OR RECEIVE

IT IS generally understood that wireless messages—code and voice—are carried on "waves." Radio impulses, *unlike* water waves, to which they have been compared until we are sick of hearing the comparison, are not confined to two dimensions, but spread out from the point of excitation in all directions. Indeed, a radio impulse is really composed of two waves, the electromagnetic and electrostatic, a condition difficult to visualize. A current pulsating in the antenna, like a current moving in any conductor, sets up about it an electromagnetic field similar to that surrounding a horseshoe magnet. There is also a capacity effect, for the aerial and ground act as the two plates of a condenser, and the intervening air as the dielectric. Whenever a difference of potential or voltage exists between these "plates," as during transmission, an electrostatic field or charge is distributed between them—a sort of electricity existing free in the air. These two fields travel from the antenna 186,000 miles a second in all directions.

As these two fields cross the receiving antenna tuned to the same wave, the lines of force (the electromagnetic field) create therein, by simple induction, a current, similar, excepting in strength, to the transmitting one. This current is augmented by the electricity which the antenna also "picks up" from the electrostatic field. Hence any method of charging a transmitting aerial with a rapidly interrupted or alternating current (for the field moves only as the current fluctuates) will set up radio waves.

HOW WE OBTAIN HIGH-FREQUENCY CURRENTS

THERE are several systems of generating high-frequency currents: the spark, alternator, arc, and bulb. The spark, until the advent of the audion, was by far the most popular means of generating radio waves, and was demonstrated by Hertz many years ago. When a condenser is charged to a high potential by a transformer or static machine, and the

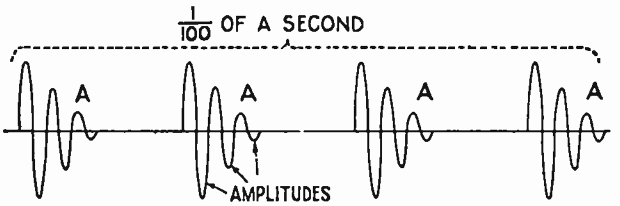


FIG. 1

terminals then approached to within sparking distance, the condenser will discharge across the gap in a spark. This spark, is not a single discharge as it appears to the eye, but a series of isolated discharges, *first in one direction and then in the other*, each one weaker than the last, until the condenser is discharged. The spark is, of course, accompanied by similar reversals in the current which, in electrical language, "alternates." But for radio-telegraphic purposes the condenser is immediately recharged, at which point the action is repeated, and the resulting radio current assumes the form of a group of oscillating discharges which can be indicated diagrammatically, as in Fig. 1.

The alternator is a modification of the alternating current generator or dynamo, designed to produce oscillations of a very high frequency, an effect that is also achieved by the arc and bulb. The radio impulses set up by these last named systems are of a continuous nature and are shown in Fig. 2. In contrast with the preceding illustration, it will be noted that the successive oscillations in Fig. 2 are all of equal amplitude or power (that is there is no

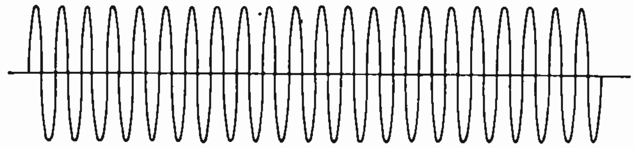


FIG. 2

"damping") and the wave train is not broken up into groups of audio frequency. In Fig. 3, the coil or inductance L2 and condenser C comprise an oscillating circuit. L1 is a similar winding connected through switch S to a battery. As the switch is closed a current flows through L1 and sets up a magnetic field which, expanding, cuts L2. As L2 is cut by these lines of force, a current is induced in it, flowing, we shall assume, in the direction indicated by the outer arrows. However, when the switch is opened, the flux collapses and L2 is now cut by the lines of force in the opposite direction, and, by the same laws of induction, the induced current momentarily follows the direction indicated by the inside arrows. Hence, by rapidly opening and closing the switch S, an alternating current is induced in the second winding. *This switch action is exactly what is effected by the three-element tube, except that the interrupting of the circuit is accomplished far more rapidly than would be possible by hand.*

Fig. 4 shows a somewhat revised circuit with the audion bulb replacing the switch. For this purpose *almost any of your detector or amplifier tubes will do.* When the filament is lighted, the potential on the grid, as determined by the condenser and leak, having first been adjusted to a slight positive charge, the tube

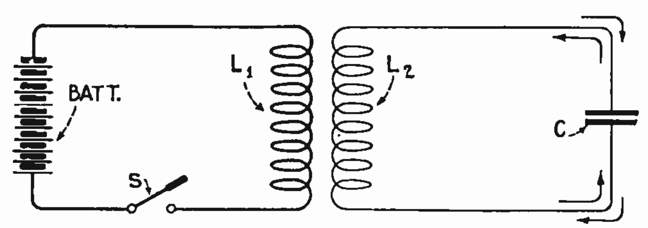


FIG. 3

will operate for a fraction of a second as indicated in A, Fig. 5. This small plus charge tends to draw the electrons (electrons are negative, and unlike charges attract one another) from the filament, boosting the plate current which flows from the filament to plate, and, further on, through the tickler coil L1. As this current rises from zero to maximum, a secondary current is induced in L2 which, if the tickler is connected in the right direction, will place a negative charge on the grid. The bulb will then react in accordance with Fig. 5, B, when the now negative grid will repel the like charges thrown off by the filament. This permits less electrons to complete their journey to the plate and decreases the plate current. As this space current drops, the magnetic field about the tickler contracts, cutting L2 in the opposite direction, reversing the flow of induced current through this coil, and, necessarily, the charge on the grid which returns to positive (Fig. 5, A and C). With the return to normal, the phenomenon repeats itself, the cycle being completed many times a second with a frequency depending on the capacity and inductance in the circuit. As in the case of Fig. 3, with which comparison is suggested, the rise and fall of the flux surrounding L1 induces an alternating electromotive force in the second inductance. If a third circuit, indicated by dotted lines in Fig. 4, comprising an aerial, ground, and inductance, be coupled to L2, a fraction of the alternating current will be transferred to the open antenna circuit where it will radiate energy from the aerial in the form of radio waves. However, this last circuit is not essential for producing oscillations, and for laboratory transmission L2 alone will set up sufficiently powerful radio impulses.

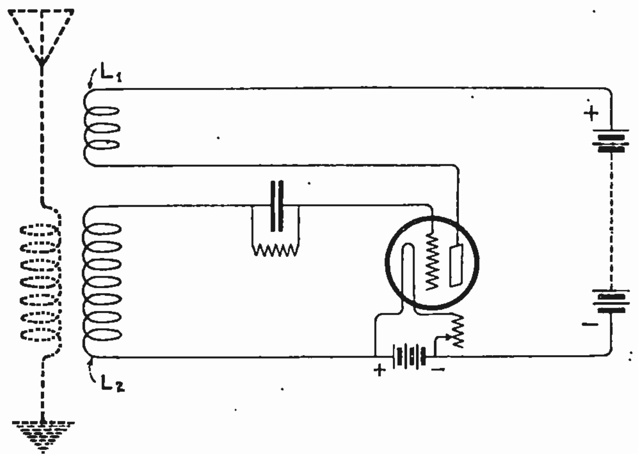


FIG. 4

The circuit just described is a fundamental one, and although to simplify it for practical purposes a single coil has been substituted for the individual plate and grid inductances, it is easier to operate in the original separate circuit form. It is suggested that the beginner, in his early experiments, confine himself to the diagram as here given. The experience of constructing and operating such a transmitter will be of great value when he eventually signs his call on the air.

An experimental arrangement is illustrated semi-diagrammatically in Fig. 6. Honeycomb coils are indicated as they are probably the most convenient form of inductance easily available. But if the experimenter desires to make his own coils, they may be roughly wound on any suitable tubing approximating three inches in diameter. L3, L2, and L1, the latter a modulating coil, are wound with any insulated wire from No. 24 to No. 30, with 25, 35, and 50 turns repectively. Any arrangement for mounting the home-made coils permitting a variation of the coupling between them will be satisfactory. If honeycomb coils are preferred, the experimenter should obtain one each of the sizes L25, L35, and L50, indicated in Fig. 6 as L3, L2, and L1, respectively. The standard three-coil mount affords the most convenient method of connecting them in their proper circuits. The rheostat may be placed directly under the coil mount with the B battery and bulb on the baseboard behind the supporting panel. Good results should be secured by using from eighty to a hundred volts on the plate of the average amplifying tube. As reference to Fig. 4 will show, the action of the set is critically dependent on the orginal grid charge, and variation of the grid leak is necessary in some sets. The addition of a variable grid leak will, in any case, add to the efficiency of the apparatus.

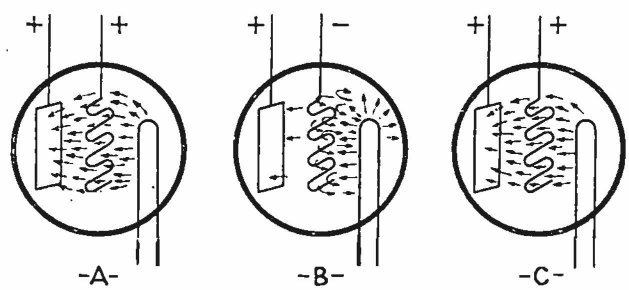


FIG. 5

Modulation is secured by shunting the L25 coil with an ordinary microphone *using very loose coupling between L3 and L2*. The resistance of the modulating circuit is varied by speaking into the transmitter, and with it the amount of energy absorbed by L3 from the oscillating circuit. The residue energy in the middle coil, varying inversely, sets up modulated wireless waves. This is known as the absorption system of modulation, and it finds favor in many amateur stations. The quality of the modulation may be adjusted by changing the coupling between L3 and the adjoining coil.

In first tuning the experimental set, it is advisable to include a pair of telephone receivers in the plate circuit, i. e., in series with the B battery. If the set is oscillating, words spoken into the microphone will be heard loudly and distinctly in the phones. *As the set is operative only with the tickler coil connected in the right direction, it may be necessary to reverse the connections leading to it.* If, after tentative adjustments on the filament and tickler, the circuit will not oscillate, it is possible that the modulating coil is absorbing too much energy from the main circuit, in which case ten or fifteen turns may be removed from L3.

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 Supt. of Documents, Government Printing Office, Washington, D. C. Price, 15 cents a copy.

This apparatus, without antenna and ground is, of course, capable of transmission only over very short distances, but it may be used for demonstration purposes across a small hall or between rooms.

If the experimenter is already in possession of his station and operator's licenses, he may transform this set into a short-range C. W. transmitter by removing the microphone and substituting an aerial with series condenser and ground. For tuning, it is advisable to include a radiation milli-ammeter in the ground lead. By breaking the plate circuit with a key, straight C. W. (continuous wave) may be used, which, under favorable conditions, should carry from three to five miles, with the one tube.

This system is known as the *inductive feedback* circuit, and is so described in order to differentiate between it and other oscillating circuits which employ a condenser coupling, rather than the tickler, to effect the transfer of energy from the plate back to the grid circuit. This latter system is classified as *capacity feedback*.

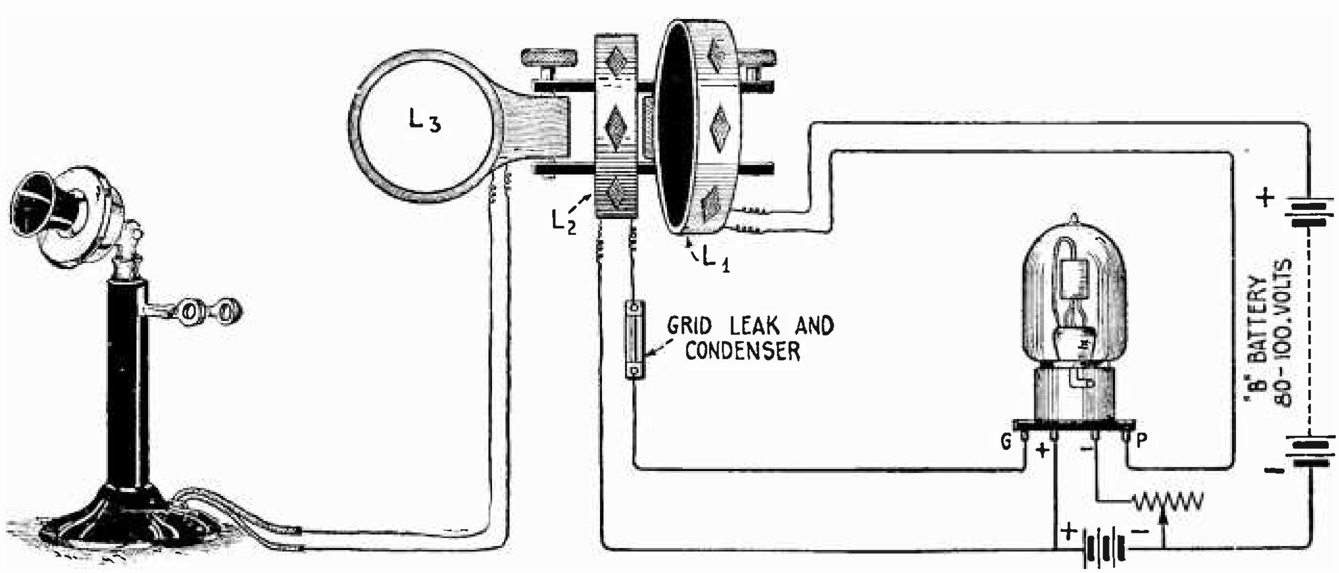


FIG. 6

Have You Written Your Radio Book?

By Following the Principles Here Laid Down, Any One, Regardless of Whether or Not he Understands the Subject, Can Write as Good a Book About Radio as Many Now on the Market

By RALPH MILNE FARLEY

Illustrated by TOM MONROE

> Perhaps in no way are faults and foibles so clearly exposed as by satire. As Dryden puts it:
>
> "*Satire has always shone among the rest,*
> *And is the boldest way, if not the best,*
> *To tell men freely of their foulest thoughts,*
> *To laugh at their vain deeds and vainer thoughts.*"
>
> The author of this article is a mathematical physicist who has recently made an investigation of the books about radio which are now flooding the market. You will be interested in what he has to say. Probably you will agree with him; certainly you will be entertained. —THE EDITORS.

SINCE the advent of the Radiophone, there has been an ever increasing number of books on the subject, until finally there has developed a regular technique for their production.

The present writer has reluctantly accepted the task of giving a simple explanation of the working theory of writing such books, so that any boy of sixteen or man of sixty can turn one out with equal facility and profit.

The first chapter should commence with an elementary explanation of the hitherto unsuspected fact that two and two make four and that stones thrown into ponds cause a wave-action. This naturally leads to the statement that sound, heat, light, color, and Hertzian waves are just alike, except as to frequency of oscillation. This isn't true, but it gets the book impressively under way. Also you can drag in the fact (which isn't true either) that seats in a theater are arranged in a semicircle so as to take advantage of the travel of sound-waves in circles.

If your readers will swallow these two statements, they will believe almost anything: you will have laid a good foundation for comparing the relation between frequency, inductance, and capacity with the dependence of the period of a pendulum upon its length and weight. Of course, it is a well known scientific fact that the period of a pendulum is absolutely independent of the weight, but why spoil a good analogy? Besides, your readers probably don't know any more about elementary physics than you do.

But be sure not to explain what inductance and capacity are. You can have a great time with these two.

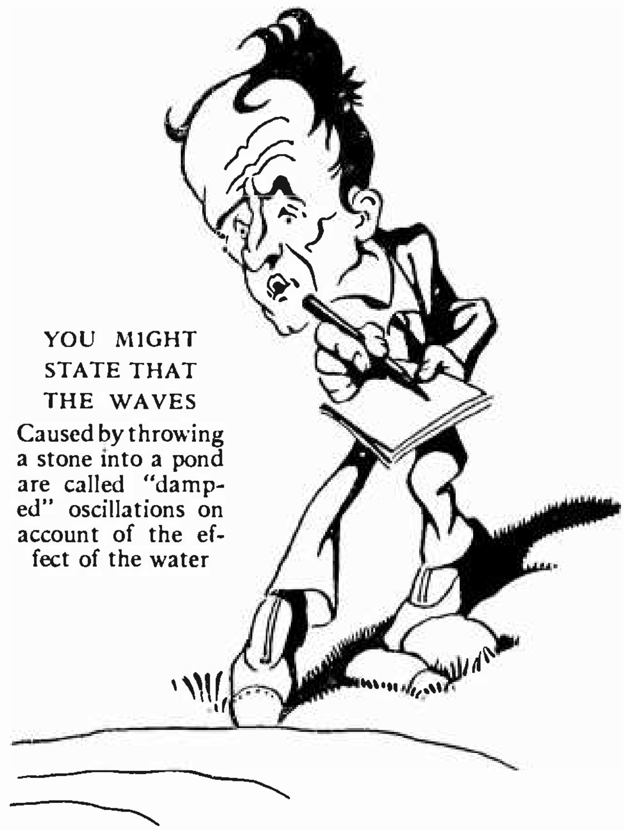
And while on the subject of oscillations, you might state that the waves caused by throwing a stone into a pond are called *damped* oscillations on account of the effect of the water.

At this point, permit me a word on the subject of illustrations for your book. The first few should show boys throwing stones into ponds, lightning striking houses in New Jersey, Ben Franklin flying a kite, etc. These can be picked up in almost any print-shop. The remainder of your illustrations, consisting of wiring diagrams and pictures of pieces of apparatus, can be lifted from the catalogues of one or two electrical supply houses. Thus you will save having to split any of your loot with some artist.

Now, to go back to the text of your book. The electron theory should next be explained. In order that you may dò this, I shall now explain it to you: each atom of matter is a little solar system, in which the sun is a positive charge of electricity, called the nucleus, and the planets are negative charges, called electrons. Conductibility consists in the presence of lots of stray electrons between the atoms. A dielectric (for Heaven's sake, don't say "non-conductor," or you might be understood) has but few stray electrons. The stray electrons in à conductor tend to flow toward any point of positive potential, i.e., a point where the stray electrons are fewer than normal. Generators and batteries act as pumps, sucking in electrons on one side and forcing them out on the other.

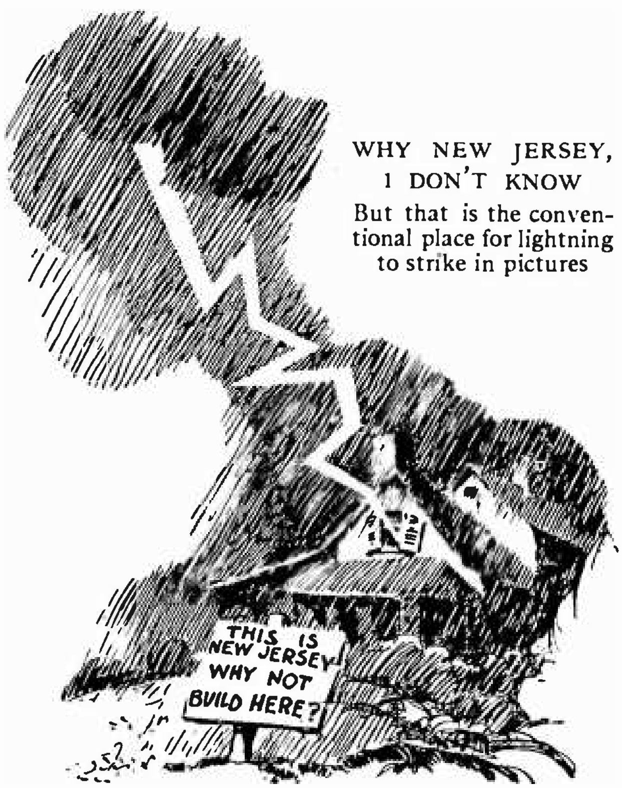
That is all there is to it. But, by the introduction of sufficient verbiage, hot-air, repetition, analogies, and plus and minus signs, it ought to be good for at least two chapters.

From this point on, explain nothing. You have been so elementary and explicit at the start, that your reputation is now safe, and the reader will blame himself alone, if he cannot follow you. And it will be just as well for you that he cannot. To be absolutely sure of this, after explaining that electricity consists in the flow of electrons, and that electrons always flow from minus to plus, you should thereafter (without further explanation) always refer to electricity as flowing from plus to minus.



YOU MIGHT STATE THAT THE WAVES

Caused by throwing a stone into a pond are called "damped" oscillations on account of the effect of the water



WHY NEW JERSEY, I DON'T KNOW

But that is the conventional place for lightning to strike in pictures

Next explain the Edison effect. You can enhance the effect, if you state that De Forest or Fleming, or some equally nice-sounding name, discovered that a Fleming tube could be used to rectify an alternating current. Don't destroy the effect by explaining what you mean by "rectify." Illustrate this chapter by a lot of wiggly lines, with appropriate titles. You can draw these illustrations yourself. Almost any sort of wiggly lines will do, if you do not explain the meaning of graphs and coördinates.

Next còver the antennas, sending and receiving. To do this, merely paraphrase and amplify the instructions which go with any amateur set put out by professionals. If you still have space left after this, get several radio amateurs to describe their installations, and then you translate, from English into radio-language, what they tell you.

Use the following words as often as possible: audion, audio frequency and radio frequency, capacity, counterpoise, filter, impedance, modulation, microfarad, potentiometer, super-regeneration, and variocoupler. This is a sure-fire way to give the impression that you are a full-fledged member of the Radio fraternity.

A whole chapter can next be made up out of cautions which are to be found in the literature of manufacturers of storage-batteries, charging-apparatus, etc.

The last quarter of the book should consist of "helpful hints." It is remarkable how much space can be filled by ringing all the changes on any simple idea. For example, each of the following should be good for at least two pages: your apparatus is delicate, don't bang it around; don't blame your own set if you can't hear, lay it to the broadcasting station; don't try to receive during a thunderstorm (here insert the specifications of the National Board of Underwriters, which can be obtained free through any friendly fire-insurance agent); don't put the various tuning knobs, etc., where you cannot reach them easily; and don't receive so loud that you can't make out the music.

In conclusion, let me tip you off to the most important idea of all, the only original thought in this entire article: get out a new edition annually, or even monthly. This can be done easily by printing a new copyright page periodically, the copyright costing you only two dollars and two copies of the book (which will be no great loss). Books on Radio are now so numerous and so alike, that a prospective purchaser will judge entirely by the date, and will invariably purchase the latest. Being the latest is infinitely more important than being of any use.

Seeking His Relatives by Radiophone

An Unusual Appeal to Thousands of Listeners-in by One Who Never Knew his Parents or Relatives or Their Acquaintances

MR. CLIFFORD HOLMES of Council Bluffs, Iowa, who has tried for years to find trace of his family, has recently been continuing the search with the help of various broadcasting stations located all over the United States. He writes: "Imagine yourself in my place and you will perhaps understand how much it means to me to get this story into the hands of all the people I can, in hopes that perhaps by some possible chance I may be rewarded."

As he suggests in his letter, the Radiophone can reach a far greater audience than was ever possible before, and may be the means of helping many people who have despaired of ever hearing from their relatives or friends, to get in touch with them.

This is the message Mr. Holmes is asking broadcasting stations everywhere to send out for him, and which he delivered himself on July 31st of this year, from the Omaha Grain Exchange station (WAAW):

"I speak over the Radiophone to-night in the hope that someone in this vast audience, hearing my message, may be able to give me information concerning myself or my relatives. Twenty-one years ago this September I was left in the Christian Home Orphanage in Council Bluffs, Iowa. That was on September 16th, 1901. The orphanage cared for me until February 14th, 1902, when I was adopted into a family. They have reared me since. At the time of my adoption, my foster parents were given the information by the matron of the orphanage (who is now dead) that my name was Clifford Holmes, and that I was born September 13th, 1901.

The information at that time was also that my mother died three days after my birth, and that my father, a laboring man, disappeared shortly afterward. Since then I have been unable to find anything of his whereabouts or the place where my mother was buried, if the story concerning her death is true. The information I now seek is news concerning either my father or mother, relatives of theirs or any friends of either of their families. To aid in possible identification, I am giving you a brief description of myself as follows:

I am twenty-one years old; six feet three inches in height; weight 170 lbs; complexion medium dark; hair, medium brown; eyes brown. My address at present is 635 Bluff Street, Council Bluffs, Iowa, and any information any of you may be able to give me will be appreciated to the fullest extent. I would also be grateful to any other broadcasting station operator who might pick up my message and re-broadcast it. With the coöperation of other broadcasting stations, I sincerely hope that I may hear news of my people."

Rich Mines We Have Yet to Explore

How Bell, Trudging Over the Hills, Stumbled Upon His Gold Mine.
The Underlying Principle of Vibrations and Their Universal Importance.
Vibrations Known and Unknown. Can We Stretch Another "Octave"?

By ALFRED M. CADDELL

DO YOU remember hearing your Uncle Abner tell what he did when he was a boy, how he and the other lads of the village rigged up telegraph lines and sets and sent all manner of messages? How they made their own coils and keys and batteries, and otherwise tinkered with "lectricity"? A young fellow wasn't in it, those days, if he didn't know something about telegraphy and the Morse code.

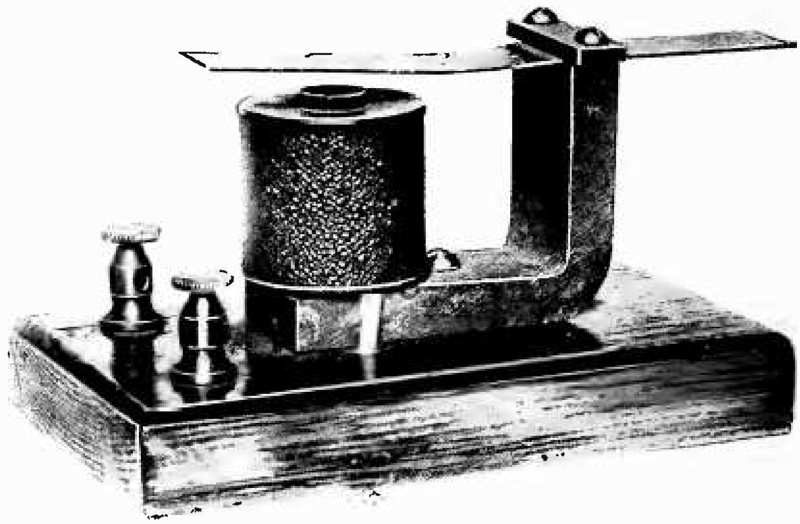
To-day, the popular interest in radio forms an exact parallel to the situation in the early days of telegraphy. Thousands of young people got their first insight into electrical science by means of that time-honored art. It made them think about electricity as nothing else could have done; and thinking about it, their thoughts carried them far afield into other branches of science—sound, heat, light, and higher mathematics. A solid foundation was laid from which great minds were to develop, and out of the maze of experiments that went on between woodshed and garret, some big discoveries were bound to come. Discoveries have a penchant for happening just that way.

The great goal in radio to-day is selectivity—the elimination of interference in sending and receiving messages. The great goal in telegraphy half a century ago was the possibility of sending several messages over a single wire at the same time. Inventors experimented with different frequencies of alternating current, utilizing the law of sympathetic vibration—the basis of tuning for all radio receiving. One receiver would be tuned to the same frequency of alternation as was the transmitter—say 200 per second—and would select the message being sent over that frequency and that alone. Other receivers would be tuned to different frequencies—300, 400, and 500—to receive messages transmitted accordingly. It was a most fascinating dream, and it awoke many an exploring mind to the wonders that electricity was destined to bring forth in the future.

Numbered among the hosts of amateur experimenters was a young man in Boston, Alexander Graham Bell, who taught the art of visible speech to deaf mutes by day, and labored among coils, batteries, magnets, and vibrating reeds at night. His particular goal was a harmonic telegraph system, by which he confidently expected to send six or eight messages simultaneously over the same wire. The secret lay in tuning the vibrating reeds of the receivers, to correspond in pitch with those of the transmitters—so Bell thought, and so he labored.

However, like the miner trudging over the hills in search of gold and unwittingly kicking a nugget at his feet, the young experimenter stumbled upon a veritable gold mine. Throughout a ceaseless vigil and nursing to make his "brain child" perform in the manner he wanted it to, Bell's thoughts went wandering down a different path from that he had been treading for more than three years. Primarily, he was a student of vibrations. He lived and moved in the very thought of vibrations. As a professor of vocal physiology, he had studied the human voice, the human ear, and the medium through which the voice traveled—air. He knew that the voice was composed of complex vibrations set up by the vocal chords in the throat; that these vibrations, when modulated by the tongue and lips and expelled from the mouth, set up a mass vibration in the air in the form of sound waves, which waves, impinging on the drums of a listener's ears, caused them to vibrate and produce the sensation of sound. Bell knew that the air varied in density according to the vibrations of the voice. And by his experiments with vibrating reeds, he knew that when a receiving reed was tuned to the same pitch of a transmitting reed it would vibrate in unison—the current of electricity would carry the vibrations. So he reasoned: "if I could make a current of electricity vary in intensity, precisely as the air varies in density during the production of a sound, I should be able to transmit speech telegraphically." Behold! the underlying principle of the telephone, both wire and radio—the varying in intensity of an electric current (or carrier wave) according to the complex vibrations of the voice.

The enunciation of this basic principle, however, antedated the actual discovery of it in action. Did it come right out in the open and show itself to the young experimenter's gaze? Indeed, it did not. All Bell had was an idea evolved by a study of the various rates and modes of vibration—a hopeful theory. But just as any one in search of a tool in his tool-box comes across a certain instrument that is especially suitable for another job he has in mind, just so Bell recognized something that filled the bill for this particular work. It was like the flicker of a camera shutter that let in a little light.

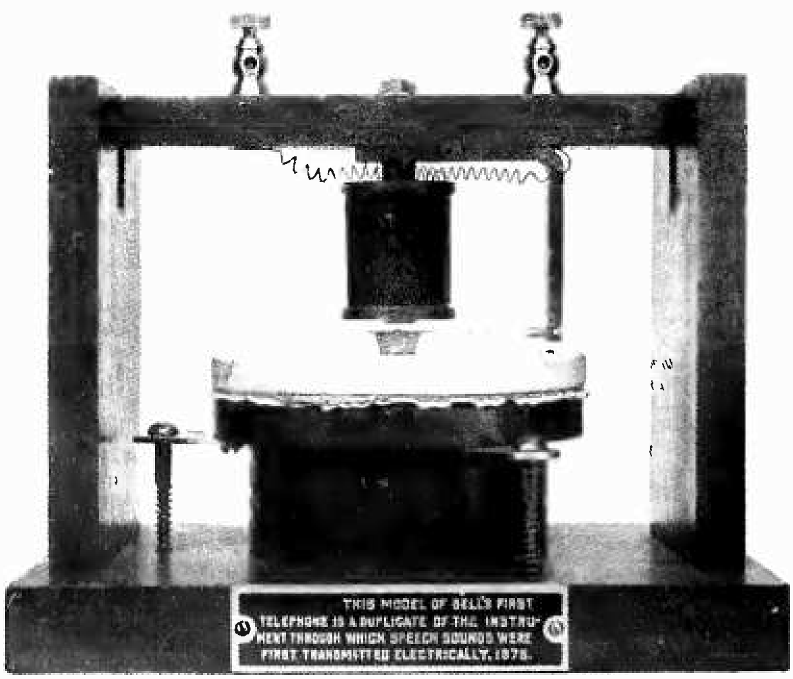


BELL'S VIBRATING REED

By adjusting the length of the reed over the magnet pole, the pitch could be raised or lowered

Hitherto, while experimenting with his harmonic telegraph, Bell's assistant had operated the transmitting key exactly as a telegraph operator does to-day—making and breaking the contact. The reed over the magnet of the trasnmitter vibrated, and if the reed over the magnet of the receiver was tuned to the same pitch, it would vibrate harmoniously with the transmitter. But now something different was destined to happen—the jinn of magic was about to spring from the lamp.

It was a hot day. Something had happened to the transmitting key. It stuck, forming a closed connection and a steadily flowing current. The assistant began fooling around with it and plucking the reed. Instantly there came a shout from Bell. Faint as it was, the twang of the reed could be heard at the receiving end—Bell had recognized the varying vibration, the complexity of pitch as the twang ranged from high to low. Then and there the telephone became an actuality, for Bell instantly knew that if a complex sound like that, with its ever-changing vibrations, could be transmitted electrically, the complex vibrations of the human voice could be transmitted equally well.



This is not intended to be a review of the history of the telephone. Rather, it is an attempt to point out the all-importance of vibrations in connection with its development, and to show that had not Bell thought in terms of vibrations and had a practical knowledge of the vibrations of speech or sound, the chances are that he would never have thought of impressing the vibrations of speech upon an electric current which could convey them swiftly to any desired place. If he had thought in terms of electricity and not in terms of the phenomena that constitute speech and sound—vibration—he would probably have lost himself in the scientific woods. For as Moses G. Farmer, one of the foremost electrical scientists of the day, said on a visit to Bell's laboratory, shortly after the discovery was announced to the world: "That thing has flaunted itself in my very face a dozen times within the last ten years, and every time I was too blind to see it. But if Bell had known anything about electricity he would never have invented the telephone."

As far back as 1872, and perhaps prior to that, vibrations meant everything to Alexander Graham Bell. And nearly half a century later —May 18, 1915—in accepting the Edison Medal presented by the American Institute of Electrical Engineers, he said in part:

"Have you done yet? Are you going to make any new advances in electricity? You have electric light, electric heat, electric power, electric speech, or rather hearing by electricity. Are you going to see by electricity? I can imagine men with coils of wire around their heads communicating thought by induction. However, that is for you to do in the future.

"But, speaking seriously, I am struck by this fact — that nearly all developments in electricity have had to do with vibrations. Starting out with the vibrations of sound in the medium of air, we have reached the height of vibrations in the luminiferous ether of space— from the low vibrations of sound to the high vibrations of X-rays. Lying in between these extremes are the electrical vibrations of radio, tuned to instruments far above our ability to hear.

DR. ALEXANDER GRAHAM BELL
Engaging in the first telephone conversation between New York and Chicago

"All our knowledge of the external universe is gained through our sensations, our sensations taking cognizance only of vibrations. Now that we know so much about sound, heat and light, and other things, we can put to ourselves a hypothetical case.

"Suppose you had a rod, clamped at one end, and free to vibrate at the other. Now, pluck this rod and it vibrates. Endow it with the property of vibrating continuously, faster and faster, and observe its vibrations in a dark, quiet room. We pluck this rod—you see nothing, you hear nothing, but put your hand upon it and you feel it move. It appeals to one sense, the sense of touch. Now let this rod vibrate faster and faster, and presently the vibrations appeal to two senses. You can feel it tremble, and when the vibrations number about thirty-two per second, you begin to hear low musical sounds. Let it go on vibrating. As the vibrations increase in frequency, they appeal more and more to the sense of hearing and less and less to the sense of touch. The pitch of the sound rises, and gradually you get a higher and higher pitch, like a siren shriek. And when the rod vibrates about 32,000 times per second, you have a very loud, shrill tone; the limit of perception will approximately have been reached. Feel it, and it is still — we no longer feel the tremble, and no human ear can hear much above 32,000 vibrations per second."

—LIKE THE MINER TRUDGING OVER THE HILLS
In search of gold and unwittingly kicking up a nugget at his feet

From mechanical vibrations in the ponderable medium of air, we now pass on to molecular vibrations in the material bodies and their related waves, not in the air, but in the very imponderable medium of ether.

In effect, Dr. Bell continued as follows:

When we get up into the millions of vibrations per second, we begin to perceive an effect, not with the sense of touch, not with the sense of hearing, but with the sense of temperature—radiant heat begins to be evolved. As the molecules vibrate faster and faster red light appears. Now it appeals to two senses—the sense of temperature and the sense of sight. As the vibrations increase in intensity the light gradually changes, going through all the colors of the rainbow. The perception of radiant heat diminishes, while the luminous perception increases. Finally, the rate of vibration becomes so great that violet light is produced—we have gone through all the colors that compose the spectrum (sunlight).

Go a little higher, and again we have no sense capable of recognizing the vibrations. Nothing can be felt, nothing heard, no temperature effect, nothing can be seen; and yet put a photographic plate near the rod and it will be affected by actinic and ultra-violet rays.

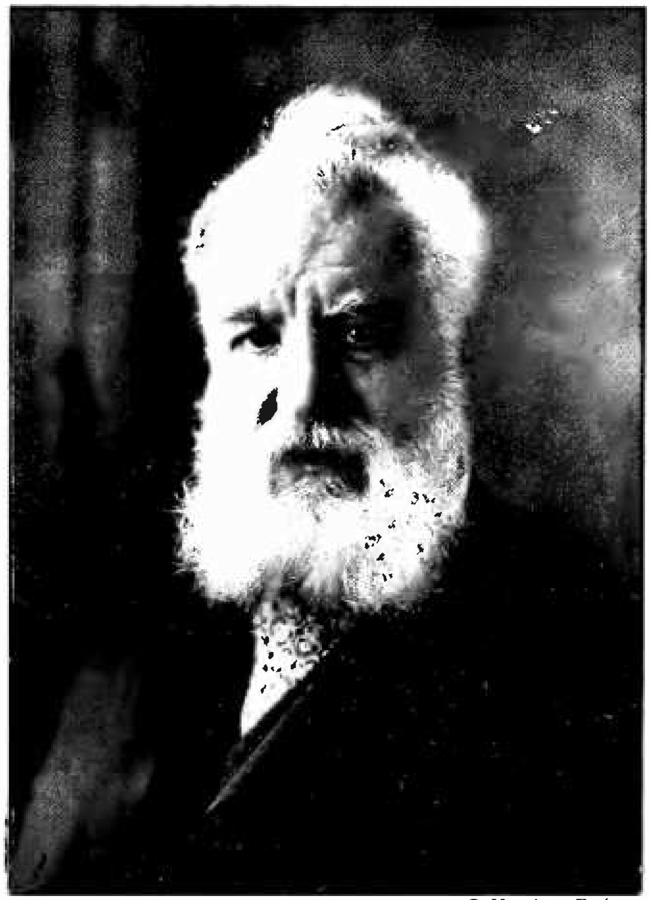
Beyond the ultra-violet lies the X-rays and radium rays. "But," resumed Dr. Bell, "how much further up we might have vibrations I do not know. Now, the thought that comes to me is this—in that great gap between the highest pitch of sound and the lowest pitch of radiant heat—a gap much greater than the rest of our sensations put together—we experience no sensation whatever. All our knowledge of the external universe is derived from our sensations which recognize vibrations. Indeed, nearly all our knowledge comes through the sense of sight (the 49th octave of the appended table). Just think of all the things you have ever seen—they are all derived through one octave of vibration. And then think of the vast gap that exists between the highest pitch of sound and the lowest pitch of radiant heat—we have no senses that can take cognizance of it, and yet these vibrations exist in nature.

THE GAP BETWEEN SOUND VIBRATIONS AND RADIANT HEAT VIBRATIONS

But now we know that there are electric waves in that gap. The phenomena of radio are made possible by the vibrations that lie in that gap. Why, then, are we not making instruments for our senses to use—creating new senses? And is there not a field for you in investigating that electrical gap? If we have derived so much knowledge of the external universe through one octave of vibrations that affect the sense of sight, may we not hope for an enormous increase of knowledge concerning the vibrations that reach us from between these points?"

The vibrating rod has indeed formed the basis of many experiments in physics. The increase in the rate of vibrations is ruled by a definite law, the number of vibrations executed at a given time being inversely proportional to the square of the length of the rod. For instance, let us take a strip of brass two inches long. Make it one inch long and the resultant sound is the double octave of the former, though the rate of vibration is augmented four times.

Suppose we start with a strip 36 inches long which vibrates once in a second. According to the above law, when the strip is reduced to 12 inches, it would execute 9 vibrations a second; reduced to 6 inches, it would execute 36; to 3 inches, 144; while if reduced to 1 inch in length, it would execute 1296 vibrations per second.



THE LATE DR. ALEXANDER GRAHAM BELL

Who recognized fifty years ago the tremendous importance of vibrations. "All our knowledge of the external universe," said Dr. Bell, "is gained through our sensations, our sensations taking cognizance only of vibrations"

In experimenting with a vibrating rod, to make its vibrations more evident, its shadow is thrown upon a screen. Sir Charles Wheatstone, the famed English physicist, devised a simple but ingenious optical method for the study of vibrating rods fixed at one end. Attaching silvered beads to the end of a metal rod and focusing a light upon the bead, he obtained a small spot intensely illuminated. When the rod vibrated, this spot described a light which showed the character of the vibration.

To a physicist, all phenomena in nature are simply various rates and modes of vibrations. Everything is motion — sound, heat, light. Sound is a wave motion in the air and heat and light wave motions in the ether. The action of light and radiant heat is exactly the same as that of sound. They are controlled by the same law, diffusing themselves in space and diminishing in intensity the farther they travel. Like sound, also, light and radiant heat, when passed through a tube with a reflecting interior surface, may be conveyed great distances with comparatively little loss. Every experiment on the reflection of light has its analogy in the reflection of sound. Engineers, when figuring problems in sound or mass vibration, may multiply the result by octaves and find correspondences of vibration in radiant heat and light; and vice versa — results found in ethereal vibrations may be "stepped down" the required number of octaves and exactly the same parallel or analogy found in mass vibrations.

But as to the region of experimental electric waves that lies between the highest pitch of sound and the lowest pitch of radiant heat—indeed, therein lies an immense field for investigation. Some day an experimenter, following in the footsteps of Bell, may stumble over another nugget while searching for a distant vein of gold. The great possibilities of television lie before us. Can the vibrations of light (the 49th octave) be reduced by some means and impinged on waves of a lower frequency and transmitted electrically as the vibrations of sound waves are impinged on an electric current or carrier wave? Will it be possible to "see" thoughts by researches in higher vibrations? Truly, the principle of vibrations underlies much that we know and a great deal more that we do not know.

TABLE OF VIBRATIONS

The 64th octave marks the approximate upper limit of vibrations that physicists have been able to register by physical means—the various rates are obtained in several ways, and are generally computed in terms of Angstrom units.

The physical meaning of the term "octave" (as in sound) is that it is a note produced by double the number of vibrations of its basic or fundamental note.

OCTAVES	VIBRATIONS PER SECOND	EFFECT OF VIBRATIONS
64th octave	18,446,746,473,709,559,616	
63rd "	9,223,373,236,854,779,808	Gamma rays, X-rays. Probably marks most rapid atomic or molecular vibration where atoms and molecules vibrate individually instead of in clusters, or masses
62nd "	4,611,686,618,427,389,904	
61st "	2,305,843,009,213,693,952	
60th "	1,152,921,504,606,846,976	
59th "	576,460,752,303,423,488	
58th "	288,230,376,151,711,744	
57th "	144,115,188,075,855,872	Unknown
56th "	72,057,594,037,927,936	
55th "	36,028,797,018,963,968	
54th "	18,014,398,509,481,984	
53rd "	9,007,199,254,740,992	
52nd "	4,503,599,627,370,496	Ultra-violet light waves
51st "	2,251,799,813,685,248	
50th "	1,125,899,906,842,624	
49th "	562,949,953,421,312	Solar spectrum light waves (sunlight)
48th "	281,474,979,710,656	
47th "	140,737,468,355,328	
46th "	70,368,744,177,644	
45th "	35,184,372,088,832	
44th "	17,592,186,044,416	Heat or thermal radiation. Infra-red rays
43rd "	8,796,093,022,208	
42nd "	4,398,046,511,104	
41st "	2,199,023,255,552	
40th "	1,099,511,627,776	
39th "	549,765,813,888	
38th "	274,877,906,944	Unknown
37th "	137,438,953,472	
36th "	68,710,476,736	
35th "	34,359,738,368	
34th "	17,179,869,184	
33rd "	8,589,934,592	
32nd "	4,294,967,296	
31st "	2,147,483,648	
30th "	1,073,741,824	Region of experimental electric waves—Unknown
29th "	536,870,912	
28th "	268,435,456	
27th "	134,217,728	
26th "	67,108,864	
25th "	33,554,432	
24th "	16,777,216	
23rd "	8,388,608	
22nd "	4,194,304	
21st "	2,097,152	
20th "	1,048,576	
19th "	524,288	
18th "	262,144	
17th "	131,072	Radio waves
16th "	65,536	
15th "	32,768	
14th "	16,384	
13th "	8,192	The region of sound. The ear is capable of hearing 11 octaves, compared to one octave (49th) for sight. Practical range of musical sounds lies between 40 and 4,000 vibrations—approximately 7 octaves range of pitch for the human voice in singing is from 60 for a low bass to about 1300 for a very high soprano. The piano has a range of pitch from 27.2 to 4138.4; the pipe organ usually from 16 to 4138 vibrations per second.
12th "	4,096	
11th "	2,048	
10th "	1,024	
9th "	512	
8th "	256	
7th "	128	
6th "	64	
5th "	32	
4th "	16	
3rd "	8	
2nd "	4	
1st "	2	

Electric Waves in the Ether

Keeping an Eye on the Icebergs

How the Use of Radio Makes Possible the Work of the International Ice Patrol and Brings to Hundreds of Navigators a Relief from the Dread of Icebergs which, during Three Months of the Year, in the Vicinity of the Grand Banks of Newfoundland, Constitute a Serious Menace to Transatlantic Shipping

By ORTHERUS GORDON and CHARLES S. O'SHEA

THE iceberg menace was by no means unknown before that dark night in April, 1912, when the *Titanic*, on her maiden voyage, crashed into a monster berg, crumpled in like so much cardboard, and sank, with a frightful toll of human lives, in less than twenty minutes. Nothing much had been done about it, however, until the international clamor for some sort of protection against a repetition of this disaster resulted in the establishment of an International Ice Patrol.

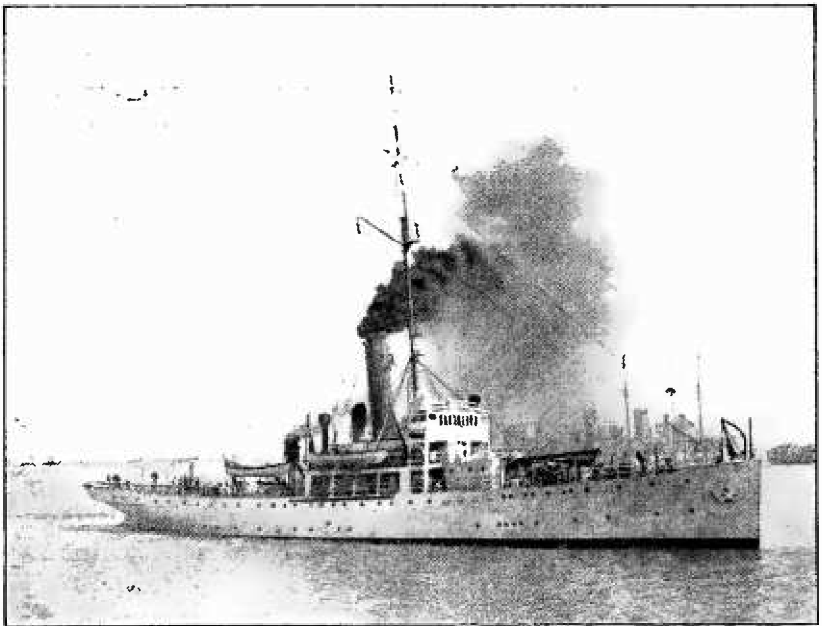
Skippers had dodged icebergs in northern latitudes and waterspouts in southern, by unending vigilance. In the old days, the transatlantic lanes ran directly through what is now the most dangerous part of the spring ice field; then with the advent of faster, larger steamers, the lanes were shifted southward, so that they would clear the *normal* southern limit of danger. But we knew that the limit of danger was by no means fixed, and that an exceptionally early start from the north might still bring icebergs into the paths of commerce. In spite of this knowledge, we waited for the costly lesson—and got it. Our cry for protection was in accordance with our habit of locking the barn doors after one of our steeds has been spirited away by the hides-and-glue man.

Still, there were others left to be cared for.

Had it not been for radio, the problem then confronting the maritime nations would have been a difficult one to solve. Although radio was then, comparatively speaking, in its infancy, it was hailed as the only way in which detached and separated vessels might be warned of the presence of these prowlers of the sea; and the nations in conference at London in 1913, one year after the great disaster, agreed that the first step toward safety of life and property at sea was to install radio outfits on all vessels. The second step calculated to destroy the menace of the ice, was to place vessels, with efficient radio equipment, on patrol in the dangerous region, whose sole duty it would be to locate the ice and disseminate the information to vessels concerned. That the ship-owners were more than willing to obey the law in the first case, if it meant the protection promised in the second, is easily believed. From that year to this, with the exception of the two years in which the United States was at war, two vessels of the Coast Guard Service have temporarily based at Halifax, Nova Scotia, and alternately sallied forth to patrol the Grand Banks of Newfoundland during the active months of the glaring white menace.

The United States, in the very year of the *Titanic's* fate, had taken upon itself the problem of ice protection, and sent out the scout cruisers *Chester* and *Birmingham* to the scene of that disaster. They formulated a procedure for the vessels which were to follow them in the work, and proved the adaptability of our seamen for this peculiar and strenuous service. All this, viewed by the nations at the International Conference, led to placing the responsibility for the Ice Patrol in the hands of our country. The work was to go on as before, but the expense was to be divided among the thirteen nations there present, in proportion to the size of their North Atlantic fleets.

Last year, the work was allotted to the Coast Guard cutters *Seneca* and *Yamacraw*, which were old hands at the game. Like all cruising cutters of the Service, they are equipped with the latest improvements in radio. The nature of their work for nine months of the year compels them to carry a reliable outfit, and also makes it imperative that the equipment be fool-proof. Always on the alert for distress calls, their sphere of usefulness is identical with their radio range. Hearing the distress call, they find their way to the vessel in trouble by means of their radio compass, despite boiling seas and swirling fogs.



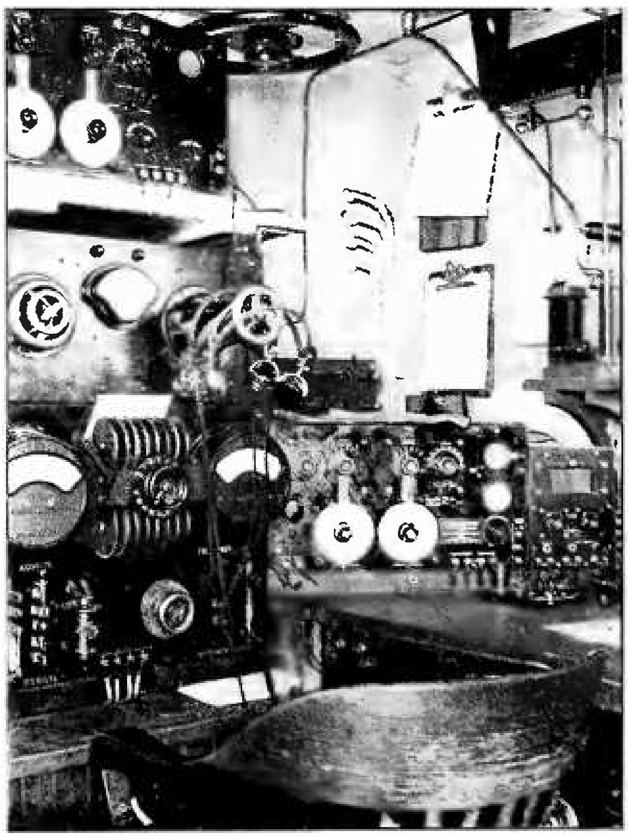
U. S. S. "TAMPA"
Showing the exceptionally high mast which makes long-distance radio work possible

However much the patrol vessels perform by means of their radio on ordinary coast duty, their work is doubled when they set out in April for their ninety days' duty on the Grand Banks. What before was an occasional rush of work now becomes an untiring vigil. The radio cabin becomes the "fighting top" of the ship, and the clearing-house for all information.

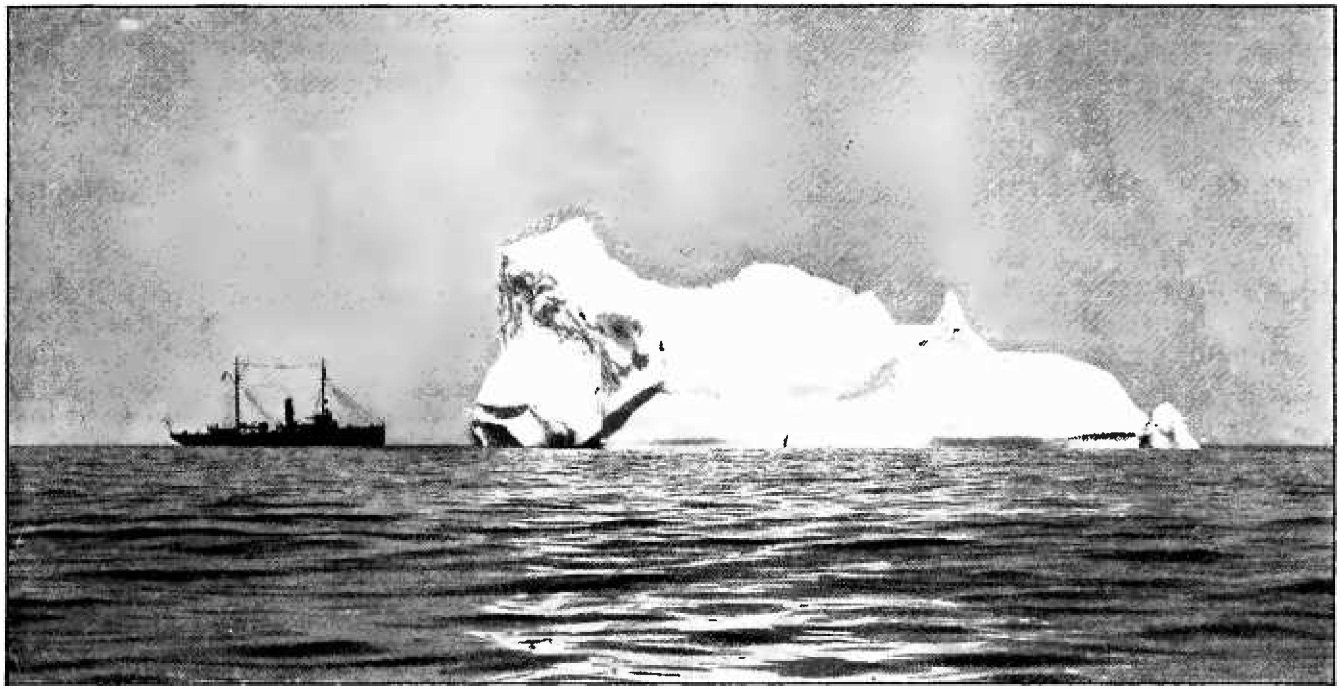
From the time an iceberg is first reported until it breaks up under the demoralizing warmth of the Gulf Stream or goes back again to the north with the receding Labrador Current, it is the subject of countless anxious messages.

In the first place, a broadcasted notice of it is sent out immediately by the patrol ship, as well as individual warnings if the plotted position on the special chart in the navigator's room prove it to be in the path of oncoming steamers. The first night of its encounter, its drift—or the direction and speed with which it is traveling—is determined by the sure method of drifting with it. From then on, its hourly position is located on the chart. Its characteristics are noted, so that it may readily be recognized when a merchant ship comes across it and reports its presence by radio. Another feature of the patrol's radio work is that every four hours a request is broadcasted asking all ships within range to send in their position, course, and distance, together with the sea-water temperature. Most ships, desiring what protection the patrol ship can afford them, respond to this call, with the result that the chart is not only a graphic picture of all the bergs in the vicinity but also of all the ships crossing the Grand Banks and likely to run into danger. The value of such a chart, continually brought up to date, is apparent, but the amount of key-pounding it means is astounding! Every four hours, there pours in on the overworked staff, a host of ship reports—TR's, as they are designated at sea—as well as hundreds of water temperature records, which come in at any and all hours.

Then there is the 4 A. M. report to the Branch Hydrographic Office in New York. Like the medical officer's morning report on the patient, this is a complete diagnosis of the condition of the ice field: its boundaries, its movement, and the individual bergs that constitute the most dangerous elements. This report is incorporated in a printed memo-



THE RADIO CABIN
Is the heart of an Ice Patrol Cutter



U. S. S. "SENECA"
Dwarfed beside this monster of the sea

randum sent out by the Branch Hydrographic Office, and distributed about New York City to the officials of interested steamship lines, to the Maritime Exchange, and to such others whose names are on the mailing list. From the New York Hydrographic Office, the 4 A. M. report goes on to Washington by land line, is recorded at the main Hydrographic Office, and broadcasted from the naval radio station at Arlington, Va. This report is undoubtedly the one that covers the most distance, and it would not be surprising if, emanating from the ship in the morning, it were to find its way back there before evening.

Again, there is the daily 6 P. M. broadcast, sent on the commercial wavelength of 600 meters, containing all the information gleaned that day from personal contact with the bergs or reported by other ships. It is repeated twice, with a two-minute interval between messages, and is designed to give navigators a chance to study the state of the stretch of ocean that lies before them that night. This done, the necessary reports for the day are completed, but not so the radio work. Assuming that the second dog watch from six to eight has been comparatively dull, things begin to hum after that.

For at eight comes the broadcasted request for all ships within the call to report themselves, so that they may be "spotted" on the iceberg chart and given all possible protection. With this request, containing as it does a note of warning and caution, every navigator who is worthy of his tickets figures out his latitude and longitude, judges the speed of his vessel, corrects the compass for his true course, and hot-wires the information to the Coast Guard cutter, throwing in a water temperature by way of thanks, and to cover his trepidation. (This, you see, is really a voluntary contribution to the list of sea-surface temperatures always in demand by the cutters.) The navigator then has the assurance that his ship is placed on the all-knowing chart, with her course stretching out in a pencil line before her, while a government officer is bending over it, ready at a moment's notice to flash a warning should an iceberg be reported on, or drift across, that course.

Most ships, however, are not content with the 6 P. M. broadcast, or with the service rendered by the chart, but must send in for special information. "Is there ice on my course?" demands one. "I am on the Louisburg (Cape Breton) track." And another asks, "What is the best route from the English Channel to New York, and what are the limits of the ice region?" "What are the limits of the danger?" "Is my course clear?" "Can I make Cape Breton without striking ice?" These three inquiries come from a group of cautious commanders. There is also the ever-present case of the navigator who takes a chance on the weather and the shortest route across the berg-infested area, irrespective of warnings. This practice, while safe in clear weather, is very trying on the ship's personnel when fog or night overtakes them before clearing the region. They bombard the ether with requests for information that will enable them to proceed, but often it is only a quick shift of the helm that saves them from crashing into a berg.

For the navigator is particularly helpless in the ice region in a fog, despite the fact that most of them erroneously believe they can "sense" an iceberg, if not by some seventh faculty of their own, then by the sudden change in air and water temperatures. It very suddenly gets cold. That is the belief, but nothing could be more misleading, nothing more dangerous to the mariner, should he depend entirely upon it. Fortunately, he does not. All sea-water temperatures taken thus far by the ice-patrol vessels fail to show that there is any marked change due to the nearness of ice, except when immediately alongside of a berg. A vindication of the tremendous amount of energy expended by the radio and chart-room personnel in carefully checking up on sea-water temperatures is demonstrated by the following incident:

It seems that near the end of the season, when the icebergs were working slowly to the north and while the *Seneca* was operating close to what she believed to be the southernmost one of the field, a radio came from a steamer reporting four of them thirty miles farther to the south. Naturally the commander of the *Seneca* was concerned and prepared to search them out. Could it be possible that these four bergs had escaped his vigilance? He thought not; but it was the sea temperature comparison that first impeached the accuracy of the steamship making the report. Her temperature report did not agree with those taken by the *Seneca* and other vessels in the same locality, so a verification of the position was requested. Then the illuminating truth came out. The ship in question had not enjoyed the company of a noon-day sun for two days, and was totally in the dark as to her actual latitude! Later, it transpired that she was one whole degree to the north of her dead reckoning position! This placed the bergs thirty miles to the north of the *Seneca* and not to the south as first reported. The sea water temperature work had saved the Ice Patrol a wild-goose chase.

STUDYING THE CONDITIONS OF A BERG
From the deck of the *Tampa*

But the work of this patrol! The constant, continual solicitation, with the willing coöperation of the merchant vessels only adding to the sum total! During the three months of operating last year, no less than 945 vessels reported themselves and the temperature of the water they were in, 2,646 times.

Recently, when the *Tampa* and *Modoc*, two new electrically driven cutters, were carrying on the patrol duties, the *Tampa* led in the number of reports received, gathering 771 in a fifteen-day period. This was done under most adverse conditions, owing to the fact that the *Tampa's* ½-KW spark transmitter, on which the major portion of the work was done, heated up, causing a bad note. A few reports were handled on arc, but this type of transmission was found unsuitable, in general, for this sort of work, where speed and simplicity of operation are of prime importance.

The personal comforts of the crew of an Ice-Patrol cutter are few. On one cruise, an eight-day gale made life miserable, while on the *Tampa's* last trip a fourteen-day fog shrouded the ice area. Contrary to general opinion, the cutters do not see a large quantity of ice. In fact, on one trip, no bergs were sighted until the very last day; yet by data received by radio it was possible to keep the danger zones plotted at all times.

Loop Aerials for Broadcast Reception

By G. Y. ALLEN

Loop aerials are being rapidly and widely adopted, now that the principles of radio-frequency amplification and Armstrong's super-regeneration are being put into use. In general, the loop aerial is more directional, more selective, and more convenient than the types heretofore used. However, for the same signal intensity, the upkeep is greater.

In this article, Mr. Allen tells just what the loop aerial is and how it works, and explains its advantages and limitations.—THE EDITORS.

DID you ever wish that your radio receiver would present deaf ears to all stations except the one you desire to hear? Does your landlord refuse to allow you to erect an antenna on the roof of your apartment? Would you like to have a receiver which you can move from place to place without moving your antenna or ground?

If any of these wishes have ever been yours, you will be interested in knowing the possibilities and limitations of the loop receiver. While the loop is by no means a perfect receiver, it has many desirable features which are already making it an important development in the field of broadcasting.

Early receivers and transmitters followed in the well-beaten path of Marconi by utilizing elevated wires to send out and receive their signals.

When the theory of radio became better understood, however, investigators looked into the possibilities of using a coil of wire, each end of which was connected to the radio receiver, thus replacing both the elevated antenna and the ground. The loops consisted of a rectangular frame varying from about two to ten feet on a side and carrying any number of turns of wire. A typical loop is illustrated in Fig. 1.

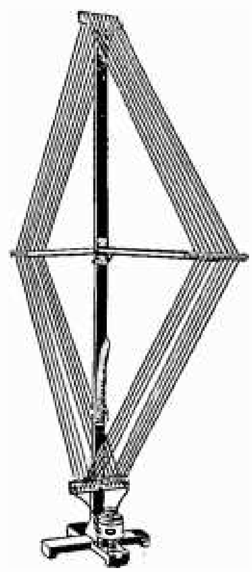


FIG. 1

It is believed that a loop for receiving radio waves was first used by a German between 1908 and 1910. About the same time, the United States Navy and Bureau of Standards carried on experiments, paying particular attention to the property of the loop of being sensitive to the *direction* of travel of the radio waves. As will better be appreciated later in this article, the loop does not collect as much energy from the radio wave as does the conventional antenna, and little progress was made in the early days, owing to the lack of sufficiently sensitive receiving instruments. With the advent of the radio-frequency amplifiers suitable for comparatively short wavelengths, however, the importance of the loop receiver has increased and its desirable qualities bid fair to make it a strong competitor, in certain fields, of the conventional elevated wire.

HOW THE LOOP WORKS

TO UNDERSTAND how a loop antenna collects energy from a radio wave and how it develops certain of its characteristics, it will be well to review briefly the character of a radio wave itself.

A certain portion of the wave consists of magnetic flux similar to that produced by the common horseshoe magnet or supplied by the field poles of an electric generator. In the case of the generator, the magnet is stationary and coils of wire revolve in the magnetic flux field, generating current in the revolving coil as illustrated in Fig. 2. In the case of the radio loop, the coil remains stationary and the flux, traveling through space, is intercepted by the loop, generating a current in it, as shown in Fig. 3.

Now, the intensity of this flux varies as it moves through space, in step with the alternations produced at the transmitting antenna, and if the instantaneous intensity of the flux is plotted against position in space, the curve will appear as shown in Fig. 4.

At the instant shown by the black line, the flux is of maximum intensity in one direction at the left side of the loop and of maximum intensity in the other direction at the right side. The result is the setting up of an electrical potential in the entire loop which will

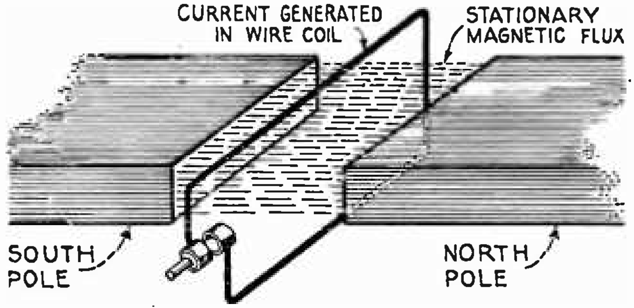


FIG. 2

cause current to tend to flow clockwise for the instant. An instant later, the wave will have passed half a wavelength to the right, and will be in the position shown by the dotted curve. Here the flux intensity is zero at each side of the loop and of course, there is no tendency to generate a current. The next instant the wave has assumed the position indicated by the dot-dash line, and the electrical potentials on either side of the loop are of the same magnitude as in the first case except that they are reversed. The wave continues to travel and the changes in electrical potential are repeated.

The resultant voltage (electrical potential) generated in the loop, if plotted against time, will appear as shown in Fig. 5. In other words, an alternating voltage will be generated across the loop, and the frequency in current reversals per second will be the same as that of the transmitter. This vibrating voltage can then be used to operate a radio receiver in the same way as the antenna and ground.

The loop shown in Fig. 4 is sufficiently long to extend over half a wavelength. Broadcasting stations operate at 360 meters and the length of the loop, therefore, would be 180 meters, or 590 feet, which would be far too long to permit the loop to be used conveniently. Loops of much smaller dimensions are therefore used, and although they do not pick up as much energy as the larger types, with radio-frequency amplifiers they generally give very satisfactory results.

WHY THE LOOP IS DIRECTIONAL

THE loop as shown in Fig. 4, is turned so that each side is in a plane with a line indicating the direction in which the wave is traveling. If the loop is turned through 90 degrees, each part of the wave strikes both sides of the loop at the same time. The result is that although there will be a voltage induced in both sides of the loop, these voltages will

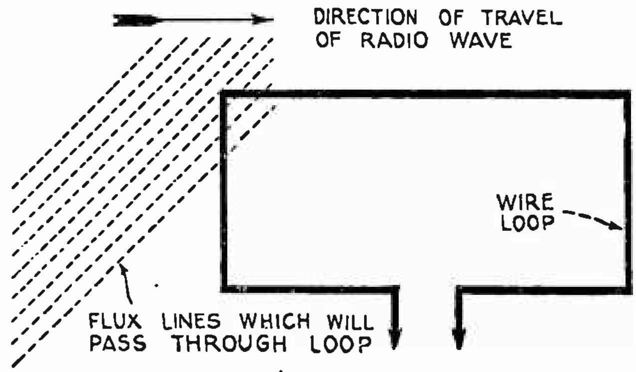


FIG. 3

be equal and opposite and there will be no current. In other words, the loop must be turned so that its edge is toward the transmitting station. When in this position, it reduces or eliminates entirely the signals coming from all other directions. In addition to the selectivity obtainable from tuning, therefore, there is a directional selectivity which is very helpful.

Fig. 6 illustrates how interfering stations

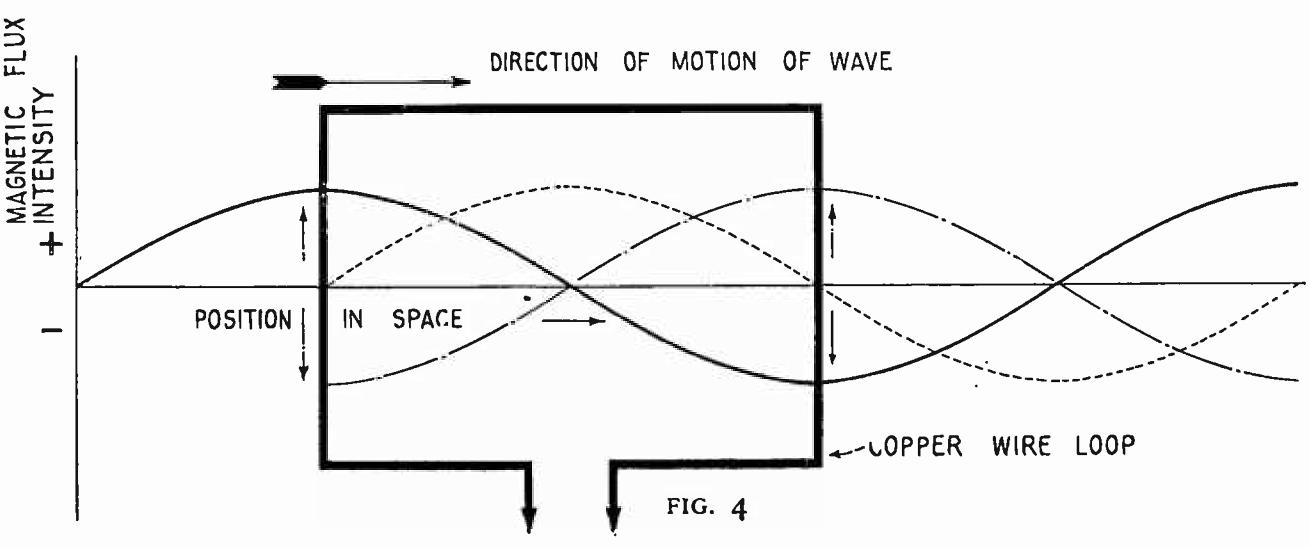


FIG. 4

lying in a different direction from the one to which it is desired to listen have their signals intensity reduced by a loop aerial. Lines A and B are assumed to be in the direction of stations whose signals are not desired and whose signal intensity on an elevated antenna would be the same as that from the station we are tuning for. In both cases, the signal intensity on a loop would correspond to the lengths of arrows A and B as compared with the length of arrow C for the station desired. A station at right angles to the direction of the desirable station would not be heard.

In addition to reducing interference from stations, the loop antenna also reduces static interference. Loops are generally used indoors. As most of the static consists of discharges of accumulated electricity, most of these charges are drained to earth by the plumbing and electrical wiring within the house, and so loop receivers are practically immune from this annoyance. Then, too, the wave sent out by a static discharge acts upon the loop in the same manner as the radio wave. From the foregoing it is reasonable to assume that static disturbances will only be noticed when they come from points directly or almost directly in a plane with that of the loop.

A further feature of the loop will be appreciated especially by those living in congested districts. Many of us have anticipated a pleasant evening listening to a broadcasting station, only to have some well-meaning neighbor persist in adjusting his tickler to give the most powerful local oscillations, and tune his set so as to obtain a beat note of about 1000 cycles with the broadcasting station. The only effective measures in the case of those

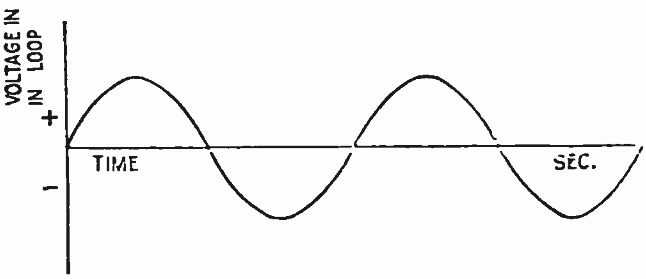


FIG. 5

possessors of oscillating receivers who seem to think that the "howl" gives a desirable quality to the music, would seem to be to give them each a loop receiver, which would give them all the noise they desire without inflicting the benefit of their pastime upon their neighbors. As the loop is a very poor radiator, it does not send out much energy even if the receiver is made to oscillate, and the enforced use of such a type of receiver on those who persist in making their receiver oscillate would be an unquestionable remedy. However, as this is impracticable, the use of a loop by the person desiring immunity from this form of interference permits him to use its directional properties effectively, at least partially eliminating the

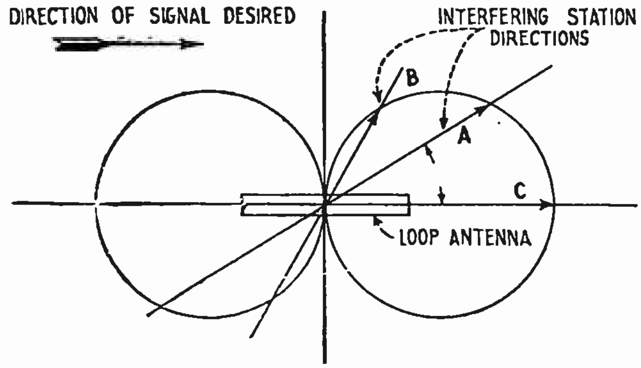


FIG. 6

interference even if the offender is using an elevated outdoor antenna.

Receivers for use with loops are generally of the simplest type. For short-wave receivers, the loop is made to take the place of the tuning coil and the wavelength adjustment is obtained by using a variable condenser across the terminals of the loop. Sometimes taps are taken from the loop if a greater wavelength range is desired. The radio-frequency amplifier, detector tube, and audio-frequency amplifier do not differ materially from similar apparatus used with elevated wire antennas.

Fig. 7 illustrates a schematic wiring diagram of a loop receiver using three radio-frequency and two audio-frequency amplifiers. Filament connections are omitted for the sake of simplicity.

TUNING THE LOOP RECEIVER

In tuning, the variable condenser is adjusted so that the circuit is resonant to the wavelength desired, causing the signals to come in strongly. The loop itself is then turned until the desired station comes in loudest.

An inspection of the circuits will show that the oscillating voltage across the loop and condenser are applied directly to the grid and filament of the first tube. The signal is here amplified and transferred to the grid and filament of the second tube through the first

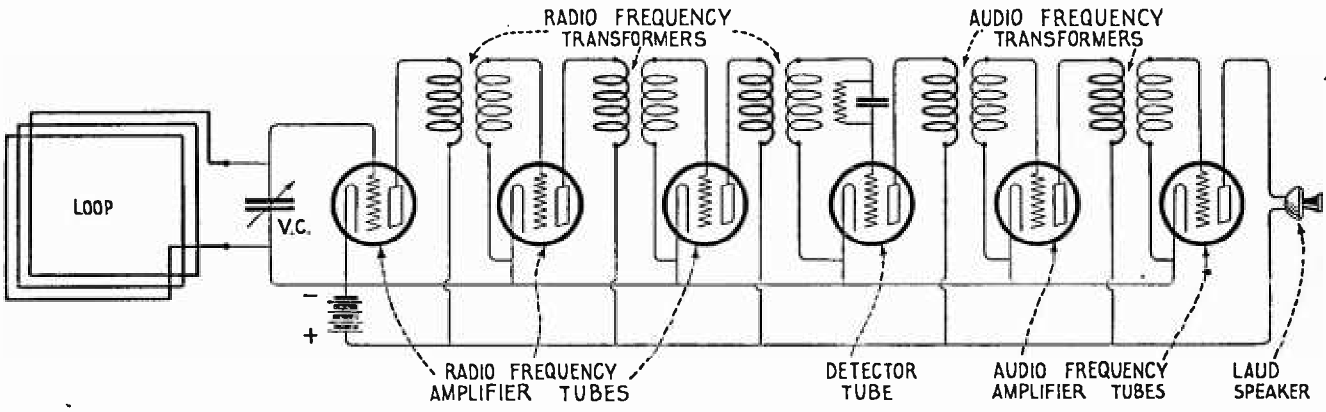


FIG. 7

radio-frequency transformer. This action is repeated through the first three tubes. By this time the strength of the signal is sufficient to be applied to the detecting tube. Detector or rectifying action is obtained in the usual way by the insertion of a grid leak and grid condenser in the grid lead of the detector circuit.

The amplifying tubes on the audio-frequency side of the detector tube amplify the voice-frequency part of the received signal and deliver it to the loud speaker with sufficient intensity to furnish the desired volume.

If it is desired to make the receiver regenerative, a number of methods may be used, one of which is shown in Fig. 8. Here a part of the inductance is connected within the receiver and is coupled to the tickler coil as in a receiver used with an antenna.

REGARDING AMPLIFIERS

AS HAS been stated before, the loop does not pick up as much energy as the outside antenna and, therefore, the success of a loop receiver depends upon its sensitivity. The most satisfactory way of getting great sensitivity with stability of operation is to use radio-frequency amplification. Before the war, radio-frequency amplification was practically unknown, but the desirability of employing the loop receiver, particularly in plotting the positions of enemy vessels, led to the development of the radio-frequency amplifier to be used with it. The proficiency of the Allies became so great toward the close of the war that they could determine with great precision the position of enemy vessels. In fact, it is reported that the Battle of Jutland occurred as it did because the British radio compasses using radio-frequency amplifiers of some twenty stages traced the German fleet through the Kiel Canal and surmised from their movements that they were preparing for battle.

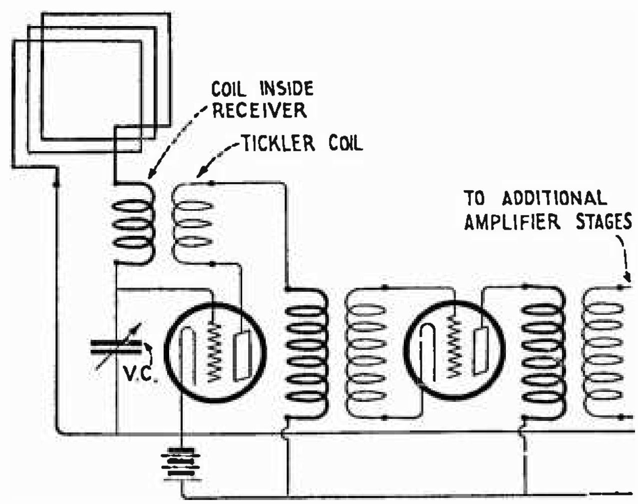


FIG. 8

As in the case of audio-frequency, so in the case of radio-frequency amplification, amplifiers are divided into three classes: resistance-coupled, reactance-coupled and transformer-coupled.

A schematic wiring diagram of resistance-coupled radio-frequency amplifier is shown in Fig. 9. With this arrangement, the amplification per stage is not high because there is no step-up of the voltage and the amplifying constants of the tubes must be depended upon exclusively for amplification, but has the outstanding advantage of amplifying with equal efficiency over a very large range in wavelengths.

Fig. 10 shows a diagram of a reactance-coupled amplifier which acts very similarly to the resistance-coupled type except that the amplification per stage is somewhat greater. It will not cover such a great range in wavelengths and likewise has the disadvantage of being confined to the inherent amplification of the tubes.

Because of the increase in the amplification per stage, the transformer type of amplifier is preferred. A schematic wiring diagram of such a transformer is similar to that shown in Fig. 7. Early designs of radio frequency transformers were of the air core type and they were generally wound in grooves cut in some insulating material. There were many objections to the air core radio-frequency transformer, among which was the tendency to start and sustain radio-frequency oscillations similar to those created by the use of a tickler coil in a simple radio receiving set. In a radio-frequency amplifier, such oscillations are very undesirable as they prevent the vacuum tube from functioning and reduce the amplification considerably.

Another undesirable feature of the air-core transformer is that each transformer in the amplifier must be operated round its own natural period for best results. The tuning effect of an air-core transformer is extremely critical, for such a transformer is nothing more than an inductance similar to that used for tuning a simple radio receiver. Early designers did not think of using iron cores for such very high radio frequencies on account of the fact that iron would make for a large amount of wasted energy in the circuits. Later developments, however, proved that the effect of thinly laminated iron was very beneficial in many respects. In the first place, iron being a better magnetic conductor than air, a greater voltage amplification is obtained in such a transformer.

The iron, as was anticipated, did cause a loss or a waste of energy, but in so doing also prevented the amplifier from setting up high-frequency oscillations. The over-all effect was an increase in the amplification, rather than a decrease. The effect of the iron in the

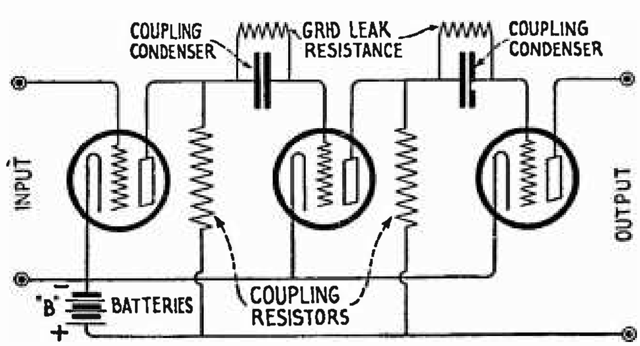


FIG. 9

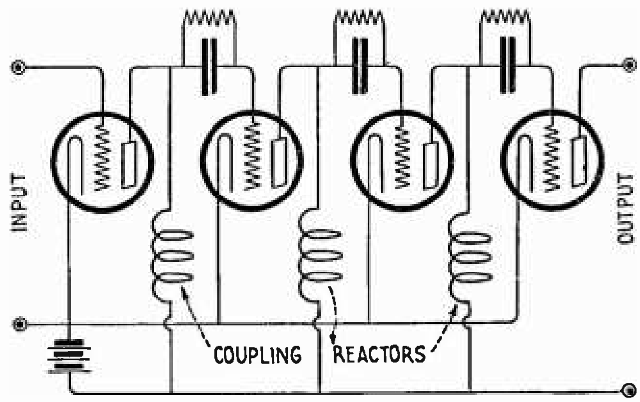


FIG. 10

transformer was similar to inserting resistance. It decreased the sharpness of tuning and permitted a transformer to be used on a greater range of wavelengths.

The wavelengths used during the war, and on which radio-frequency amplifiers were used, were generally above 600 meters. Now it is comparatively easy to design a radio-frequency amplifying transformer for wavelengths above 600 meters, but very difficult to design one that will operate efficiently below 600 meters, and particularly below 400 meters. Many attempts have been made to procure satisfactory results on these short wavelengths, but until recently they have been only partially successful.

A number of different makes of radio receivers using loops and radio-frequency amplifiers have been placed on the market during the past year. They are generally placed in cabinets similar to talking machine cabinets and the loop is found in a compartment at the bottom of the cabinet. When installing the receiver, the owner adjusts the loop until he gets the loudest signal, indicating that it is turned in the direction of the transmitting station.

In conclusion, it is doubtful whether the the loop receiver will ever entirely supersede the receiver using an elevated antenna. The radio-frequency amplifier, of course, is more expensive and has a higher maintenance cost than a simple receiver, and therefore, where price is an important factor, the simple receiver will probably always find a field. However, it is generally agreed that the radio-frequency amplifier type of receiver, utilizing a loop and installed in a cabinet, will find very wide use in the future in many of the homes of those who desire the best that is to be had.

The Englishman as a Radio Amateur

By M. B. SLEEPER

IT IS rather hard for the average American to realize the difference between the English radio enthusiasts and our dot-and-dash artists, hams, concert fans, and experimenters. In the first place, the Englishmen have no such classifications as these, nor any radio slang. For one thing, they take radio very seriously, making it either a real scientific study or a sport, which, if you know English sport enthusiasm, means a decidedly business-like pastime. This is particularly noticeable in the radio stores: in contrast to the rapid-fire discussions, claims, and arguments heard in our stores, the English shops have the atmosphere of scientific instrument salesrooms.

> The author of the accompanying article is well known in American radio circles for his writings and other activities, not the least of which is his connection with the radio corporation bearing his name. Like many other manufacturers, Mr. Sleeper has been keenly interested in radio telephone developments in England, and has endeavoured to determine the field for American-made apparatus in that country. He has just returned from a visit to England during which he made every effort to understand the slow progress in broadcasting, allowing for the fact that British experimenters do not share the freedom of the ether enjoyed in the United States.
>
> In our next issue, the broadcasting situation in England as seen from the British point of view will be discussed by Mr. Philip R. Coursey, editor of "The Wireless World and Radio Review" (London). —THE EDITORS.

THE ENGLISHMAN'S ATTITUDE

WITH the Englishman considering the purchase of supplies, it is a case of "How can I get along without it?" With us, it is "How can I manage to get it?" In consequence, he constructs more of his own equipment, improvises in every way possible, studies apparatus built for sale and reproduces it in his own way, and usually to his own satisfaction. And it may be said in passing that some of the workmanship is as fine as that on commercial products.

I have often heard it said that English automobile owners generally know much more about their cars than the average American. Perhaps, by the same token, English experimenters know more about the scientific aspect of radio than most of us, although I think that is hardly true, because they have not had the advantage of our many books and magazines on the subject. I did find that they are very keen for competitions of all sorts, quicker than we are to express their views through the medium of the press and take full advantage of opportunities offered through the magazines to ask questions. They go at the radio game in a quieter way than we do, but probably enjoy it just as much, and certainly learn how to build and operate their apparatus more thoroughly than the majority of us.

It was interesting to note that their experimenters are much older than ours. The small boy takes practically no part in radio activities; it is the English fathers rather than sons who make up the ever-growing number of experimenters.

THE HAND OF THE LAW IS HEAVY

IT IS doubtful if radio broadcasting will find the wide popularity in England that its great appeal to the imagination has won for it here. Rather, it will be taken up by the many mechanical and electrical hobbyists who are responsible for the great industry of making models.

One of the great difficulties which will be met in popularizing radio is of a governmental source. We know that there would be many less stations here if each person had to go through the formalities of applying for a receiving license. Our freedom in this respect has helped radio greatly, because it is such a simple matter to buy our equipment and set it in operation. Our ardor would be dampened if, in addition to obtaining a license, we had to pay a yearly license fee for the privilege of having a receiving set.

There seems to be the fear that stations operated by department stores or newspapers would be used for advertising purposes. At least, that is the reason given for keeping broadcasting in the control of the radio companies. That it does not work out that way, we know, of course, but there has been very little disposition to investigate the exact status of broadcasting in America.

The most extraordinary regulation of all is that which differentiates between experimental and broadcast receiving sets. The former are permitted to receive on all wavelengths, but the latter must be so designed that, with the 100-foot single wire allowed for the antenna and lead-in, the set will not be capable of receiving below 300 meters or above 500 meters. It must be far more difficult to decide whether a set designed for wavelengths of from 350 to 450 meters will or will not receive beyond the limits than it has been for our Bureau of Standards to say what process should be followed in judging the merits of a receiving set. It is obvious that a difference in the material over which an antenna is suspended would alter its capacity sufficiently to increase or decrease the wavelength more than 50 meters, assuming that the antenna inductance in the receiver remains the same. This regulation is so new that *no sets to meet these requirements have been designed for production thus far.*

NO SINGLE-CIRCUIT REGENERATIVE RECEIVERS

ANOTHER difficulty has been introduced by the condemnation of the single-circuit regenerative receiver. There is the most extraordinary fear in England that oscillating receivers will beat with each other, and in that way cause howling. Although I listened-in a great deal, both in London and in the country, I did not experience this dreaded difficulty at any time. However, the fact remains that the single-circuit regenerative receiver, once used almost universally in England, is no more. Our tickler coil circuits or the familiar loosely coupled regenerative sets with variometer tuning are almost unknown. It is practically impossible to buy a variometer in England. Very likely hundreds of dollars' worth of regenerative equipment in the hands of manufacturers will never see the dealers' shelves.

Perhaps the most extraordinary thing of all is the fact that English experimenters and manufacturers do not seem to mind the difficulties introduced by the new legislation. A number of radio men with whom I talked ad-

Photo by Bachrach

MILTON B. SLEEPER

mitted the apparent absurdity of conclusions which could hardly have been drawn by men familiar with the science of wireless, yet they are in no way disturbed by them or concerned with the delay in developments which must surely result.

NO FOREIGN APPARATUS FOR TWO YEARS

AMERICAN manufacturers who have been considering the exportation of radio equipment will be somewhat disappointed to learn that, during the next two years, one of the conditions under which licenses will be granted is that the apparatus used be of English manufacture. While this does not actually preclude the exportation of equipment, it does mean that imported apparatus will have no sale there. This may remove a possible field for expansion, and yet the manufacturers cannot be blamed for expecting the protection of the Government until such time as they can get well under way producing sets and supplies.

There are about fifty radio companies manufacturing apparatus, most of them in a very small way. The Marconi Scientific Company and Marconi's Wireless Telegraph Company are the largest builders of commercial equipment and have also gone in for amateur sets. Their factories may be taken as typical of the

CONTROL PANEL OF ENGLISH RECEIVER
This outfit is one of the best that is made, and sells for £25

larger concerns. At both places, complete shop equipment is provided for all kinds of work from turning out screw machine products, milled and drilled parts, coil windings, engraving, plating, polishing, and assembling.

WHEREIN ENGLISH EQUIPMENT DIFFERS FROM OURS

THE Marconi Company seems to be leading the way toward nickel finish, replacing the old and expensive method of lacquering brass parts. Instead of giving the pieces a high polish as we do, they use a dull nickel that looks like German silver. The effect is decidedly attractive. Only replacement parts are now lacquered. This change has not yet become universal, for such concerns as Burndept's still employ the other system in the belief that it gives the apparatus a more substantial and richer appearance.

It is hard to explain exactly the difference between English equipment and ours. It is probably a matter of the designers' point of view. That is, we have what might be called a definite school of design for radio equipment, while in England their apparatus is distinctly in the class of scientific instruments. The result has been something similar to that achieved by the Western Electric Company, whose first radio apparatus was planned by men who had grown up in the school of telephone instrument design.

A striking characteristic of their equipment is that the panels are horizontal in nearly every case, with the tubes mounted outside. Possibly the fact that we have used vertical panels and cabinets with hinged covers permitting the inspection of the parts behind the panel accounts for our development in neatness of wiring and arrangement. That their sets are not open to inspection except by the removal of screws holding the panel down on the cabinet may account for the general appearance which we would call disorderly. That effect is heightened in apparatus made by some of the companies by the use of paraffin and a general daubing of shellac over wires, coils, and connections.

As for vacuum tubes, theirs are about the same price as ours, but in the matter of efficiency they are much superior. The most widely used design is similar to that originally known as the hard, French tube. The same type is used for both detector and amplifier, with 40 volts on the detector plate and up to 350 volts on the amplifiers.

NO MOULDED INSULATION TO BE HAD

AN OUTSTANDING feature of British manufacturing methods is the universal use of machine-finished insulating parts, for which hard rubber is used exclusively. I did not see a single molded part in England. Mr. Goodman, of the English Dubilier Company, told me they would like very much indeed to buy molded parts, but that it is impossible to secure acceptable electrical and mechancical characteristics in such material. Their good grades of hard rubber, on the other hand, are somewhat superior to those available in the United States. This rubber is low in price, too, but they consider it necessary to use such thick panels that our more expensive materials, which can be used half as thick, seem to me more desirable.

NO QUANTITY PRODUCTION

SO FAR there is no real quantity production of any radio supplies. In fact, it is difficult to see how quantity production can be effected when so much handwork in turning, milling, and drilling is required. This, no doubt, accounts for the embargo which, in effect, has been placed upon the importation of foreign-made equipment. But British manufacturers should have plenty of time to increase production, judging from the slow rate at which broadcasting arrangements are progressing.

Sales distribution is accomplished either by mail or by direct business with the dealers. There are no radio jobbers. Compared to our prices, even at the present rate of exchange, their equipment is, in general, expensive. The discounts to dealers are, in many cases, only 10%, running up to 15% or 20% in large quantities. On some parts in which I was interested the very best export quotation in large quantities was only 15%.

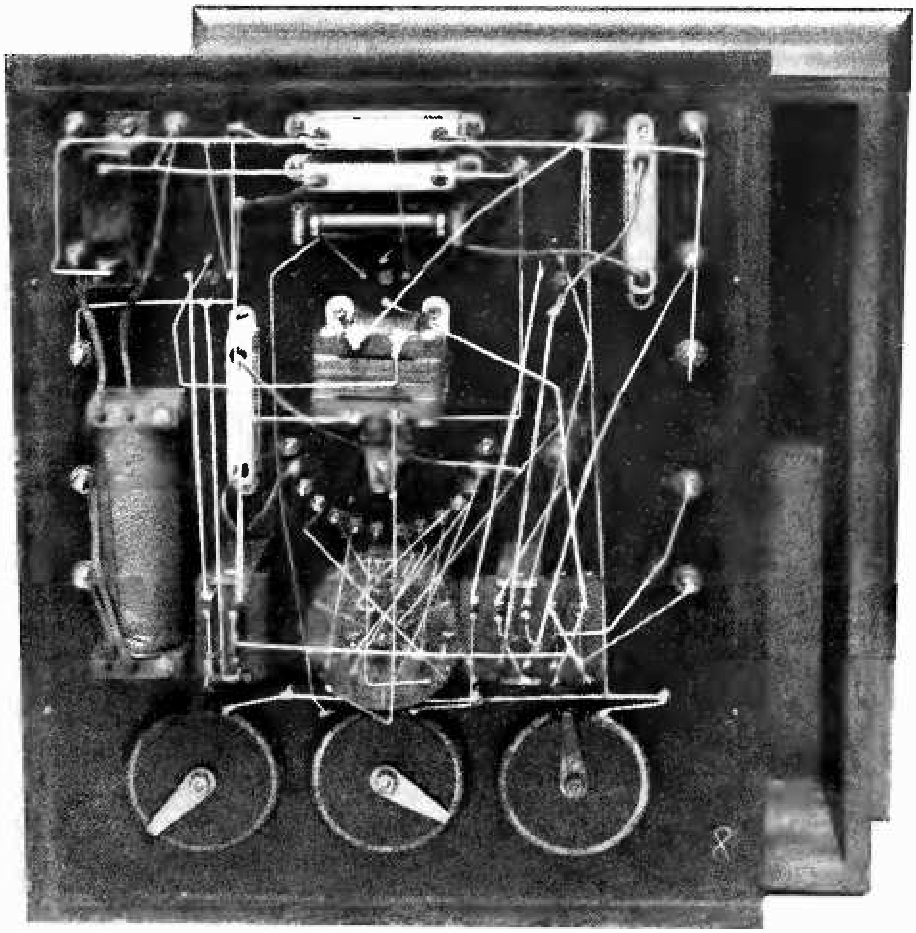
The wireless magazines published in England are four in number, "The Wireless World," with which we have long been familiar, "The Broadcaster," "Amateur Wireless" and "Popular Radio," providing plentiful sources of information of developments. As is the case here, great numbers of books have been put on the English market within the last few months written for those who are interested in taking up radio work.

Perhaps there is no better way of summarizing experimental radio in England than printing the following letter from Mr. E. Schulten, of Melchoir, Armstrong and Dessau, dated London, Aug. 29, 1922:

"The radio situation in England is, if anything, more befogged than when you were here. The latest Government regulation is that apparatus designed for purely amusement purposes, i.e., the reception of broadcasted concerts, is to be so constructed that it cannot receive a greater wavelength than five hundred meters. This has caused consternation in the Trade, as many firms had got into production apparatus of much greater capacity, and they have now all to be altered. It is further announced that when broadcasting comes into operation, a royalty of 10% on each complete machine will have to be paid to the Broadcasting Company toward the upkeep of their stations, and the Government will also contribute 50% of the existing license fee for the same purpose. This regulation about wavelength is not to apply to experienced experimenters who can obtain licenses for the reception of unlimited wavelengths, and also use a regenerative circuit, which is forbidden to be used by the general public taking up broadcasting for amusement purposes only.

"While there are certainly firms pushing the sale of units for home assembly, I have not as yet come across one who explains in a clear, non-technical manner just what is to be done with the units, and how they are to be assembled when bought.

"It seems that the *Daily Mail* erected a broadcasting station on American lines above their offices and the Government refused them permission to use it. Then they took over the station in Holland, which is not a success and has not been heard with any degree of enjoyment by any of the experts I have talked to, and it is a hopeless failure for the ordinary amateur."



THE INTERIOR OF THE RECEIVER

Which is shown on the opposite page. Compare the wiring with that of the infinitely more complicated American receiver on page 12

© Harris & Ewing

DR. J. H. DELLINGER
Chief of the Radio Laboratory, U. S. Bureau of Standards

The Bureau of Standards Lends a Hand[1]

By J. H. DELLINGER
Chief of Radio Laboratory

THE recent remarkable popularity of radio in the United States has caused the widespread impression that radio is something very new. While it is true that its use for popular entertainment is new, the principles have been well known and certain uses of radio have been undergoing development for many years. The seed of the present extraordinary growth was, in fact, planted sixty years ago by the scientific research of the English physicist, Maxwell. This article will endeavor to give a glimpse of what Uncle Sam's radio laboratory is doing to increase the knowledge and extend the usefulness of this science.

THE CHANGING APPEAL OF RADIO

RADIO is now being exploited through its appeal to the play instinct of mankind, but it contains also the means of satisfying the service instinct; it is one of those extensions of man's powers which science is ever revealing. It seems certain that the present radio boom will last several years, and that its present popularity based on its entertainment features will be succeeded by an era of more substantial progress based on actual service. It is this which justifies whole-hearted effort and serious scientific radio work by Government and commercial interests alike. One of the interesting things about radio is that it furnishes perhaps the greatest stimulus to the popular study of science known. Radio puts life into the study of science—something which, possibly through his own fault, the average man has not always observed there.

THE BUREAU OF STANDARDS RADIO LABORATORY

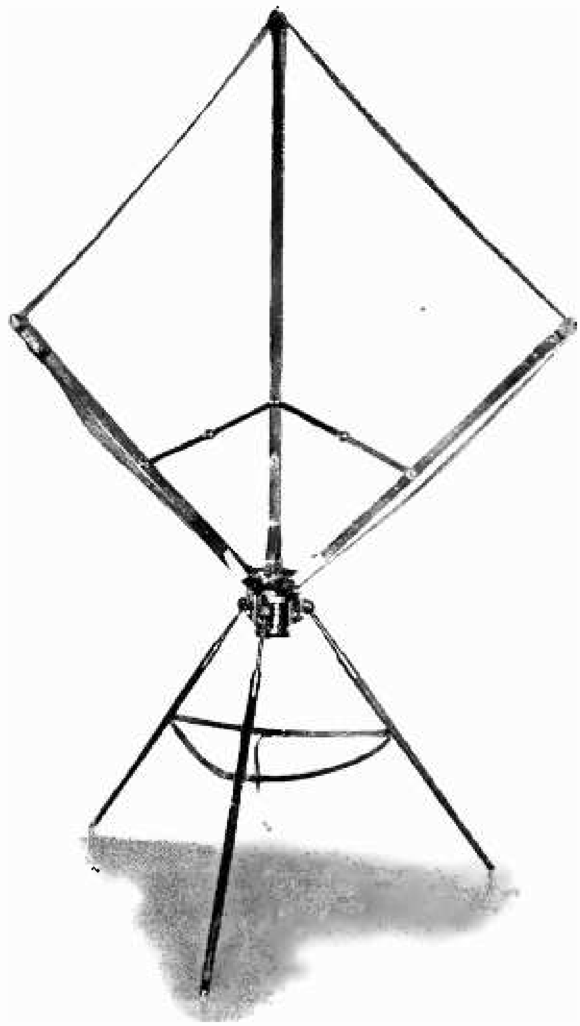
THE Bureau of Standards of the Department of Commerce is the principal Government institution for scientific research and standardization work of all kinds. It specializes on fundamental principles, measurements, and standards, and in this field assists the various other Government departments. On account of the extensive scientific facilities of this Bureau in electrical and related lines, it is the institution best equipped to carry on scientific radio work effectively. In recognition of this fact, there is located at the Bureau of Standards not only its own radio laboratory but also radio research laboratories of the Navy Department and of the Signal Corps.

The Navy Department's research laboratory has been situated at the Bureau since 1902 when the Bureau was founded. Then came th the Signal Corps laboratory. The Bureau' own radio work was begun in 1910 in respon to requests for standardization of wave mete and other measuring instruments. In t same year General George O. Squier did pioneer work on line radio at the Bureau Standards laboratory of the Signal Corps. work which has been done by Dr. L. W. Austi in the Navy Laboratory is well known amon technical students of radio and is the foundatio of a large part of the radio engineering of to day. The bureau's own work during the w is described at some length in Miscellane Publication[2] of the Bureau of Standards 46, "War Work of the Bureau of Standar pages 222 to 245. There were forty person the radio staff during the war. At pres there are fifteen.

The radio laboratory is housed in a two-st building adjoining the electrical building of Bureau. The Bureau laboratory occupies the upper floor, the lower floor containing the research laboratories of the Navy Department and the Signal Corps. Two 150-foot towers support antennas. There are in addition two field stations consisting of small wooden buildings located at points within five miles of the Bureau. These stations, with auto trucks, facilitate experiments in radio transmission and reception.

[1] Published by permission of the Director of the Bureau of Standards of the U. S. Department of Commerce.

[2] Obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C.



A COLLAPSIBLE, PORTABLE LOOP ANTENNA
Used by the Bureau of Standards for radio compass and similar experiments in the field

The Bureau's work in radio includes, broadly, research on principles and measurements, standardization of apparatus, and radio engineering, publication, and information.

RADIO WAVES AND SIGNAL "FADING"

WHILE the transmission of information by radio is carried on according to the process which is in accordance with simple scientific theory, yet any one who uses radio soon finds out that there are many vagaries in its action. Some of these are due to the behavior of the radio waves themselves. It is by no means easy to predict how loud received signals will be even when all the facts about the transmitting and receiving apparatus are known. One of the principal objects in radio research, therefore, is to determine the behavior of the radio waves with reference to time, weather, and the character of the surface over which they travel. The gathering of information on this important problem involves an almost endless amount of scientific work. Careful measurements of radio wave intensity have to be made over long periods of time, by many observers in different places. This work is, in fact, being organized on an international scale, with the Bureau of Standards assisting. A study of the underlying principles of radio waves has been made, as a result of which it has been possible to develop simple ways of calculating approximately the amount of current received in various types of antennas. This helps one to determine how sensitive a receiving set is necessary to receive from a station at a given distance.

There are a number of interesting angles to this problem of predetermination of the signal intensity. One factor which complicates it is the erratic variation of signals at night. This variation, which has been noticed by many people who receive broadcasted entertainment and information, is called "fading." The Bureau, in coöperation with the organized amateurs of the country, carried on an investigation of fading a year ago which has led to a better understanding of its nature and cause. About a hundred of the best equipped amateurs took records each night of the variation in intensity of special signals transmitted from six amateur transmitting stations in the eastern half of the United States. The results showed that the radio waves are affected by conditions from far up in the atmosphere, as well as by conditions of the ground over which they travel.

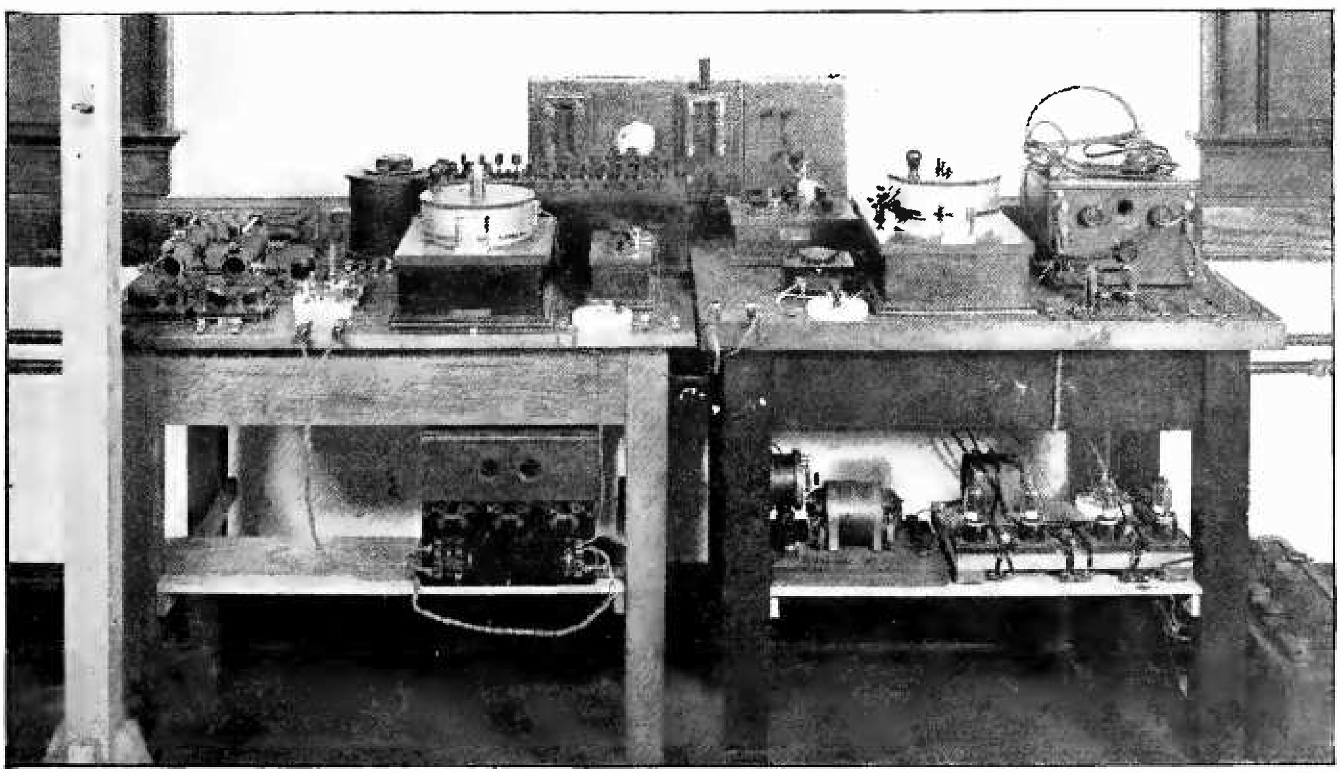
"CONDENSER" AND DIRECTIONAL ANTENNAS

A GREAT deal of work has been done toward determining the best type of antenna for various purposes. This has led to improved understanding of the correct design of the two principal types, the ordinary elevated antenna and the coil antenna. It was found that a modification of the ordinary elevated antenna is valuable for many purposes, particularly at short waves; this is the "condenser antenna" consisting of an elevated pair of metal plates. The very great improvements that have been made in radio receiving apparatus make it possible to use much smaller antennas than heretofore, so that the condenser antenna and the small coil antenna are practicable. Among the contributions to the design of antennas has been the study of antenna resistance, as a result of which it was shown that the efficiency of an antenna may be improved by keeping it away from trees and other objects.

One of the great future possibilities in radio is a means for confining the waves to one direction. Little progress has been made in this as far as the transmitting antenna is concerned, but a great deal has been done on the related problem of directional antennas for receiving. It has been found that the coil antenna is a very satisfactory direction finder, and a large amount of development work has been done to determine its accuracy, to improve its efficiency, and to adapt it to various uses. It not only determines the direction from which a radio wave comes but, by its use, it is possible to eliminate entirely any particular radio wave. The direction finder has been applied to marine and aerial navigation and found to be a valuable supplement to other navigational instruments. By enabling ships to be steered in fog, it has saved lives and property. The work at the Bureau showed that the coil antenna can be also used on a submerged submarine, or on lifeboats used in rescue work, and that it gives satisfactory communication where other types of antenna would be entirely useless.

The three-electrode thermionic tube is now a part of almost all radio receiving and transmitting sets. It is also extensively used in wire telephony, electrical measurements and other applications. Its use is certain to extend still further, since it is so satisfactory in such diverse rôles as amplifier, rectifier, modulator, and generator of alternating current. These various uses of the electron tube have been among the objects of research. The Bureau has developed special methods of measurement, has prepared standard tubes, and developed new ways of using them. The use of electron tubes in amplifiers shows the dependence of practical utility upon scientific knowledge of the properties of the apparatus. A study of one of the properties of the electron tube, called the input impedance, has made it possible to design amplifiers much more accurately for any desired use. While the Bureau does not concern itself so much with practical development as with fundamental principles and underlying phenomena, its work occasionally includes specific applications. Thus it has recently developed an amplifier in which the current for the electron tubes is obtained from the ordinary alternating current supply, instead of from storage batteries.

One of the great advances that the electron tube has made possible is satisfactory radio telephony. In this field, the electron tube solved the two main problems: a constant

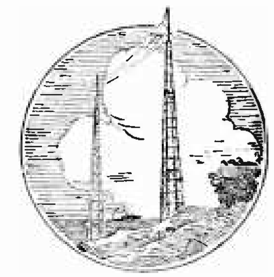


A VERY COMPLETE TESTING TABLE
Employed for making accurate measurements of the functioning of vacuum tubes

source of radio-frequency current, and a means for modulating it, that is, for making it reproduce faithfully the speech wave created by the voice. The Bureau has made studies of both uses of the electron tube, and the design of radio telephone apparatus for a given power or conditions has been correspondingly improved.

PRECISE MEASUREMENT—THE BASIS OF RESEARCH AND PROCESS

ALL scientific radio work is dependent upon special methods of measurement. It will be readily appreciated that radio measurements are more complicated and specialized than other kinds, because of the very rapidly alternating currents used. The simple methods devised by the Bureau for measuring the constants of electron tubes have formed a basis for methods now in general use. Methods of measuring signal intensity in telephone receivers have been developed and applied to measurements upon amplifiers and antennas. Measurement work has included resistance, power loss, decrement, wavelength, capacity, inductance, properties of conductors, and also the development of methods for producing and measuring high voltages and large currents. The laboratory has been equipped with cathode-ray oscillographs which make it possible to study the actual form of radio-frequency currents in radio apparatus. This is valuable in the study of electron tube phenomena and the mode of operation of spark-generating apparatus.



Radio instruments used as standards outside the Bureau are tested, and an effort is made to improve the apparatus and advance the principles of design. Such apparatus includes inductance coils, condensers, wave meters, decremeters, resistors, ammeters, crystal detectors, telephone receivers and accessory devices.

Measurements are also made of the properties of insulating materials and conductors. This work opens up a large field essential to progress in improving radio apparatus. A great deal has been done in the development of standard methods of testing apparatus all of which involve complicated and difficult procedure. Wave meters have been designed which have become standard in this country. As a result of study of the principles of decrement measurement, simple means were developed for converting any wave meter into a decrementer. Work done on the study of the fundamental theory of some of the methods and apparatus has resulted in the production of formulas by which the capacity of antennas and of inductance coils can be calculated, such calculations forming an alternative to measurement. This study of measurements is fundamental to all radio research work and progress.

The research work sometimes leads into the design and development of apparatus, and of methods of utilizing radio communication. Such work is often requested of the Bureau by other Government agencies. The principal work of this kind is technical assistance to the Radio Inspection Service of the Bureau of Navigation. That Bureau issues licenses and regulates the radio communication of the United States. The Bureau of Standards coöperates with it by furnishing technical information, designing and testing measuring instruments for the use of the Radio Inspectors, and making studies of special problems. On several occasions the Bureau of Standards has made investigations of interference conditions in particular areas, to assist the Bureau of Navigation in its administration of the law.

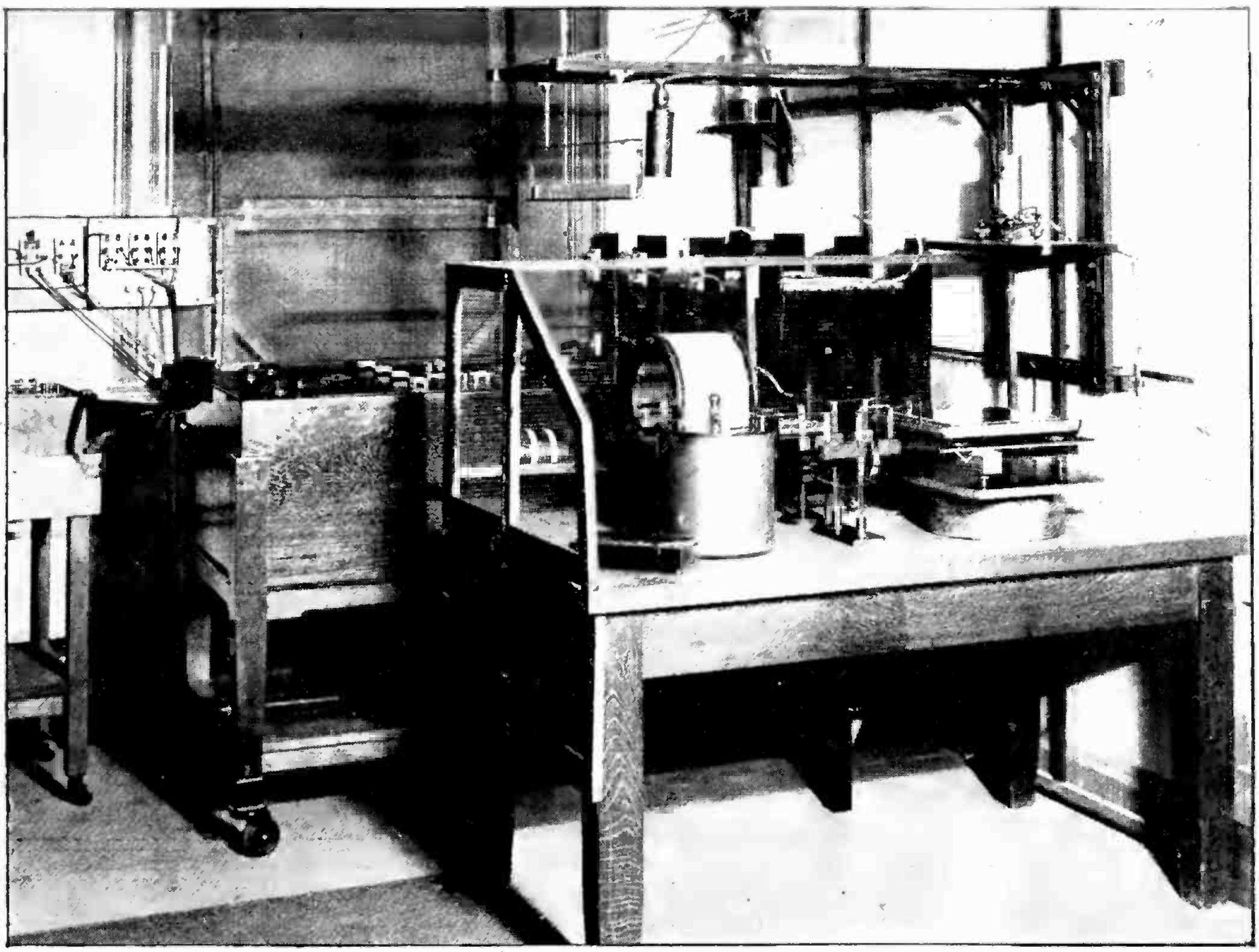
The question of radio interference is an engineering problem which is of vital importance to the future of radio. It was recognized as such by the recent Radio Telephony Conference, which requested the Bureau of Standards to undertake an extensive investigation of interference in its various aspects. The same Conference requested the Bureau to undertake two other problems, the distance range of radio sets and the width of wave band required for radio telephony. On the range problem the Bureau's work already done includes the development of formulas for calculating the distance covered for given values of current in the transmitting and the receiving antennas.

In the general field of radio transmitting sets the Bureau, several years ago, designed a number of quenched gap sets for the use of various Government bureaus, and has more recently designed and constructed electron-tube generating sets for laboratory measurements and for radio telephony. Studies of receiving sets have included comprehensive tests of the various types now on the market. Other work along this line included the development of very small, portable receiving outfits.

An investigation of the coil antenna as a direction finder has led to the development of a complete fog signaling system as an aid to marine navigation. Automatic transmitting apparatus was evolved for continuous transmission of radio waves from a lighthouse, together with a simple, practical direction finder for use on shipboard. This was begun before the war, in coöperation with the Bureau of Lighthouses. The development was suspended during the war, but the work done on the direction finder was found of considerable value for military use. Since the war, radio beacons have been installed at five lighthouses, and arrangements are being made by the Bureau of Lighthouses to install five more. With this aid, a ship can steer toward a lighthouse or determine its position during the heaviest fog.

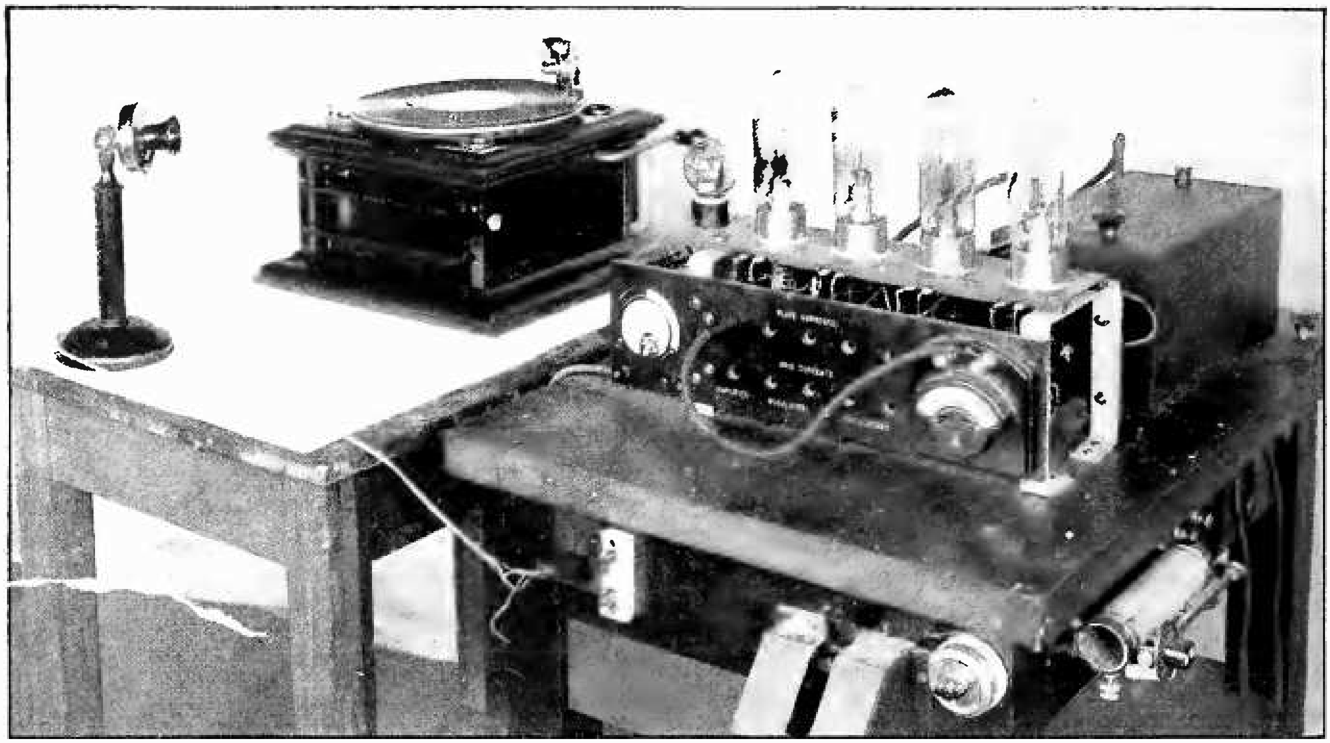
The Bureau serves as a radio laboratory of the Government in the sense that it is called on for technical assistance by various of the Government departments and bureaus. Advice upon the choice of equipment for particular kinds of service is given, for instance, to the the Coast and Geodetic Survey, Bureau of Fisheries, Shipping Board, Coast Guard, Coast Artillery, Bureau of Markets, and Forest Service. The Bureau of Standards also coöperates in radio research with such Government organizations as the Signal Corps, Air Service, Navy Department, Patent Office, Patent Section of the Department of Justice, Post Office Department, Committees of Congress and Bureau of Lighthouses.

In all of this, the Bureau supplements the work of other Departments. The development



TESTING INSULATORS IS A VERY IMPORTANT WORK

Where we deal with such infinitesimal voltages as those which find their way into our receiving sets, every little leak reduces the range and the strength of signals. Insulating materials play an essential rôle here. Where the high voltage surges of our transmitters are considered, the insulator is also very essential



RADIO BROADCASTING TRANSMITTERS

Present many difficult problems which cannot be solved at the broadcasting station, so the Bureau of Standards seeks the solution

of particular apparatus for military purposes, for instance, does not ordinarily come within the scope of the Bureau's activities; but research on the principles on which the design and development should be based constitutes a large part of this Bureau's work.

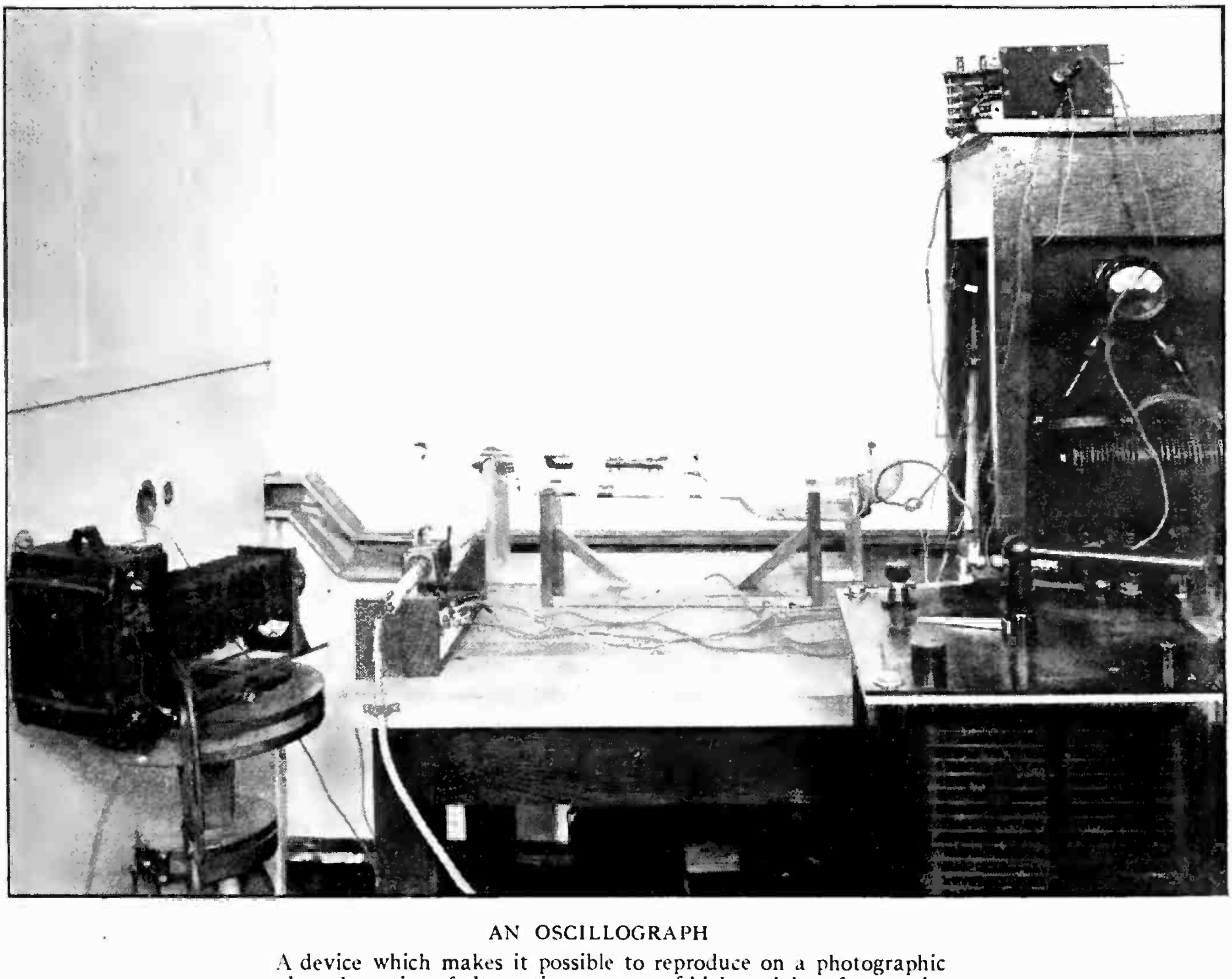
Lately, the Bureau has been closely identified with the remarkable rise of radio broadcasting. Near the end of 1920, the Department of Agriculture asked whether it would be technically feasible to transmit daily reports of crop prices and other agricultural news by radio for the benefit of the farmers. The Bureau undertook to try out the scheme and did transmit an agricultural news bulletin from its laboratory station daily for four months. The success of the plan having been demonstrated, a more permanent system of broadcasting was then instituted by the Post Office Department. The Bureau also showed in 1920, in an experimental way, that broadcasting of music by radio was feasible. This was done by a number of other experimenters about the same time and the great development of entertainment and other forms of radio broadcasting is now well known.

The rise of broadcasting has emphasized the need of careful radio regulation. Since all communications are carried on in the same ether, the possibility of interference between simultaneous messages is very great and requires special understandings and rules. Radio is unique in that all concerned in it are enthusiastic for Government regulation. Recognizing this situation, in the early part of 1922 the Secretary of Commerce called a conference to consider the kind of regulations necessary in view of the constant growth of radio telephony and broadcasting. The Director of the Bureau of Standards was Chairman of this Conference. The problems and remedies were of a technical nature and centered about the assignment of different wave lengths for different uses. The principal result of the Conference was the assigning of a number of bands of wave lengths to radio telephony. This was a considerable extension of the work of international conferences which have been held in the past, and which naturally restrict the available wave lengths almost entirely to radio telegraphy. In these various conferences, the Department of Commerce has been represented by a member of the Bureau of Standards radio staff. The most recent of these international conferences was the one held in Paris in 1921.

Coöperation with manufacturers, universities, and others concerned with radio is included in the Bureau's work. Service is rendered the universities through the furnishing of research suggestions, technical data and publications, bibliographies, information on radio laboratory equipment, etc. Coöperative transmission experiments are undertaken with university laboratories. Radio instruction in a number of universities has been facilitated by the use of the two textbooks prepared by the Bureau, "The Principles Underlying Radio Communication," and "Radio Instruments and Measurements." A file of research problems is maintained which facilitates the work of advising universities and other research workers.

The Bureau works with international research men, as well, participating in the work of the International Union for Scientific Radio Telegraphy. This Union has formulated a number of problems which require investigation by a large number of persons simultaneously. They include variations of radio wave intensity and direction, atmospheric disturbances, electron tubes, and the improper radiation causing interference.

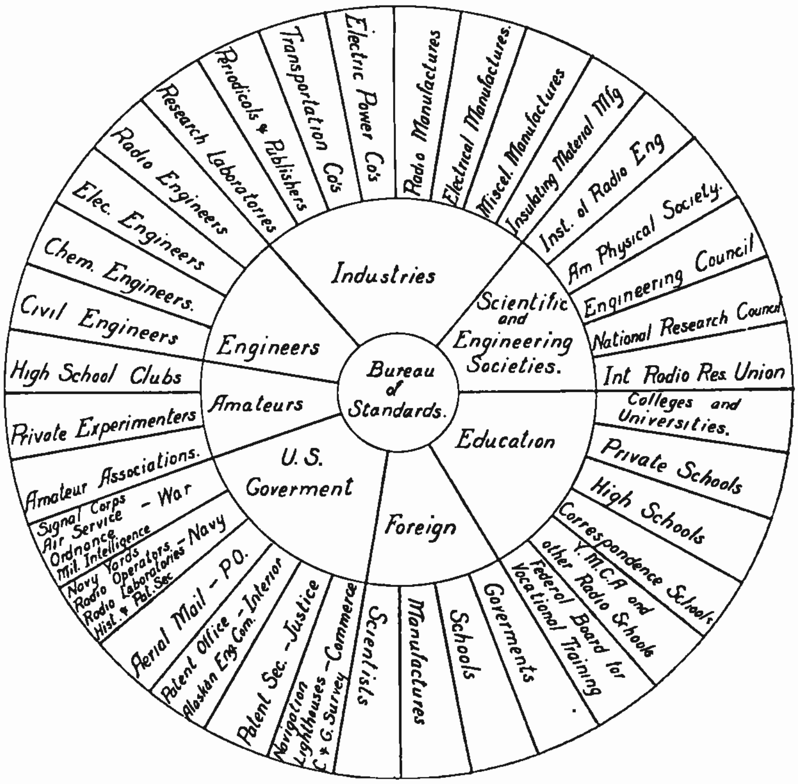
The Bureau is called on more and more for assistance in the commercial standardization of apparatus. There is great demand from dealers and users for standards of quality and performance by which to judge everything from tubes to loud speakers. In response to this demand, the Bureau has undertaken tests of the various commercial makes of receiving apparatus. One of the results of this work is the preparation of specifications for radio apparatus which are of use to the manufacturer and dealer as well as to the user. In this connection, a list of the manufacturers of radio receiving apparatus has been prepared. Little work has been done, as yet, on telephone transmitting apparatus, but the Bureau has received many requests for similar work in this field, and it is evident that a considerable need for standardization and information on transmitting apparatus exists.



AN OSCILLOGRAPH

A device which makes it possible to reproduce on a photographic plate the action of alternating currents of high and low frequencies

By the collection and dissemination of radio information, the Bureau acts as a technical information clearing-house. Files are kept, containing results of information derived from printed articles, correspondence, reports from various organizations, and the research work of the Bureau itself. Part of the technical information is available in the form of printed publications, appearing either as Government bulletins or in radio and electrical periodicals. In addition, some of the information is edited in the form of mimeographed pamphlets, for example: "Radio Publications of the Bureau of Standards," "Extension of the Dewey Decimal System Applied to Radio," "Methods of Radio Direction Finding as an Aid to Navigation," "Proposed Revision of Rule 86 of the 'National Electrical Code' on Radio Equipment" and "Electron Tube Amplifier Using 60-Cycle Alternating Current to Supply Power for the Filaments and Plate."



THE BUREAU'S MANY ACTIVITIES

And the numerous governmental and private institutions it serves are indicated by this chart

The Bureau does not in general supply its publications directly to the public. They are obtained by purchase from the Superintendent of Documents, Government Printing Office, Washington, D. C. The prices are usually from 5 to 15 cents. A list of the Bureau radio publications and other books, etc., on radio is given in Bureau of Standards Circular 122, "Sources of Elementary Radio Information," price 5 cents. Announcements of new publications of the Bureau are given in the "Radio Service Bulletin," which is a monthly publication of the Department of Commerce and can be secured by subscription, from the Superintendent of Documents, for 25 cents a year.

In recent months, the Bureau has been called on for a wide range and large volume of information. One of the principal types of inquiry has been for information as to how a person should proceed to receive material broadcasted by radio. The Bureau prepared a number of brief pamphlets giving directions for the operation of simple home-made types of receiving equipment.

Radio has greatly stimulated the imagination of the American public. This is, in general, good. Under this stimulus, however, and lacking technical knowledge, many people are buying radio apparatus that is practically worthless. Work of the kind which the Bureau of Standards does will help this situation by supplying accurate knowledge, and eventually improving the apparatus on the market.

The greatest difficulty is that the technical work in this field which requires the most highly specialized knowledge, has to be carried on with a constantly changing staff. The salaries which the Government pays scientific assistants are such as, in general, retain only inexperienced men just out of college. These men must be trained by the Bureau in this special field of work and they remain on the average but a short time. To maintain a staff of twenty scientific workers, there have been a total of seventy different persons on the radio staff in the past three years. This type of difficulty is especially serious at the present time when there is great demand for the services of any one who has a specialized knowledge of radio. Indeed, it may be stated that one of the Bureau's valuable functions in the radio field is the training of men for the industry.

Singing to Tens of Thousands

Impressions of an Artist During His First Radio Concert

By LEON ALFRED DUTHERNOY

WHAT were my impressions when I sang, for the first time, over the Radiophone? What were they not! I ranged the gamut of human emotions, from helplessness to exultation.

Concert singers are all familiar with the complaint known to phonograph record makers as "horn fever," which means a bad case of nerves. That was it with me. It was a blue funk of the deepest indigo. If my knees had had cymbals attached to them, I should have been a whole brass band. Ask any movie actor who has faced the camera for the first time.

It has been my privilege to appear before 7,000 people at the New York Hippodrome, the Chautauqua Assembly Grounds, and the Chicago Auditorium, and I thought I was fairly intimate with mob psychology, but when I realized that there were 400,000 wireless outfits sold in this country, and that possibly ten per cent. of them were being tuned on me, the roof of my mouth puckered up, my tongue felt paralyzed, and my lips were blanched. Cæsar may have had his thousands, but I was to have my tens of thousands! The thought went to my head, my feet, and my stomach at one and the same time.

There was I, alone in the wireless studio, except for an unassuring and impersonal accompanist and the radio representative, standing over there at the side, a model of decorum (not a bit interested in my repressed *mal de mer*), attending strictly to his knitting, said knitting being the care of some electric light bulbs. In front of me was a skinny arm, or skeletonized frame, and from that frame there hung the transmitter. It was a silly-looking little instrument about the size and shape of a ten-cent baked-bean can. When I realized that that wretched little tin can was all that stood between me and the world, his wife and his family, there was an acute palpitation around the heart, and a dry blottery feeling in the mouth.

I could think of nothing but that line of Henley's from "Invictus" which all baritones love to burble, "Out of the Night that Covers Me," except that I was far from being "the captain of my fate" and "the master of my soul." In my mind I visualized a life-size map of the United States, and in every town, every hamlet, every cross-roads, there was *nothing but ears*. And all of these countless thousands of ears were cocked and pointed in my direction. I could see ears sticking out from behind library tables, book-cases and sideboards; the handles were ears, the glass knobs were ears, *and they were waiting for me*. Then came a comforting and cheering thought; one that brought a little gulp to my throat and a foolish bit of moistness around my eyes, and it was this: if there were ears on every sideboard and library table, then by the same token there must be people in hospitals, the bed-ridden folk at home, tubercular patients in sanitariums, old men and women in institutions, and little children in cripples'

NOTHING BUT EARS!
All cocked and pointed in my direction. If my knees had had cymbals attached to them, I should have been a whole brass band

wards. They, too, must be waiting and tuning in to catch stupid, simple me. It was with a sigh of relief that I thought of these people.

This all happened while that meticulously polite attendant fiddled around with his electric light bulbs. I tell you, it is a great mistake for a radio attendant to leave a professional singer alone to look around just before he is to sing. It is like wheeling a patient who is only half under the ether into the antechamber of an operating room, while the doctor is putting on his operating robe or thumbing the edge of his knives. One of these days the patient is going to get up and walk off, and one of these days when the radio gentleman looks up, he will find his singer has jumped out of the window. An amateur may be led to the slaughter unawares, but when you lead a professional to the dark water, you should keep an eye on your horse and bridle.

"ER-R-, IT IS 8:30. SHALL WE BEGIN?"
Said the model of decorum, looking up from his knitting

While waiting for 8:30 I looked the "studio" over. It was a room of about twenty feet square, and it was perfectly clear that no woman had had a hand in its design. It was furnished for utility, not beauty. Chairs were pushed in a row against the wall which was hung with thousands of yards of yellow burlap. All the potato sacks in the city must have been draped from that ceiling. "Our accoustical engineer designed that," said the attendant, "to deaden all sound." I would have judged it the work of the office boy. To think that all this had been "conceived and deadicated" by a pedigreed gentleman with four years behind him in some technical institution! Education is certainly a wonderful thing. It looked exactly like a jute factory, although the smell was lacking.

Later I was to find that the burlap did precisely what was expected of it: namely, keep out extraneous sounds.

Over in the corner was what appeared to be a telephone switchboard—minus the gum-chewing central. At the side was a handsome grand piano. The room was certainly nothing to write home to one's mother about, although undoubtedly it was practical and efficient. Quiet reigned over all.

Presently the attendant stopped leaning over his insatiable bulbs and looked up and said, "Er-r-, it is 8:30. Shall we begin?" He then stepped over to the transmitter and announced in a voice so beautifully modulated that it was almost what actors call "Shakespearean," that "Mr. Duthernoy will begin the evening's concert with 'Vesti la giubba,' from 'I. Pagliacci.'" He then led me to within three feet of the transmitter, told me to withdraw my head for crescendi, and to step nearer for diminuendi—and abandoned me to the beyondness of the behindness of the nothingness.

I sang the aria to the tiny tin can. When I had finished, the room seemed dead. The piano had stopped reverberating and there was not the slightest sound.

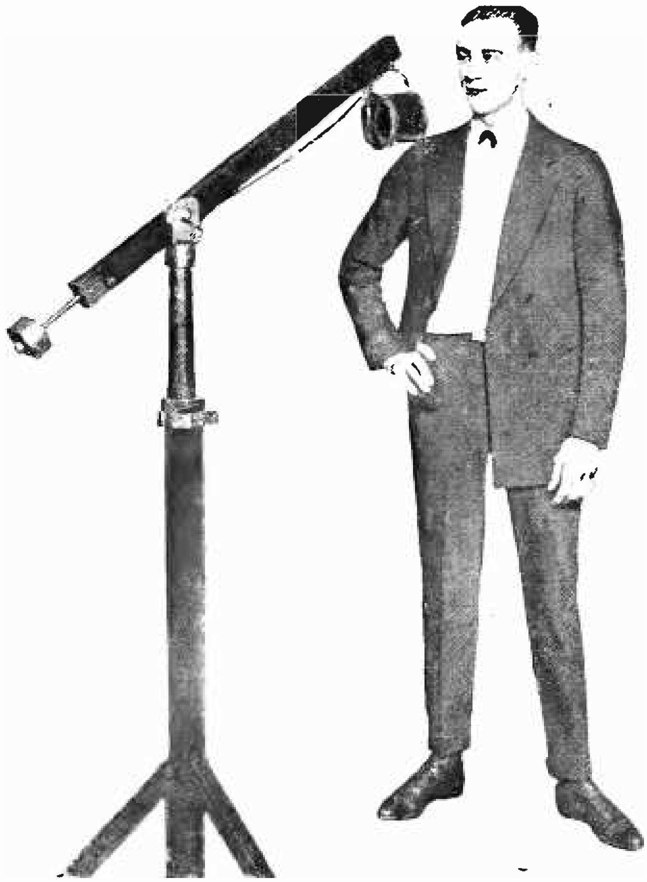
So, that was that. Nothing more to it. I asked the courteous attendant if the people 'way off in Council Bluffs, Idaho, had heard that aria. He replied that to the best of his knowledge he "fancied they had."

The attendant then went over to the transmitter and announced that I would sing two songs, Bizet's "Angus Dei" and Verdi's "Celeste Aïda" from the opera "Aïda." This I then proceeded to do. At the end, there was the same dull, empty silence. I would have given anything for even a pathetic pattering of applause. It was my meat and drink, my board bill. But no—not a sound, not a flutter of a programme. I felt like a bell tinkling in a vacuum—you know the example we used to have in high school in physics. I swore to myself that of all the stupid experiences, singing through a tin can was the most stupid. While I was catching my breath, the telephone jangled. The attendant picked up the receiver, and said "Yes, I will try." He then came over to me with the information that "A family up in Logan's Ferry, forty miles away, had just phoned in to ask if you wouldn't please repeat that last song again. They said it was the finest thing they had ever heard." So there was my applause—my encore! Oh, garçon, that was a moment of exaltation! Would I repeat that song? No power on earth, unless the electric juice gave out, could prevent me. That telephone call was better than a salvo of applause, all the claques in the world couldn't make the noise that that one phone ring did in my head. When someone takes the trouble to phone in from forty miles away, it means that you scored a hit, that you shot a bull's-eye. No dead-heads in that audience. No "paper" in that house. These people knew what they wanted. Talk about flattery, satisfaction, appealing to one's vanity—it was all rolled up in one telephone call.

I stepped over to the dinky transmitter, and this time it looked as large as the Union Station. I repeated the "Aïda" song. Later on in the evening, when I sang "Deep River" and "Swing Low, Sweet Chariot," the phone rang again and asked me to repeat both of them, and then someone called up to enquire if the singer wouldn't sing "Annie Laurie." I knew that all the "press agent stuff" and the three-sheetings were as nothing. These people didn't know whether I was blonde or brunette, whether I wore my hair parted in the middle, side, or in fact if I had any at all; or whether I won people through my "attractive personality" and all the other ridiculous prattle of the profession. Furthermore, they didn't give a tinker's profanation. What they liked was the singing and they wanted more of it. You may believe that they got it.

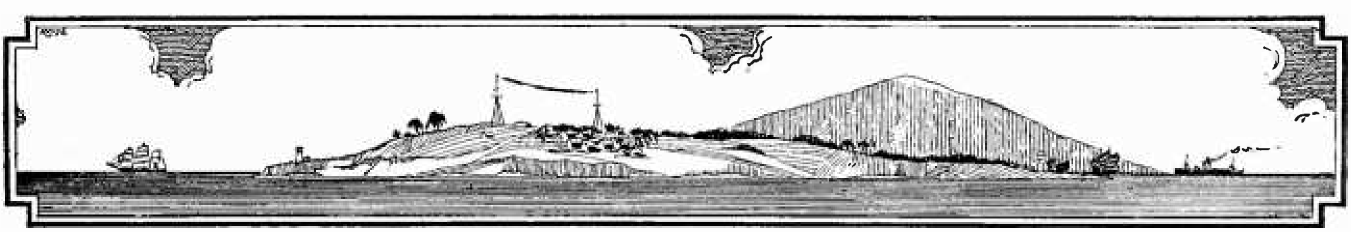
When unseen and unknown people clamor to hear you sing, it is far more to be desired than the roaring applause in the concert hall. I felt like the Boy Scout who had "done his good deed daily" and had shaken hands with the President.

I never though much of Benjamin Franklin and his kite-and-key episode, but when I think what he did for mankind by discovering something for little boys and grown men to



—AND ABANDONED ME
To the beyondness of the behindness of the nothingness

capture and train, even if they don't know what it is, I genuflect; and when I think of what Westinghouse and Station KDKA have done and are doing for this country, I orientate. It's your old antenna to your Uncle Dudley, that wireless is *the* invention of the age.



Will Radio Replace the Phonograph?

Or Will the Radio Concert Merely be Added to the Existing Sources of Musical Entertainment without Supplanting Any of Them?

By WINSLOW A. DUERR

ANOTHER invention, rushed to a high state of perfection by the exigencies of the war, has entered our daily life and is this time disturbing the placid surface of our musical habits and traditions. According to some, it even threatens a revolution in musical entertainment. We have heard it predicted in speech and in writing, that with the radio telephone bringing music to every home, the faithful phonograph will soon be left to collect dust in the attic, symphony concerts will be attended only by impossible eccentrics who desire to have their names in the papers, and opera seats will go begging.

Of course, we cannot agree altogether with these predictions. Self-appointed prophets are as plentiful in most communities as seeds in a watermelon—like which, they are ordinarily to be avoided, not swallowed. We used to hear that the airplane would supplant the automobile by 1924, yet to-day, even in the most modern cities, the few specimens still to be observed look good for two or three years more. Once, the telephone was counted on to give the death-blow to wire telegraphy-hundreds of good-natured but erring folks had planned it so—yet the Western Union is still said to be eking out a precarious existence. And wasn't the movie to make the spoken drama a has-been? But—no further example is necessary.

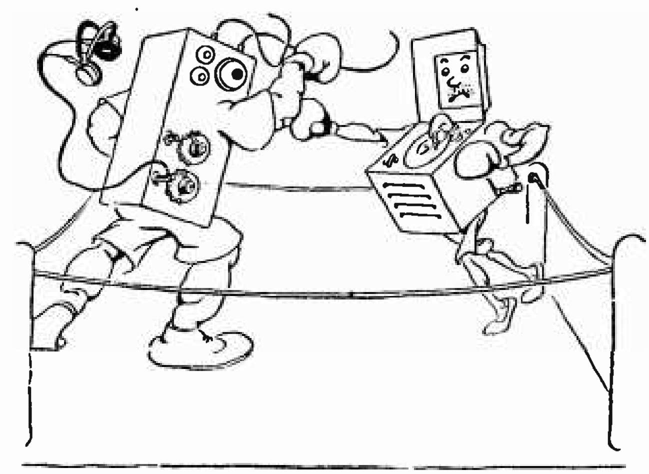
As a matter of fact, what is there to be said on this radio-vs.-phonograph controversy? Both instruments are able to reproduce music played by great artists and played at a distance from the "consumer"; both are more or less at the owner's beck and call, the phonograph, to be sure, to a somewhat greater degree than radio; and both furnish entertainment at a comparatively low cost after the original investment.

There is evidence of a constantly growing feeling that the radio telephone is likely to supplant the phonograph as a means of entertainment. Many people will readily call to mind certain uses of radio which coincide with those heretofore served by the phonograph; and others can point out several important respects in which the functions of these two reproducing instruments are, and must always be, radically different. Perhaps, instead of a struggle for survival between the phonograph and radio, we shall find the newer instrument merely supplementing the older one. For example, the broadcasting of music may increase the sale of phonograph records throughout the country, as it has already done in the vicinity of some of the larger broadcasting stations.—THE EDITORS.

Fifteen years ago the talking machine was still a fad. People would listen to the most horrible airs—appalling combinations of scratches and screeches—merely for the sake of hearing the human voice issue from a mechanical contrivance. But the rapid improvement in machines and records soon raised the phonograph above the plane of a curious toy. To-day, with an initial outlay of from forty to four hundred dollars, depending on the fineness of the machine and the class of records desired, one can furnish his own home with concerts, either classical or popular. The dance music is clear and loud enough to fill a good-sized room; the operatic stars are reproduced so faithfully that their voices can be readily recognized; piano and violin solos; string-quartet and even whole orchestra selections are rendered with almost the original fineness of tone and sometimes with greater clearness than is found in a concert hall. So fine is the reproduction, in fact, that great musicians and singers have often studied their records with a view to possible improvement in their own technique.

The greatest claim to popularity of the phonograph is, however, that you can have *what you want when you want it.* You can choose your favorite songs from your favorite opera and hear them as often as you like; or you can dance at a moment's notice and need pay the orchestra no overtime. Practically every piece of great music that has been written is available on a record played or sung by one of the world's greatest artists; all the most modern popular music is to be had in its most modern form; and these are to be had at any moment of the day or night—unless the family next door lodges a complaint.

The radio concert seems to fall down in the face of such an array of advantages; but to be fair we must consider not only the radio of to-day but what we may expect in five or ten years. Broadcasting stations will be more powerful and long-distance reception consequently improved. Interference will be decreased by the ability to tune more finely. Receiving instruments will have been perfected to avoid "howling," and loud speakers will give a clearer tone. Static can probably never be entirely eliminated, but will be considerably reduced by the use of small, directional aerials and by other devices.



With these improvements, however, radio will still have some difficulty in crowding out the phonograph. The original cost of almost any serviceable bulb set is bound to be greater than the cheaper models of the phonograph, and no amount of large-scale production or improvement in manufacture can reduce, a great deal, the cost of the materials and skilled workmanship—even if manufacturers do content themselves with smaller profits. Breaking a bulb will doubtless always be more expensive than breaking a record; and in general, the radio apparatus, especially the batteries, will always require more attention than a phonograph. Finally, the fact that the choice of music lies with the broadcasting station, not with the audience, constitutes an inevitable and serious handicap. If we imagine a time when every receiving set is within range of ten or a dozen broadcasting stations, and if we suppose that the instrument is selective enough to tune out all but one station, with complete avoidance of interference, still the choice of entertainment will be limited. It is possible to supply the music for an entire dance by radio, but a whole evening of dance music would be acceptable to only a small number of listeners-in. Concerts, operas, and symphony orchestra performances are necessarily limited to productions actually being broadcasted—whether direct from the broadcasting station or from the theatre, and one might have to wait for weeks for a particular entertainment. Furthermore, the broadcasting of programmes given in theatres and concert halls, wonderful as it is, is far from perfect.

Besides the popular music and opera, many other kinds of entertainment are sent out at the same time. It might be well if two stations, for instance, occupied themselves with instrumental music (one for the soloists and quartets, another for symphonies), if a third broadcasted the semi-popular song, such as the announcer always insists on calling "That old but well-loved selection," and if still others would give news, market and business reports, political speeches, travel talks, children's stories, and all the various types of entertainment included in the present-day programmes of our big stations. This distribution could conceivably be managed. Different types of entertainment transmitted on slightly different wavelengths are undoubtedly to be an improvement of the near future. But even with this choice as to what sort of music one will hear, the radio must bow to the phonograph when it comes to supplying the individual with the particular selections he wants. Broadcasted programmes can please some of the people all of the time, and all of the people some of the time, but they can't please them all all of the time.

Generally speaking, then, radio is not likely for some time to capture the position held by the phonograph. Just as the phonograph has made no great inroads on the other sources of musical entertainment but has, instead, made more general the appreciation of good music and thus added to the desire of the public to hear the great artists, so radio is taking good music into still more homes, and, since it cannot in many ways replace the phonograph, is supplementing it. We can readily imagine the time when the issue of the monthly record catalogues will be followed by broadcasting the records so that one may sit at home and listen to all of them before deciding what to buy.

But the greatest possibilities of radio are not as a competitor to the phonograph nor as an advertising agent for it. Its limitations are not greater than, but different from, those of the talking machine. The wireless transmission of church services has reached a remarkable degree of excellence, and for those who find the highest inspiration of divine service in the words of a great preacher or the singing of a famous choir, radio will supply that lack which may have prevented their attendance at a church which did not possess these advantages. The phonograph, furthermore, could make no attempt to publish in oral form the historical speeches, mass-meetings, and conferences which it is within the scope of radio to put at the disposal of the entire country. Many of us will listen to the next president's inaugural address in his own voice at the actual time he delivers it. We shall be able to hear, from their own lips, the opinions of congressmen, labor-leaders, and visiting celebrities. In the realm of good music, too, radio offers this advantage: many who are too dubious of their appreciation of certain classical entertainments to purchase the expensive phonograph records will listen eagerly to symphony and vocal concerts when the cost is very small. Thus may grow up that universal appreciation of good music which cheap concerts and opera have given to Italy and Germany.

So, while we shall not expect the phonograph to suffer from the advent of radio, neither shall we expect to see radio falling into disuse because of any inherent inferiority; especially so long as there exists that almost universal fondness for tinkering with a machine ourselves and getting results *which are immediately dependent upon our own work.* This game of constructing one's own apparatus, trying out new hook-ups, and employing all one's skill in tuning the far-off stations *in* and the interference *out*, will always make the radio telephone a fascinating instrument.

Broadcasting the World's Best Literature

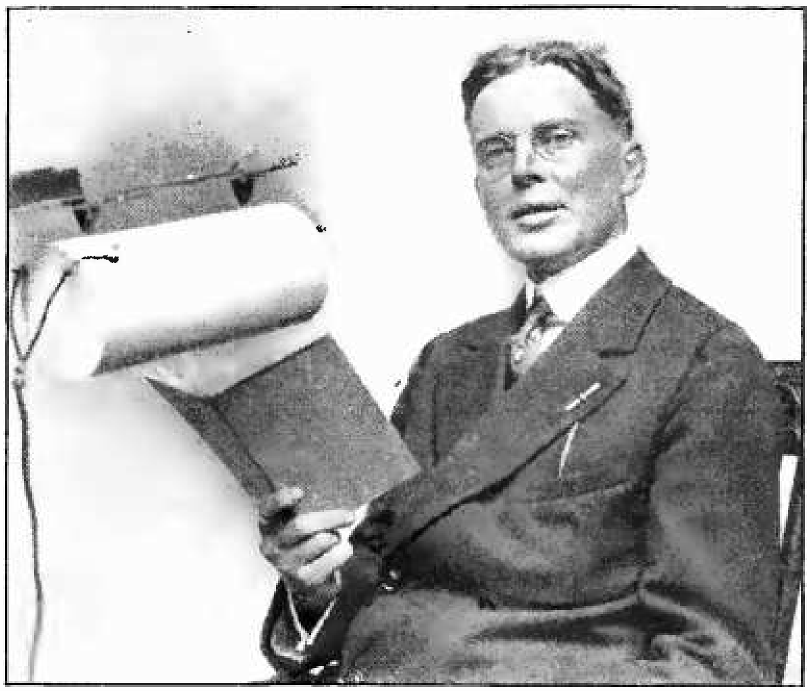
By EDGAR WHITE BURRILL

IT HAS been for some time apparent that radio audiences are becoming dissatisfied with many of the amateur or semi-amateur performances. The novelty of music and addresses by radio is already wearing off, and thousands of enthusiasts can no longer be held spellbound with recitals by ambitious young soloists or the mediocre efforts of would-be entertainers glad of all the free advertising they can get. Only the best will satisfy, and the leading artists are now agreeing that their services can no longer be regularly given gratis. Eventually, it is evident, just compensation must be given to those whose real talent is to be broadcasted to millions. The artist is worthy of his hire, especially if the manufacturers of receiving sets are to reap profits from his services.

But the problem of a satisfactory programme can be met in part if the quality of the literary features is of the highest. The purpose of the "Literary Vespers" given by the writer is to bring to busy people each week the choice passages of the world's best literature. The heart of each talk is a story that inspires, a story condensed to its essential human values, around which are grouped two or three famous poems, the whole being linked up with important current events.

It will be seen, therefore, that there is something deeper than merely entertaining the public in these presentations. There is a permanent stimulation in the direction of good literature, an impetus given toward the reading of books that will build character.

That the idea has been successful, there is



EDGAR WHITE BURRILL
Broadcasting one of his literary talks

abundant testimony, but the secret of this success is in the idea itself. Unlike the academic atmosphere associated with college and university courses in literature, these talks emphasize only the basic human values of books. Unlike the usual addresses before clubs and Chautauquas, they are not book reviews, not talks *about* literature; they *are* the literature itself. There is no attempt to cover the mere facts of an author's life, nor to trace the influences at work on his style. The virile message of the man—what it is that makes his work of enduring value—is always the heart and soul of the presentation.

The task of selecting just the right portions of a piece of literature and of focusing upon them the light of sympathetic appreciation is a difficult one. To go a step further and select a group of poems of like theme with the short-story or drama under discussion, so that the whole shall illuminate a vexatious current problem, is perhaps the most difficult, as well as most distinctive feature of the talks.

Linking up in this way the week's news items with interpretative comment on the literature shows appealingly the vital relation between literature and life. No matter how high on the roll of honor a masterpiece may stand, it is of little avail in building character to-day unless its message can be interpreted in terms of the living present. The current events, therefore, serve not only as illustrations of a contemporary literary theme, but add a timely quality to the literature of remote ages. They point to a universality of experience which binds the centuries together.

SELECTIONS CHOSEN THROW LIGHT ON MODERN PROBLEMS

FREQUENTLY the literature selected bears intentionally upon a world problem prominent in the public eye, such as the war against war, the idea of racial solidarity, efforts for industrial peace, and the objective in education. When Mr. Wells had just arrived in this country, a story of his was introduced to illustrate the efforts for world peace then about to be made at the Washington Conference. The next week, the burial of the Unknown Soldier at Arlington led to a discussion of the literature of the war. Sir Arthur Conan Doyle's visit to this country was the occasion for a talk on the great poems and stories dealing with immortality. The midnight before Memorial Day, a special address was given from the Wanamaker station (WWZ) entitled "In Memory of Those Who Died that America Might Live," the feature of which was Mrs. Frances Noyes Hart's prize war story, "Contact." Lincoln's birthday was observed by reading the major portion of Miss Ida M. Tarbell's "He Knew Lincoln," probably the best pen portrait ever made of our greatest President. Along with this were several of the best poems written to commemorate Lincoln's life and achievements.

A programme of special interest to those interested in radio is one called "The Radio of Spirit," with selections from Kipling's story, "Wireless." The let-down in idealism after the strain of war is met by the talk "The Will to Live," which includes Maupassant's "The Necklace," one of the finest short stories ever written, together with Kipling's "If," Henley's "Invictus," and Clough's "Say Not the Struggle Naught Availeth."

But whatever the theme, the core of every talk is a story, for the world is always hungry for stories. It may be a scene from a play, a passage from a novel, or part of a short story or fairy tale.

Stories have always been the surest avenues to truth, from the time of Æsop's fables and Christ's parables to Kipling's jungle tales. And the purpose of the talks, while not sectarian in any sense, and devoid of any intent to sermonize, is always in the broadest sense religious.

In the poems used, as in the news items, the aim is to throw the theme of the day into sharp relief. Just as a whole chapter of exposition and argument may be replaced by reference to a timely event, so the condensed beauty of a melodious line is often the key to a page of prose. A poem is sometimes a delightful short-cut across a field of thought. For instance, all the arguments that can be brought to bear against child-labor in the factories never have done so much good as four lines of verse:

> "The golfer's club is on a hill,
> And every sunny day
> The toiling children in the mill
> Can see the men at play."

Shelley said that "poets are the unacknowledged legislators of the world." Songs reach the hearts of men, and overturn thrones; melodies like "Tipperary" and "Over There" and "John Brown's Body" can win great battles.

THE UNIVERSALITY OF THE MATERIAL

UNDER the inspiration of famous poems and stories, the solution of our personal and social difficulties becomes more simple. A mental attitude is stimulated that is in itself helpful in the adjustment of daily problems. One does not need to preach, but to show what clear vision the poets have. "The world is so full of a number of things, I'm sure we should all be as happy as kings," sang Stevenson.

But the selection of material is not limited to masterpieces of proven worth. Often a bit of contemporary verse or fiction, or even a passage from a campaign speech, will shed light on a topic as well as a paragraph from some classic.

The keynote, however, is inspiration rather than mere information; not facts alone, but high ideals.

The world is our field, the living word of all times and ages our supply. And the choice of material for the talks has been widely endorsed not only for crystallizing the ripest race experience into the most helpful form, but for directing attention to the reading of books that are worth while.

From all sides have come expressions of appreciation that this type of service strikes home. People see how the inspired books really assist in the solution of the most perplexing difficulties. They testify to the balm and cheer to be found in the records of the best minds at their happiest moments, which alone constitutes great literature. They find a spiritual interpretation of current events, and, by analogy, a method of approach for their personal problems.

BEGINNING OF THE TALKS IN NEW YORK LAST NOVEMBER

THE home of the Literary Vespers is the Town Hall, New York City, where they were inaugurated on November 6th, 1921. Starting with no publicity campaign, the attendance grew steadily until the hall was filled. People liked the idea and went home and told their friends. It drew a constantly larger and more deeply interested class of men and women, some coming many miles especially for the service. People attended regularly from a dozen New Jersey towns, many from places well up the Hudson, or along the Sound.

The Town Hall itself is one of the most beautiful auditoriums in the city, dedicated to the service of truth and freedom. It was built to provide a suitable forum for the discussion of public questions, without partisan or sectarian bias, and is devoted to the perpetuation of American institutions and ideals. Here in the heart of the busiest city in the world, just around the corner from Times Square, where more people pass every twenty-four hours than in any other similar area, stands this temple erected to the mind and soul. It is a spiritual retreat indeed, a great radiating centre for many forms of community welfare, for all movements that will promote civic betterment.

But only a fraction of the people who listen to the talks by radio could ever be accommodated in this building. The wireless services reach far beyond the confines of one great city or one state. The ideal arrangement, of course, would be to reach both audiences simultaneously with the same service. Perhaps this will sometime be done.

Do You Know Them by Sight or by Sound?

DURING SPARE MOMENTS

When not developing receiving outfits, W. F. Diehl, Chief Engineer of A. H. Grebe & Company, seeks enjoyment at Bayside, N. Y. His voice has been heard over the radiophone in nearly every state in the Union

"HELLO 2XJ—KDOW CALLING"

The voice of Chief Radio Officer F. G. Black of the S. S. *America* was heard in several thousand homes as the history-making radio telephone tests were carried on between that vessel and the Deal Beach, N.J., Station of the Western Electric Company

IF HER VOICE IS UNFAMILIAR

You may recognize her face, for Miss Norma Shearer shares the stellar honors with Reginald Benny in "The Leather Pushers"

THE MAN WHO SPEAKS TO YOU FROM WGY

Kolin D. Hager is studio manager of the General Electric Company's broadcasting station and thousands know his voice

Regenerative Radio Reception

What the Armstrong "Feed-back" Circuit Is, How It is Used, and How to Tune It Properly

By PHIL M. RILEY

NEXT to the audion or vacuum tube, patented by Dr. Lee De Forest in 1907 and now generally used in its various forms as transmitter, detector and amplifier, perhaps the most important single instrumentality in radio is regenerative reception, or self-amplification. The invention of Edwin H. Armstrong, it is commonly known as the Armstrong "feed-back" or regenerative circuit. It makes possible the amplification of incoming waves, and without it neither long-distance radio telephone communication, nor broadcasting as practiced to-day, would be possible.

Under licensing agreements, several different forms of receiving sets now employ the Armstrong circuit. Many amateur enthusiasts are also applying it to apparatus, not so equipped, which they have bought or constructed themselves.

Receiving sets which do not provide for regeneration bring the waves of radio-frequency direct to the detector, which rectifies and passes them along to the telephone receivers at audio frequency.

Now, the Armstrong circuit includes a vacuum tube detector connected in such a manner that, prior to detection and rectification, the waves of radio frequency are partly reimpressed upon the grid of the audion. The resulting reënforcement of the grid charge causes a greater variation of the plate current and thereby produces louder signals. Hence the terms "feed-back," "regenerative," and "self-amplifying" circuits: the same tube is made to act as amplifier as well as detector.

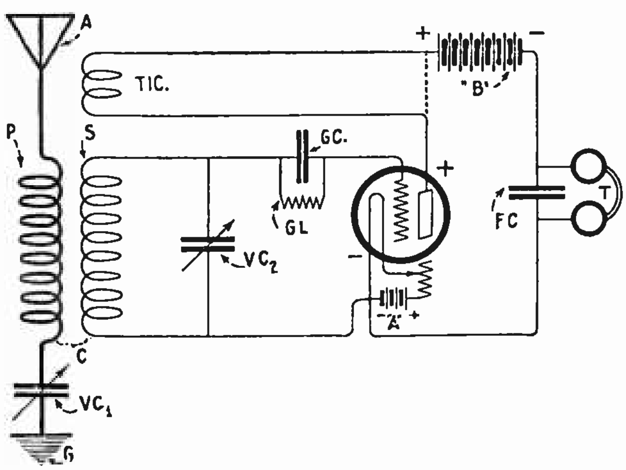


FIG. 1
A standard regenerative receiving circuit

TWO PRINCIPAL METHODS

TWO principal methods are commonly employed to reimpress the plate energy upon the detector grid in order to obtain the regenerative effect. Of these the simpler, and perhaps the more common, is known as the "tickler." It is a small extra coil located close to the winding of the secondary of the receiving tuner. A regenerative receiver may therefore consist of three adjustably-mounted air-core coils—the primary, secondary, and tickler coils.

Referring to the hook-up in Fig. 1, the first coil, P, is the primary of the loose coupler, C, connected with the antenna-ground circuit; the second coil, S, is the secondary of the coupler, connected with the detector grid of the vacuum tube; and the third coil, TIC, is the "tickler" coil connected with the plate circuit of the vacuum tube. The dotted line across this latter circuit shows the wiring which would be employed in a non-regenerative receiving set. Other symbols in the drawing are as follows: VC_1 is a variable condenser in the primary circuit for varying the antenna-ground wavelength, while VC_2 is a variable condenser for varying the secondary wavelength of the coupler. GL is the grid leak; GC, the fixed grid condenser, and VT the vacuum tube detector. "A" is the 6-volt filament battery for lighting the vacuum tube, and rheostat R controls the filament voltage; "B" is the high-voltage plate battery, which serves to pass current across the electronic bridge from the filament of the vacuum tube through the grid to the plate. FC is a fixed condenser, and T are the telephones.

In the second method of regenerative reception a variometer serves, instead of the "tickler" coil, to tune and feed back, into the grid of the vacuum tube, part of the increased voltage of the plate circuit. A variometer is an instrument which varies the inductance and therefore wavelength value of the circuit in which it is used. It comprises a set of fixed windings and a set of rotable windings. When the current flow in both sets of windings is in the same direction, the variometer is at maximum inductance value and wavelength; when the rotable winding is turned so that the current flow in the two windings is in opposite directions, the variometer is at minimum inductance value and wavelength.

Numerous wiring arrangements may be employed to secure regenerative reception by means of variometers. One of the simplest is shown in Fig. 2. C is a loose- or variocoupler (two names for the same instrument). VC_1 is a variable condenser in the primary circuit for varying the antenna-ground wavelength, V_1 is a variometer in the grid circuit for varying the secondary wavelength of the coupler; and V_2 is the "feed-back" or regenerative variometer in the plate circuit of the vacuum tube.

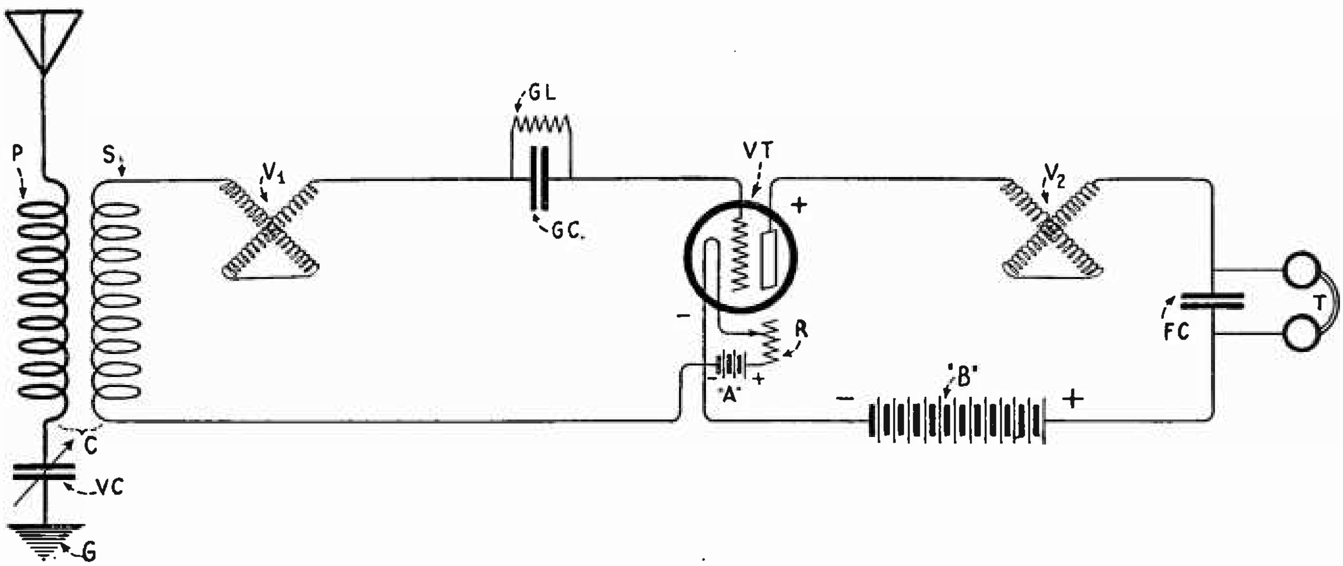


FIG. 2
A vario-coupler and twin variometer regenerative circuit

Another wiring arrangement for obtaining regenerative reception by means of variometers which permit of finer tuning is shown in Fig.3. P is the primary of the vario-coupler C. VC_1 is the variable condenser in the primary circuit. V_1 is a variometer in the grid circuit. VC_2 is a variable grid condenser instead of a fixed grid condenser as in the previous hook-up. R is the filament rheostat, and R_1 a plate battery rheostat, commonly called a "potentiometer," used across the "A" battery and in series with the plate battery to control its voltage. V_2 is the "feed-back" or regenerative variometer in the plate circuit of the vacuum tube.

A still different wiring arrangement for regenerative reception by means of variometers, also enabling very fine tuning, is shown in Fig. 4.

As in Fig. 1, VC_2 is a variable condenser for varying the secondary wavelength of the coupler, and VC_3, is a variable grid condenser like that in Fig. 3. R is the filament rheostat, and R_1 a plate battery rheostat. V is the "feed-back" or regenerative variometer in the plate circuit. The other symbols are as before.

Owing to their much greater sensitiveness, regenerative receiving sets are somewhat more difficult to operate than non-regenerative sets. But once the operator has grasped the purpose and use of the dials and become familiar with their concerted effects through a little practice, he will find that the self-amplifying feature of the "feed-back" circuit will greatly improve results. Distant signals, often even those inaudible with a non-regenerative set, will be heard much more loudly and clearly, and radio telegraph messages as well as radiophone broadcasts can be received. Except for Fig. 1, it will be noted that all regeneration in the circuits shown is controlled by variometers. The tickler coil arrangement of Fig. 1 is generally used for wavelengths above 1,000 meters. The other changes in the circuits are in the antenna and detector circuits, rather than in the regenerative or feed-back plate circuit.

Unless carefully tuned, regenerative sets cause many sorts of annoying noises in the telephone receivers, such as hissing, humming, and whistling. Indeed, so sensitive are these sets that it is advisable to place a metallic shield between the operator and the instruments comprising the set, in order to prevent the capacity of the human body from affecting delicate adjustments. High-grade regenerative sets have such metallic shields on the inner side of the front panel.

ADJUSTING SINGLE-CIRCUIT RECEIVERS

TO OPERATE a single-circuit regenerative tuner for radiophone reception, the detector tube is first adjusted to make it as nearly silent as possible, yet responsive to signals. Usually the signals are loudest and clearest when the filament rheostat has been advanced to a point just before the tube causes a hissing sound in the telephone receivers. Occasionally, however, better results are obtained by advancing the filament rheostat beyond the point where noise is heard and into another zone of relative silence.

Some variation of the plate voltage from the "B" battery is often necessary in order to obtain the clearest and loudest signals. "B" batteries of the variable voltage type, with connections for voltages from 16½ to 22½ volts, make this possible, though still more accurate adjustment may be had by means of a potentiometer, with which some of the best receiving sets are now equipped.

After the filament and plate currents of the detector tube have been properly adjusted, the tuning dial, often an arm or handle moving above a scale, must be adjusted to bring in the desired signals.

By turning up the dial of the "tickler" coil, thereby generally increasing the "feed-back" or regenerating action, the audibility of the signals can be increased. Careful adjustment of the "tickler" coil is essential. The "tickler" dial should be turned up only to a point just below but on the verge of oscillation of the detector, which is indicated by a slight hissing sound heard in the phones. Excessive regeneration, due to too much "tickler" action, causes a "mushy" distortion of the signals.

Final adjustment is made by means of a vernier, now provided on most single-circuit regenerative sets. A vernier is a small auxiliary tuner capable of producing much finer variations than the large tuning dial, a complete turn of the vernier being rarely equivalent to more than a movement of two points of the large tuning dial.

After a regenerative receiving set has been carefully tuned it will maintain its adjustment fairly well. Occasional changes of the vernier. and sometimes even of the tuning dial, may have to be made. Alteration of the filament rheostat now and then may also help.

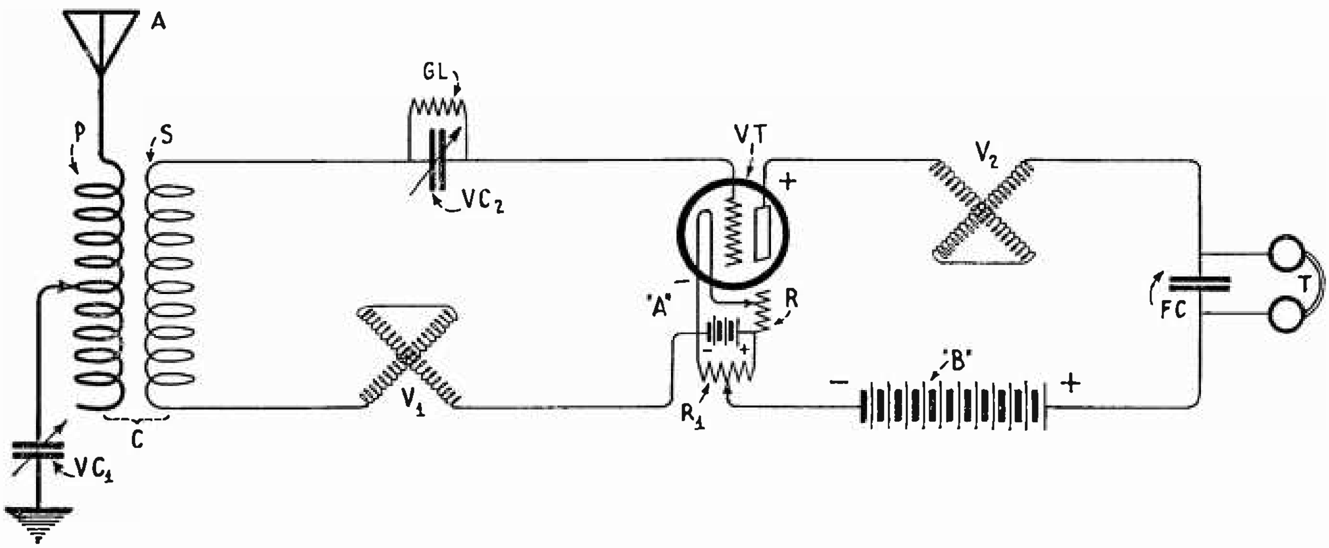


FIG. 3
In this circuit, a variable grid condenser and "A" Battery potentiometer are employed

THREE-CIRCUIT TUNERS

THREE-CIRCUIT regenerative receiving sets, employing variometers for separate control of the tickler and secondary circuit wavelengths, are operated substantially the same as the simpler "tickler" coil sets except that more careful tuning is necessary. With such highly sensitive sets it is sometimes necesary to adjust the secondary and the "tickler" or plate variometer simultaneously, in order to preserve the right relation between them and keep the receiver in its most sensitive condition, on the verge of oscillation.

No one should find difficulty in operating a regenerative receiving set having several controls, once the function of each dial is understood.

Most regenerative receiving sets have controls for (1) filament brilliancy, (2) tuning the wavelengths of antenna and secondary circuits, (3) coupling the primary or antenna circuit by induction with the secondary circuit of the receiving set, and (4) for regeneration. If a two-stage amplifier is also part of the set, it is controlled by a filament rheostat for each vacuum tube, or sometimes one rheostat regulates both. In the case of single-circuit or single-control receivers, one control dial combines coupling with tuning the wavelength of both the primary and secondary circuits.

HOW FAR HAVE YOU HEARD?

There is all manner of loose talk about broadcasting concerts being heard at great distances with very simple equipment. For instance, a man in Florida and another in Cuba tell of hearing concerts from New York and other Northern cities with receiving outfits employing a single vacuum tube. Other folks wonder why, with a single tube outfit, they have difficulty in hearing *anything* and feel incredulous about the heralded wonders of radio.

Stations are heard over great distances at times and many elements must be considered in determining the difference between the *reliable* and *possible* range of a given receiver.

We are anxious to learn of experiences in broadcast reception, believing that their publication may help others to obtain the best results from their outfits.

Whenever you receive over distances in excess of 500 miles at night or 150 miles by day—*with a single vacuum tube*—let RADIO BROADCAST tell its readers how you have done it. For letters published, a very liberal rate will be paid.

Your reception should be authentic—that is, you must be sure of the station you report hearing. You must be positive of the name of the station as well as the call letters, for if you based your report solely upon the latter, it is quite likely that errors would occur. For instance, KDAN might be interpreted as KDAM, unless the name of the station was actually heard.

We are also anxious to tell our readers of the results obtained with loop aerials used with radio-frequency amplifiers or super-regenerative receivers.

In telling of your experience, a paragraph or two describing briefly the type of receiver employed would also be helpful, and good circuit diagrams are always in order.—THE EDITORS.

TUNING THE RECEIVING SET

THREE preliminary adjustments are necessary before it is possible to receive from any transmitting station.

(1) The antenna switch is thrown into the receiving position.

(2) The filaments of the vacuum tube are lighted by means of a filament switch or an automatic jack which completes the filament circuit when a plug for the telephone receivers is inserted in the jack.

(3) The filament rheostat is gradually turned up until a slight hissing sound is heard in the telephone receivers. The rheostat is then turned back just enough to render the hissing inaudible.

The set is then ready for tuning, which is effected with the regeneration dial turned to zero. This dial is variously marked "tickler," "regeneration," "plate load," and, rarely, "grid load."

The tuning operations are as follows for single and two-circuit receiving sets:

(1) Adjusting the set to the wavelength of the transmitting station.

In a single-circuit or single-control set having only one tuning dial or arm, it is necessary only to turn up the dial away from the zero position until the signals of the desired station are heard.

(2) Adjusting the vernier of two-circuit receiving sets after the best position of the large tuning dial has been found.

With three-circuit receiving sets the procedure is somewhat more intricate:

(1) Adjusting the wavelength of the primary circuit.

Several high-grade receiving sets have separate controls for the primary and secondary circuits, both of which must be adjusted to the wavelength of the incoming signals. This makes the set a little more complicated to operate, but its greater selectivity enables much interference to be tuned out.

An approximate adjustment of the primary circuit is first made by means of the variable condenser and inductance switches or slider. If the average dial position for any given wavelength is not known, it may be set tentatively at one third to one half its maximum value. Meanwhile, if the coupling between the primary and secondary circuits is variable, the variocoupler dial is turned up to its maximum position where the two sets of windings are parallel or in their closest position.

(2) Adjusting the wavelength of the secondary circuit:

The dial of the secondary circuit variometer or variable condenser is then turned up until

After the receiving set has been tuned, regeneration is accomplished in the following manner:

(1) The dial of the "tickler" or "plate load" variometer is gradually turned up from the zero position for amplification of the signals.

At first the effect is imperceptible. Then comes a sudden and marked increase in signal strength, followed by increasing distortion of the tonal qualities of voice or music. High musical notes are first affected, complete distortion following if regeneration is increased too much.

(2) Filament brilliancy is reduced as regeneration is increased, until the maximum degree of regeneration is reached without signal distortion or reduced amplification.

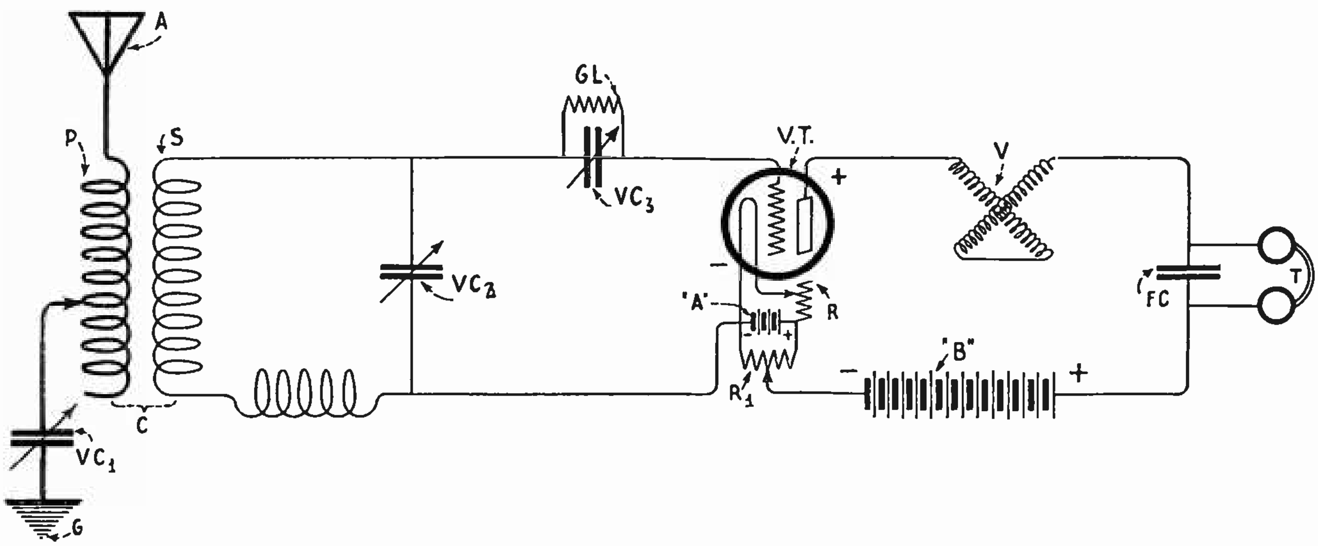


FIG. 4
Here the wavelength of the secondary circuit is controlled by a variable condenser

signals from the desired station are heard with the variocoupler still at maximum.

(3) Readjusting the primary circuit for maximum loudness of the signals.

(4) Final slight readjusting of the secondary circuit if necessary to increase the strength of the signals.

(5) Changing the coupling to eliminate interference.

With separate controls for primary and secondary wavelength tuning and variable coupling between the two circuits, great selectivity is possible. For example, should an interfering station begin transmitting, its signals can usually be eliminated by decreasing the coupling between the primary and secondary circuits and then re-tuning the primary and secondary circuits.

For storage battery economy and longer life of the vacuum tube, it is always best to employ the minimum filament brilliancy consistent with adequate audibility of the signals being received. Nothing is gained by burning the filament above the temperature necessary for maximum regeneration, and white heat is seldom necessary to accomplish this. By resorting to a two-stage amplifier in receiving from distant broadcasting stations, ample audibility can be obtained without excessive filament brilliancy.

As a matter of fact, signal strength may well be sacrificed to purity of tone in voice and music, for after all it is faithful reproduction of sound rather than maximum noise which makes radiophone reception enjoyable.

Radio for the Deaf

By P. J. RISDON

A YEAR or two ago an instrument was developed in England which is now arousing wide interest. The inventor is Mr. S. G. Brown, of London, and the invention is known as the ossiphone—derived from the Latin "os" or "ossis," a bone, and the Greek "phone," meaning sound. It is no less, as its name implies, than a device *which enables one to hear through one's bones.*

The writer has tested the ossiphone in a variety of ways, both in connection with the ordinary telephones, and with another instrument known as an aural box.

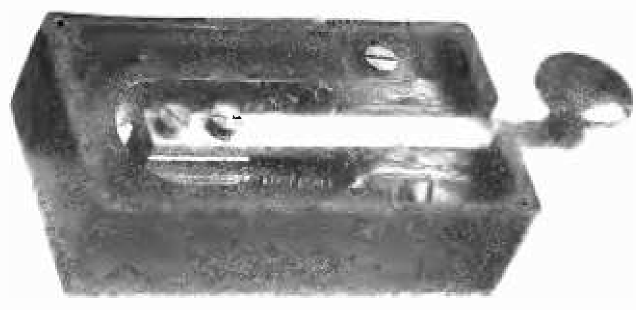
The ossiphone is quite small and can be carried in the waistcoat pocket. It comprises a little ebonite case containing an electromagnet of the horseshoe pattern, between the poles of which an iron bar is fitted that can be made to vibrate. The electromagnet is energized by current from the telephone batteries when used as a receiver in radio or wire telephony, or from dry cells in the aural box when employed for carrying on an ordinary conversation between persons in the same room.

The aural box and ossiphone together are used to take the place of the ear appliances commonly used by deaf persons. The former is a metal horn, in appearance like a loud speaker, with a microphone at the lower end. Connections between the ossiphone and aural box or telephone are made by means of small plugs and sockets to which ordinary flexible cord is attached. Dry cells in the aural box provide electric current for the microphone.

In order to carry on a conversation over the telephone, a small socket is wired in parallel with the ordinary receiver and, for the sake of convenience, is secured to the outside of the telephone box. There is a similar socket on the ossiphone, with a length of flexible cord having a twin plug at each end connecting the two. The vibrator bar, which projects outside the ossiphone case, has a small ebonite button screwed to the end of it. The case is held in one hand and the button is pressed gently but firmly against the finger knuckle. By this means, the vibrations of a person's voice at the other end of the line are conveyed through the body to the aural nerves, and so to the brain, where the sensation of sound is produced independently of the outer ear. This may be proved by stopping the ears effectually, or by putting the ordinary telephone receiver temporarily out of commission. In this way it is possible actually to hear more clearly than with the ordinary receiver, although incidentally the ossiphone constitutes an excellent duplicate receiver.

It is not quite certain whether the vibrations follow the bony structure all the way, or whether the nerves compressed between the ossiphone knob and the bone take up and transmit them. In the former case it would certainly appear that, where the bones are separated by cartilage, the vibrations must be carried by nerves from bone to bone. In either case, however, it is only by means of the bones that the vibrations can be transmitted.

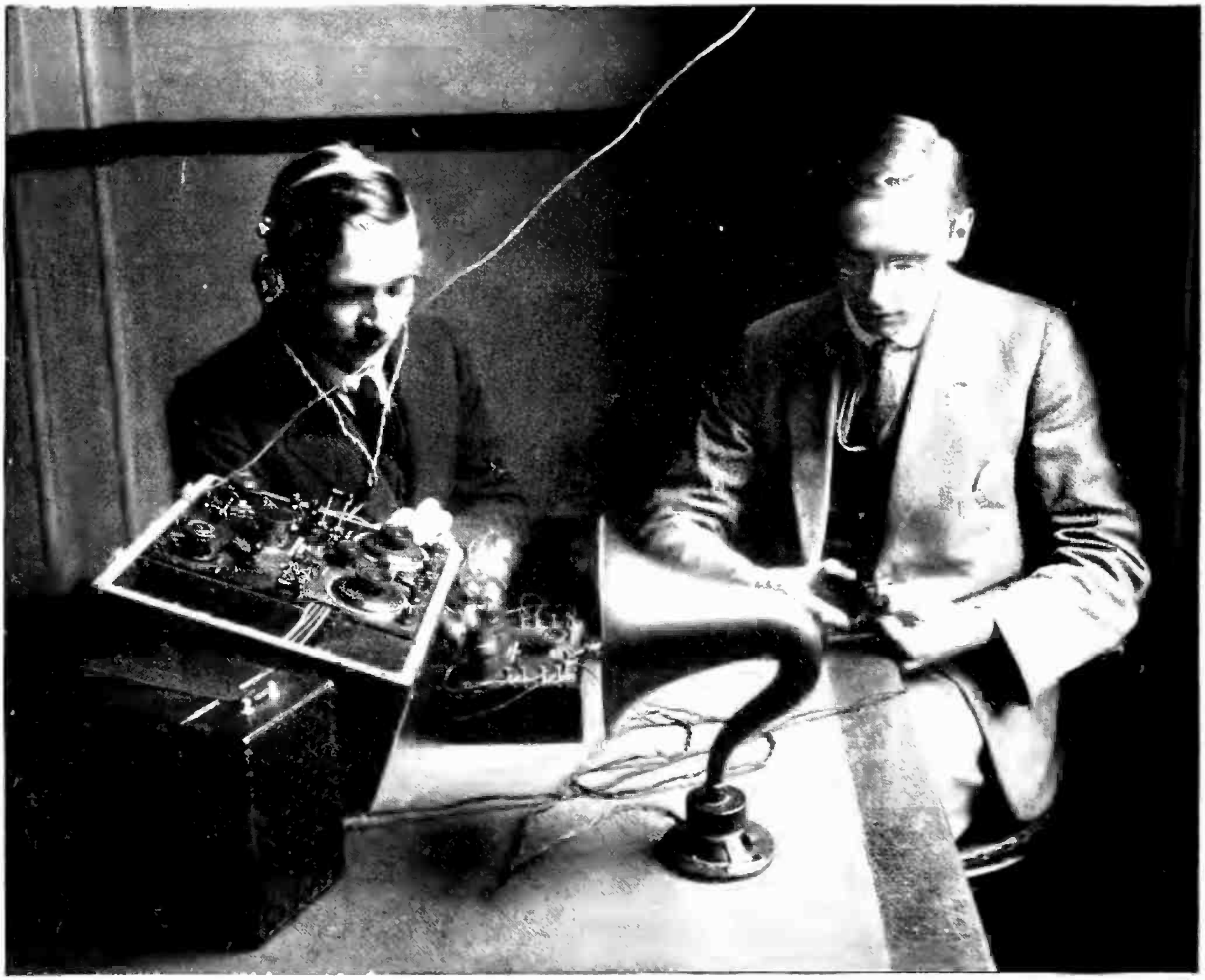
When it is desired to converse in the usual manner, one end of the flexible cord is secured to the ossiphone, and the other to the aural box, which is placed in any convenient position near one of the speakers, who merely has to face it and speak in an ordinary tone of voice within about eighteen inches of the opening. The other person may be anywhere in the room, holding and applying the ossiphone as already described.



THE OSSIPHONE VIBRATOR

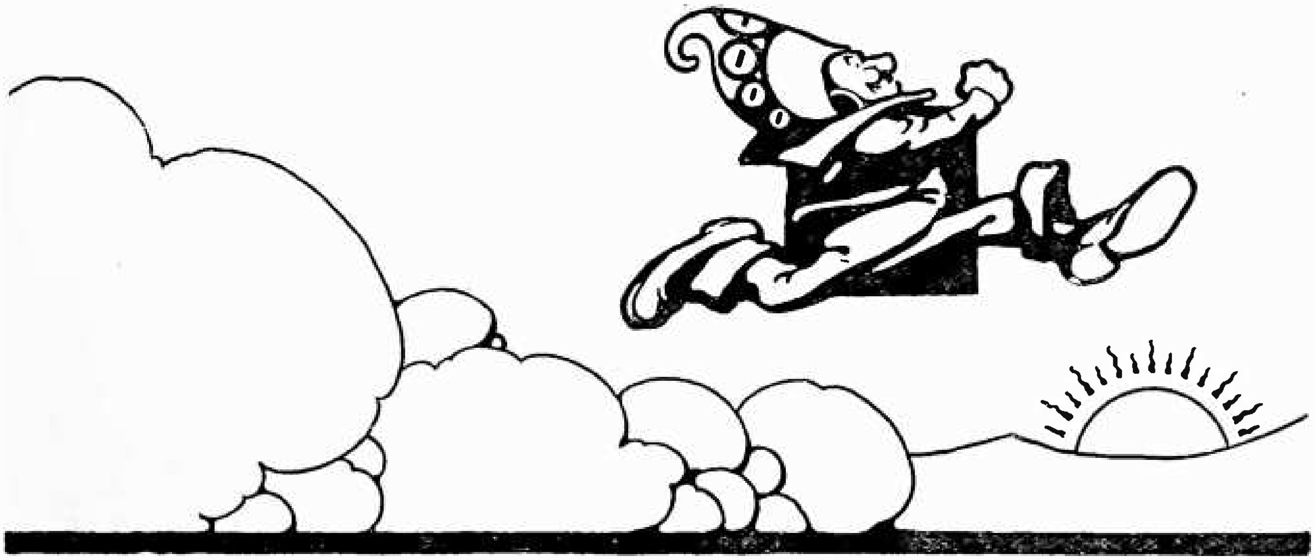
In order to appreciate the action of the ossiphone, it is necessary to bear in mind that sound is an effect on the brain produced by vibrations. When one person speaks to another, the vibrations of his voice cause the ear drum of the other person to vibrate, and so to communicate the vibrations through the mechanism of the ear to the brain. If the middle or outer ear be damaged or stopped up or if the ear drum itself be injured, the vibrations cannot reach the aural nerves leading to the brain and the person is unable to experience the sensation which we call sound. Ordinary appliances for the deaf consist in magnifying sound waves. This, while of temporary service in certain cases, may in the long run simply aggravate the original trouble and increase the degree of deafness. With the delicate vibrations of the ossiphone, such a result could not occur.

The value of this instrument to deaf persons depends to a great extent upon the nature and cause of their deafness. When deafness is due to what one may call mechanical causes, affecting the outer and middle ear, the ossiphone has often proved successful where all other appliances have failed. If, however, there be disease of the aural nerves leading to the brain, there is little hope of any instrument proving successful, since the aural nerves are an essential connection between the mechanism of the ear and the brain. It should therefore be clearly understood that it is not claimed for the ossiphone that it constitutes a certain remedy in every case of deafness.



MR. PHILIP R. COURSEY
Editor of *Wireless World* (London), and his assistant demonstrating the use of the ossiphone

From the foregoing description of this interesting invention, it is evident that, in all cases where it assists the deaf to hear, it will enable them to enjoy equally well radio music and speech. For there is no difficulty in connecting the ossiphone to an ordinary receiving set, or in using it in conjunction with an aural box and loud speaker. Thus a way of hearing is opened to many deaf persons, to whom, otherwise, sound would be an almost meaningless expression, or a symbol of pleasures and interests not experienced for many years.



KING ELECTRON

On Vacuum Tubes

By R. H. RANGER
Engineer, Radio Corporation of America

Illustrated by TOM MONROE

SUCCESS has crowned the efforts of the experimenter who, with King Electron and his radio band, produced sound from radio waves by using a crystal; but with this success achieved, he seeks other fields to conquer.

"More power!" is his cry, to satisfy which, Fleming invented the vacuum-tube detector. This consists of a wire filament in a vacuum, much the same as any ordinary light; but something most important is added—the plate around the filament inside the glass tube.

A storage battery forces a current, that is, a flow of electrons, through the filament. "How does this make the wire filament red hot?" King electron will explain.

"I have billions of electrons at my command. They live in many worlds. You people have speculated on life outside your world in Mars; many worlds inside yours are very common to us electrons. And we jump around from one to the other. In radio, we are guided by the operator.

"Well, we have many little worlds called atoms and larger ones called molecules. These molecules have all the attributes of your ordinary substances except size. Many of them are clustered together to form a single substance, such as the wire filament. And then several different substances may go to make up such a weighty object as your storage battery.

"In this big storage-battery world, things are arranged so that there is so-called electric power in it. The reason for this power is that a large number of electrons are concentrated on the negative pole of the battery, clamoring to get away, and there are very few on the positive pole.

"The great concentration of electrons on the one side of the battery, is, of course, what gives that side a negative charge, as each of the electrons is negative. If a wire connects the negative pole of the battery to the positive, there will be a rush of the electrons to even things up.

"To get some practical use out of this great rush, the filament of the vacuum tube is included in the circuit.

"Onward pushes this happy throng, down this midway of the radio Mardi Gras.

"The filament is made up of molecules. The

Trade Mark "King Electron" for illustrations registration pending. R. H. Ranger molecule is a little center of attraction between the atoms which go to make it up. These little side-show atoms contain lots of electrons having a great time in their merry-go-rounds with a positive center keeping them together.

"Upon this scene rushes a crowd of electrons from the electrical world of the storage battery. They have heaps of energy and won't stay on the filament. They crowd back and forth, traveling very fast, first into this side-show, then into that.

"They take the places of some of the electrons already there, forcing them to go on to other centers. There is great vibration inside the molecules, which produces heat. As it increases, a point is finally reached at which the electron vibration is fast and furious enough to move the space in which the electrons live—the ether—back and forth so rapidly as to send out ether waves, known to common mortals as light.

"Now, the motion of each individual electron hither and yon is most rapid, in fact it may approach the speed of light—some 186,000 miles a second. And the movement starts all along the line very quickly. The word is passed from molecule to molecule that the electrons are coming. What might be termed this news-wave down the midway is fast, too; only something less than the individual speed of the electron or of light. But the general motion of all the electrons onward is much less than any of you might guess. If it were as much as half an inch a second, the tube would be dangerously near burning up.

"It all goes to show how a lot of running around may produce only an infinitesimal amount of general advance. But it is quite sufficient to do the job in this case. In the process of rushing about, many of the electrons get out of the beaten path, and go floating off from the filament. To be sure, some of them will come back, but if there is a great attraction for them elsewhere, they will certainly be normal and make the most of the opportunity. The plate of the vacuum tube is just such an oasis.

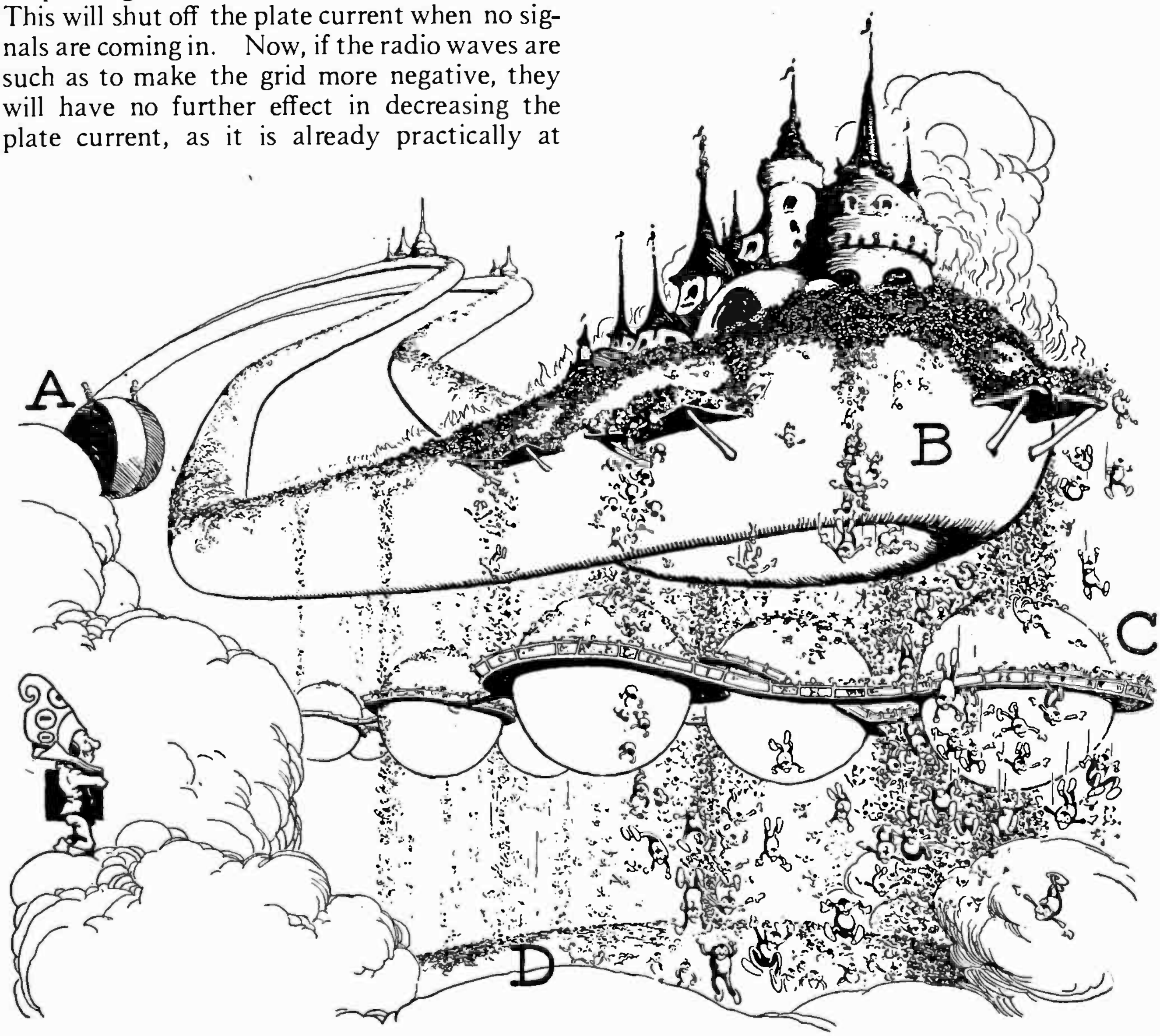
"Another battery, known as a 'B' battery, is connected to the plate of the vacuum tube. Its positive pole is connected to the plate of the tube, and its negative pole to the filament. This means that the plate is connected to the pole of the dry battery which is not occupied by the electrons. This is the sort of place the floating electrons in the vacuum tube are looking for. So once they get away from the filament, they rush to the plate. From here, the dry battery carries them up to the top of the chute again by pulling them to the negative of the battery which is connected to the filament, and on goes the process."

The simple Fleming valve, as outlined by King Electron, is no longer used very much, because of another great invention brought about by De Forest. He was working with Fleming's valve and gaslights of different types, when he discovered that the addition of a "grid" between the filament and plate of a vacuum tube would have a great effect on the action of these floating electrons. This grid is just what the name implies, a grating of parallel wires placed between the filament and the plate. Some of the electrons will of course go to this grid. If it were not connected to anything, it would soon get filled up, and this would have an important effect on the motion of the rest of the electrons floating towards the plate. Ordinarily, electrons leaving the filament would be attracted by the grid as it is so much nearer than the plate, but if they see that the grid is already crowded, they will not have any great desire to go that way. As a consequence, very few will go on to discover that attractive new world—the plate. But if something is done to remove the electrons from the grid even to such an extent as to have less of them there than normally, the floating electrons would come rushing over. Then many of them, in fact most of them, would miss the small wire grid and go on to the plate. So the number of electrons on the grid, or its "electric charge," has a tremendous effect on the flow of electrons to the plate.

THE TUBE AS DETECTOR

TO USE the tube as a detector of radio signals, a one-way action must be realized. A pair of telephone receivers is included in the circuit leading from the plate of the tube to the positive pole of the plate dry-battery. In this position the telephone will produce sounds as changes in the plate current take place, if the vibrations occur at the frequencies of sound. But these radio vibrations are much faster—some thousand times too fast in broadcast work. So as radio vibrations alone, they mean nothing to the telephone receiver. But if all the changes which may be caused by radio waves are in one direction, the telephone receiver will notice the average effect of the rapid vibrations.

One means of getting this one-way effect is to keep the grid in a rather negative condition. This will shut off the plate current when no signals are coming in. Now, if the radio waves are such as to make the grid more negative, they will have no further effect in decreasing the plate current, as it is already practically at zero. But on the other half-swing of the radio wave, when all the electrons have left the top of the tuning coil and the grid which is directly connected to it, the plate current will start to build up. Under these conditions, the plate current will increase with any radio waves, because the positive impulses alone produce an effect; and the more intense each radio wave is, the more the plate current will increase. As the intensity of the radio waves is determined by sound directed into the microphone at the transmitting station, the plate current will change in step with these sound-controlled variations in the intensity of the radio waves, and the telephone receiver will reproduce the sound.



"THE VACUUM TUBE," SAYS KING ELECTRON

"Is a miniature universe, composed of many individual worlds, inhabited by electrons. Here we find millions of these electrons crowded on the sunny side of the storage battery, 'A.' They force their way through the filament 'Mardi Gras' at 'B' and some of them seek other worlds to conquer. The grids at 'C' look inviting and they cannot resist the impulse, and while in the space between 'B' and 'C' they see an even more attractive and less thickly populated world, 'D,' which is called the plate"

THE "C" BATTERY AND THE GRID LEAK

THIS negative condition of the grid may be established by connecting a small flashlight battery of $1\frac{1}{2}$ to 6 volts in the grid circuit, with the negative side of it leading to the grid. This is called the "C" battery. (The filament lighting battery is called the "A" battery. The plate battery is called the "B" battery.)

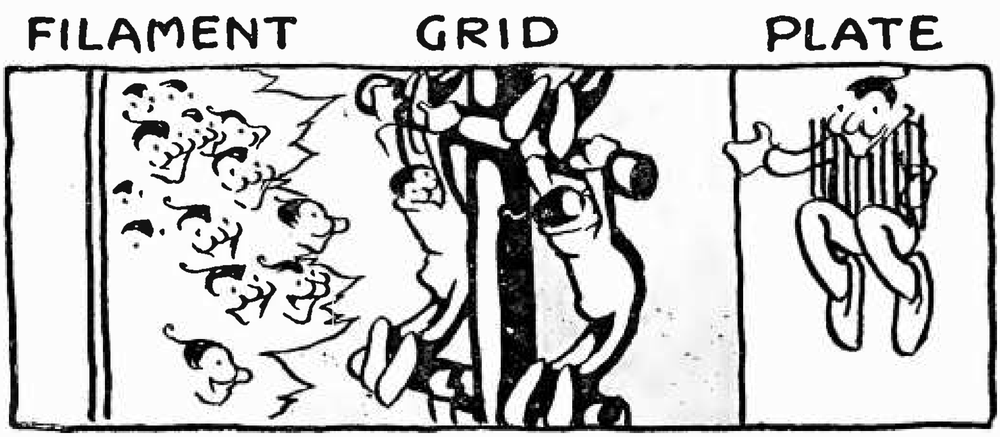
But there are already too many batteries around a radio set, so the use of the grid leak-condenser combination, which replaces the "C" battery as well as giving better signals, is a welcome development.

If a high resistance is inserted between the top of the tuner and the grid of the vacuum tube, the floating electrons in the tube which hit the grid will not be able to pass around to the tuner coil and back to the filament of the tube so readily. As a result they will pile up, to a certain extent, on the grid of the tube. This means that the grid will have a negative average condition due to the floating electrons themselves. But this resistance should not be large enough to permit its negative condition to shut off the plate current completely. In fact, the grid is kept well above this condition.

THE GRID-LEAK CONDENSER

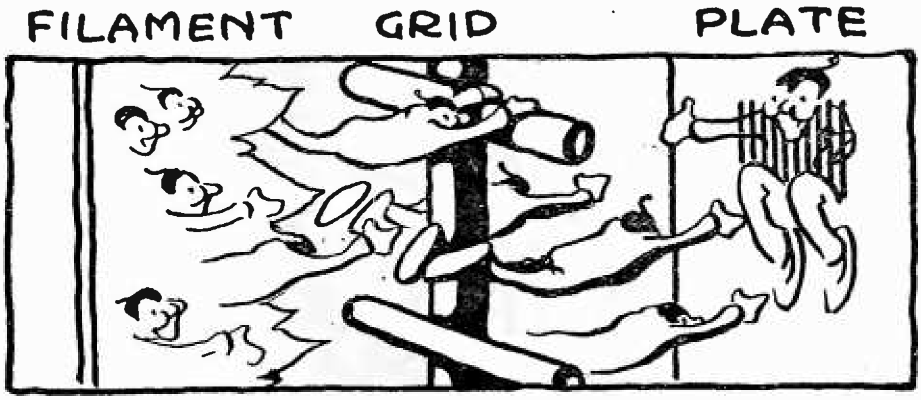
ACCORDINGLY, another device is added. This is a small condenser in parallel with the grid leak; that is, it is connected between the same two points as the grid leak. This condenser consists of two metallic plates close together but separated by insulation. Electrons may rush on to one side of this condenser and in consequence shove off those on the other side. To this extent the condenser acts to the grid will act quite well through this small condenser. This means that when there is a rush of electrons down the tuner coil, due to the radio wave, the electrons will pass from the grid to the small condenser. This leaves the grid "positive," which means that the plate current will increase, but more important still, it means that the grid will catch some more of the floating electrons. So there are now more electrons on the grid and the grid side of the small condenser than there were before. So, on the next negative half of the radio wave, when the electrons rush up through the tuner and small condenser to the grid, the grid will have more electrons in the way of the plate electron flow than before.

On each swing of the radio wave, this trapping of electrons will continue on the positive half of it, and the corresponding depression of the plate current will take place. This will more than offset the momentary increases in the plate current on the positive halves of each wave cycle of the radio vibrations. The grid leak will not let this concentration of electrons on the grid, and on the grid side of the small condenser, go too far, as the trapped electrons can pass off slowly through this grid leak resistance. So, when ether waves strike the receiving aerial and build up oscillations in the tuner, many of the floating electrons in the vacuum tube will be trapped by the grid and the plate current will be decreased. The plate current will hold this decreased value as long



GRID NOW NEGATIVE BLOCKING PASSAGE. ELECTRONS CANNOT LOOSE THEMSELVES FROM COOL GRID

as if the sudden movements of electrons went right through. But this is only true for short, sudden movements such as the rapid radio vibrations. So, as the radio waves cause the electrons in the tuner to vibrate, the sympathetic movement of electrons back and forth as the radio waves hold steady in their intensity. But if their intensity goes up, more floating electrons will be trapped on the grid, and in consequence the plate current will go down more. Therefore, an increase in the radio waves means a decrease in the plate current through the telephone receiver. The fact that this action is thus reversed is of no consequence, as sound vibrations are back and forth. If they were "forth and back" they would sound just the same provided the vibration frequencies are the same, as is the case here. signals. This latter condition is desirable from many points of view, as it will give the output of the telephone receiver a characteristic more truly representative of the actual radio wave variations. It is also advantageous from the point of view of static. For, if a detector is



working on the square law basis, a good crack of static would produce many times the effect of the desired signal in the receivers.

The grid leak-condenser connection for the detection of radio wave changes is very reliable, although its efficiency compared to the crystal detector would make a poor showing if it were not for the radio-frequency amplification which may be accomplished in the same tube as King Electron told us in the September issue of Radio Broadcast.

THE HETERODYNE

When Fessenden was at work in research tests in radio reception, he noted that stronger signals were received when a small generator was operating in the basement of the same building. He improved upon this arrangement and the result is the well-known "heterodyne" invention.

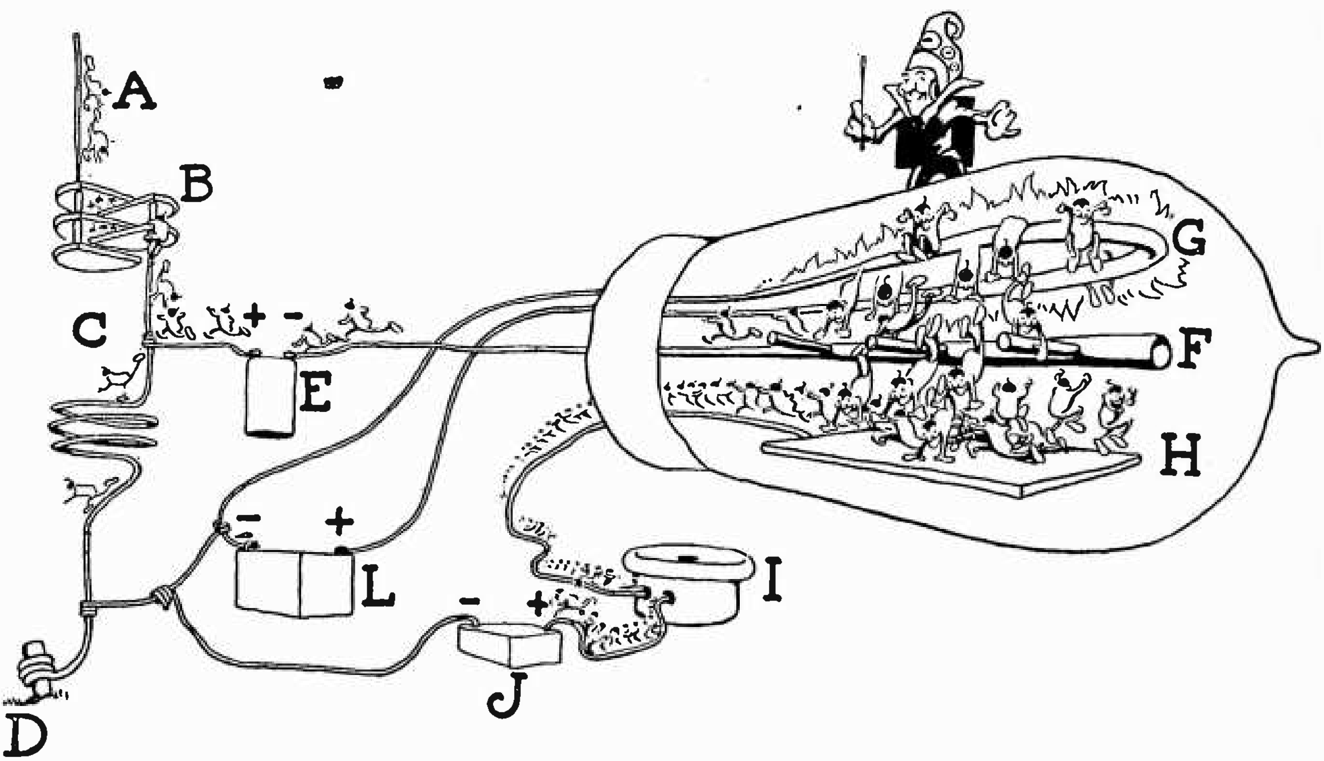
Almost any radio device has what might be termed a "threshold" value. This means that a certain minimum of electric energy must act on it before anything will happen. Incoming signals, for example, below this value will have no effect on such a device. Detectors in particular seem to possess a threshold value. A certain intensity of signals which may be referred to as having strength 1, will produce a certain effect in the telephone receiver. But a signal of strength 2 will produce four times the effect in the telephone receiver. This is sometimes referred to as the square law, inasmuch as the result increases as the square of the cause. But after the lower values of signal are passed, the resultant effects in the telephone receivers become more directly proportional to the strength of the incoming

Fessenden overcame this difficulty with the heterodyne, and made a simple detector at the same time.

Reduced to its simplest form, his invention comprised a special form of telephone receiver. This telephone receiver had two different coils in it. One was fixed in the base in the same manner as in the normal receiver, the other was attached to the receiver diaphragm. The coil, fixed in the base was energized by a local generator of rapidly alternating radio current vibrations, located at the receiving station. The other coil on the vibrating diaphragm was energized by the incoming radio waves. These coils then became magnets of which the polarity reversed with the very rapid vibrations of the electric currents in them. Current passing through a coil of wire forms an electro magnetic field around the coil and the end faces of the coil are called its poles. And if the current goes in one direction through the coil, one face will become a south magnetic pole, and the other will become a north magnetic pole. (These names are used as they indicate the directions in which these poles would face if the electromagnet were free to swing.) When the direction of current flow reverses, the magnetic poles will also reverse.

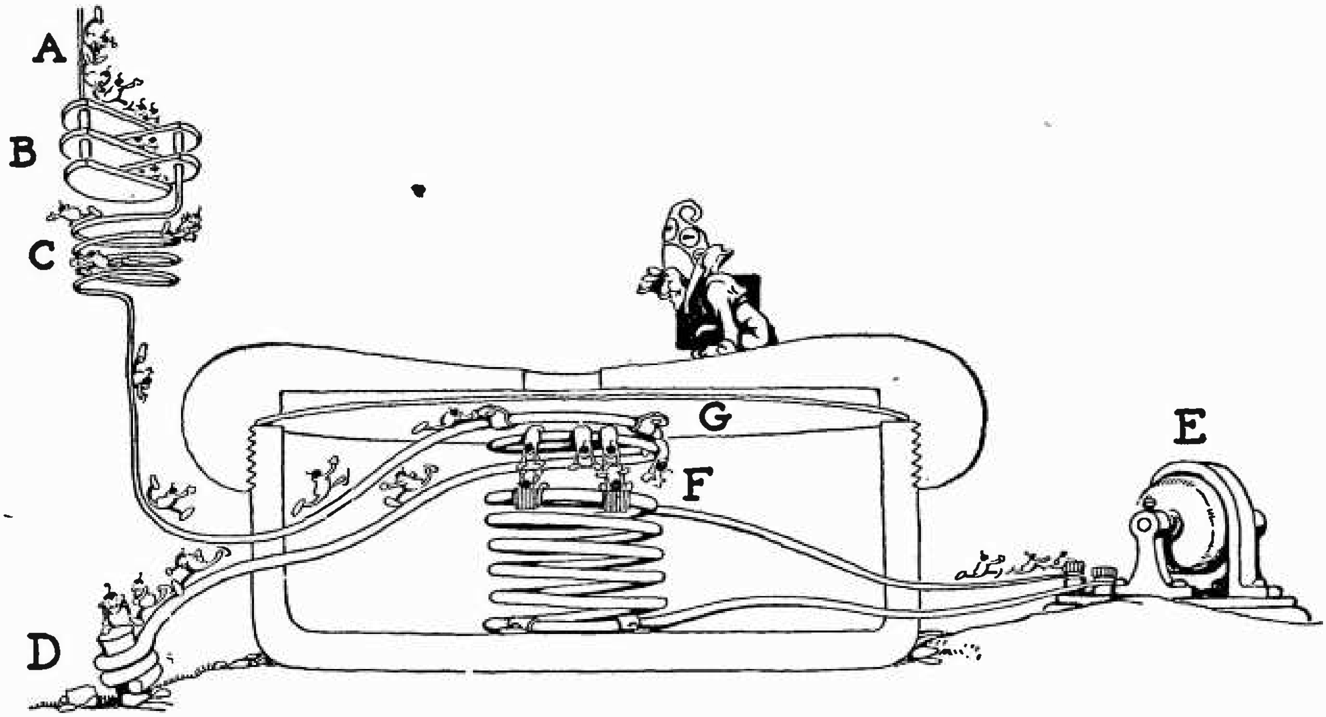
Now Fessenden so arranged things that his local generator had a steady frequency slightly different from the signal he desired to receive. At the moment we start our consideration of this, suppose that the currents are going through each coil in such directions as to make the poles of the small electromagnets opposite to each other; that is, one a north pole and the other a south pole. As opposites always attract, they will then attract each other and the diaphragm will tend to move in. As the currents rapidly reverse, the poles of the magnets will also reverse; but as they both reverse, they will still be opposite to each other and therefore still attract each other, and the tendency of the diaphragm to which the movable coil is attached will be to continue to move in. So, although the current vibrations are most rapid, still they tend to produce but one general movement of the diaphragm inwards. Now, as the two sets of electric currents, the locally generated and the received signals, are slightly out of step, this condition of being exactly opposite as we first considered, will not continue, and therefore the two magnets will not continue to be always opposite. Therefore, as the currents get out of step the diaphragm will gradually recede, to return again when the currents are again opposite. This action will therefore make the telephone receiver diaphragm move in and out as long as the signals keep up, at a vibration period determined by the difference between the two current frequencies. As this can be made anything desired by changing the frequency of the local generator, the receiving operator has the means of getting a good readable note for his signals. Of course, it is evident that this was arranged primarily for radio telegraph work, where the operator reads the long and short tones as signals by the combination of the transmitted signals and the locally generated current. The action is very similar to that of the beats in sound made by two piano strings slightly out of tune with one another. The beating of the two with each other will be much slower than the vibration of either one alone, so rapid radio vibrations are brought down to slower audible vibrations by this device.

It was a natural step from this to combining the two electric currents in the same detector



"IN A TUNED RECEIVING CIRCUIT"

King Electron tells us, "the grid 'F' of the vacuum tube is connected to the top of the tuner coil 'C,' through a small battery at 'E.' When radio waves rush down from the aerial, 'A,' the rush through 'C' pulls the excess of electrons supplied by the battery 'E' away from the grid, and the electrons from the filament 'G' then rush across to the plate 'H' and actuate the telephones 'I'. When the rush in the aerial to the ground circuit is over, the electrons rush back through the battery 'E' to the grid 'F,' and the rush of electrons to the plate ceases. With the back wave of the incoming radio signal, even more electrons pass from the coil 'C' to the grid 'F,' but they do not affect the electrons going to the plate and the latter have stopped their activity. In this case it is impossible to make the plate current less than nothing. So, we see, the action only takes place when the electrons rush down the aerial to ground circuit and the result is an increase in the rush of electrons to the plate, which in turn, pass through the telephone receiver"



"THE HETERODYNE"

King Electron explains, "requires two groups of electrons to produce a sound in the telephone receivers. A local generator, 'E' supplies a group of electrons rushing to and fro at a very great rate, which pass through the coil 'F' attached to the base of the special telephone receiver. The incoming radio waves cause electrons to rush down the antenna 'A', condenser 'B,' and coil 'C' to the ground 'D.' A part of the coil 'C' is attached to the diaphragm 'G.' The two currents caused by the rush of electrons in the aerial to ground circuit, and those rushing through the circuit supplied by the generator, change their direction of movement at slightly different frequencies. At regular intervals the electrons move in the same direction at the same time, causing a sound to come from the telephone receiver. At other intervals the electrons in the two circuits repel each other, causing the telephone diaphragm to move in the opposite direction. The result is called a 'beat' frequency and the pitch of the sound made by the telephone receiver depends upon the rapidity with which the beats occur"

circuit. In fact, this is just what was happening when it was first noticed that the received signals were stronger when the small generator was working in the same building. So the local generator puts a rapidly oscillating current in the receiving circuit, and when the incoming signals are received, these alternately add to and subtract from the local current. And any of the detectors which have been described will give the beat tone for telegraph signals, when energized by incoming signals together with a local radio wave generator.

As the local generator can be made to give its power to any of the above arrangements continuously, the latter will be carried beyond their "threshold" values and the incoming signals will have an easier task for producing the changes which will give the sound.

For the local generator, the detector tube itself may be used in the Armstrong oscillating feed-back arrangement described in the September number. The oscillation of the tube in this condition will be constant and therefore give the telephone receiver a steady pull, and will not produce sound—provided there are no other oscillations present in the set itself, causing the bothersome howling. When only the single oscillation is present, the incoming signal will add to or subtract from this steady radio vibration and a tone will result. This makes a very compact arrangement.

For telephony or broadcast reception, this steady tone is not desirable; but if the local generator is adjusted to be of practically the same frequency as the incoming signals, the beating of the two will be so slow as to be inaudible, and under these conditions the signals will be heard most loudly. It is hard to keep this adjustment, however, so it is not recommended for telephone reception except for picking up distant signals. After they are picked up in this manner, the set may be tuned sharply and the regeneration decreased just below the point of oscillation when the distant telephony should be heard more distinctly.

Should Radio Be Used for Advertising?

By JOSEPH H. JACKSON

Drawings by TOM MONROE

EVERY new discovery brings a host of problems with it. The well-known thorn and the rose, the familiar bitter and the sweet, the silver lining which theoretically forms the better half of every dark cloud—all these are not such inseparable companions as Discovery and his crony Difficulty.

Radio is a case in point. One after another, dating from the beginning of radio as a popular science, problems have had to be met and conquered. With clockwork regularity, Old Man Difficulty in one form or another has bobbed up to confront the pioneer, only to be just as regularly knocked down again. However, he's a hard one to keep put. Persistence is his middle name; trampled on and a hundred times subdued, he is up and at it again; and in his latest incarnation has assumed what threatens to be the most unpleasant guise in which he has appeared so far.

> Have you answered the question yourself? Perhaps advertising by radio has not yet affected you one way or another. But if what Mr. Jackson says in this article is true, the question is one which is going to demand interest, and thought, *and a decision* on the part of all who are in any way concerned with the transmission or reception of radio broadcasting.—THE EDITORS.

"*Advertising by Radio*" is his new name; and a very troublesome pest he is likely to become unless something is done, and that quickly.

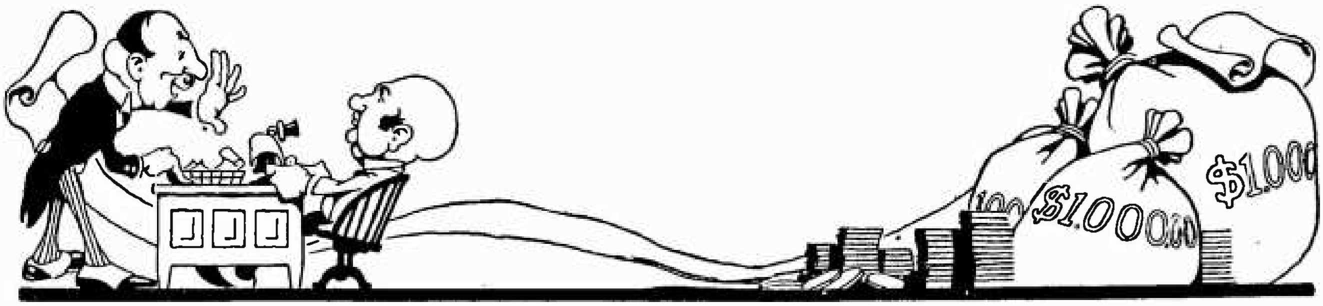
No one who reads this article will have to consider very long what broadcasting advertising implies, before the presence of the difficulty becomes apparent enough. The very thought of such a thing growing to be common practice is sufficient to give any true radio enthusiast the cold shakes. And he doesn't need to be a dyed-in-the-shellac radio man to see the point, either; the veriest tyro with his brand-new crystal set can realize, if he has listened in only once, what it would mean to have the air filled with advertising matter in and out of season; to have his ears bombarded with advertisers' eulogies every time he dons a pair of head phones.

Once the situation is realized, its actuality as a first-class Problem with all modern attachments cannot be doubted for a moment. Indeed, in the very plausibility of the idea lies the greatest danger. For, on the surface, to the uninitiated or to the man who is not particularly concerned about the pleasure and profit to be derived from radio, there seems to be nothing very improper or unethical in using radio as an advertising medium.

It is precisely this apparent harmlessness of the notion that makes it all the more likely to take hold, unless action is started against it. Let us look at the question for a moment from the angle of the total outsider: the regrettable probabilities may be more clearly focused in that way.

Forget, then, that you are a radio enthusiast. Imagine yourself utterly and abysmally ignorant of any inside facts about the subject. You know that radio has suddenly become very popular, you have heard about broadcasting, you see the radio columns in your daily paper and hear folks talk about it, but you never bought a radio publication of any sort in your life; your knowledge of the subject, other than the most elementary facts, is nil.

Now suppose, for instance, that you are the maker of some household article used universally. There are a dozen others putting out the same kind of article; it is a home necessity—every family should have one. Competition is keen: you're anxious to get the name of your product before as many people as you can, as often as you may, and, naturally, as inexpensively as you are able to do it. It is budget time and you are face to face with the job of okaying next years' advertising appropriation. It looks like a pretty big chunk of money. You don't mind spending it—no-o-o, not exactly—but you sometimes wonder whether everybody who passes a billboard,



ALONG COMES A MAN WITH A PLAN

And says to you: "Suppose I guarantee to put over whatever advertising message you wish, to several hundred thousand people, who have *got* to listen to it"

picks up a newspaper, reads a magazine, or enters a store sees your dearly bought advertising and is influenced by it. You are wishing two things: that you could tell potential buyers what you have to tell them so you could be *sure* they heard you, and that you could tell them without spending quite so much in doing it.

Just as you are chewing over this thought and trying to resign yourself to the inevitable, along comes a man with a plan. He says to you:

"Suppose I guarantee to put over whatever advertising message you wish, to several hundred thousand people who have *got* to listen to it. All of them—since your product is a universal necessity—are potential customers. Suppose I promise to do this for you at a tiny fraction of the amount you pay for the usual advertising which may or may not be attracting attention. Suppose I tell you, in addition to this, that through my plan you can say ten times as much as you could through any other advertising medium with any hope of being listened to. Will you give me a hearing?"

Would you? And when you found that his plan was to utilize the practically national system of broadcasting radio messages; that he would syndicate your advertising so that it was distributed from coast to coast if you wished, or centralize it so that it was intensive in the localities where your distributing facilities were best equipped to handle massed sales: that he would guarantee you, in fact, what advertising salesmen call "one hundred per cent. coverage" among a certain class of people who, *ipso facto*, have money to spend—*would you be interested?*

And if you didn't care in the least about radio and its future but were only concerned with putting over your advertising with the least possible cost and to the greatest possible advantage, *would you agree to use his methods?*

Why! You'd probably run and lock the door to prevent that man from getting away!

Let's look at the question from another angle.

Suppose you are an advertising "free lance," more or less unscrupulous, out to get what pickings you can. Advertising by radio suggests itself to you. You tie up a dozen or so broadcasting stations on contracts which bind them to broadcast advertising matter at certain hours each day—the hours when most listeners are likely to be reached—and to take only such advertising as is placed through yourself. You get very reasonable rates from them, as they are beginning to feel the drain of operating and maintenance expenses and are glad to see a little something on the other side of the ledger. Then you are ready to go after the manufacturer. You have something good to sell him —a "circulation" of several hundred thousand *guaranteed listeners*. You can sell it at a low rate, comparatively speaking. You are on the crest of a wave which is sweeping the country: you have "talking points" galore for your plan: you don't care two pins for the radio enthusiast or what he feels in the matter. *Would you go out and sell your scheme?*

Of course you would—and you'd sell it as hard as the Lord would let you!

Now we'll examine the question from a third angle:

Suppose you are a manufacturer, jobber, or retailer of radio supplies. You have maintained a broadcasting station for some time. It has been good publicity for you; it has helped you sell instruments; it has been a source of pleasure to thousands who have listened in on your concerts. But the saturation point is slowly approaching. Sales of apparatus are dropping off a little. You begin to feel the drain on your pocketbook incident to keeping your station going. You can't dismantle very well, it would hurt your prestige; but you would certainly like to see some way to make that station pay for itself, at least.

Along comes a plausible, so-called advertising expert. He talks about *profits* from your broadcasting station. (You have just been thinking that you'd be glad to have it break even and call your publicity the profit.) He talks persuasively, expansively, in large figures: he produces a contract, an advance payment. You see all worry about how that station is to pay for itself sliding from your shoulders. *Do you sign that contract?* You not only do that, but you phone the wife that there will be company for dinner and put in a call for your favorite bootlegger!

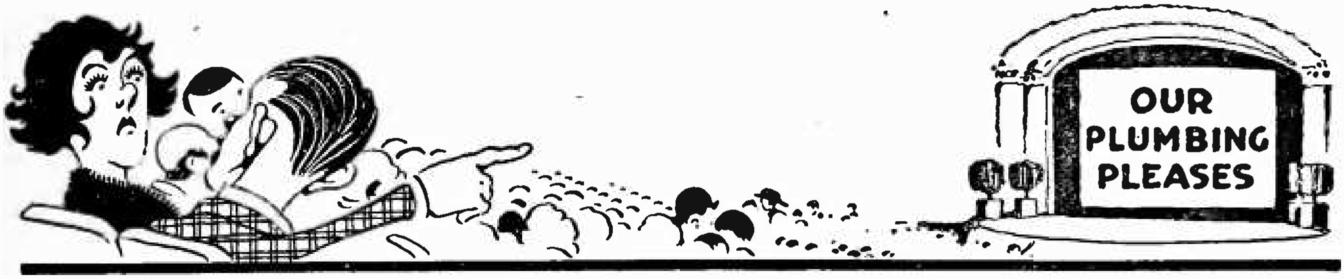
And, looking at the matter from the angle of the outsider, you couldn't be blamed very much for acting as you did in any of these three cases.

So much, then, for examples which show how easily advertising by radio might almost overnight become an Old Man of the Sea—practically impossible to shake off once he got a good grip. It wouldn't take much time to get such a scheme going full blast: you have seen how plausibly it might be argued, how simply it could grow to be a fact.

Now, if you can bear one more impersonation, a more natural one, think of yourself as you really are—a radio enthusiast not above getting up on your hind legs now and then, as every liberty-loving citizen and taxpayer

THERE IS SOME EXCUSE

For mentioning the call letters and name of a particularly good station which conducts only the better sort of programmes, even though it is owned by some commercial company. This is KPO, Hale Bros. Department Store, San Francisco. A station may be made valuable to the operators without grating on the nerves of listeners-in



A GHASTLY BLUE-AND-ORANGE ATROCITY
Informing you that Blah & Blooey had in stock absolutely the best bathroom fixtures that could be bought anywhere for the money

should, and yelling loudly for what's coming to you. Try to realize, if you will, that there is nothing remote about this problem, and that the solution to it will directly affect all of us who like to spend an hour or so, of an evening, listening to good broadcasting. Now let's look into the matter from your own standpoint, that of the radio enthusiast.

By way of illustration and to point the moral a trifle more sharply, consider a little story.

Remember ever taking your girl, or your family maybe, to a regular, first-chop, home-and-mother, melodrama movie? You know the kind I mean—one that made you sneak out the old pocket-handkerchief and sort of wipe your nose on the sly. The picture was simply great! You were right *with* the heroine all the way; you felt her trials and her sorrows yourself, and when she and her shiny-haired leading man melted away in one last, lingering clinch against a pink sunset background, with the art-title, "And So, Hand In Hand, They Took The Long, Long Trail Together," you had that creepy feeling up and down the old backbone, and you were glad that everything had come out right after all, and you settled back in your seat kind of running over the picture in your mind, enjoying it—all the sad parts—and waiting for the news weekly to begin.

And then what happened? A miserable purple, yellow, and green splash on the screen announced that Dr. Bunkum's Pale Pills for Punk People might be obtained at Goofey & Gink's Drug Store, "right in the same block with the theater"; a ghastly blue and orange atrocity informed you that Blah & Blooey, "just around the corner from the theater," had in stock absolutely the best bathroom fixtures that could be bought anywhere for the money —"Our Plumbing Pleases"; and a thumb-printed, ugly art-slide advised all and sundry that the Elite Bootery and Shoery would be only too glad to have your valued patronage and that their place of business was "only three minutes from the theater where you are now sitting."

By that time you had entirely lost the thrill of the picture you had paid your good money to see. And as the awful, endless procession of advertising slides trailed before your eyes, each worse than the one before, you grew more and more disgusted.

Remember anything like that ever happening to you? Probably. In fact, some show-houses still cram advertising slides down their patrons' throats. But not most of them. Why? Because people didn't like that sort of thing and they let the exhibitor know it.

There's the illustration. Now for its application.

Supposing—just supposing—you are sitting down, head phones clamped to your ears, or loud-speaker distorting a trifle less than usual, enjoying a really excellent radio concert. A famous soprano has just sung your favorite song, and you're drawing a deep breath, sorry that it's over. Your thoughts, carried back to some pleasant memory by the magic of the radio, are still full of the melody. You are feeling sort of soothed and good-natured and at peace with the world. All of a sudden a gruff voice or a whining voice or a nasal voice or some other kind of a voice says "Good Morning! Have you used Hare's Soap?" Or maybe a sweet, girlish baritone implores you "Ask for Never-Hole Sox. There's a Reason. You just *know* she wears 'em."

Well, how about it? Do you like the idea? Can you picture to yourself the horror of sitting down to listen to a good song or two, or perhaps a newsy chat on the events of the day, and then being forced to listen to a broadcasting programme that is nine tenths advertising matter? Yes, "forced" is the word—there's the difficulty, life-size—for you can't refuse, like movie-goers, to patronize the show. If such a thing as broadcasting advertising matter should become general—and it is no remote possibility—you'll *have* to listen to it or listen to nothing at all! And you didn't buy receiving apparatus to listen to nothing at all.

Now then, you have impersonated half a dozen or so characters in pursuing your way through this article. You have seen to what unmitigated horrors advertising by radio would lead, should it ever become a reality. You have seen how plausibly such a scheme might be presented and developed before measures to stop it could be taken.

Granted that it is possible enough: is it really likely? Does the problem of radio advertising seem at all imminent or is any warning regarding it merely to be classed with the alarmist's cry of "Wolf!"?

Any one who doubts the reality, the imminence of the problem has only to listen about him for plenty of evidence. Driblets of advertising, most of it indirect so far, to be sure, but still unmistakable, are floating through the ether every day. Concerts are seasoned here and there with a dash of advertising paprika. You can't miss it: every little classic number has a slogan all its own, if it's only the mere mention of the name—*and* the street address, *and* the phone number—of the music house which arranged the programme. More of this sort of thing may be expected. And once the avalanche gets a good start, nothing short of an Act of Congress or a repetition of Noah's excitement will suffice to stop it.

There is one factor which may appear at first blush to lighten the situation; that is the attitude held at present toward such means of advertising by recognized, reputable advertising agencies and by men who govern the advertising policies of the larger manufacturers. *Most of these are openly arrayed against the exploitation of radio for advertising purposes.* Sensing the situation broadly, they realize what a drag upon the science its use for purposes of this kind would prove. But the danger is not from reliable firms and individuals, so that the disapproval of these folk, pleasant though it may be for us to know their attitude, does not help matters much. It is the irresponsibles who are to be feared. Fly-by-nights, plenty of them, unburdened by any sense of what is fair and right, are always ready and waiting to put public enthusiasm to work for them. The woods are full of opportunists who

DRIBLETS OF ADVERTISING

Indirect, but unmistakable, are floating through the ether every day. You can't miss it: every little classic number has a slogan all its own, if it's only the mere mention of the name—*and* the street address, *and* the phone number—of the music house which arranged the programme

are restrained by no scruples when the scent of profit comes down the wind.

Those who care to look about may find signs of what we may expect on every hand. Particularly in the Far West has this tying-up of advertising with radio become a nuisance. The writer was recently asked to broadcast a ten-minute talk on the dangers of advertising use of broadcasting facilities. The talk was sent out from one of the larger Western stations and the response from those who heard it was tremendously significant. Letters from all parts of the West were received: suggestions of all sorts were offered to remedy the evil which all who heard the talk recognized as *already existing*.

There is our problem—what are we going to do about it? Unfortunately, nothing can be accomplished sectionally. There must be a country-wide movement, which will be powerful enough to overcome the inevitable legislative hesitation and which will result in definite, speedy action. The thing cannot be prevented by ordinary methods; legislation, carefully calculated and effectively administered is the only remedy. And the radio enthusiasts are the ones to whose interest it is that such measures become law as soon as possible. It is *they* who must bring it to pass.

Progress of Radio in Foreign Lands

PRESENT STATUS OF RADIO TELEPHONY FROM BRITISH STANDPOINT

RECENTLY a British Government committee, consisting of Admiral Sir H. B. Jackson (Chairman), Prof. C. L. Fortescue, Prof. G. W. O. Howe, and Major A. G. Lee, made a report regarding the possibilities of radio telephony. The conclusions of the committee are summarized as follows:

(*a*) The development of radio telephony for long ranges is in an extremely elementary stage, and no line of development which would be likely to lead to its establishment on a commercial basis within a measurable period is visible.

(*b*) For ranges of the order of 1,000 miles in certain remote localities, where the interference from atmospherics and other radio communications is not excessive, it would be possible to establish non-secret radio telephonic services using waves of the lengths usually employed by medium power radio telegraph stations communicating over the same range. The power necessary for radio telephony, however, would be much greater than that required for satisfactory communication by radio telegraphy over the same distance.

(*c*) For ranges of the order of 200 miles, the position is more hopeful, and the lines of experiment which are being followed will lead to the development in a reasonable time of a system of radio telephony which will approach approximately, at least, to the requirements of a commercial system.

(*d*) The use of radio telephony as a substitute for any other means of telegraphic communication cannot be recommended except in those cases where the special requirements can be met in no other economic way—for example, the broadcasting of intelligence of general information where one costly transmitting station supplies a great number of simple, inexpensive receiving stations, seems a practical commercial problem, especially in localities ill-equipped with land lines.

THE RADIO TELEPHONE IN JAPAN

IT IS reported that telephone communication by radio has been inaugurated across the Chosen Strait. The stations at Fukuoka and Fusan contain the necessary equipment for maintaining communication under virtually all conditions, and it is expected that shipping along the coasts of Kiushu and Chosen will take advantage of this service. This particular installation is a unit in the Japanese Government's plan for linking up the various islands of the Empire by radio telephone and telegraph, as a supplement to the cable service.

RADIO WEATHER REPORTS FOR FRANCE

THE Eiffel Tower radio station at Paris is preparing to send out radio telegraphic weather reports and forecasts three times daily. A suggestion has been made that radio receiving sets be installed at central points in the various country communes, and that the information thus received be signaled to the farmers by a code of sound signals from the church bells. For example, no signal would be given if no change in the weather is forecast; three strokes of the bell if rain is expected; six strokes for frost; and ten strokes for wind or hail storms.

DOUBLING THE TRAFFIC CAPACITY OF A RADIO STATION

IT HAS remained for Messrs. H. Abraham and R. Planiol, French radio engineers, to develop a new method of radio transmission which allows two messages to be transmitted simultaneously, each with the full power of the station, without one message interfering in any way with the other. In this way the full range is obtainable for both messages just as in the case of ordinary transmission. This result is obtained without difficulty by simple changes in the wavelengths of the emission.

According to the account of the new method given in the *Comptes Rendus*, the first message is sent mainly on a wavelength A, the second on a wavelength B; things are so arranged, however, that when the two signaling keys are simultaneously depressed the emission is made on a third wavelength C. Each of these three sets of signals is made with the full power of the station. The signals of the first message are in this way sent partly on wavelength A and partly on wavelength B. The receiving station for which the message is intended should therefore receive without discrimination signals of wavelengths A or C, but of no other wavelength. It suffices for this purpose to arrange at the receiving station two groups of resonant circuits, tuned to the frequencies utilized. These circuits actuate a receiving instrument which may be either a telephone or a recording apparatus.

This new method permits the amount of traffic handled by the station to be doubled, without any increased outlay. It is claimed that a transmitting station equipped in the way mentioned will give the same service as two separate stations of the same power. Incidentally, moreover, the constant changing of the wavelength of the emissions is a very effective aid to secrecy of the messages. Tests have been carried out with this new method, using the large naval arc station at Nantes, France. Two messages were sent simultaneously on full power. Satisfactory results were obtained.

BRAZIL'S STATION ON MOUNT CORCOVADO

WHETHER the new broadcasting station on Mount Corcovado, overlooking Rio de Janeiro is an earnest effort on the part of the Brazilians to inaugurate radio broadcasting service in their capital city, or only an addition to the attractions of the already spectacular Centennial Exposition, is not known. Whatever the case, the very fact that such a station has been established and is in operation is an indication that the Radiophone craze has at last struck the United States of Brazil. Buenos Aires has had radio concerts for over a year, and the practice has fostered a sizable coterie of radio enthusiasts; but this Corcovado station is Brazil's first attempt.

In some respects, perhaps, the Mount Corcovado outfit is the most unusual in the western hemisphere. Certainly it occupies a most commanding and spectacular position. Perched on an inaccessible peak, it is far above the height attainable by the average mountaineer. It can be reached only by the aid of the Swiss Electric Mountain Climber, which leaves the base of Corcovado every hour and laboriously pulls itself to the top on its cog railway. The entire metropolis below lies spread out before an observer on the summit.

The technical details of the installation have not yet reached this country. The apparatus is probably of American manufacture. A press report is responsible for the slight information that the concerts and news reports have been heard in Sao Paulo, which is less than two hundred miles distant from Rio de Janeiro. If the station has any power at all, its radius should extend north of Cape St. Roque and south to Rio Grande do Sul; in short, from one end of the country to the other.

AMATEUR BROADCASTING LOCALLY CONTROLLED IN CANADA

ONE of a number of important new regulations governing amateur radio stations in the province of Ontario, Canada, is that local associations are given control of all amateur broadcasting in their territory, with power to issue licenses and withdraw them, to fix hours for broadcasting and to collect fees.

Discussing these new provisions at a recent radio convention in Toronto, Commander C. P. Edwards, director of the Canadian Government Radio Service said: "To meet the demand of the amateur for a broadcasting wavelength, a new license, called an amateur broadcasting license, has been established. This license is subject to certain restrictions, and with a view to protecting amateurs in each locality, it has been decided that the issue of the amateur broadcasting licenses will be limited to associations and they will be given the power to authorize the stations of one of their members to use the license. The wavelength for this class of work has been fixed at 250 metres.

"The underlying idea in this arrangement," he said, "is that if the majority of the members of any association desire local broadcasting, they can, under this license, obtain it."

Commander Edwards added that such amateur stations would be limited to a normal daylight range of twenty-five miles.

Experimental licenses are to be granted to advanced amateurs, who are undertaking original experimental or research work. The wavelengths are: spark, 175; continuous wave, 275.

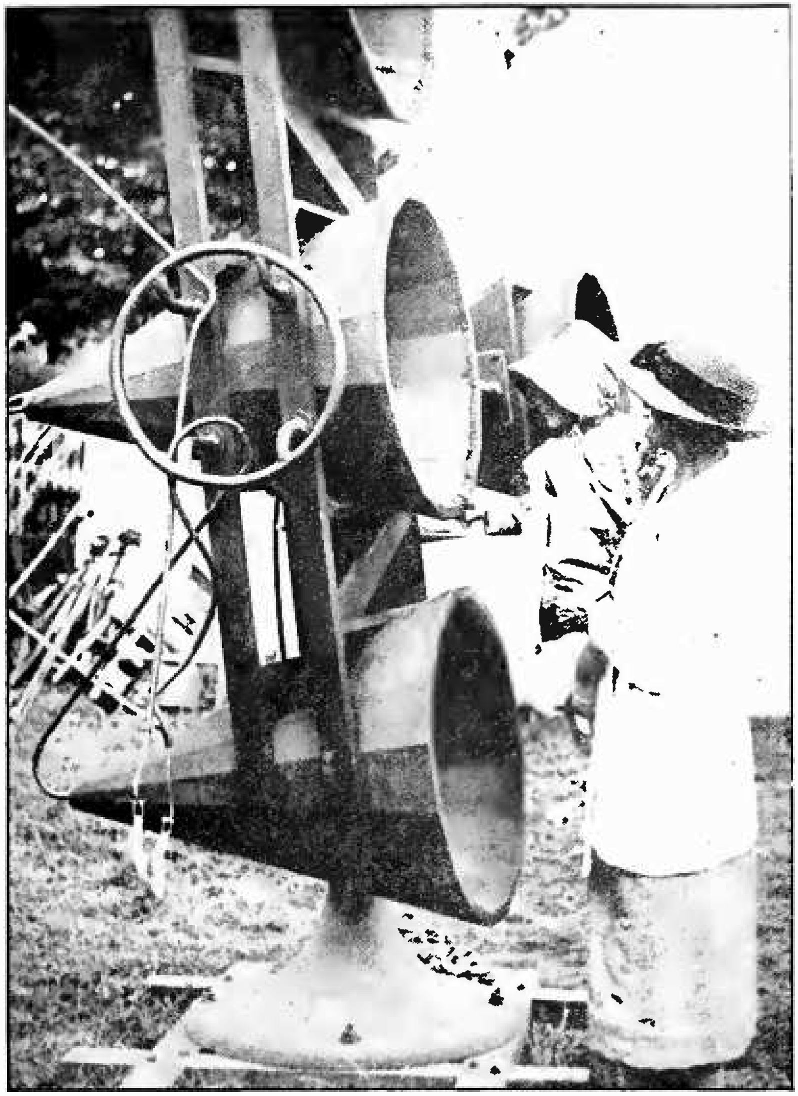
Transmitting licenses of any class are to be granted only to British subjects, but receiving licenses may be obtained by any person, irrespective of nationality.

A NEW AFRICAN RADIO STATION

FROM the British annual Colonial report for Gambia, West Africa, we learn that radio telegraph and telephone stations have been completed in that colony at Bathurst and at McCarthy Island, distant 176 miles. These stations are intended for internal communication, as the colony has no organized telegraphic wire system.

BRITISH RADIOPHONE RECEIVERS FOR BRITISHERS

WHILE Great Britain's radiophone broadcasting plans are still more or less in the air and will no doubt take quite a time before they crystallize into something like a definite programme, there is one outstanding fact that has been established since the very beginning: British radiophone enthusiasts are going to use British-made receiving sets. The companies which are to carry on broadcasting in Great Britain are going to see to it that no German or any other country's receiving sets flood their market to the detriment of home industry. Government aid has practically been pledged in this connection.



ONCE SEARCHLIGHTS, NOW LOUD SPEAKERS

These horns, used during the war to illuminate an English flying field, have been converted into amplifying horns for broadcast reception

Meanwhile British receiving sets are now making their appearance. The Radiophone sets follow American practice quite closely; indeed, one line of sets practically parallels a well-known American line, using the designations "Junior" and "Senior" to indicate the difference between crystal detector sets and vacuum tube sets. A crystal receiving set, with telephones and single tuner control, sells for the equivalent of twenty dollars, complete with antenna wire, insulators, and ground connection. A vacuum-tube set makes use of two tubes—one as a detector and the other as an audio-frequency amplifier. The "B" or plate battery and the filament storage battery are contained in a separate acid-proof wooden case. The "B" battery is adjustable by means of a multi-point switch. The set complete with batteries, antenna materials, telephones, tubes and so on sells for the equivalent of one hundred dollars.

PLANS FOR ENGLAND'S MOST POWERFUL STATION

THE new transmitting station which the British Government proposes to erect at Bourne, near Spalding in Lincolnshire, in connection with the Imperial Wireless Chain, will be the largest yet constructed in the British Isles. There will be eight steel masts, each 800 feet high. Owing to the fact that steel is a conductor, and therefore liable to cause loss of electrical energy, the masts will be insulated in sections, and will stand on an insulating base. They will be guyed to concrete anchorages and will be designed to take a horizontal pull of ten tons at the top and a wind load of 60 pounds per square foot. The masts will be arranged in the form of a square, in the centre of which will be located the transmitting station. The apparatus will consist of vacuum-tube transmitters capable of transmitting continuously at 90 words per minute for reception in Poona, Johannesburg, or Perth. The new receiving station at Banbury, which will represent the other terminal of the Imperial Chain, will be built on similar lines to the station already in existence there in connection with the Leafield-Abu Zabal (Egypt) link of the chain.

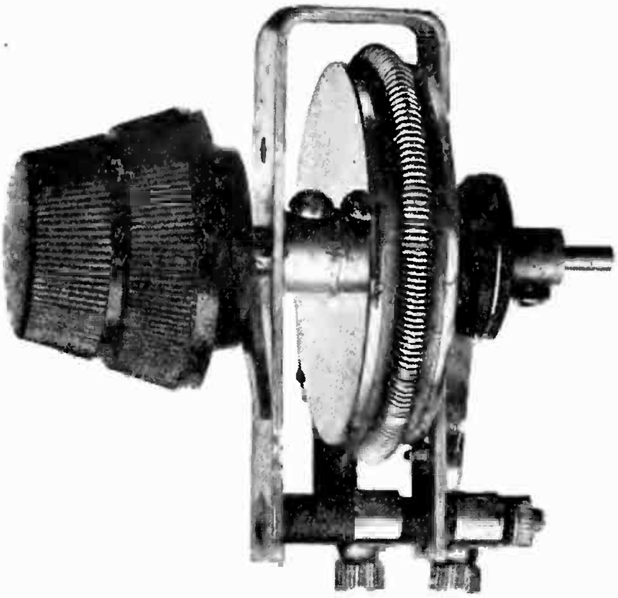
C. BRANDES, INC. ESTABLISHES CANADIAN FACTORY

ON JULY 3rd, Mr. Frederick Dietrich and Mr. M. C. Rypinski, President and Vice-President, respectively, of C. Brandes, Inc., left New York City for Canada to establish a Canadian factory for the manufacture of Brandes headsets. The following day C. Brandes, Ltd. was incorporated at Ottawa, and a day later a factory was leased in Toronto, Ontario Immediately upon the return of the Brandes officials to New York, the entire output of the Canadian plant was sold for the next six months.

SUPPLEMENTAL LIST OF BROADCASTING STATIONS IN THE UNITED STATES FROM AUGUST 11 TO SEPTEMBER 16 INCLUSIVE

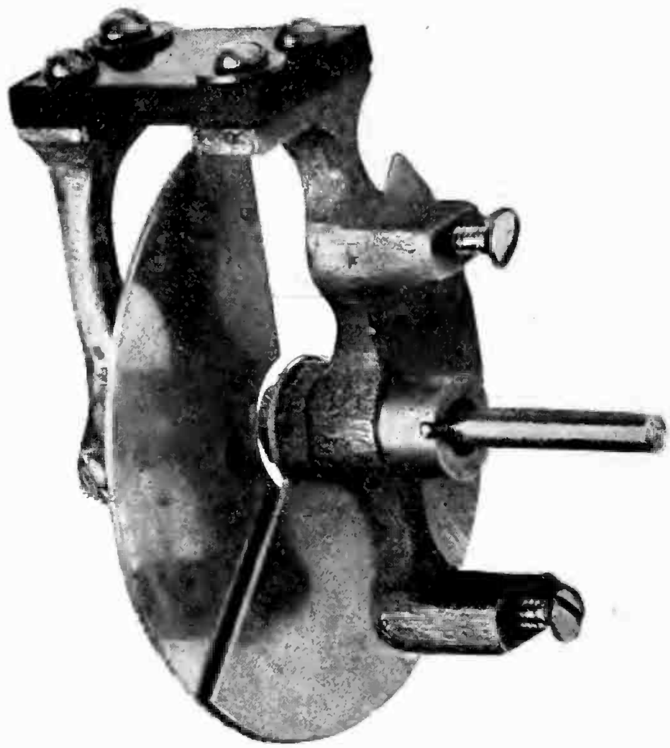
CALL SIGNAL	OWNER OF STATION	LOCATION OF STATION	WAVE LENGTH
KFAY	Virgin Milling Co.. W. J.	Central Point, Oreg.	360
KFBJ	Boise Radio Supply Co.	Boise, Idaho	360
KFBK	Kimball-Upson Co.	Sacramento, Calif.	360
KFBL	Leese Bros.	Everett, Wash.	360
KFBM	Cook & Foster,	Astoria, Ore.	360
KFBN	Borch Radio Corp.,	Oakland, Cal.	360
KFBQ	Savage Elect. Co.,	Prescott, Ariz.	360
KFCB	Nielsen Radio Supply Co.	Phoenix, Arizona	360
KFCC	Auto Supply Co.	Wallace, Idaho.	360
KFCD	Salem Elect. Co.	Salem, Oregon	360
KFDB	McKee, John D.	San Francisco, Cal.	360
WGAI	Southern Equipment Co..	San Antonio, Tex..	360
WGAX	Radio Elect. Co.	Washington, Ohio.	360
WJAH	Central Park Amusement Co.	Rockford, Ill.	360
WJAM	D. M. Perham,	Cedar Rapids, Iowa	360
WJAX	Union Trust Co.	Cleveland, Ohio	360
WJAZ	Chicago Radio Lab.	Chicago, Ill.	360
WKAG	Bruce, M. D., Edwin T.	Louisville, Ky..	360
WKAH	Planet Radio Co.	West Palm Beach, Fla.	360
WKAJ	Fargo Plumbing & Heating Co.	Fargo, N. D.	360
WKAK	Okfuskee County News,	Okemah, Okla.	360
WKAL	Gray & Gray,	Orange, Tex.	360
WKAM	Hastings Daily Tribune	Hastings, Neb.	360
WKAN	Alabama Radio Mfg. Co.	Montgomery, Ala.	360
WKAP	Flint, Dutee Wilcox,	Cranston, R. I.	360
WKAQ	Radio Corp. of Porto Rico	San Juan, P. R.	360
WKAR	Michigan Agri. College,	East Lansing, Mich.	360
WKAS	Lines Music Co., L. E.	Springfield, Mo.	360
WKAT	Frankfort Morning Times,	Frankfort, Ind.	360
WKAV	Laconia Radio Club	Laconia, N. H.	360
WKAW	Turner Cycle Co.	Beloit, Wis.	360
WKAX	Macfarlane, William A.	Bridgeport, Conn.	360
WKAY	Brenau College,	Gainesville, Ga.	360
WKAZ	Landau's Music & Jewelry Co.	Wilkes-Barre, Pa.	360
WLAB	Grossman, George F.	Carrollton, Mo.	360
WLAC	North Carolina State College	Raleigh, N. C.	360, 485
WLAF	Johnson Radio Co.	Lincoln, Neb.	360
WLAG	Cutting & Washington Radio Corp.	Minneapolis, Minn.	360
WLAH	Woodworth, Samuel,	Syracuse, N. Y.	360
WLAK	Vermont Farm Machine Co..	Bellows Falls, Vt.	360
WLAL	Tulsa Radio Co.	Tulsa, Okla.	360
WLAM	Morrow Radio Co.	Springfield, Ohio	360
WLAN	Putnam Hardware Co.	Houlton, Me.	360
WLAP	Jordon, W. V.	Louisville, Ky..	360
WLAQ	Shilling, A. E.	Kalamazoo, Mich.	360
WLAR	Mickel Music Co.	Marshalltown, Iowa	360
WLAT	Bosch Co., Chas. G.	Burlington, Iowa	360
WMAB	Radio Supply Co.	Oklahoma City, Okla.	360
WMAC	Page, F. Edward	Cazenovia, N. Y.	360
WMAD	Atchinson County Mail	Rockport, Mo..	360
WMAF	Round Hills Radio Corp.	Dartmouth, Mass.	360
WMAH	General Supply Co.	Lincoln, Neb.	360, 485
WMAJ	Drovers Telegram Co.	Kansas City, Mo.	360
WMAM	Beaumont Radio Equipment Co.	Beaumont, Tex.	360
WNAC	Shepard Stores	Boston, Mass.	360
WNAL	Rockwell, R. J.	Omaha, Neb.	360

New Equipment



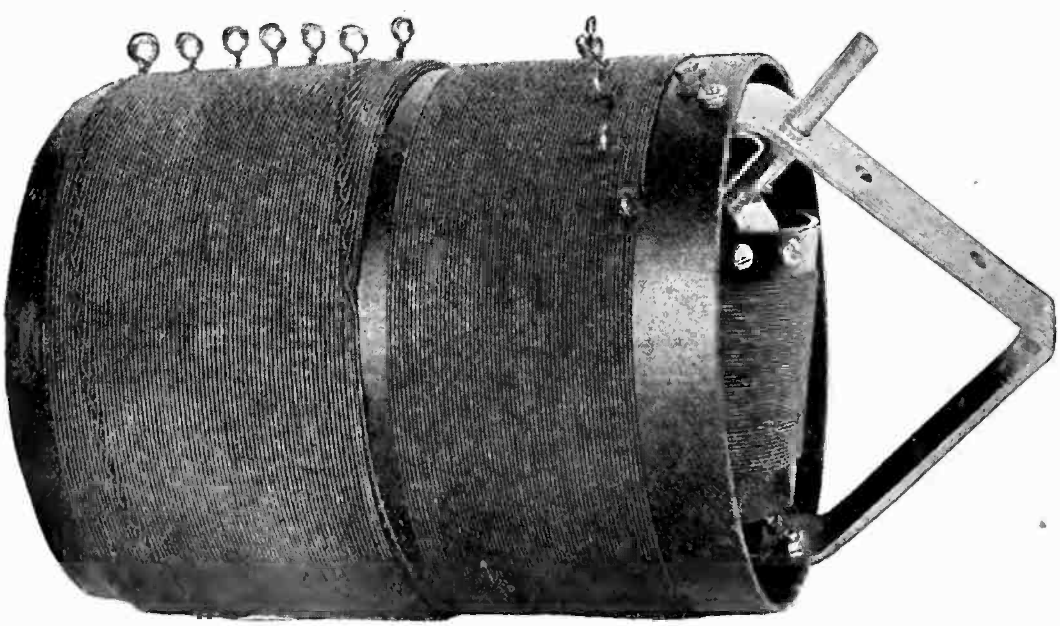
WHITE ADJUSTABLE VERNIER CONDENSER

Type IVC, manufactured by the O. C. White Company, is one of the best devices which has come to our attention. In perfecting this unit, the makers have left no stone unturned, and it embodies many new and attractive features—one being the provision for altering the maximum capacity by changing the distance between the stationary and rotary plates. The list price is $2.50



CUTLER-HAMMER VERNIER RHEOSTAT

Type 1601-H1 is a fitting contribution to radio by an old manufacturer of electrical supplies. No mechanical details have been slighted in this rheostat and it enables the operator to obtain very precise filament adjustment. The list price is $1.50 and the type 11601-H2 which is made without the vernier is listed at $1.00. A paper template is provided with each rheostat to facilitate drilling the holes for panel mounting



RADIO GUILD MULTI-RANGE COUPLER

This unit is well designed and well made. Its wavelength range, when employed with an average antenna, is approximately 180 to 3000 meters, the long-wave section is bank-wound and the windings are of silk-covered single conductor copper, on composition tubes. This unit is listed at $11.00

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.

Diagrams and Graphs

There are several things in the illustrations and diagrams accompanying radio articles that I do not understand.

Many diagrams indicating bulb apparatus show no connections to a filament battery, and the tubes themselves are often depicted as having only three terminals.

How are graphs to be interpreted?

E. S. H., Boston

DIAGRAMS are often abbreviated to avoid confusion resulting from a repeated criss-crossing of wires that are diagrammatically unnecessary. The fourth connection to the tube, invariably the remaining terminal of the filament battery in series with the rheostat, is understood. Also, a series of separate cells, such as a B battery, is often indicated merely by a line of dots between the terminal cells. Fig. 1 shows a circuit of this character. The A battery has been drawn in with dotted lines.

A graph is really a form of picture-writing, which conveys at a glance a series of happenings, and the relations of one thing to another, that might otherwise take pages to describe. For example, a graph may show the relation of varied grid charges to the plate current in a vacuum tube, i. e., the effect that such variations have upon the plate current. In the case of a variable condenser, a graph might show the correlation between the turning of the knob in degrees, and the capacity variation which results. In the two examples just given, the graph indicates immediately: (1) the plate current of the audion at any grid potential (other things being constant) and the general characteristics of the tube; secondly, the capacity of the condenser in farads at any degree on the condenser scale.

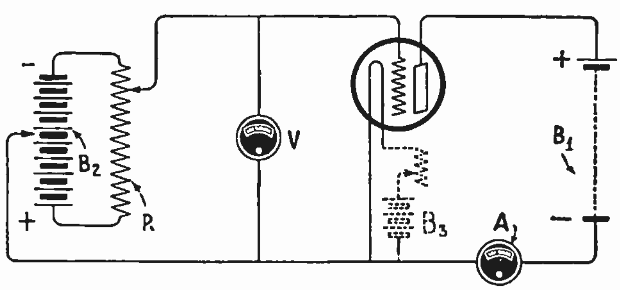


FIG. 1

Probably the clearest idea of how a graph is to be interpreted may be conveyed by showing how such a graph is built up. The graph itself is the curved or straight line plotted on a chart laid out in vertical and horizontal lines known respectively as ordinates and abscissae.

If it is desired to establish a relationship between the plate current (the current passing through a bulb from filament to plate) of a certain type vacuum tube and the applied grid potential, observations of the tube's behavior in this respect must first be made.

The tube is connected with auxiliary apparatus according to the diagram in Fig. 1. B2 is a grid battery of twenty volts, tapped at approximately half that potential, and shunted by the potentiometer, R. B1 is the plate battery of a constant voltage, and B3 lights the filament. V and A are micro-volt and milli-ampere-meters, respectively, from which the readings are made. As the contact on the potentiometer is varied, any plus or minus charge, within the limits of the battery, may be placed on the grid.

Starting from the negative side of the grid battery, the potentiometer slider is lowered until the first definite reading is shown in the milli-ampere-meter, at which point we shall assume the grid voltage to be between −5 and −4 volts. But bearing in mind that we are going to observe the *fluctuations in the plate current at certain definite grid voltages*, in other words, that we are going to plot Eg (grid voltage) as a function of Ip (plate current), we make our primary reading on the milli-ammeter, not at the first grid voltage (probably a fraction) at which an appreciable fluctuation is noticed, but at the round number (−4 volts) approximating it. At −4 volts, the plate current is found to be .3 of a milli-ampere, or .0003 of an ampere. Increasing the grid voltage in steps of one volt, we arrive at the following table showing the relations between grid voltages and plate current:

GRID POTENTIAL (volts)	PLATE CURRENT (milli-amperes)
−4.0	.30
−3.0	.90
−2.0	2.00
−1.0	3.50
0	5.00
+1.0	6.50
+2.0	8.00
+3.0	9.00
+4.0	9.55
+5.0	9.90
+6.0	10.00

Having determined the above relationship, it now remains to express it in the form of a graph—to "plot" the data. The squared paper is first scaled, a definite number of squares or units from left to right (on the abscissae) corresponding to one volt, and another predetermined number (according to the arrangement that will best emphasize the curve) on the ordinates (up and down)

Choke off that "squawk"

AFTER all it is not always the bad vaudeville actors that "get the hook." Many owners have found an efficient hook to choke off the "squawk" of their radio sets and secure enjoyable music, by adding Acme *Audio* Frequency Amplifying Transformers to the ordinary detector unit. Acme Transformers cost but five dollars, yet the results are almost marvelous. Not only do they amplify sound, but they bring it naturally—realistically. They are necessary to the proper operation of the Acme Clear Speaker which enables a whole roomful of people to enjoy the broadcasting concerts.

In order to get more than one broadcasting station and thereby pick out the concert you like best, you should also add an Acme *Radio* Frequency Transformer. This greatly increases the range of your set whether it be vacuum tube or crystal detector type. This wonderful little transformer sells for the same price as its twin brother the Acme *Audio* Frequency Amplifying Transformer. Your set is not complete without both these transformers and the Acme Clear Speaker.

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The Acme Apparatus Company (pioneer transformer and radio engineers and manufacturers) also make detector units, the Acmefone, Acme C. W. and Spark Transmitters, etc. Write for interesting Transformer booklet if your own radio or electrical dealer cannot supply you. The Acme Apparatus Company, Cambridge, Mass., U. S. A. New York Sales Office 1270 Broadway.

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for amplification

representing one or more amperes. As *volts* are being measured with relation to various *current* values, following an arbitrary rule, they will be indicated by distances on the abscissae, and the amperes, the result of the voltage variation, will be plotted as distances on the ordinates.

Referring to the relations arrived at by experiment, the line of the graph passes through points indicating those relationships. This is accomplished exactly as the position of a city or town is located on a map by two sets of numbered or lettered parallel lines running vertically and horizontally. The first point will fall at a position (A, Fig. 2) −4 volts horizontally and .3 of a milli-ampere (the plate current reading for that voltage) on the ordinates. The second point, B, will be located at the intersection of −3 volts and .9 of a milli-ampere, and so on.

The data being plotted, the next step is to draw "the best representative line," a smooth curve, following on an average (deviating, if necessary, first on one side, then on the other) the points on the chart.

The result is the characteristic curve of the vacuum tube, which, taken as a whole, instantly shows to the initiated mind, the complete action of the tube—its possibilities as a detector, radio and audio frequency amplifier.

A general analysis of the graph teaches that a decrease of a small minus grid potential (a positive increase) will cause a comparatively slight rise in the plate current for the first few volts; but as we approach zero the rate of plate current increase is much greater. For several volts on each side of zero the rate of increase is the same (the straight portion of the "curve"), but when a positive potential of approximately two volts is attained, the *rate* of increase drops back and continues to subside until, finally, at +5.5 or +6 volts, further increase in the grid potential does not augment the plate current.

Furnished with this information at a single comprehensive glance, the experimenter realizes that the bulb in question is an excellent amplifying tube. For, if operated at an original zero grid potential, variations of the grid charge by the signals, within the limits of two volts on each side of zero, will produce a uniform change in the plate current. (X-Y on the minus variation, and Y-X[1] on the positive side.) However, if the tube was not characterized by the straight line, or if it were operated

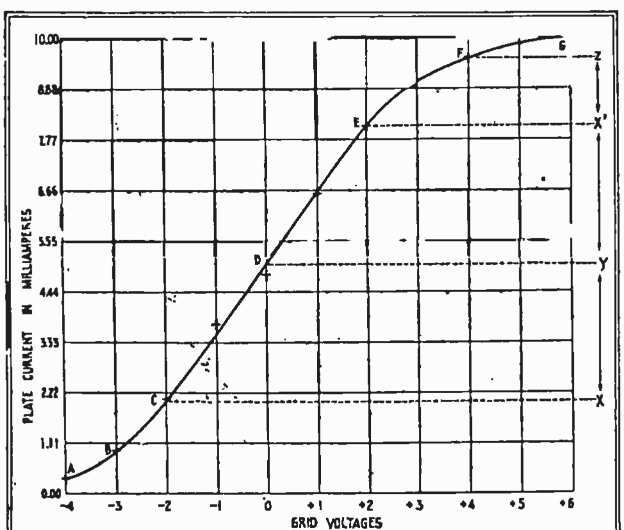

FIG. 2
Showing plate current variation with a constant plate voltage but a varying grid charge

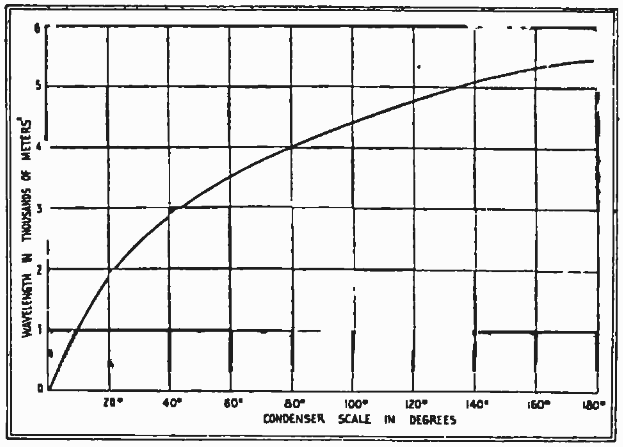

FIG. 3
Wavelength of a US500 duo-lateral coil shunted by a Standard 23-plate condenser

at +2 volts, point E on the curve (which, in effect, is the same as another tube deficient in the straight portion of the curve), a decrease in two volts would cause a much greater change in the plate current (X^1-Y) than would be effected by an equal increase (X^1-Y). Due to this lack of uniformity distortion—and hence unsatisfactory amplification—would result.

In the characteristic curve of an audion, there is little value in the individual volt-ampere relationship. That is to say, there is small opportunity to apply practically, for instance, the knowledge that at −2.5 volts on the grid, the space current, under a constant plate potential, will be 1.40 milli-amperes, or, at +2 the plate current will be 8.00 milli-amperes. The value of a tube's characteristic curve lies in its entirety, not in any one of the single readings from which it is drawn. Likewise, in resonance curves, and graphs depicting the effect of antenna resistance on sharpness, the reading at a single point is of less value than the graph as a whole.

However, in many cases—for example, the wavelength of a coil shunted by a variable condenser (Fig. 3), or the capacity of a condenser itself in relation to the dial indications—the significance lies in the individual readings.

Fig. 3 is a graph showing a variable capacity (a popular make of twenty-three plate condenser) shunted across a duo-lateral coil US500, in its relation to wavelength, i. e., the wavelength of the circuit at any degree on the condenser scale. If the experimenter is receiving a medium wave arc station, and desires to know to just what frequency he is tuned, a glance at the chart will tell him. If his condenser scale reads one 148°, the set is in resonance with 5200 meters; if 44° the wave is 3000 meters. Such a chart is of a very practical value on long-wave reception where, as the stations sign at long intervals, the only way of identifying a station is by the length of its wave.

While listening to radio telephone broadcast, I am often disturbed by a whistle, clear and flute-like, "swishing" across the music. As I am not touching the control knobs at the time, I should like to know if the fault is in my set.
R. W., TOPEKA, KANSAS

THE phenomenon is a beat wave or signal set up in the receiving circuit either by local oscillations (those caused in the receiving apparatus by its suddenly falling into an oscillating state) or, as is most

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probable, those of a nearby receiving station *that is being tuned in a manner hardly considerate of neighboring stations.* There is also the third but unlikely alternative of another radiophone transmitter being tuned or tested on approximately the same wave as the broadcasting station.

A "beat" is the phenomenon resulting from superimposing one frequency or wave upon another. All waves are characterized by frequencies or periods of vibration, and when two of them are brought sufficiently close to interfere, a third wave is generated known as the "beat," the frequency of which is the difference between the frequencies of the two original waves. The phenomenon is analogous to the effect achieved by placing a yellow glass over a blue one. When the combined glasses are held to the light, the green filtering through is a very different shade from the two primary tints.

Previous to the coming of single-circuit broadcast receivers, beats in radio were most commonly heard when two radiophone stations were operating on waves so nearly alike that the voices were confused and jumbled. But loud above the speech would be the squeal or whistle, the beat note of the two stations. For a more specific illustration, it will be assumed that the first station is transmitting on 360 meters (a frequency of 833,300 cycles) and the second station on 359.8 meters (833,800 cycles). The beat note, as before explained, would be the difference between these frequencies, or 500 cycles, a high flute-like note. If there was a greater diversity between the two waves, if, for instance, the stations were operating on 360 and 350 meters respectively, a beat would still exist, but, as the difference between the two frequencies, 23,800 cycles, is far above the range of audibility, it would not be heard.

Thus any two-bulb transmitting stations within interfering distance of one another, and transmitting simultaneously, will generate a beat, which, if the difference between the individual waves is slight, will be heard as a howl or whistle.

A regenerative receiving set, similar to the Aeriola Senior, is capable of oscillating or producing radio waves, and in this respect acts as a short-range bulb transmitter.

Many operators tune their sets with the bulb oscillating (radiating wireless waves), searching around for the howl or beat note set up by the superimposition of local upon incoming oscillations when resonance has been practically effected. At this point the filament, or the tickler coupling, is reduced until oscillations are stopped, and the signals brought in loud and clear. But the squeal heard in the operator's phones during the process of tuning is also audible in nearby receiving sets tuned to the broadcasting station, due, as before explained, to the fact that the "local" oscillations are not confined to the receiving apparatus, but are radiated as wireless waves. As the operator of the interfering receiver tunes his station, i. e., varies the frequency of his emitted wave, the beat note necessarily changes in pitch, running up and down the scale with the effect that our inquirer described as disturbing.

In tuning for broadcast reception there is no necessity for doing so in the manner just outlined. Indeed, the beginner will find the process greatly facilitated if he tunes scientifically with the bulb quiescent. An oscillating tube is characterized by hissing, a general amplification of static and tube noises, and the distortion of phone and spark signals.

Tuning Your Broadcast Regenerative Set

THE following is suggested as a considerate and efficient method of tuning the average broadcast regenerative set:

The filament should be first lowered appreciably below its normal brilliancy. At this point the set is adjusted in the usual manner for resonance and regeneration, by the antenna and tickler adjustments respectively. The filament is then turned up slowly to just below where oscillations commence, at which point the signals will have reached maximum amplification. It is likely, in achieving this final adjustment, that the critical point will be crossed and the tube oscillate until the filament is again lowered. However, if the preliminary tuning was skillfully and accurately accomplished, the local oscillations will "lock" with those radiated from the broadcasting station, and vibrate at exactly the same frequency. Thus no frequency difference, with the resulting howl, can exist—in other words, a "zero beat" has been effected.

It is also a very good practice to note the various positions on the dials and taps at which different consistent stations are received, and to tune to these adjustments before the filament is lighted. By this proceedure all local and interfering oscillations are obviated.

It is interesting to note that in several foreign countries bulb receiving sets must be licensed, due to the possibility of interference.