The EASY COURSE in HOME RADIO

MAJ. GEN. GEO. O. SQUIER, EDITOR-IN-CHIEF

LESSON I.-A GUIDE FOR LISTENERS IN

BY ABBY MORRISON
INSTRUCTOR IN RADIO AT Y.W.C.A.

ONE OF THE FOLLOWING SET OF SEVEN LESSONS

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The EASY COURSE IN HOME RADIO

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LESSON ONE

A Guide for Listeners In

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Instructor in Radio at Y. W. C. A.

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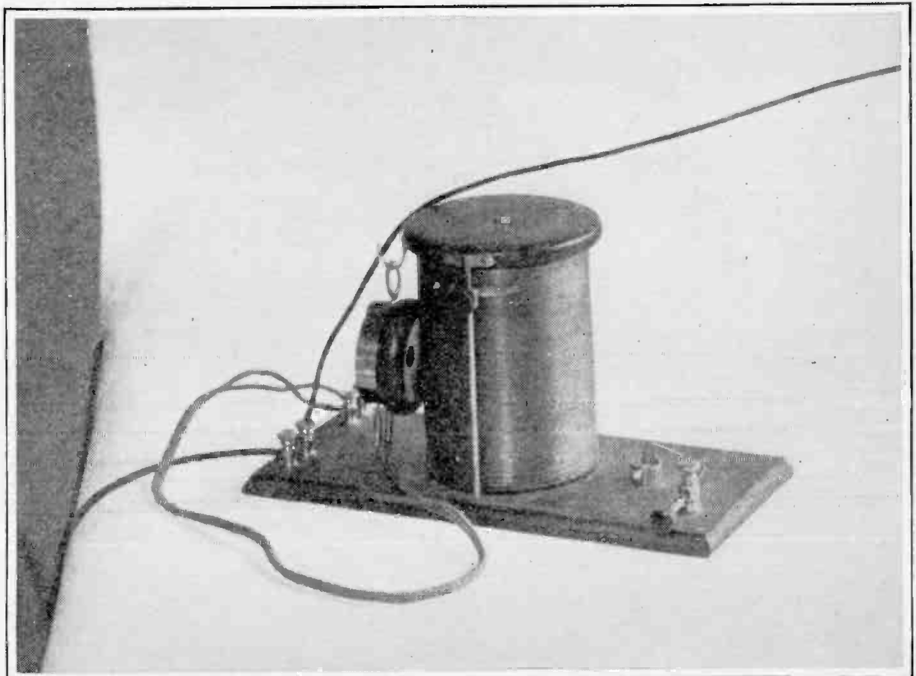
This is the simplest crystal-detector set that can be made. Its range is about 10 miles.



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LESSON ONE

How Complicated is a Radio Receiving Set?

A RADIO set is no more difficult to operate than a phonograph and you don't need to tire your arm cranking it every five minutes and to disturb yourself getting up to put on a new record or to restart the old one. You can recline in your arm chair with a good book and read to a dreamy waltz accompaniment or go to bed, put out the light, place the receivers on your ears and drowse off with the refrains ringing in your dreams all night.

There is no stopping of the radio receiver when it gets going and once the handles are set. Like the brook, it goes on forever, that is, until the A battery runs down, which may happen in from 13 to 120 hours, according to the kind of battery and number of tubes employed. You can stop the sound by turning one knob. No profound knowledge of electricity is required to operate a set—nothing more than common sense. Thus, no sensible person would leave tubes burning when the set is not in use. Tubes burn out quickly, and they cost from $5 to $6.50 each. If the directions supplied with a set are followed no mistake need be made in connecting the right battery with the right terminals of the tube.

What Does a Set Look Like?

The present stage of radio development has produced a compact small neat receiving apparatus. In fact, it resembles the ordinary phonograph cabinet in outward appearance, so that it can harmonize with library or even drawing-room furniture. Sets may be bought for all prices from the small crystal detector set in a brown polished case the size of a cigar box to a large phonograph cabinet of mahogany or daintily painted wood. Any kind of case can be made to order which will harmonize with the period of the furniture or color of the hangings. The wire brought in the window from the antenna can be skillfully hidden behind curtains or under rugs. The latest designs have a loop aerial which is daintily and artistically suspended above the cabinet, and no outdoor aerial is needed.

In fact, rather than an object to be avoided as an eyesore in the modern housekeeper's home, the radio apparatus is a novelty which enhances and adds mystery and interest to the atmosphere of the room. It catches the eye with its striking appearance and detains the visitor with its results.

What To Buy and Why

Radio is a peculiar study in more ways than one. Perhaps its greatest claim to peculiarity rests in the violent extremes that we encounter at every turn. At one moment we are dealing with the most advanced engineering and the highest kind of electrical efficiency; at the next we are confronted with trivialities and sheer nonsense.

Listening to "Sandman" stories with a short-range receiver.

Whenever we are face to face with the sublime, we may be sure that the ridiculous is just around the corner. In radio the two extremes meet in the set either bought or made at home. In the survey of radio equipment of all kinds, let us therefore start with the ridiculous, so that we may better appreciate good construction and good results when we encounter them. This particular piece of ridiculousness has to do with cheap radio sets and the consequences that follow their use.

Ten cents is the cost of a radio receiving set that may be constructed by anyone. Of course, there are sets that sell for ten dollars, twenty-five dollars, seventy-five dollars, one hundred and fifty dollars, three hundred dollars, and upward; but it is a fact that a set can be built for ten cents. Simply buy ten cents worth of copper wire, find a discarded safety pin about the household, borrow any kind of telephone receiver, and then try out one piece of anthracite coal after another until one is found that possesses suitable rectifying properties for use as a radio detector. The search for the right piece of coal may prove discouraging. As a matter of cold truth, it is estimated that one can reasonably count on one suitable piece of coal in a ton.

What May Be Done With a Piece of Coal and a Safety-Pin

For the antenna of this set, connection is made with a fire escape, metal bedstead, or other large metallic structure, since there is no money available for antenna wire. The ground is the usual water pipe or steam pipe. The detector is simply the discarded safety-pin, held on a piece of wood by means of a nail, and the piece of coal, held on the same piece of wood by means of three nails and a few turns of wire. The point of the pin rests on a sensitive spot of the coal. The telephone receiver is connected across the detector, while the latter is connected with the antenna and the ground.

It goes without saying that there are several drawbacks to this inexpensive set. First of all, no one relishes the thought of picking over a ton of coal to find a sensitive lump. Then the problem of borrowing a telephone receiver is no simple one, and to appropriate a telephone company's instrument is certainly not advocated. Also, there is the little question of tuning, and since no provision for tuning is made in this set, there is apt to be a Babel of sounds to mess up the radio-phone reception. Finally, and perhaps most important of all, the set so simply constructed will work fairly well when it is installed on the same roof as the aerial of the broadcasting station. A short distance away it becomes absolutely inoperative, because it lacks even a low degree of sensitiveness to say the least.

All of which must not be taken seriously, the purpose being to show once and for all how ridiculous it is to expect much of very cheap receiving equipment. For worth-while results, a fair sum of money must be spent. Radio efficiency is a function of a pocket book's thickness. A $10 outfit will do just half or one-third the work of the $25 outfit, while the $75 outfit is at least three or four times as serviceable as the $25 outfit, and so it goes. Every dollar spent wisely means just so much more efficiency and good service. Miles of radius can be bought only with dollars, and it is a generally accepted fact that every dollar invested in receiving sets means an extra mile of average range.

Before we discuss crystal receiving sets and vacuum tube equipment, it may be well to point out that radio receiving apparatus comes in three different forms, quite aside from the various classes of receiving equipment which have already been mentioned. Thus there is the first form, comprising merely the component parts of a receiving set. You can buy the parts of a crystal detector, the binding posts, the tube and wire and the sliders for a tuning coil, the binding posts, the bakelite panel and the cabinet, and so on, and assemble the receiving set to please your individual fancy.

Then there is the second form, consisting of separate receiving units, each complete in itself. Of late years the unit construction has taken firm hold in amateur radio circles, and more than one manufacturer is offering his complete receiving units in a uniform style and size, so that they may be assembled into any desired receiving set, very much after the fashion of a sectional bookcase. Truly, the unit construction has many things to commend it. You can start with a simple tuner unit and a crystal detector, adding a loading coil to obtain longer wave lengths, a series-parallel condenser to decrease or increase the wave length, a vacuum tube control unit, an amplifier unit, and so on, going all the way from the simplest set to the most elaborate without throwing out all that has already been acquired, which is the case when complete receiving sets are purchased.

Then there is the third form, which is the complete receiving set. This form is especially intended for the novice who wants results—quickly, surely, and without bother. Such equipment has just a few binding posts—two for the antenna and ground; two for the storage battery, if it is a vacuum tube set; perhaps two for the "B" battery, although this battery may be inside the cabinet; two for the telephones, although a jack and plug arrangement may be used instead. At any rate, a few connections, and the set is ready to receive the radio-phone programs. It is neat, has a minimum of exposed wires, and all in all can well fit into the general scheme of the living-room or den without giving that room the appearance and atmosphere of a power house or electrical laboratory.

There is another form of radio equipment which we have not yet touched upon, but which should be included in this discussion. It is really a development of the cabinet form, but considerably more elaborate and well in keeping with the present state of the art which has attracted so many novices who are interested first and last in the reception of the radio-phone programs, and not at all interested in the radio practice itself. The radio set is simply a means to an end—that of receiving radio-phone programs. The simpler it is, the better they like it. Hence the phonograph type of receiving set which is now making its appearance. It is generally mounted in a typical phonograph cabinet, and all the controls and batteries are out of sight. In some type a loop is employed instead of the usual antenna and ground, in which case the apparatus is of a most elaborate character and the set is quite expensive. Other types use the usual antenna and ground arrangement, so that the apparatus is simpler and less expensive. Some of the latest offerings in this category are in the form of a combination phonograph and radio receiving set. The machine may be used as a phonograph while the same horn is used for the loud-speaker of the radio receiving set, mounted in the same cabinet.

There Are Five Types of Radio Receiving Sets

For the purposes of this survey, all radio receiving equipment may be grouped into five large classes, namely, (1) the simple crystal detector sets; (2) the simple vacuum tube set; (3) the regenerative set; (4) detector and two-step amplifier set; (5) loop receiver set of the most elaborate type. Just what these five classes of receiving equipment are and how they differ one from the other will now be taken up in turn.

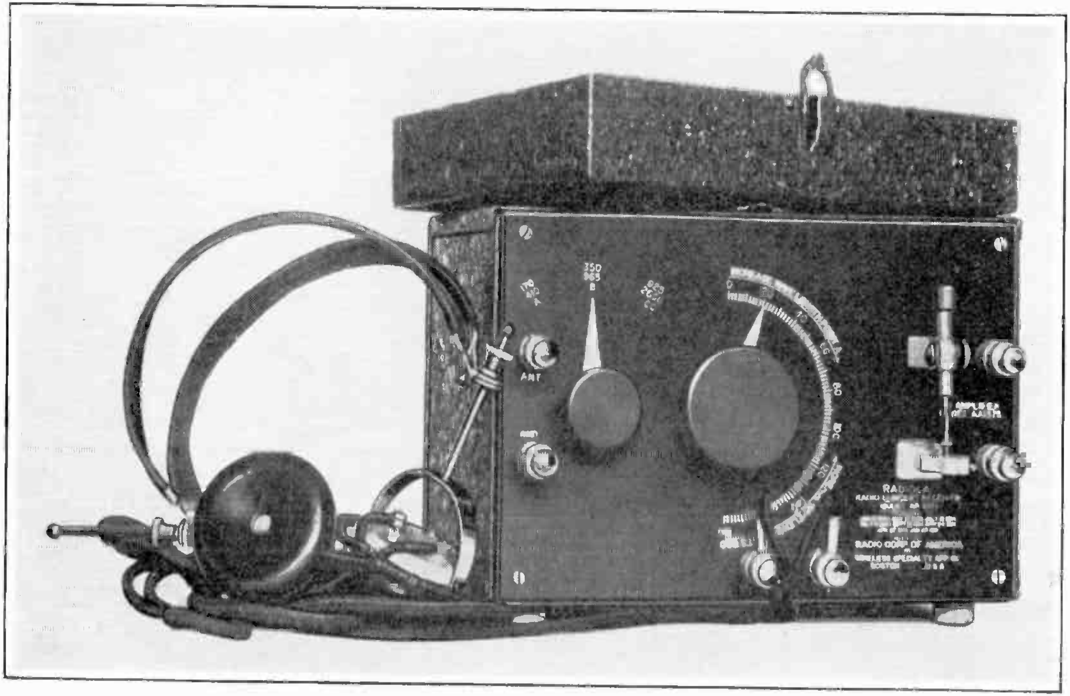
The Crystal Detector Set.—The simplicity of the crystal detector makes it suitable for inexpensive radio receiving sets. No batteries, variable resistances, sockets, bulbs or other accessories are required. In fact, the usual crystal detector set consists of antenna and ground, tuner, detector, and telephone receivers; and its operation is just as simple as its construction is elementary. Crystal detector receiving sets range in price from $10 to $25. The cheaper sets of this category are mounted on a board with the tuner exposed, giving them the appearance of an electrical laboratory instrument, while the more expensive sets are mounted in a neat cabinet or even in a case with a hinged top, with the result that they are both neat and portable. The telephone receivers, together with their headband, can usually be carried in the same case.

In considering the crystal detector set, please note that it has its serious limitations. While the low cost may prove a great attraction, the set is certain to be of little or no

A twenty-five-dollar crystal detector set, good for about 25 miles. Probably most radio enthusiasts begin with such sets.

value if it does not bring in the radio-phone programs clearly. The simpler kinds of crystal detector sets will prove ineffective at a greater distance than ten or fifteen miles from the nearest broadcasting station, and even then only one pair of telephone receivers can be connected to the set. The better sets, selling for $25 or even $35, may be used up to distances of 25 miles and even 35 miles, but the latter range is the maximum. While the crystal detector may be of the same sensitiveness in the various sets, for there is little latitude in such a simple device whose efficiency rests entirely on the rectifying properties of the crystal employed, the better tuning arrangements in the more expensive crystal detector sets make greater efficiency and sharper tuning possible, so that undesirable signals may be suppressed to an astonishing degree.

Now it is a fact that simple crystal detector receiving sets have been successfully used in receiving from radio-phone stations fifty miles away or more. There is on record one case of an amateur, located in Albany, who received the radio-phone music from Newark, N. J., a distance of some one hundred and forty miles, using an inexpensive crystal detector set. But such a feat is due to freak conditions, which, while they often exist, especially during the winter months, cannot be counted upon. If these conditions were not extraordinary, it would be possible to dispense with the vacuum tubes and regenerative sets and amplifiers, and to use a simple crystal detector set instead. Under normal conditions, however, the simple sets are very limited in their range and workability, and since it is the daily performance that counts, we must consider the average range only, and not the exceptional range, in comparing one set against another.



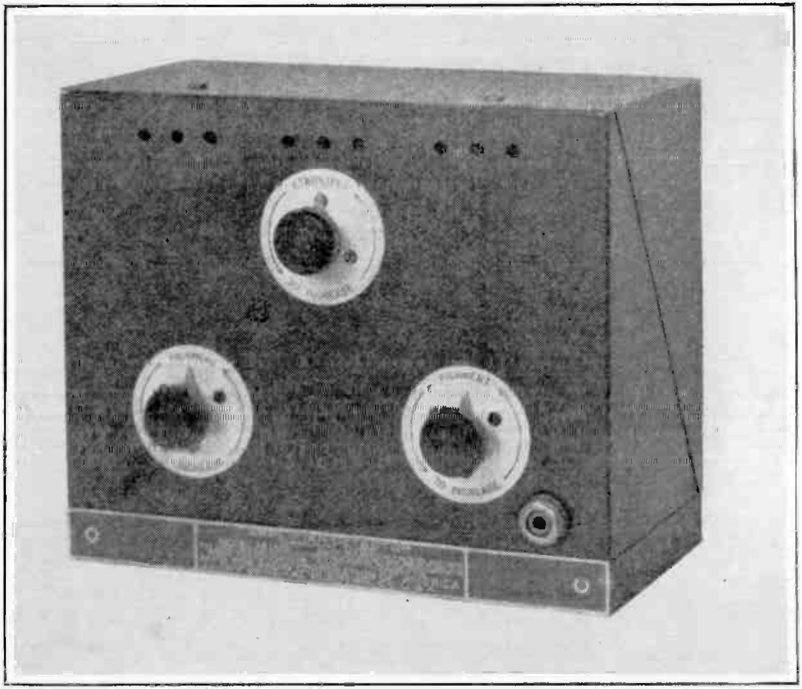
A crystal-detector set good for the wave-band 170 to 2650 meters.

If you are located within twenty-five miles of a broadcasting station whose program is satisfactory to you, by all means consider a crystal detector receiving set. Remember, the usual crystal set will give you good results at this range, and you may employ a second set of telephone receivers if desired; but that is about the limit, for the reason that all crystal detectors merely rectify or convert the radio energy into pulsating direct currents that can be heard by means of the telephone receivers, and add absolutely nothing to that energy. The vacuum tube detector, on the other hand, has its local source of current which is sufficiently powerful to operate a large number of telephone receivers at a time, and even a loud-speaking device, when an amplifier is employed.

If you desire to employ a number of telephone receivers with your radio set so that a number of persons can enjoy the radio-phone programs, a crystal set will not do. It becomes necessary to use one of the simpler vacuum tube receiving sets for this purpose. And if you desire to dispense with head 'phones and to use some form of loud-speaking device in order to dance or to entertain a large group of persons, then it becomes necessary to use an amplifier—a device that builds up the intercepted radio waves to a point where they can actuate a special telephone mechanism capable of producing loud sounds which are distributed over a large area by means of a horn not unlike the old-time phonograph horn.

So much for the various forms of radio equipment.

The Simple Vacuum Tube Set.—Knowing and ap-appreciating full well the limitations of the crystal type receiving set, we come to the simple vacuum tube set. The vacuum tube, as we learn elsewhere in this course, is a



This is a detector-amplifier costing seventy-five dollars. It consists of a vacuum-tube detector and two stages of audio-frequency amplification.

far more sensitive device than the crystal detector. Having its own local source of power, which is controlled by the weak incoming radio waves, it gives a far greater response in the telephone receivers, and that is why it can be used in connection with a number of pairs of receivers if desired. At any rate, it gives far louder music and speech than the crystal detector, and realism in radiophone reception can be obtained only through a fair degree of loudness.

The simpler types of vacuum tube receiving sets comprise a one- or two-control tuner, a vacuum tube detector, a rheostat for controlling the filament current of the tubes, a filament battery, and a "B" or plate battery, not forgetting the telephone receivers. Some offerings in this category are making use of special low-voltage vacuum tubes which operate on a single dry cell. These offerings are extremely simple, and do away with the necessity of a storage battery with all the trouble and mess incidental to using the latter source of current. But most vacuum tube sets make use of the standard types of tubes requiring anywhere from 4 volts to 7 volts, and a current of about 0.8 ampere to 1.25 amperes. This means that it is best to use a storage battery, for the reason that a drain of this kind soon exhausts a dry battery. However, if a storage battery cannot be used, then two or three sets of dry battery can be arranged in series-multiple, so that the drain is distributed over two or three sets. Still, dry batteries, when used in conjunction with standard vacuum tubes, are certainly a luxury.

The simpler types of vacuum tube receiving sets start at about $35 and run all the way up to the elaborately tuned sets costing $100. And these figures do not include the

A set which costs about four hundred dollars with all its accessories and which has the most modern detecting and amplifying devices. Such a set has a range of perhaps two hundred miles.

storage battery or the "B" or plate battery, which are "extras."

The Regenerative Set.—Sensitive as the vacuum tube is as a detector, its sensitiveness can be increased many times by the simple expedient of feeding back or throwing back a certain amount of energy from the plate circuit to the grid, so that the voltage impressed on the grid will be increased. This increased grid voltage, on the other hand, causes greater fluctuation in the plate circuit, and again a certain amount of energy is thrown back into the grid circuit, there to have a still greater influence on the plate circuit, and so on. This action, it will be noted, is a self-amplifying effect, and is known as the regenerative or feed-back action. It is the discovery of Edwin Armstrong and represents one of the greatest advances ever made in the radio art. Roughly speaking, it is estimated that the regenerative action gives an amplification value of about eight times, so that the regenerative receiving set is far more sensitive than the plain vacuum tube detector set. However, the Armstrong patents are rigidly enforced and all manufacturers of the regenerative arrangement must pay royalties, after they have succeeded in obtaining a license. For this reason many vacuum tube receiving sets are not licensed to use the regenerative arrangement and must get along as best they can with the plain vacuum tube circuits.

So the third class of receiving set is the regenerative set, making use of the famous Armstrong circuits. There are two methods of obtaining regeneration. First, there is the tuned plate circuit, which contains a variometer or some other device for varying the value of the plate circuit in order to feed back a certain amount of plate energy into the grid. The second method makes use of a few turns of wire in series with the plate circuit and brought into inductive relation with the circuit that leads to the grid member of the tube. These few turns comprise the "tickler," and the number of turns as well as the distance between the plate circuit coil and the grid circuit coil may be varied to alter the feed-back action.

By all means employ the regenerative receiving set if the price is within your means. The regenerative receiving set enables good ranges to be covered without extra amplifying apparatus. Thus with the simpler regenerative receiving sets, costing as low as $40, without vacuum tube, "B" battery, storage battery, or telephone, a radiophone broadcasting station may be heard over a distance of several hundred miles. An excellent regenerative receiving set with a 1¼ volt special vacuum tube is being sold for $75, complete with tube and 'phones, and operating on a single dry cell and the usual 22½ volt "B" battery. Other regenerative receiving sets vary in price from the low figure already mentioned up to several hundred dollars, depending on how elaborate in finish and in adjustments is the receiving set.

All genuine regenerative sets are so labeled and carry a notice regarding the special license agreement under which they are being manufactured. Be sure the set which you think of buying is so marked, or at least that the circular describing the set plainly states that the manufacturer is licensed under the Armstrong patents.

Detector and Two-Step Amplifier Set.—Leaving the regenerative sets behind us, we come to the amplifiers. In the regenerative sets we have the highest type of receiving apparatus known to the radio art today. The amplifiers are really auxiliary apparatus; they may be added to any set, even a crystal receiving set, for the purpose of amplifying the intercepted signals. Amplifiers come in one-stage and in two-stage models, which are connected to the output terminals or the "telephone" terminals of the usual receiving set. The output energy from the receiving set is passed through the transformer of the amplifier and serves to control still more powerful currents, which, when they have reached the desired strength, are led to a telephone receiver or even to loud-speaking devices capable of filling the largest halls, if need be. There is even a three-stage amplifier available, although in general practice it is found that the two-stage model is about the limit for the average radio novice. In commercial and military communication work amplifiers with as many as a dozen stages have been constructed and used with wonderful results. It is said that during the World War the British constructed a nineteen-stage amplifier which served to intercept the infinitesimal waves set up by ordinary battery buzzers of the German fleet in Kiel harbor. Ordinarily, battery buzzers are employed for inter-ship communication when steaming in close formation or lying close together at anchor. Little wonder, therefore, that the Germans chatted back and forth with their buzzers, not realizing for a single moment that perhaps someone, somewhere, somehow, in this advanced age of ours, was eavesdropping by means of a multi-stage amplifier.

The usual amplifier amplifies electrically about sixteen to twenty times for the first stage. Since the sound is the square root of the electrical strength, the result is a sound amplification of about four to five times, which is considerable. But the second stage gives a total as high as

Short wave regenerative receiver. This set has a vacuum-tube detector and two stages of audio-frequency amplification. The wave lengths that can be received vary from 180 to 700 meters, but by adding a load-coil, wave-lengths from 1800 to 2800 meters can also be received.

four hundred times the original electrical strength, or a sound value of about sixteen to twenty times as great again, which is truly enormous. That is why it becomes possible with the usual two-stage amplifier to operate a loud-speaking device. Many wild statements have been made about amplifiers. There are loose statements about amplifications running into the thousands and the tens of thousands, and some quite sincere writer, having become acquainted with the marvels of the vacuum tube, is just as likely to state that the amplification runs into the millions with the ordinary two-stage amplifier. The figures, as already given, are far more modest but at least truthful, which is what counts after all. The most difficult thing for the average person to do is to estimate the relative volumes of sound, which probably accounts for the extravagant statements made.

Loud Speakers and Amplifiers

Some receiving sets, which are mounted in large cabinets, include a self-contained amplifier as well. However, in most instances the amplifier is an additional piece of apparatus which may often be obtained in the same size and general style as the receiving unit. All the phonograph types of receiving set have self-contained amplifiers.

The volume of sound that is obtained by means of a one- or two-stage amplifier makes it possible to use a large number of telephones with a single receiving set. As many as a half-dozen sets of telephones can be readily connected in series with the set, and even up to a dozen pairs may be used. However, sooner or later the ambitious

A radio receiver on one side and a phonograph on the other—both in same case.

novice or amateur wants to use some form of loud-speaking device, so that head 'phones may be dispensed with.

Of loud-speakers, there are two general types. First of all, there is the improvised type, which is really nothing more than the usual telephone provided with some form of horn for projecting the sound. One well-known model of this kind is a horn with two open stems at its lower end, fitted with soft rubber collars, so that the ordinary telephone receivers may be slipped over these stems and the sounds projected through the horn. There are other models of this same general design, all of which work pretty well within certain limits, of course. Then there are other horns which take a single telephone receiver, and there are single telephone receivers arranged to be fastened on the tone arm of the conventional phonograph, so that the sounds may be projected through the usual phonograph horn.

Strictly speaking, these devices are not truly loud-speakers. They are simply improvisions. The true loud-speaking devices are of much heavier construction and are intended for use with at least two-stage amplifiers. They are provided with huge horns and require a fair input of current in order to produce their full volume of sound. Most of these loud-speakers require additional storage battery current to energize certain coils of their mechanism, but they certainly do produce a great volume of sound and are ideal for dancing or for entertaining a large gathering of persons.

The usual one-stage amplifier costs from $15 to $35, depending on how elaborate is the instrument. While all amplifiers may seem to be built in more or less the same manner, such is not the case. The amplifiers make

A huge cabinet in which the entire receiving set is housed. A whole auditorium can be entertained with this set.

use of little iron-core transformers which have much to do with the amplifying characteristics, and it is well to bear in mind that in paying a somewhat higher price a proportionately better transformer and hence louder telephone sounds with less distortion. The two-stage amplifier sells for $25 to $50.

The improvised loud-speakers, comprising simply a horn that may be used in conjunction with one or two of the regular head 'phones, sell for anywhere between $5 and $12. The loud-speaking devices, on the other hand, range from $40 to $175, the more expensive offerings representing additional amplifying equipment known as power amplifiers, which are necessary in order to build up the current strength to a point where the large mechanism of the huge loud-speaker can be operated.

Loop Receiver Sets.—So far we have dealt with apparatus used with the antenna and ground. Since radio is merely a question of a *cause* and an *effect*, the cause being the broadcasting station transmitter, and the effect the results produced at the receiving station, it follows that the greater the cause the greater the effect, and, by the same token, the nearer the cause the greater the effect. Furthermore, the larger the antenna system employed, the more radio energy is intercepted, and therefore the greater the effect.

Now then, there are times when one wishes to dispense with the usual antenna arrangement. For the city dweller, especially in apartment houses where the landlord does not take very kindly to wires on the roof, the antenna must be dispensed with. Again, if a lecture is to be given on radio, there is perhaps insufficient time to install an antenna. The portable set should be used without an

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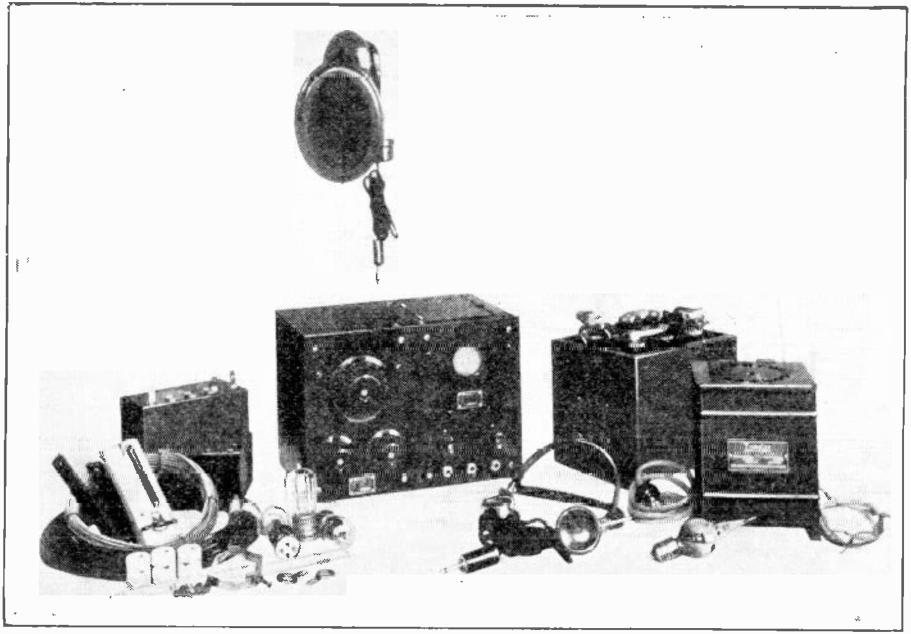

The elements of a loud speaking set. Here everything is shown from tubes to battery charger.

antenna, if it is to be truly portable. And there are many other instances where the antenna must be dispensed with, and some other means employed of intercepting the radio waves.

So, at this stage, we come to the fifth and final and most advanced class of radio receiving apparatus—the loop apparatus. Instead of an antenna and a ground connection, we make use of a simple loop comprising a few turns of bare or insulated wire, spaced ½ inch to 1 inch apart, on a wooden frame measuring four or five feet on a side. This loop serves for both the antenna and the ground. Its two end-wires are brought to the receiving set, which, in this case, may be considerably simpler, so far as the tuning arrangement is concerned, than when the usual antenna and ground are employed. In fact, the tuning is accomplished with a simple variable condenser placed across the two ends of the loop. A variometer or other tuning member is placed in the plate circuit of the vacuum tube detector in order to obtain a regenerative or feed-back action. And that is all there is to the set—at least for nearby work.

The loop receives best when pointing end on towards the transmitting station. In this manner it becomes possible to note from what direction signals are coming, and this same arrangement is the basis of the radio compass which is proving such a boon to navigation. Again, the loop is remarkably free from "static"—the "noises of space," as they are often called. Static is due to atmospheric electricity, and it is at its very worst in summer and at its lowest ebb, fortunately, during the long, cold winter evenings when most of us like our radio sets best. The loop enables one to work satisfactorily through the summer months when, with the conventional antenna and ground,

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static breaks up the radio-phone program to a point where it is hardly worth while "listening in." Still another advantage, the loop, being a directional affair, gives an added means of selecting a given transmitter to the more or less complete exclusion of all other transmitters. The operator can tune in the usual way and, by means of his directional facility, eliminate all stations that do not happen to be in a straight line with the desired transmitter.

But, unfortunately, the loop does not begin to intercept as much energy as the usual antenna and ground, and therein lies its weakness. While it is true that the loop can be used indoors or out and is exceedingly compact, some method has to be employed for building up the very weak wave energy that is intercepted, in order that it may actuate the usual vacuum tube detector circuit.

Radio Frequency and Audio Frequency

There is a critical point in all vacuum tube detector circuits, below which the detector will not detect. In other words, if the incoming energy is too weak to actuate the detector, then any amount of amplification behind the detector will do absolutely no good, for the simple reason that there is nothing to amplify. So we must use another kind of amplification—one that amplifies the radio wave energy instead of the rectified or "sound" current. Our usual amplifier is called an *audio* frequency amplifier because it deals with current of a frequency within the range of audibility. It is a *sound* current, so to speak, and we are building up not the radio energy, mind you, but the sound-producing energy.

Another form of amplification which is coming into more general use every day is the *radio* frequency amplifier, which deals with the radio energy. It builds up this intercepted energy, no matter how weak it may be, and finally passes it on to the detector above the critical point so that the detector will rectify and pass along the sound values, whether they be music or speech or the monotonous dot-dash tongue of the Continental code to the telephone receivers or, if desired, through the *audio* frequency amplifiers, so that the *sound* volume may be built up in order to actuate a loud-speaking device.

Now radio frequency amplification is somewhat more complicated than the usual audio frequency apparatus. It requires more apparatus and more adjustments, and is therefore more expensive. But as times goes on this radio frequency equipment is being consistently reduced to its simplest terms and in time it will be quite as common as audio frequency equipment.

If a loop arrangement is to be employed, say ten or fifteen miles away from a broadcasting station, a simple vacuum tube detector with a regenerative or feed-back action can be employed with good results. A crystal detector is simply out of the running, unless the distance be not greater than about three miles. For distances greater than fifteen miles, a two-stage amplifier should be used to build up the *sound* strength to satisfactory audibility. At distances greater than 75 miles, according to our observation, it is necessary to resort to radio frequency amplification, one-stage being resorted to, up to say 150 miles, and two stages for greater distances. Fortunately, with radio frequency amplification, one can use a number of stages without undue complication. This is not the case with audio frequency.

Please remember, however, that radio frequency amplification is elaborate and expensive, especially if audio frequency is also employed to build up the *sound* strength so as to permit of using a loud-speaking device. Yet in connection with the loop, the results are well worth the trouble. It is a foregone conclusion that in time virtually all amateur radio receiving sets will be using the loop instead of the antenna and ground, just as the loop is now being used in commercial and Government work.

All in all, there is radio apparatus available for every requirement. Furthermore, radio manufacturers and radio dealers are always ready to supply all the information that may be required in guiding you in the selection of a satisfactory set for your special needs.

Recharging the Battery

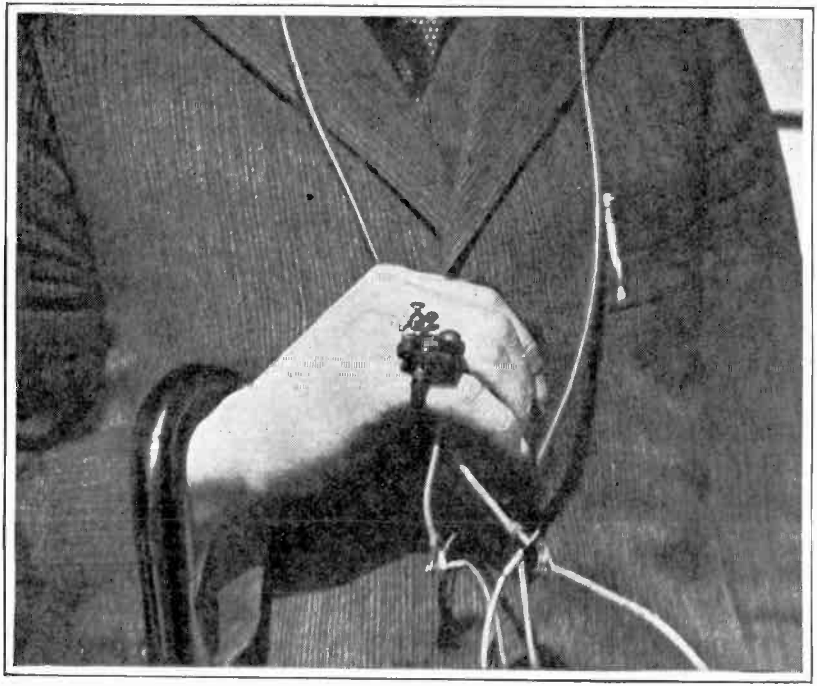
The battery charging depends on the size of the battery. If it is of, say 40 ampere hours capacity, it should be charged after 40 hours use and if larger, it may be used longer. One can judge at the rate of one tube using 1 ampere and a little arithmetic will tell you how many hours will use up the battery capacity. If using one tube at 40 ampere hours capacity, the battery will run 40 hours. If using three tubes the battery will run only 13 hours before it needs recharging. A hydrometer to test the condition of the battery electrolyte is the best and safest judge when the battery is seen to be running down. Don't wait until it gets to the bottom but charge before further use. The battery may be sent to any garage that has a service station or a battery shop and for 50c or $1, according to the locality and prices of the place, in 24 hours the battery will be recharged. Some service stations send for and return the battery if telephoned to do so. One can rent a battery from these stations for 25c. a day. Stations also require a deposit of the price of a new battery, $12 to $15 until the battery is returned. But if your own old battery is left to be charged while the new battery is rented, a deposit is not always required.

How to Buy a Battery

There are a number of good A batteries on the market ranging in price from $6 to $40. These are nothing more than ordinary automobile batteries but as in all advertised radio apparatus, it is well to learn their reputation and have them well vouched for by a competent authority before expending your money on perhaps a makeshift which gives poor results. The more one pays for a battery, the longer that battery is apt to last. One can buy batteries with a capacity of 40 ampere hours up to 200, but the most commonly used batteries for radio are those of 40, 60 and 80 ampere hour capacity.

Who Will Install and Repair the Set?

Receiving apparatus will be repaired at any radio shop or electric shop carrying radio equipment. The store at which the apparatus is bought will repair free of charge



The radio-ring — a receiver that can be worn on the finger. Such small sets have a range so short that they can hardly be considered practical.

for a time and install it for a small sum. Repairing is becoming a business in itself. Electricians who specialize in this line of radio activity advertise in the radio columns of the newspapers.

CODES

	International	Morse
A.	• —	• —
B.	— • • •	— • • •
C.	— • — •	• • •
D.	— • •	— • •
E.	•	•
F.	• • — •	• — •
G.	— — •	— — •
H.	• • • •	• • • •
I.	• •	• •
J.	• — — —	— • — •
K.	— • —	— • —
L.	• — • •	——
M.	— —	— —
N.	— •	— •
O.	— — —	• •
P.	• — — •	• • • • •
Q.	— — • —	• • — •
R.	• — •	• • •
S.	• • •	• • •
T.	—	—
U.	• • —	• • —
V.	• • • —	• • • —
W.	• — —	• — —
X.	— • • —	• — • •
Y.	— • — —	• • • •
Z.	— — • •	• • • •
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International

Apostrophe .... • — — — — •
Hyphen .... — • • • • —
Bar indicating fraction.............. — • • — •

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Parenthesis	— • — — • —
Inverted commas	• — • • — •
Underline	• • — — • —
Double dash	— • • • —
Distress Call	• • • — — — • • •
Attention call to precede every transmission	— • — • —
General inquiry call	— • — • — — • —
From (de)	— • • •
Invitation to transmit (go ahead)	— • —
Warning—high power	— — • • — —
Question (please repeat after interrupting long messages)	• • — — • •
Wait	• — • • •
Break (Bk.) (double dash)	— • • • —
Understand	• • • — •
Error	• • • • • • • •
Received (O. K.)	• — •
Position report (to precede all position messages)	— • — •
End of each message (cross)	• — • — •
Transmission finished (end of work) (conclusion of correspondence)	• • • — • —

Numbers

	International	Morse
1	• — — — —	• — — •
2	• • — — —	• • — • •
3	• • • — —	• • • — •
4	• • • • —	• • • • —
5	• • • • •	— — —
6	— • • • •	• • • • • •
7	— — • • •	— — • •
8	— — — • •	— • • • •
9	— — — — •	— • • —
10—0	— — — — —	——
10—0	——	

Foreign Letters (International)

Ä (German)	• — • —
A or A (Spanish or Scandinavian)	• — — • —
CH (German-Spanish)	— — — —

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É (French) .... ● ● — ● ●
N (Spanish) .... — — ● — —
Ö (German) .... — — — ●
Ü (German) .... ● ● — —

ABBREVIATION.	QUESTION.	ANSWER OR NOTICE.
PRB	Do you wish to communicate by means of the International Signal Code?	I wish to communicate by means of the International Signal Code.
QRA	What ship or coast station is that?	This is........
QRB	What is your distance?......	My distance is........
QRC	What is your true bearing?..	My true bearing is........degrees.
QRD	Where are you bound for?...	I am bound for........
QRF	Where are you bound from?..	I am bound from........
QRG	What line do you belong to?.	I belong to the........Line.
QRH	What is your wave length in meters?	My wave length is........ meters.
QRJ	How many words have you to send?	I have........words to send.
QRK	How do you receive me?.....	I am receiving well.
QRL	Are you receiving badly? Shall I send 20?.......... ● ● ● — ● for adjustment?	I am receiving badly. Please send 20. ● ● ● — ● for adjustment.
QRM	Are you being interfered with?	I am being interfered with.
QRN	Are the atmospherics strong?.	Atmospherics are very strong.
QRO	Shall I increase power?......	Increase power.
QRP	Shall I decrease power?......	Decrease power.
QRQ	Shall I send faster?..........	Send faster.
QRS	Shall I send slower?.........	Send slower.
QRT	Shall I stop sending?........	Stop sending.
QRU	Have you anything for me?..	I have nothing for you.
QRV	Are you ready?...............	I am ready. All right now.
QRW	Are you busy?...............	I am busy (or: I am busy with........). Please do not interfere.
QRX	Shall I stand by?...........	Stand by. I will call you when required.
QRY	When will be my turn?......	Your turn will be No.........
QRZ	Are my signals weak?........	Your signals are weak.
QSA	Are my signals strong?......	Your signals are strong.
QSB	{Is my tone bad?............	The tone is bad.
	{Is my spark bad?..........	The spark is bad.
QSC	Is my spacing bad?..........	Your spacing is bad.
QSD	What is your time?..........	My time is........
QSF	Is transmission to be in alternate order or in series?..	Transmission will be in alternate order.
QSG	....	Transmission will be in series of 5 messages.
QSH	....	Transmission will be in series of 10 messages.

ABBREVIATION.	QUESTION.	ANSWER OR NOTICE.
QSJ	What rate shall I collect for ....?	Collect........
QSK	Is the last radiogram canceled?	The last radiogram is canceled.
QSL	Did you get my receipt?	Please acknowledge.
QSM	What is your true course?	My true course is........degrees.
QSN	Are you in communication with land?	I am not in communication with land.
QSO	Are you in communication with any ship or station (or with........)?	I am in communication with ....(through........).
QSP	Shall I inform........that you are calling him?	Inform........that I am calling him.
QSQ	Is........calling me?	You are being called by......
QSR	Will you forward the radiogram?	I will forward the radiogram.
QST	Have you received the general call?	General call to all stations.
QSU	Please call me when you have finished (or: at....... o'clock)?	Will call when I have finished.
*QSV	Is public correspondence being handled?	Public correspondence is being handled. Please do not interfere.
QSW	Shall I increase my spark frequency?	Increase your spark frequency.
QSX	Shall I decrease my spark frequency?	Decrease your spark frequency.
QSY	Shall I send on a wave length of........meters?	Let us change to the wave length of........meters.
QSZ	....	Send each word twice. I have difficulty in receiving you.
QTA	....	Repeat the last radiogram.
QTE	What is my true bearing?	Your true bearing is........ degrees from........
QTF	What is my position?	Your position is........latitude........longitude.

* Public correspondence is any radio work, official or private, handled on commercial wave lengths.

When an abbreviation is followed by a mark of interrogation, it refers to the question indicated for that abbreviation.

Station Call Letters

All radio stations throughout the world under the jurisdiction of any countries adhering to the London International Radiotelegraph Convention of 1912 are assigned station calls consisting of three or four letters. Practically all countries of importance have adhered to this convention. There is no duplication of calls. Groups of call letters have been assigned to each of the countries under the authority of the convention. The calls assigned cover both land and ship stations.

The "International List of Radio Stations of the World" can be procured from the International Bureau of the Telegraphic Union, Berne, Switzerland. This list gives the call letters assigned to all stations, including those in the United States, and also gives the rates applying to and from stations. A copy of the International List should be in every land and ship station open to commercial business.

The "Yearbook of Wireless Telegraphy," published in London in May of each year, gives a list, with calls, of the radio stations of the world, and also contains in convenient form a compilation of the laws regulating radio communication in practically all countries.

United States Government and Commercial Calls.—The call letters assigned to the United States are all three and four letter combinations beginning with the letter N and all beginning with the letter W, and all combinations from KDA to KZZ, inclusive. All combinations beginning with the letter N are reserved for United States Government stations and have in most cases been assigned to stations of the United States Navy.

The combinations from WUA to WVZ and from WXA to WZZ are reserved for stations of the United States Army. Calls assigned to the United States beginning with K and W, not assigned to Government stations, are reserved for commercial stations open to public and limited commercial service. In addition to calls consisting entirely of letters, certain Army and Navy stations use calls consisting in part of numbers.

United States Amateur Calls.—The station license issued for the operation of an amateur transmitting station in the United States designates a call which is to be used by that station at all times. This call consists usually of a number followed by two letters, as 1AB, but may consist of a number followed by three letters, as 1ABC. The number is the number of the radio district in which the station is located. Experiment stations have calls consisting of a number followed by two or three letters of which the first one is X, as 1XA. Technical and training school stations have calls consisting of a number followed by two or three letters of which the first one is Y, as 1YA. Special amateur stations have calls consisting of a number followed by two or three letters, of which the first one is Z, as 1ZA. It is unlawful for any transmitting station at any time to sign any call except the call assigned in its station license. No station is allowed to transmit unless a station license has been issued.

The call letters assigned to the various radio stations of the United States are given in two pamphlets, commercial, Government, and Special Radio Stations of the United States, and Amateur Radio Stations of the United States. These are sold by the Superintendent of Documents, Government Printing Office, Washington, D. C.,

Percy Hemus singing an aria from Mozart's opera, the "Impresario," at the Newark broadcasting station.

at 15 cents each. A new edition of each of these pamphlets is compiled June 30 of each year. Changes during the year are noted in a monthly publication, the Radio Service Bulletin, which contains also information concerning changes in radio laws and regulations and traffic information. Subscriptions for the Radio Service Bulletin may be placed with the Superintendent of Documents at the rate of 25 cents per year for subscribers in the United States or its possessions, or in Canada, Cuba or Mexico. To other countries the subscription price is 40 cents per year.

List of Stations Broadcasting Market or Weather Reports (485 Meters) and Music, Concerts, Lectures, Etc. (360 Meters)

Owner of Station	Location	Lengths Wave	Signal Call
Alabama Power Co.	Birmingham, Ala.	360	WSY
Aldrich Marble & Granite Co., C. F.	Colorado Springs, Colo.	485	KHD
Allen, Preston D.	Oakland, Calif.	360	KZM
Altadena Radio Laboratory	Altadena, Calif.	360	KGO
American Radio & Research Corp.	Medford Hillside, Mass.	360	WGI
Anthony, Earl C.	Los Angeles, Calif.	360	KFI
Atlanta Constitution	Atlanta, Ga.	360, 485	WGM
Atlanta Journal	Atlanta, Ga.	360, 485	WSB
Atlantic-Pacific Radio Supplies Co.	Oakland, Calif.	360	KZY
Arrow-Radio Laboratories	Anderson, Ind.	360	WMA
Auburn Electrical Co.	Auburn, Me.	360	WMB
Banberger & Co. L.	Newark, N. J.	360	WOR
Beacon Light Co.	Los Angeles, Calif.	360	KNR
Benwood Co.	St. Louis, Mo.	360	WEB
Bible Institute of Los Angeles	Los Angeles, Calif.	360	KJS
Blue Diamond Electric Co.	Hood River, Ore.	360	KQP
Braun Corporation	Los Angeles, Calif.	360	KXS
Buckeye Radio Service Co.	Akron, Ohio	360	WOE
Bush, James L.	Tuscola, Ill.	360	WDZ
Central Radio Co.	Kansas City, Mo.	360	WPE
Church of the Covenant	Washington, D. C.	360	WDM
Chicago, City of	Chicago, Ill.	360	WBU
City Dye Works & Laundry Co.	Los Angeles, Calif.	360	KUS
Clark University	Worcester, Mass.	360, 485	WCN

Owner of Station.	Location of Station.	Wave Length.	Call Signal.
Columbia Radio Co.	Youngstown, Ohio	360	WMC
Commonwealth Electric Co.	St. Paul, Minn.	360	WAAH
Continental Electrical Supply Co.	Washington, D. C.	360	WIL
Cooper, Irving S.	Los Angeles, Calif.	360	KZI
Cosradio Co.	Wichita, Kansas	360, 485	WEY
Cox, Warren R.	Cleveland, Ohio	360	WHK
Crosley Manufacturing Co.	Cincinnati, Ohio	360	WLW
Daily News Printing Co.	Canton, Ohio	360	WWB
Dallas, City of	Dallas, Tex.	360, 485	WRR
DeForest Radio Tele. & Tele. Co.	New York, N. Y.	360	WJX
Detroit News	Detroit, Mich.	360, 485	WWJ
Detroit Police Dept.	Detroit, Mich.	360	KOP
Doerr-Mitchell Electrical Co.	Spokane, Wash.	360	KFZ
Doron Brothers Electrical Co.	Hamilton, Ohio	360	WRK
Doubleday Hill Electrical Co.	Pittsburgh, Pa.	360	KQV
Doubleday Hill Electrical Co.	Washington, D. C.	360	WMU
Duck Co., William B.	Toledo, Ohio	360	WHU
Dunn & Co., J. J.	Pasadena, Calif.	360	KLB
Eastern Radio Institute	Boston, Mass.	360	WAAJ
Electric Equipment Co.	Erie, Pa.	360	WJT
Electric Lighting Supply Co.	Hollywood, Calif.	360	KGC
Electric Power & Appliance Co.	Yakima, Wash.	360	KQT
Electric Supply Co.	Clearfield, Pa.	360	WPI
Elliott Electric Co.	Shreveport, La.	360	WAAG
Emporium, The	San Francisco, Calif.	360	KSL
Erie Radio Co.	Erie, Pa.	360	WSX
Examiner Printing Co.	San Francisco, Calif.	360	KUO
Fair, The	Chicago, Ill.	360	WGU
Federal Institute of Radio Tele.	Camden, N. J.	360	WRP
Federal Tele. & Tele. Co.	Buffalo, N. Y.	360, 485	WGR
Fergus Electric Co.	Zanesville, Ohio	360	WPL
Findley Electric Co.	Minneapolis, Minn.	360	WCE
Ford Motor Co.	Dearborn, Mich.	360	WWI
Fort Worth Record	Fort Worth, Tex.	360	WPA
Foster-Bradbury Radio Store	Yakima, Washington	360	KFV
General Electric Co.	Schenectady, N. Y.	360	WGY
Gilbert Co., A. C.	New Haven, Conn.	360	WCJ
Gimbel Brothers	Milwaukee, Wis.	360	WAAK
Gimbel Brothers	Philadelphia, Pa.	360	WIP
Gould, C. O.	Stockton, Calif.	360	KJQ
Grove-Thornton Hardware Co.	Huntington, W. Va.	360	WAAR
Hallock & Watson Radio Service	Portland, Ore.	360	KGG
Hamilton Manufacturing Co.	Indianapolis, Ind.	360	WLK
Hatfield Electric Co.	Indianapolis, Ind.	360	WOH
Hawley, Willard P., Jr.	Portland, Ore.	360	KYG
Herald Publishing Co.	Modesto, Calif.	360	KXD
Herrold, Charles D.	San Jose, Calif.	360	KQW
Hobrecht, J. C.	Sacramento, Calif.	360	KVQ
Hollister-Miller Motor Co.	Emporia, Kans	360	WAAZ
Holzwasser (Inc.)	San Diego, Calif.	360	KON
Howe, Richard H.	Granville, Ohio	360	WJD
Howlett, Thomas F. J.	Philadelphia, Pa.	360	WGL
Hunter, L. M. & G. L. Carrington	Little Rock, Ark.	360	WSV
Hurlburt-Still Electrical Co.	Houston, Tex.	360, 485	WEV
Interstate Electric Co.	New Orleans, La.	360	WGV

Owner of Station.	Location of Station.	Wave Length.	Call Signal.
Iowa Radio Corp.	Des Moines, Iowa	360	WHX
J. & M. Electric Co.	Utica, N. Y.	360	WSL
K. & L. Electric Co.	McKeesport, Pa.	360	WIK
Kansas State Agricultural College	Manhattan, Kansas	485	WTG
Karlowa Radio Co.	Rock Island, Ill.	360, 485	WOC
Kennedy Co., Colin B.	Los Altos, Calif.	360	KLP
Kierulff & Co., C. R.	Los Angeles, Calif.	360	KHJ
Kluge, Arno A.	Los Angeles, Calif.	360	KQL
Kraft, Vincent I.	Seattle, Wash.	360, 485	KJR
Lindsay-Weatherill & Co.	Reedley, Calif.	360	KMC
Los Angeles Examiner	Los Angeles, Calif.	360	KWH
Love Electric Co.	Tacoma, Wash.	360	KMO
Loyola University	New Orleans, La.	360	WWL
Maxwell Electric Co.	Berkeley, Calif.	360	KRE
May (Inc.), D. W.	Newark, N. J.	360	WBS
McBridge, George M.	Bay City, Mich.	360	WTP
McCarthy Bros. & Ford	Buffalo, N. Y.	360	WWT
Metropolitan Utilities District	Omaha, Nebr.	360, 485	WOU
Meyberg Co., Leo J.	Los Angeles, Calif.	360, 485	KYJ
Meyberg Co., Leo J.	San Francisco, Calif.	360, 485	KDN
Midland Refining Co.	El Dorado, Kans.	485	WAH
Midland Refining Co.	Tulsa, Okla.	485	WEH
Minnesota Tribune Co. & Anderson-Beamish Co.	Minneapolis, Minn.	360	WAAL
Missouri State Marketing Bureau	Jefferson City, Mo.	485	WOS
Modesto Evening News	Modesto, Calif.	360	KOQ
Montgomery Light & Power Co.	Montgomery, Ala.	360, 485	WGH
Mulins Electric Co., Wm. A.	Tacoma, Wash.	360	KGB
Mulrony, Marion A.	Honolulu, Hawaii	360	KGU
Nelson Co., I. R.	Newark, N. J.	360	WAAM
New England Motor Sales Co.	Greenwich, Conn.	360	WAAQ
New Mex. College of Agri. & Mech. Arts	State College, N. Mex.	360, 485	KOB
Newspaper Printing Co.	Pittsburgh, Pa.	360	WPB
Noggle Electric Works	Monterey, Calif.	360	KLN
Northern Radio & Electric Co.	Seattle, Wash.	360	KFC
Northwestern Radio Mfg. Co	Portland, Ore.	360	KGN
Nushawg Poultry Farm	New Lebanon, Ohio	360	WPG
Oklahoma Radio Shop	Oklahoma City, Okla.	360, 485	WKY
Oregonian Publishing Co.	Portland, Ore.	360	KGW
Palladium Printing Co.	Richmond, Ind.	360, 485	WOZ
Paris Radio Electric Co.	Paris, Tex.	360	WTK
Pine Bluff Co.	Pine Bluff, Ark.	360	WOK
Pomona Fixture & Wiring Co.	Pomona, Calif.	360	KGF
Portable Wireless Telephone Co.	Stockton, Calif.	360	KWG
Post Dispatch	St. Louis, Mo.	360	KSD
Precision Equipment Co.	Cincinnati, Ohio	360, 485	WMH
Precision Shop, The	Gridley, Calif.	360	KFU
Prest & Dean Radio Research Lab.	Long Beach, Calif.	360	KSS
Purdue University	West Lafayette, Ind.	360	WBAA
Radio Construction & Electric Co.	Washington, D. C.	360	WDW
Radio Corporation of America	Roselle Park, N. J.	360	WDY
Radio Service Co.	Charleston, W. Va.	360	WAAO
Radio Supply Co.	Los Angeles, Calif.	360	KNV
Radio Telephone Shop, The	San Francisco, Calif.	360	KYY

Owner of Station.	Location of Station.	Wave Length.	Call Signal.
Radio Shop, The	Sunnyvale, Calif.	360	KJJ
Register & Tribune, The	Des Moines, Iowa	360	WGF
Reynolds Radio Co.	Denver, Colo.	360, 485	KLZ
Ridgewood Times Printing & Pub. Co.	Ridgewood, N. Y.	360	WHN
Riechman-Crosby Co.	Memphis, Tenn.	360, 485	WKN
Rike-Kumler Co.	Dayton, Ohio	360, 485	WFO
Rochester Times Union	Rochester, N. Y.	360, 485	WHQ
Roswell Public Service Co.	Roswell, N. Mex.	360	KNJ
St. Louis University	St. Louis, Mo.	485	WEW
St. Martins College (Rev. S. Ruth)	Lacey, Wash.	360	KGY
St. Joseph's College	Philadelphia, Pa.	360	WPJ
St. Louis Chamber of Commerce	St. Louis, Mo.	360	WAAE
San Joaquin Light & Power Corp.	Fresno, Calif.	360	KMJ
Seeley, Stuart W.	East Lansing, Mich.	485	WHW
Service Radio Equipment Co.	Toledo, Ohio	360	WJK
Ship Owners Radio Service	New York, N. Y.	360	WDT
Ship Owners Radio Service	Norfolk, Va.	360	WSN
Shotton Radio Manufacturing Co.	Albany, N. Y.	360	WNJ
Southern Electrical Co.	San Diego, Calif.	360	KDPT
Southern Radio Corp.	Charlotte, N. C.	360	WBT
Spokane Chronicle	Spokane, Wash.	360	KOE
Standard Radio Co.	Los Angeles, Calif.	360	KJC
Stix-Baer-Fuller	St. Louis, Mo.	360	WCK
Strawbridge & Clothier	Philadelphia, Pa.	360	WFI
Stubbs Electric Co.	Portland, Oreg.	360	KQY
Tarrytown Radio Research Lab.	Tarrytown, N. Y.	360	WRW
Taylor, Otto W.	Wichita, Kans.	360	WAAP
T. & H. Radio Co.	Anthony, Kans.	360	WEL
Union College	Schenectady, N. Y.	360	WRL
Union Stock Yards & Transit Co.	Chicago, Ill.	360, 485	WAAF
United Equipment Co.	Memphis, Tenn.	360	WPO
University of Illinois	Urbana, Ill.	360	WRM
University of Minnesota	Minneapolis, Minn.	360, 485	WLB
University of Missouri	Columbia, Mo.	360	WAAN
University of Texas	Austin, Tex.	360, 485	WCM
University of Wisconsin	Madison, Wis.	360, 485	WHA
University of West Virginia	Morgantown, W. Va.	360	WHD
Wanamaker, John	Philadelphia, Pa.	360	WOO
Wanamaker, John	New York, N. Y.	360	WWZ
Warner Brothers	Oakland, Calif.	360	KLS
Wasmer, Louis	Seattle, Wash.	360	KHQ
Western Radio Co.	Kansas City, Mo.	360, 485	WOQ
Western Radio Electric Co.	Los Angeles, Calif.	360	KOG
Westinghouse Elec. & Man. Co.	East Pittsburgh, Pa.	360	KDKA
Westinghouse Elec. & Man. Co.	Chicago, Ill.	360, 485	KYW
Westinghouse Elec. & Man. Co.	Newark, N. J.	360	WJZ
Westinghouse Elec. & Man. Co.	Springfield, Mass.	360	WBZ
White & Boyer Co.	Washington, D. C.	360	WJH
Williams, Thomas J.	Washington, D. C.	360	WPM
Wireless Tele. Co. of Hudson Co N. J.	Jersey City, N. J.	360	WNO
Yeiser, John O., Jr.	Omaha, Nebr.	360	WDV
Young Men's Christian Association	Denver, Colo.	485	KOA
Zamoiski Co., Joseph M.	Baltimore, Md.	360	WKC

Government Broadcasting Stations

THE GOVERNMENT BROADCASTING STATIONS

U. S. Navy Radiotelephone broadcasting from Anacostia, D. C. Music and talks by Government officials. Waves, 380 or 1100 metres. Times various, usually during early evening between 8:00 and 11:00 p. m., 75th meridian time.

Radiotelegraph broadcasts from 48 stations on wavelengths from 507 to 17,145 metres. Weather, Hydrographic Information, Time Signals, and Press, all times 75th meridian. Time Signals from 18 stations NAA—NPG call letters at six stated hours between 8:55 a. m.—4:25 p. m.

U. S. Army Signal Corps is co-operating with the Navy Department in broadcasting. It has one station broadcasting entertainment at Fort Wood, New York, from 9:00 p. m. to 9:55 p. m. on 1450 metres.

The Army operates twenty stations, telegraphing to one another official Government messages, five of which are used for air service, meteorological and traffic, and two of which broadcast Government messages by radiophone regularly between 9—10 p. m.

The Army sets operate on wave lengths between 1,000—3,000 metres. They are changed within this military band to avoid interference.

They operate between 8:00 a. m. to midnight or longer if necessary. Four of them operate for twenty-four hours every day.

In addition to all of the above the Army has 16 radio

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stations in operation in Alaska, 22 on army transports, 28 on army harbor tugs, 14 on junior mine planters, 18 on mine planters, 32 at Coast Defense forts, and 4 at Signal Corps schools, making a total of approximately 170 radio stations owned and operation by the Army. This does not, of course, include any of the radio equipment in the hands of troops in the field, consisting of mobile sets on trucks and portable sets of short range

War Department.

The Coast Artillery operates fifteen stations with wavelengths from 300—1,1C0. Call letters begin with W. The stations are employed for official use and do not broadcast general information.

Department of Commerce.

The U. S. Lighthouse Service maintains radio communication stations on twenty light vessels, primarily for Government purposes for reporting vessels and for general emergency messages. Various wave lengths from 300—952 metres are employed and there are no specific hours of communication. Also in co-operation with the Bureau of Standards, radio fog signals are sent out by three light vessels to give radio compass bearings to ships. In bad weather, the stations operate continuously on a 1,000 metre wave, at other times from 9:00 to 9:30 a. m. and 3:00 to 3:30 p. m.

Department of the Interior.

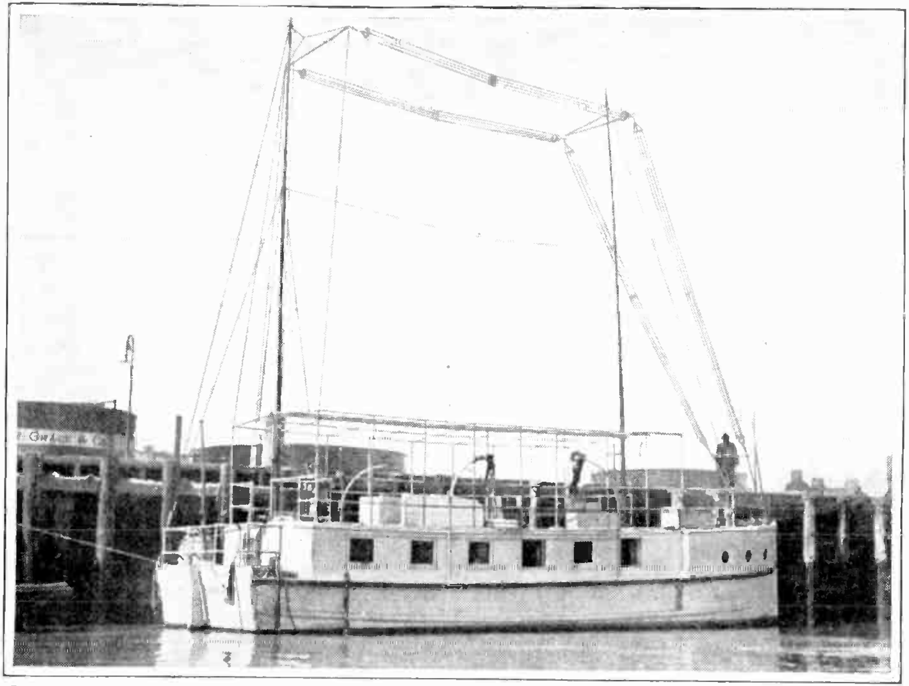
a. *Bureau of Mines*: Several short talks on different phases of the work of the Bureau of Mines by members of the large experiment station of the Bureau at Pittsburgh, Pa., have been broadcasted from the station of the Westinghouse Company at East Liberty, Pa. They are also considering the development of a program for broadcasting safety talks by radio to members of the classes that are taught first-aid and mine safety methods by the Bureau of Mines employees on its six mine safety railroad cars and at its six mine safety stations east of the Mississippi River. They have taken up an investigation of the question as to whether or not it may be possible to use radio telephony in underground mining work as a substitute for the ordinary telephone service, both on account of the hazard in the use of ordinary telephone circuits in gaseous mines, and because of interrupted service caused by the breaking of ordinary telephone circuits in the mine through falls of roof, etc.

b. *The National Park Service* has one small radio telephone outfit in Yosemite National Park, California, which is sometimes used for communication between headquarters in the Valley and Glacier Point on the rim of the canon some 3,000 feet above.

c. *The Alaskan Engineering Commission* installed several years ago, in Alaska, a set costing $5,000.

The Department of the Treasury.

a. *The U. S. Coast Guard* maintains continuous 24-hour service, primarily for Government business but also



© International

Alan Cormack's motor launch "Spoonbill" equipped with radio apparatus to receive the news of the day.

open to the general public on 31 vessels, each one with 2, 3, 4, or 5 wavelengths from 300—2,400 metres. The call signals begin with N and have three or four letters.

Department of Agriculture.

a. *The Bureau of Markets and Crop Estimates* since April 15, 1921, in co-operation with the Air Mail Radio Service of the P. O. Department has been broadcasting market news by radio daily except Sundays and holidays. It operates six stations from 9:00 a. m.—8:45 p. m. mostly on arc sets with from 2500—3200 metre wavelengths. The Washington station has four radio telephone sets operating on 1160 metres and two C. W. tube telegraph sets operating on 1980 metres.

b. *The Weather Bureau* early recognized the potentiality of wireless telegraphy in its relation to the collection and distribution of meteorological information, and it was a pioneer among government organizations in taking up systematic experimentation in developing the meteorological application of radio.

The Weather Bureau ceased its investigations and operations in wireless telegraphy and turned over to the Navy Department all telegraph apparatus under its control. Steps were taken to arrange to have Naval wireless stations furnished with storm warnings for dissemination by wireless to vessels at sea. This arrangement was effected in April, 1905.

The Weather Bureau has continuously utilized all available radio agencies in the distribution of weather forecasts and warnings to inland places as well as to vessels at sea.

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An exceptional and indispensable feature of radio communication is the collection of weather observations from ships at sea as an aid in the location of storms over the ocean areas. This was first accomplished in 1906 from Naval vessels, and it was later extended to merchant vessels. During the past year approximately 10,000 weather observations were thus obtained.

In 1913 arrangements were made whereby a bulletin consisting of weather reports from selected coast and interior stations were broadcast daily on scheduled hours, giving barometric readings, wind direction and force, and weather forecasts and storm warnings.

A feature of the major bulletins is the broadcasting of aerological reports and forecasts in the aid of aviation. The bulletin published on May 16, 1921, was the first of its kind issued in this country for the benefit of aviators.

In the fall of 1921 the Bureau began arranging for a systematic distribution of weather forecasts, storm, frost, heavy snow, and other warnings for the benefit of agricultural and commercial interests in all the states. The work is being rapidly extended, and now includes 76 broadcasting stations in 29 states. The state broadcasting is done by commercial and private radio plants, and for this purpose a permit to use a special and exclusive wave length of 485 meters is granted by the Bureau of Navigation, Department of Commerce.

Radio Laws and Regulations

Every person engaged in the handling of radio traffic should be thoroughly familiar with the radio communication laws of the United States and the International Radiotelegraphic Convention. These are printed in a pamphlet, Radio Communication Laws of the United States, of which copies may be purchased for 15 cents each from the Superintendent of Documents, Government Printing Office, Washington, D. C.

The law provides that in order to operate a radio transmitting station, both a *station* license, and an *operator* license must be secured. The law provides penalties for the operation of a transmitting station without proper licenses.

Provision is now made for eight classes of land stations:

(1) Public Service Stations, General.
(2) Public Service Stations, Limited.
(3) Limited Commercial Stations.
(4) Experiment Stations.
(5) Technical and Training School Stations.
(6) Special Amateur Stations.
(7) General Amateur Stations.
(8) Restricted Amateur Stations.

Station licenses for Classes 4, 5, and 6 are issued only under exceptional circumstances, as set forth in the pamphlet mentioned above.

General amateur stations are restricted to a transmitting wave length not exceeding 200 meters and a transformer input not exceeding 1 kilowatt.

Restricted amateur stations are amateur stations located within five nautical miles of a naval or military station and

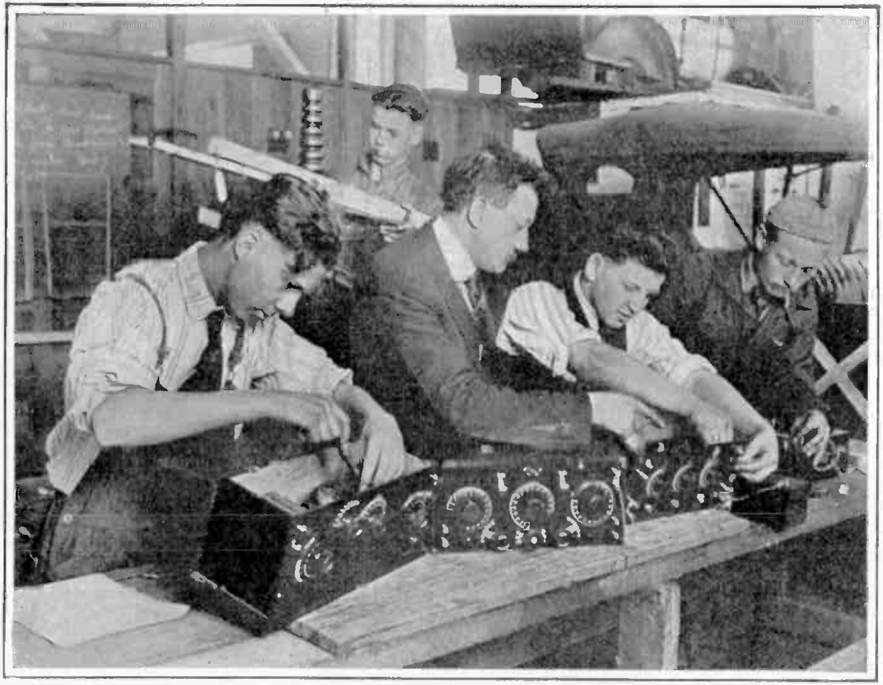

Photo by Keystone

Students making their own apparatus at Los Angeles, California.

are restricted to a wave length not exceeding 200 meters and to a transformer input not exceeding one-half kilowatt.

If a transmitting station radiates more than one wave length, the energy in no one of the lesser waves shall exceed 10 per cent. of the energy in the principal wave.

The logarithmic decrement per complete oscillation must not exceed two-tenths.

A station used only for receiving does not require a station license. Operators of stations used only for receiving do not require operators' licenses, but must maintain secrecy in regard to messages.

Operators' licenses are divided into the following classes: Commercial extra first grade, commercial first grade, commercial second grade, commercial cargo grade, experiment and instruction grade, amateur first grade, and amateur second grade. In order to obtain an operator's license of any grade, it is necessary to pass an examination showing certain qualifications, as set forth in the pamphlet mentioned above.

Both station licenses and operators' licenses are issued by the Bureau of Navigation of the Department of Commerce, Washington, D. C. The United States is divided into nine radio districts. Each district has a radio inspector, who has charge of the issuing of both station licenses and operators' licenses in his district. Application for either kind of license should be addressed to the radio inspector of the district in which the station is located, or, if this is not known, to the Bureau of Navigation, Department of Commerce, Washington, D. C.

Offices of the radio inspectors are located as follows:

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First District, Radio Inspector, Customhouse, Boston, Mass.

Second District, Radio Inspector, Customhouse, New York, N. Y.

Third District, Radio Inspector, Customhouse, Baltimore, Md.

Fourth District, Radio Inspector, Customhouse, Baltimore, Md.

Fifth District, Radio Inspector, Customhouse, New Orleans, La.

Sixth District, Radio Inspector, Customhouse, San Francisco, Cal.

Seventh District, Radio Inspector, 2301 L. C. Smith Building, Seattle, Wash.

Eighth District, Radio Inspector, Federal Bldg., Detroit, Mich.

Ninth District, Radio Inspector, Federal Bldg., Chicago, Ill.

It is probable that the radio laws will be revised in the immediate future. For authoritative information regarding the provisions of the current laws and regulations inquiry should be made of the Bureau of Navigation, Department of Commerce, Washington, D. C.

When and Where to Get a Radio License

Fortunately, our radio laws are simple and fair. While other nations have piled up restriction upon restriction with regard to radio communication, our Government, by simple and sensible laws, has contributed its share toward the rapid development of radio and the

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widespread public interest in this method of communication.

First of all, if you are going to operate a receiving set only, no license is required. If you are going to operate a transmitter, on the other hand, two licenses are required, one for the operator of the transmitter, and the other for the transmitter itself. Of course, the law does imply that if you are operating a transmitter that does not transmit signals across a state boundary and does not interfere with signals received by a neighboring station from another state, you do not have to obtain a station and operator's license. The fact is, however, that virtually any transmitter, no matter how small it may be, does interfere with other stations, so that virtually all transmitters and their operators must be licensed.

Government licenses granted for amateur stations are divided into three classes as follows:

Special Amateur Stations.—This group is known as the "Z" class of stations, and stations of this category are usually permitted to transmit on wave lengths up to approximately 375 meters.

General Amateur Stations.—In this group stations are permitted to use a power input of 1 kilowatt, but must not employ a wave length in excess of 200 meters.

Experimental Stations.—This group is known as the "X" class, and also as the "Y" class in the case of school and university radio stations. They are usually allowed a greater wave length and greater power at the discretion of the Department of Commerce, which has charge of the granting of licenses and the enforcement of the radio laws.

All stations are required to use the minimum amount of power necessary to carry on successful communica-

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Nearly every Boy Scout organization carries a radio set on its "hikes." In a few minutes the equipment is set up, antenna being strung on trees.

tion. This means that while an amateur station is permitted to use, when circumstances so require, an input of 1 kilowatt, this input should be reduced or other means provided for lowering the antenna energy when communicating with nearby stations, in which case full power is not required.

Interference must be reduced to a mimimum in all radio work. Hence the law states that malicious or wilful interference on the part of any radio station or the transmission of any false or fraudulent distress signal or call is prohibited. Severe penalties are provided for violation of these provisions.

Special amateur stations may be licensed at the discretion of the Secretary of Commerce to use a longer wave length and higher power than general amateur stations. Applicants for special amateur station licenses must have had two years' experience in actual radio communication. A special license will then be granted by the Secretary of Commerce only if some substantial benefit to the science of radio communication or to commerce seems probable. Special amateur stations located on or near the sea coast must be operated by a person holding a commercial license. Amateur station licenses are issued to clubs if they are incorporated, or if any member holding an amateur license will accept the responsibility for the operation of the apparatus.

For full information concerning station and operator's licenses, we repeat that application should be made to the district Radio Inspector or to the Bureau of Navigation, Department of Commerce, Washington, D. C. In order to obtain an operator's license it is necessary to take an examination, but while waiting the opportunity of taking the examination, a temporary license is often granted.

The applicant for an operator's license must fill out a questionnaire describing his set, and mail it to the Inspector's Office. To him then is returned a station license with the call letters recorded in the Inspector's list.

The Inspector's office is open certain days and hours for the amateur examination. A row of desks is fitted with head telephones connected to an omnigraph. A code test is first given of five-letter words at the speed of ten words a minute, for five minutes. In order to pass, fifty consecutive letters must be copied without error, that is to say, one minute out of the five-minute test must be consecutively perfect. The letters are sent mixed with numbers, punctuation marks and disconnected words. There is no test for transmitting, although the Government has considered adding this part of the work to the examination.

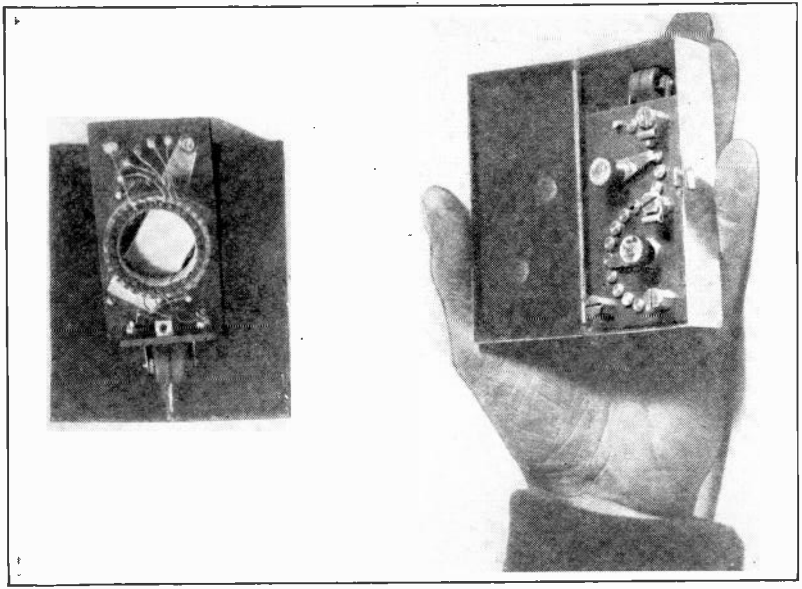
The theoretical examination consists of questions on the theory and diagrams of the transmitting and receiving apparatus which the amateur intends to operate.

The Question of Radio and Fire Insurance

The usual fire insurance policy is not blanket protection in case of the destruction of property through fire. Numerous "ifs" and "buts" are sprinkled throughout a mass of technical and legal verbiage, which must be complied with if the policy is to protect the policy holder in a real and worth-while sort of way. Hence it is well at all times to make sure that the various requirements of a fire insurance policy are complied with to the letter.

The National Board of Fire Underwriters, who formuate the "ifs" and "buts" of the fire insurance policies, have not been over-friendly towards radio in the past. So long as the young art was in the hands of a handful of radio amateurs, whose numbers, although running into the hundreds of thousands, were too few to register a thunderous kick, the fire regulations pertaining to radio were little short of ridiculous, in view of the fact that the usual receiving antenna offers little more attraction for lightning than the telephone wires, electric light wires, metal leaders, and even the bell wiring of the house, when it happens to be grounded. These former regulations called for a heavy double-throw single-pole switch which had to be mounted on the outside of the house, at least six inches away from the wall, and connected with the antenna and a special ground. The ground lead had to be of No. 6 B. & S. gauge wire or even larger. Verily, it was a young powerhouse installation that these former rules called for.

Now all this red tape, for such it really is, has been eliminated. The large numbers of radio enthusiasts have given weight to their opinion in the matter, and the Na-



© International

Pocket radio set made at home from materials costing seventy-five cents.

tional Board of Fire Underwriters have revised their rules and applied good common sense in this direction, so that the maximum safety is now afforded to property equipped with radio receiving apparatus, with a minimum of trouble and expense.

The specifications, given in the following paragraph, were drawn up by a special committee of the National Fire Protection Association, which is the authority for the National Electrical Code and which sets the safety standards of engineering practice. Not only were the underwriter organizations represented upon this special committee, but also engineers acting for the American Radio Relay League, Radio Corporation of America, American Telephone & Telegraph Company, and the Independent Telephone Association.

The new rules are being published as proposed amendments to be included in future editions of the electrical code and are truly sensible. The former requirements were based largely to meet the conditions that prevail when a radio transmitting set is used, with an aerial so large that it is far more likely to attract lightning than the usual single-wire antenna used for receiving purposes only, although in all events the danger is slight. Furthermore, the transmitter has high-voltage power of its own, which has to be safeguarded in every possible way. Hence a change in the regulations had to be made to meet altered conditions. To insist on the old regulations would have meant the installing of a switch and ground-lead costing as much as some of the cheaper outfits.

The following specifications now apply for receiving stations only:

Antenna

a Antenna outside of buildings shall not cross over or under electric light or power wires of any circuit carrying current of more than 600 volts, or railway trolley or feed wires, nor shall it be so located that a failure of either antenna or of the above-mentioned electric light or power wires can result in a contact between the antenna and such electric light or power wires.

Antenna shall be constructed and installed in a strong and durable manner and shall be so located as to prevent accidental contact with light and power wires by sagging and swinging.

Splices and joints in the antenna span, unless made with approved clamps or splicing devices, shall be soldered.

Antenna installed inside of buildings are not covered by the above specifications.

Lead-in Wires

b Lead-in wires shall be of copper, approved copper-clad steel or other approved metal which will not corrode excessively, and in no case shall they be smaller than No. 14 B. & S. gauge except that approved copper-clad steel not less than No. 17 B. & S. gauge may be used.

Lead-in wires on the outside of buildings shall not come nearer than four (4) inches to electric light and power wires unless separated therefrom by a continuous and firmly fixed non-conductor that will maintain permanent separation. The non-conductor shall be in addition to any insulation on the wire.

Lead-in wires shall enter building through a non-combustile non-absorptive insulating bushing.

Protective Device

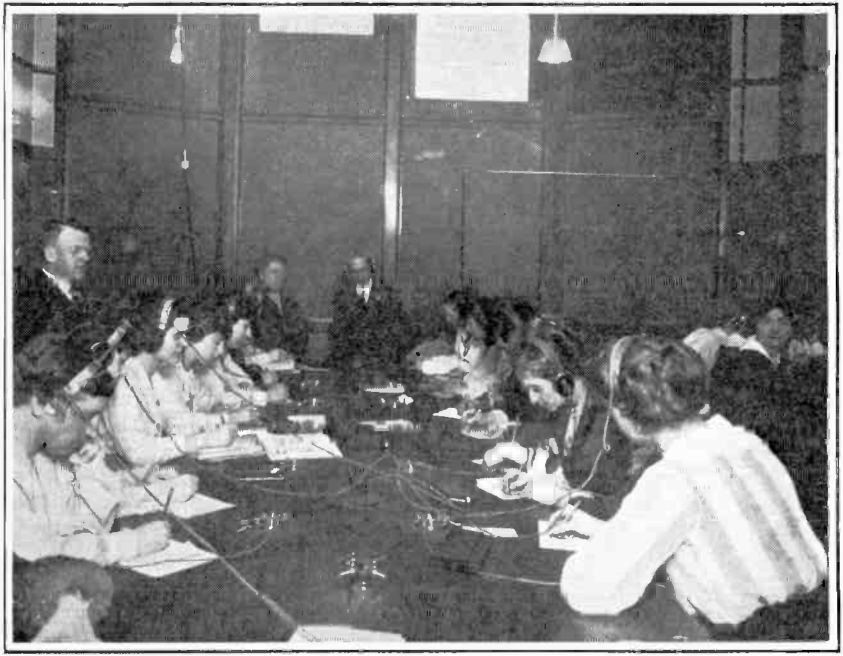
c Each lead-in wire shall be provided with an approved protective device properly connected and located (inside or outside the building) as near as practicable to the point where the wire enters the building. The protector shall not be placed in the immediate vicinity of easily ignitible stuff, or where exposed to inflammable gases, or dust, or flying or combustible materials.

The protective device shall be an approved lightning arrester which will operate at a potential of five hundred (500) volts or less.

The use of an antenna grounding switch is desirable, but does not obviate the necessity for the approved protective device required in this section. The antenna grounding switch if installed shall, in its closed position, form a shunt around the protective device.

Protective Ground Wire

d The ground wire may be bare or insulated and shall be of copper or approved copper-clad steel. If of copper the ground wire shall be not smaller than No. 14 B. & S. gauge, and if approved copper-clad steel it shall be not smaller than No. 17 B. & S. gauge. The ground wire shall be run in as straight a line as possible to a good permanent ground. Preference shall be given to water



The radio class at Hunter College, New York.

piping. Gas piping shall not be used for grounding protective devices. Other permissible grounds are grounded steel frames of buildings or other grounded metallic work in the building and artificial grounds, such as driven pipes, plates, cones, etc.

The ground wire shall be protected against mechanical injury. An approved ground clamp shall be used whereever the ground wire is connected to pipes or piping.

Wires Inside the Building

e Wires inside buildings shall be securely fastened in a workmanlike manner and shall not come nearer than two (2) inches to any electric light or power wire unless separated therefrom by some continuous and firmly fixed non-conductor making a permanent separation. This non-conductor shall be in addition to any regular insulation on the wire. Porcelain tubing or approved flexible tubing may be used for encasing wires to comply with this rule.

f The ground conductor may be run inside or outside of building. When receiving equipment ground wire is run in full compliance with rules for Protective Ground Wire, in *Section d*, it may be used as the ground conductor for the protective device.

Regulations covering sending stations have also been drawn up and copies may be secured from the National Board of Fire Underwriters.

How the Boy Scouts mount their radio receiving sets on sleds in the winter.

How to Form a Radio Club

To form a Radio Club a small group of amateurs should obtain from the Radio Inspector's Office at the Custom House, a list of the amateurs with licensed stations. A certain day and evening should be set for the first meeting and the amateurs invited to attend. A number of the newspapers in each city publish radio pages or columns and at least once a week a list of radio clubs and their activities. The papers will be glad to print a notice of the organization meeting of the new club. A notice should also be sent to the various radio magazines. In this way all amateurs in the locality who own receiving sets, who hope to own one, or who are interested in the subject, will be informed of the meeting.

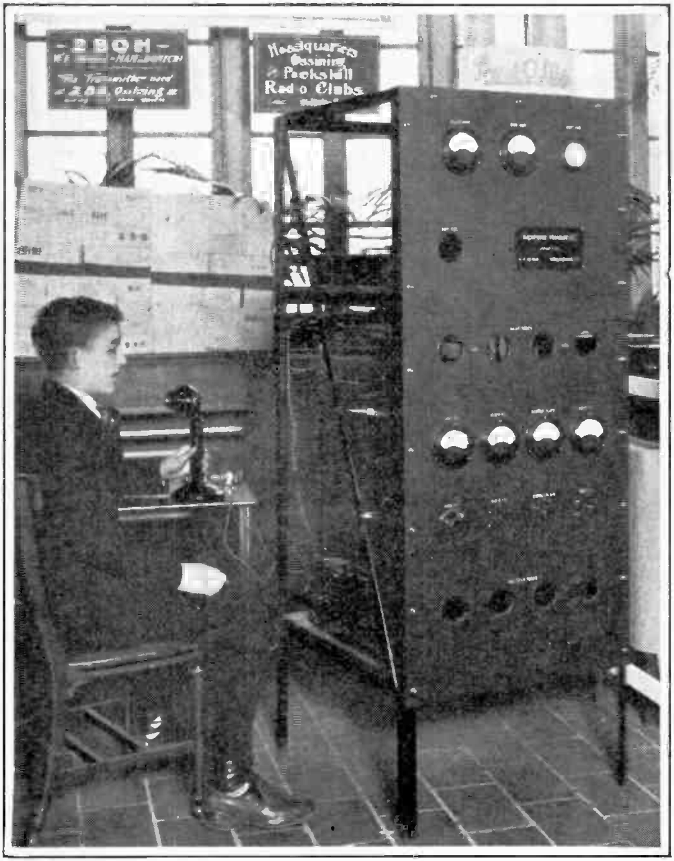
At the first meeting, as a preliminary to the oganization of a permanent club, a temporary organization should be formed. Following Parliamentary procedure, a chairman and recording secretary should be elected from among the original organizers. A discussion should take place as to the advisability of forming a club and its possibilities and aims.

A Resolution Committee is appointed which draws up a statement of policy for the club.

A Nomination Committee suggests for nomination the names of officers of the permanent organization.

The Rules and Regulations Committee drafts a constitution and by-laws.

An Elegibility or Character Committee investigates the elegibility of members. Rules sometimes are made that a member should have been active in amateur telegraphy for one year and must be familiar with the United States



The transmitting set installed by a radio-club in New York state. Most of the parts were made by members of the club.

laws for amateurs. New members should be voted upon by all present.

The permanent organization is ordinarily formed at the second meeting but it may be organized at the first.

A good general constitution should include:

1. The name of the organization.

2. The object. Familiarity with radio. The knowledge and development of the art.

3. Two classes of members:
   a. Those who have had one year's experience and who are able to take down five words a minute in code.
   b. Students.

4. Initiation fee $1.00 or $.50 and annual dues $2.00 and $1.00 or $.50 a month, as desired.

5. Officers: President, Vice-President, Secretary and Treasurer.

6. Officers, as Board of Directors, pass on expenditures and adopt by-laws to be ratified by the members.

7. Officers are elected semi-annually on the same day of the year.

8. Three committees should be formed:
   a. Library Committee to collect radio current literature and books.
   b. Meetings and Papers Committee to keep alive the interest in the club; to arrange that a paper on experiments and suggestions be read each month by a member; to invite prominent authorities to speak; and to make the meetings of scientific and intellectual value.
   c. Electrical Committee in charge of club apparatus whether owned by the club or individuals;

Photo by Keystone

A radio club has for its primary purpose the technical education of its members. They should learn how to make and set up their own apparatus.

to oversee all experiments and insure their scientific performance.

9. Semi-annual meetings should be held on a definite date.

10. Weekly club meetings should be held on a certain day of the week.

The Department of Commerce requires the station license to be issued in the name of the club, if incorporated in some State of the United States; otherwise the license must be in the name of some member of the club who will be held responsible for station's activities. An official call signal must be obtained from the radio inspector and used for all radio communications. The club is punishable for failure to comply with the rules governing stations.

The American Radio Relay League, which includes most of the Radio Clubs of America, assigns from among the members of each club, an official relay station. At the home of this operator may be held the meetings of the club, or a room may be hired for a club headquarters.

There should be on hand as many radio magazines and books as possible; a blackboard for class work or lecturer, and maps of the broadcasting stations with their ranges and commercial stations. A locational map with the range of club stations marked by a string, is useful and instructive.

In the room or in an adjoining one, the apparatus should be placed. A carpenter shop and a laboratory may be added. Subscriptions or money-raising entertainments should bring in funds for tools and materials. A drawing table with drawing implements with which to make diagrams, construction plans and curve plots would be a desirable addition.

The more apparatus a club can own, the more interest will be maintained. Each club should have at least a continuous wave transmitting set. This can be made from parts and manufacturer's diagrams with two five-watt transmitting-tubes and 110-volt house-current. A 200-meter two or four wire aerial, that is to say, an L-antennae between 80 and 100 feet long and 40 feet high. A vacuum-tube receiving set, preferably with a two-step amplifier; a wave meter; a hot wire aerial ammeter and possibly another receiving antenna of greater length from 500-1500 feet for receiving the very long wavelengths, although honey comb coils will carry the set to a high wavelength reception; a buzzer tester; a complete buzzer practice system.

These suggestions are made for a large organization; smaller groups of amateurs may form radio clubs without so much formality or expense.

Division Managers of the American Radio Relay League

Alaskan Division
Roy Anderson,
P. O. Box 206,
Ketchikan, Alaska

Atlantic Division
C. H. Stewart,
St. David's, Pa.

Central Division
R. H. G. Mathews,
6433 Ravenswood Ave.,
Chicago, Ill.

Dakota Division
N. H. Jensen,
Box 894,
Sioux Falls, S. D.

Delta Division
J. M. Clayton,
1301 Welch St.,
Little Rock, Ark.

East Gulf Division
B. W. Benning,
50 Whiteford St.,
Atlanta, Ga.

Hawaiian Division
C. J. Dow,
Wailuku, Maui,
T. H.

Maritime Division
K. S. Rogers,
19 Upper Prince St.,
Charlottetown, P. E. I.
Canada

Midwest Division
L. A. Benson,
4942 Wieselian Ave.,
St. Louis, Mo.

New England Division
P. F. Robinson,
149 Hollis Ave.,
Braintree, Mass.

Northwestern Division
H. F. Mason,
3335 33rd Ave. So.,
Seattle, Wash.

Ontario Division
A. H. K. Russell,
11 Pinewood St.,
Toronto, Canada

Pacific Division
J. V. Wise,
Walnut Grove, Cal.

Quebec Division
A. J. Lorimer,
497 Grosvenor Ave.,
Westmount, Quebec

Roanoke Division
W. T. Gravely,
854 Main St.,
Danville, Va.

Rocky Mountain
M. S. Andelin,
1153 Harrison Ave.,
Richfield, Utah

Vancouver Division
Wm. D. Wood,
The Barron Hotel &
Restaurant,
Vancouver, B. C.

West Gulf Division
F. M. Corlett,
1101 E. 8th St.,
Dallas, Texas

Winnipeg Division
J. H. Gjelhaug,
Baudette, Minn.

Electrical Measurements Used in Radio

In connection with the units of the metric system the prefixes given below are used to indicate smaller or larger units. Besides those listed, the prefix "pico" (abbreviation p) is coming into use to mean the 10/12 part, that is, one million-millionth. Thus, "pico" means the same as "micromicro," which latter is abbreviated $\mu\mu$.

Prefix	Abbreviation	Meaning
micro	μ	One millionth
milli	m	One thousandth
centi	c	One hundredth
deci	d	One tenth
deka	dk	Ten
hekto	h	One hundred
kilo	k	One thousand
mega	M	One million

Without giving any historical information as to the development of electric and magnetic units, it may be said that those now used are the so-called international electric units. The international units are based on four fundamental units—the ohm, ampere, centimeter, and second. The first of these is the unit of resistance, and is defined in terms of the resistance of a very pure conductor of specified dimensions. The ampere is the unit of current, and is defined in terms of a chemical effect of electric current, the amount of silver deposited from a certain solution for a current flow for a definite time. The other electric units follow from these in accordance with the principles of electrical science. Some of the units thus defined are given in the following definitions, which are those adopted by international congresses of science and universally used in electrical work.

The "ohm" is the resistance of a thread of mercury at the temperature of melting ice, 14.4521 grams in mass, of uniform cross section and a length of 106.300 centimeters.

The "ampere" is the strength of the current. It is the current which when passed through a solution of nitrate of silver in water in accordance with certain specifications deposits silver at the rate of 0.00111800 of a gram per second.

The "volt" is the electromotive force or pressure which produces a current of one ampere when steadily applied to a conductor the resistance of which is one ohm.

The "coulomb" is the quantity of electricity transferred by a current of one ampere in one second.

The "farad" is the capacity of a condenser in which a potential difference of one volt causes it to have a charge of one coulomb of electricity.

The "henry" is the inductance in a circuit in which the electromotive force induced is one volt when the inducing current varies at the rate of one ampere per second.

The "watt" is the power expended by a current of one ampere in a resistance of one ohm.

The "joule" is the energy expended in one second by a flow of one ampere in one ohm.

The watt and joule are not primarily electric units, but they need to be learned in connection with electric units because the energy required or the power expended in electrical processes are among the most important phases of the actions.

The "horsepower" is sometimes used as a unit of power in rating electrical machinery. The horsepower is equal to 746 watts.

The "gram-calorie," or simply "calorie," is the energy required to raise one gram of water one degree centigrade in temperature. One gram-calorie is, very nearly, equal to 4.18 joules.

Another unit of quantity of electricity, in addition to the coulomb, is the "ampere-hour," which is the quantity of electricity transferred by a current of one ampere in one hour, and is therefore equal to 3600 coulombs. This is used in connection with the capacity of a battery.

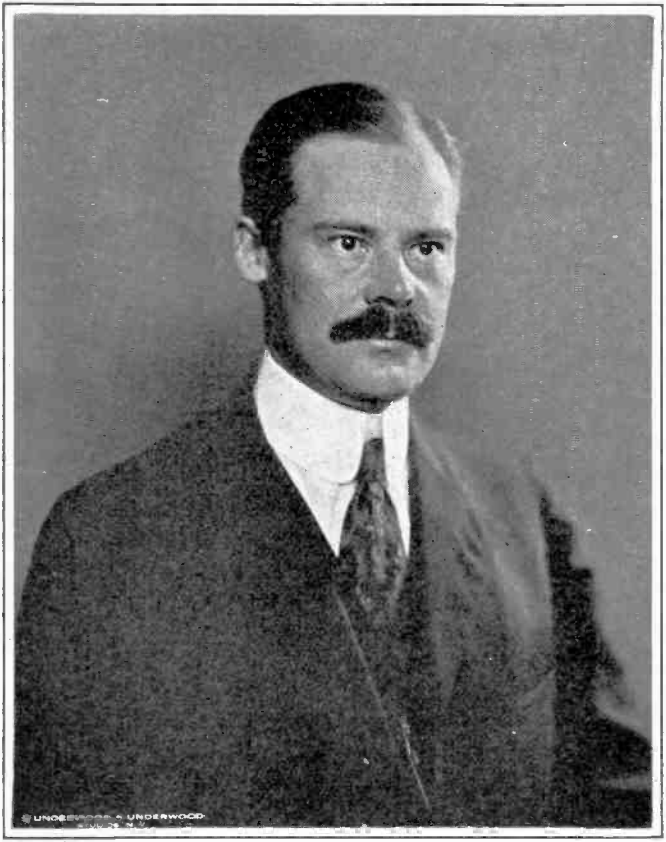
The units of capacity actually used in radio work are the "microfarad" (a millionth of a farad) and the "micromicro-farad" (a millionth of a microfarad), since the farad is found to be too large a unit. Another unit sometimes used is the "C. G. S." electro-static unit of capacity," often called the "centimeter of capacity," which is approximately equal to 1.11 microfarads.

The units of inductance commonly used in radio work are the "millihenry" (a thousandth of a henry) and the "micro-henry" (a millionth of a henry). Another unit sometimes used is the "centimeter of inductance," which is one one-thousandth of a microhenry.

For further information regarding electric and magnetic units see Bureau of Standards Circular No. 60, Electric Units and Standards (price 15 cents), and Bureau of Standards Scientific Paper No. 292, International System of Electric and Magnetic Units (price 10 cents). These publications can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. Other Government publications of electrical and radio interest are listed in Price List 64 issued by the Superintendent of Documents, of which he will send a copy on request.

Abbreviation of Units

Unit	*Abbreviation*
amperes	amp.
ampere-hours	amp.-hr.
centimeters	cm.
centimeter-gram-second	cgs.
coulomb	
cubic centimeters	cm^3
cubic inches	cu. in.
cycles per second	
degrees Centigrade	° C.
degrees Fahrenheit	° F.
farad	fd.
feet	ft.
foot-pound	ft.-lb.
grams	g.
henries	h.
horsepower	h. p.
inch	in.
joule	
kilogram	kg.
kilometer	km.
kilowatt	kw.
kilowatt-hour	kw.hr.
kilovolt-ampere	kva.
meter	m.
microfarad	mfd.
micromicrofarad	mmf.
millihenries	mh.
millimeters	mm.
ohm	
pound	lb.
second	sec.
square centimeter	cm^2
square inch	sq. in.
volt	v.
watt	w.



Ernest F. W. Alexanderson, inventor of the Alexanderson alternator.

WHO'S WHO IN RADIO

Ernest Frederick Werner Alexanderson

As the result of a number of remarkable inventions which stand as veritable milestones in the development of radio, no name stands for more in radio progress than that of Alexanderson. It is particularly well known among the radio engineers, by whom alone a full appreciation of its significance is possible.

First of all, Ernest Frederick Werner Alexanderson is best known for the development of the Alexanderson high-frequency alternator, such as the 200-kilowatt alternators now being employed in the largest radio telegraph transmitting station in the world—the Rocky Point, Long Island, Radio Central station. Ordinary alternators such as are used in light and power work produce a current of 60 cycles per second frequency, whereas the Alexanderson alternator produces a current with a frequency of 30,000 cycles per second. The high-frequency oscillations obtained make it possible to introduce the radio energy directly into the aerial circuit with few accessories.

Another Alexanderson contribution to radio is the magnetic amplifier. This is a device which makes it possible to control or modulate large volumes of radio energy with relative small currents.

Alexanderson came to the United States from Sweden as a young engineer graduate of the High School and University of Lund, of the Royal Institute of Technology of Stockholm, and a post graduate of a course in Berlin. He secured a position with the C and O Electric Company, in 1901. He was then 23 years of age. In 1902 he joined the General Electric Company.

Born in Upsala, Sweden, on January 25th, 1878, Alexanderson has nevertheless become one of us in every sense of the word. He holds a large number of United States and foreign patents. He is a Fellow of the American Institute of Electrical Engineers, Fellow of the Institute of Radio Engineers, and holds other honors. He is the author of a number of papers read before the various technical societies. Address, 8 Adams Road, Schenectady, N. Y.

Edwin H. Armstrong

How an amateur discovered an interesting method of increasing sensitiveness of the usual vacuum tube detector and of generating oscillations in a simple yet efficient manner, much to the amazement of radio engineers, is one of those many romances which make radio progress read like fiction rather than fact. Yet such is the story of Edwin H. Armstrong, of New York city, who is responsible for much of the present radio-phone broadcasting activities, for it is his inventions that have made the technical achievements possible. Armstrong is the inventor of the regenerative or "feed-back" device, which takes some of the plate or rectified energy of the usual vacuum tube, and throws it back into the grid, where it causes greater variation of the plate or rectified energy, part of which is again thrown back into the grid, and so on. This is virtually a self-amplifying action and makes the usual vacuum detector circuit far more sensitive. The same general principle is also applied in the generation of radio waves employed in continuous wave transmission of the dot-dash language of the radio telegraph, and the radio telephone.

Armstrong is President of the Radio Club of America, an amateur organization which includes many of the radio pioneers. He has worked on the problem of radio telephony with Prof. Pupin in the Columbia University laboratories. He is a director of the Institute of Radio Engineers, and was recently awarded the medal of the Institute. For his excellent war work, during which he served as a Major in the American Expeditionary Forces, he received the decoration of Chevalier of the Legion of Honor from France.

Armstrong was born in the United States, December 18th, 1890. He was graduated from Columbia University in 1913. Present address, Columbia University, New York City.

Dr. Ettore Bellini

The radio compass, of which we have heard so much of late, is by no means a new idea. Many years ago the same general principle was introduced in a limited way under the name of the Bellini-Tosi radiogoniometer. Dr. Ettore Bellini was jointly responsible for this device, which receives and transmits directionally, so that the direction of intercepted signals can be determined, and transmission of signals can be effected in some definite direction. The radiogoniometer consists of two triangular loops, connected with two coils placed at right angles to one another. A third coil placed in the center of the two fixed coils is movably mounted so that it may be brought into inductive relation with one coil or the other. The adjustment which produces the loudest signals indicates the direction of the intercepted signal.

Dr. Ettore Bellini carried out research work in radio telegraphy on warships and submarines. He was born in Italy, April 13th, 1876, and educated at the Naples University.

J. F. J. Bethenod

France has its own high-frequency alternators and its Alexanderson. His name is Bethenod, his initials, J. F. J. Born at Lyons in 1883, Bethenod has devoted his life to the study of electrical engineering in all its various branches, although of late years he has turned his attention to high-frequency alternators. His alternators are said to give excellent results, and the best proof lies in the fact that they are now being used in several French long-distance stations. Bethenod, by the way, was the assistant of Professor Blondel for a number of years, and that training alone is sufficient to qualify anyone for the more advanced forms of electrical engineering.

Andre E. Blondel

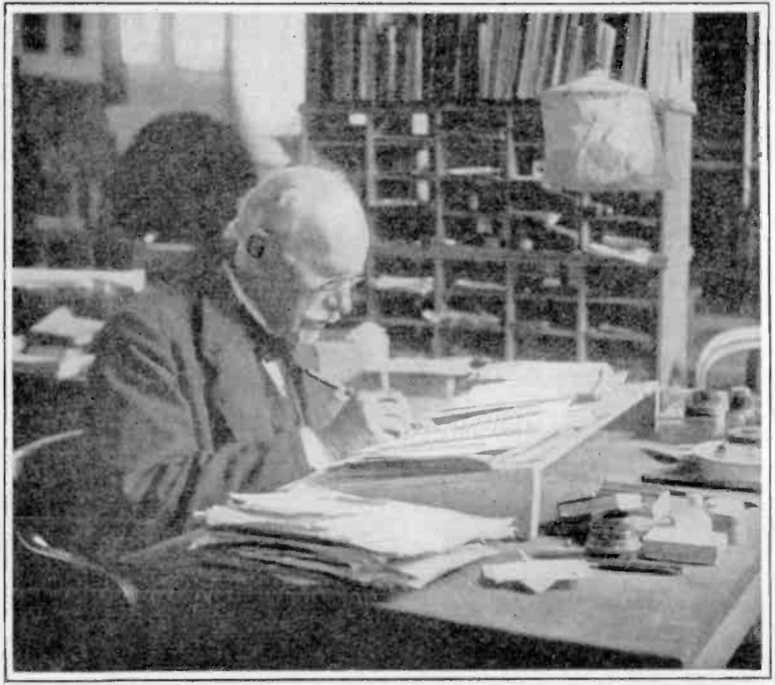
Andre E. Blondel invented in 1893 a new apparatus, which is known as the "Oscillograph,"—a recorder of oscillations—and which opened a fresh field for the study of alternating currents. He was the first to explain mathematically, in 1893, the effect of inertia in the connecting of alternators in pairs. That is to say, when two alternators are placed in parallel they alternate at different frequencies and interfere with one another. The amount of their interference is measured mathematically. Among his other activities in wireless telegraph, mention should be made of directed waves produced by a double aerial oscillating on the fifth harmonic, and also of a system of acoustically syntonic wireless telegraphy. He discovered audio-frequency tuning with a condenser placed across the head telephones.

He contributed to learned societies and technical journals on several subjects, including wireless telegraphy.

He was born at Chaumont, France, 1863. Graduated from Paris University.

Edouard Branly

Edouard Branly wrote extensively on the electrical conductivity of radio-conductors and received for his exhibition of these in 1900, a grand prix from the International Jury of Superior Precept Instruction. He constructed various independent distributing apparatus for producing tele-mechanical effects without wires. He was an early experimenter with coherers—an antiquated type cf detector comprising a glass tube filled with silver and iron filings between metal plugs, which cohere together to let a current pass one way through them, when under the influence of radio waves, but shake apart and restore the very high resistance when the radio waves cease. The varying resistance can be used to operate local devices, such as a Morse dot-dash recorder. The French Minister of Public Instruction made him a Chevalier of the Legion of Honor in recognition of the part he played in connec-



Dr. Edouard Branly is one of the pioneers in radio. Long before the days of the crystal and vacuum-tube detector he invented a detecting device known as the "coherer." This device was simply a glass tube filled with metal filings, which cohered when the current from the receiving antenna passed through them and therefore became conducting, and which were "decohered" by tapping them. Marconi used such coherers in his early receivers.

tion with the discovery and development of "Wireless telegraphy."

He was born in Amiens, October 23rd, 1844. He was educated at St. Quentin College and Henry IV College, Paris. Fellow of the University and Doctor of Physical Science, and Doctor of Medicine.

Sidney George Brown

Sooner or later in our study of radio communication we come across the Brown telephone receivers, and various other devices called Brown this and Brown that. All of which are the invention of Sidney George Brown, who was born in Chicago, Ill., back in 1873, but was brought to England when eighteen months old and has remained there ever since. Educated at Harrogate and London University, Brown soon discovered his penchant for electrical work and developed along those lines. That his time and effort have been well spent is attested to by the fact that he has a number of important inventions to his credit. He invented the drum cable relay and the magnetic shunt in 1898. Since that time he has given much of his time to radio communication. As a consequence, we have the Brown microphone relay, which can take the place of the vacuum tube amplifier when necessary, both for radio work and for telephone work. A well-known type of telephone receiver, especially one with an adjustable pitch, is the result of his work.

Professor E. L. Chaffee

Back not so many years ago when the radio amateur was casting about for some simple yet efficient type of radio telegraph transmitter, he was delighted when Professor E. L. Chaffee came to his rescue by developing a highly efficient yet simple type of quenched gap which became the basis of many an amateur transmitter. Professor Chaffee was born on April 15th, 1885, at Somerville, Mass. He was educated at Somerville High School and the Massachusetts Institute of Technology. Since then, he has been awarded the degree of M. A. in physics and Ph. D. by Harvard University. For many years past Professor Chaffee has been engaged in radio research work and in a consulting capacity. He has written numerous technical works on radio. During the war he was engaged in developing radio apparatus.

Louis Cohen

When anyone wants to know something really "deep" about radio communication, the Bureau of Standards Publications are consulted. And that is virtually to say that Dr. Louis Cohen is also consulted, for he presides over much of the work of the Bureau, particularly that section that has to do with radio research. Indeed, during all the recent study of radio and the formulating of suitable regulations to take care of the radio-phone broadcasting situation, Dr. Cohen has been very much in evidence in the discussions tending towards the moulding of suitable laws for radio traffic. Born in 1876, Dr. Cohen was educated at the Armour Institute of Technology, University of Chicago, and Columbia University. From 1905 to 1909, Dr. Cohen was on the scientific staff of the Bureau of Standards, followed by three years with the

National Electric Signalling Company as chief of research department. The George Washington University had the good fortune to secure Dr. Cohen as professor of electrical engineering. Dr. Cohen has been actively engaged in radio work, particularly research activities, and is now consulting engineer for the War Department. He is a fellow of the American Institute of Electrical Engineering, Institute Radio Engineers, American Physical Society, American Association for Advancement of Science, and has given many contributions to scientific literature and research.

William Dubilier

William Dubilier is known by his invention of the Dubilier mica condenser, one of the most popular condensers of its kind on the market. He is undoubtedly the greatest authority on condensers and has devoted much attention to wireless telegraph, telephone and high-frequency experiments. He has obtained nearly 150 patents and applications for wireless apparatus.

William Dubilier was born July 25th, 1888, in the U. S. A. He is consulting radio engineer, principal of the Dubilier Electrical Syndicate, Ltd., London, England, and of the Dubilier Condenser Co., Inc., New York.

Thomas Alva Edison

No matter in what field we delve, we are almost certain to come across the work of Thomas A. Edison. Never has there been such a versatile, indefatigable inventor.

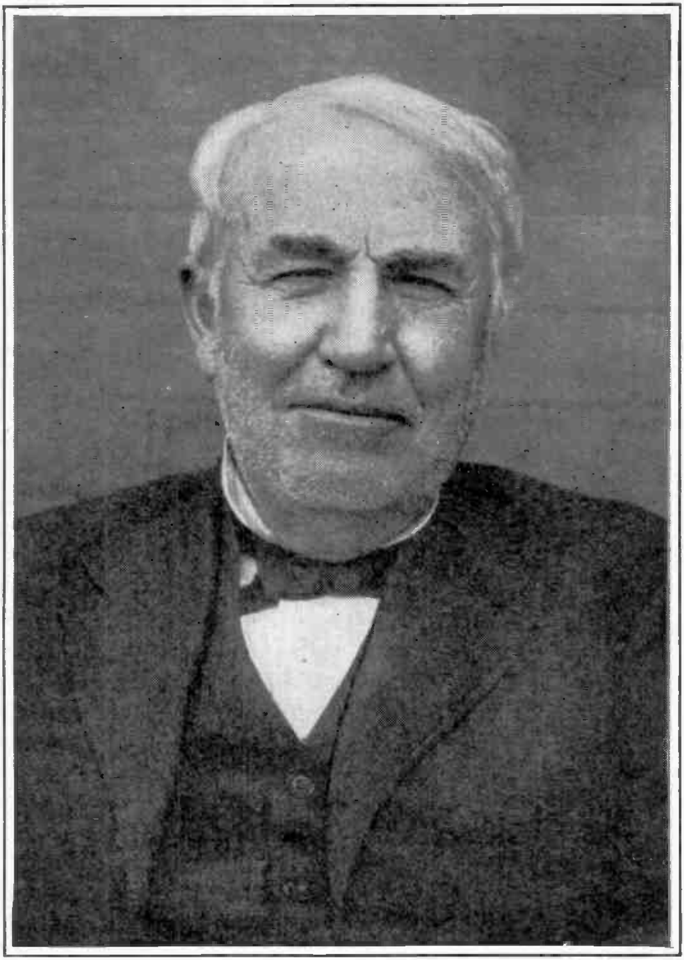


Photo by International

Thomas A. Edison, the man who discovered the Edison effect, which is the basis of the vacuum tube's amazing properties.

And even though Edison has devoted very little time and effort to radio communication during the last decade or two, the fact remains that he contributed very largely to its present success by his numerous experiments and inventions in the early days of wire telegraphy and applied electricity in general.

Take the vacuum tube, now in such general use. It is very doubtful indeed if we would be using these tubes were it not for Edison. In the course of certain experiments on electric lamps, Edison introduced a piece of platinum wire in one of his bulbs. He noticed that as long as the filament was cold, no current could be passed from the filament to the wire. He also noticed that when the filament was heated, it became possible to pass a current from the filament to the wire, but not in the reverse direction. He discovered the uni-lateral or single-direction conductivity of the electric lamp. This became known as the "Edison effect," and is the basis of the present vacuum tubes.

Also, Edison did work out a wireless system back in his early experimental days. Even though it was operative for a short distance only, it showed a true conception of the possibilities of signaling through space.

But then Edison has done so much for telegraphy, telephony, the generation of electricity, and other phases of applied science that without his work we should certainly not be enjoying our radio and many other conveniences of everyday life.

Born at Milan, Ohio, on February 11th, 1847, Edison received his early education, meagre as it was, from his mother. At twelve years of age he became newsboy on

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Lee De Forest, the inventor of the three-electrode vacuum-tube, that is the tube with a grid to control the flow of electrons from the filament to the plate.

the Grand Trunk Railway, and later learned telegraphy. Working as an operator in various parts of the country, he finally invented many telegraphic appliances from the proceeds of which he was able to start a laboratory of his own, where he could experiment and invent to his heart's content. And he has kept at these things ever since, until now he has over a thousand patents to his name. The French Government has made him Chevalier, followed by Officer and Commander of the Legion of Honor. Edison has received numerous honorary degrees from the leading universities and various medals and prizes from engineering and other societies.

Dr. Lee de Forest

Dr. Lee de Forest is best known for his work in putting in the third element, the grid, in the vacuum tube, and in adapting and using the vacuum tube for receiving telegraph and telephone signals and for transmitting apparatus. He was awarded the gold medal for radio telegraphic work at the St. Louis Exhibition in 1904. He distinguished himself in the American-Spanish War in 1898.

De Forest was born at Council Bluffs, Iowa, August 26th, 1873. He graduated Ph. D. in 1899. He founded the De Forest Wireless Telegraph Company 1902, and later the Radio Telephone Company and the De Forest Radio Telephone and Telegraph Company. He is a member of the Institute of Electrical engineers, of the Franklin Institute, and of the Institute of Radio Engineers.

General Gustave Ferrié

Ever since he witnessed the early experiments of Marconi in transmitting messages between Wimereaux and Dover, back in 1899, General Gustave Ferrié has been an active worker in the field of radio. In 1900 he inaugurated the radio telegraphic section of the French Army, and he is responsible for draping the Eiffel Tower, in Paris, with numerous wires which form the aerial of that high-power station operating in the very heart of Paris for many years back. General Ferrié was a member of the French Delegation to the International Electrical Congress in 1904, and member of the French Delegation to the International Radio-telegraphic Conference of London in 1912. He was appointed General Secretary of the International Time Conference at Paris in 1913. He recently visited this country to attend discussions regarding international radio. General Ferrié, back in the very early days of radio, invented an electrolytic detector which was about the most sensitive thing then in use. Various other developments are credited to him. Today he is in charge of the Signal Corps of the French Army.

John Ambrose Fleming, M.A., D.Sc., F.R.S.

John Ambrose Fleming might be said to be godfather of radio telephony. Certainly without his invention the thermionic valve and the Fleming two-element valve, the remarkable receiving range and the radio telephonic transmitting would not be with us today. His was one of the real milestones in the progress of radio telephony. Fleming's valve was a vacuum tube which enclosed a filament and a plate. This acted on the same principle as the present vacuum tube to detect the radio frequency oscillations and changed them into audio frequency. It was a more stable detector than the crystal detector, as it kept its adjustment; but the addition of a grid by Dr. Lee de Forest, has increased the strength of the signals, and made a transmitter of the tube, as well.

John Ambrose Fleming was born at Lancaster, England, on November 29th, 1849. He was educated at the University College School, London; University College; Royal School of Mines. Sometime fellow of St. John's College, Cambridge; Hughes Gold Medallist, Royal Society. In 1880 Lecturer in mechanics and applied science, Cambridge University. First Professor of Mathematics and Physics (1881), University College, Nottingham. First occupant of Pender Chair of Electrical Engineering, University College, London (1885); Vice-President of Wireless Society of London. Later appointed Scientific Advisor to the Edison Electric Light Company. Publications: Numerous contributions to scientific literature and research. Author of well-known text-books, particularly on wireless telegraphy. Twice awarded Institution Premium of Institution of Electrical Engineers; also silver medal of Royal Society of Arts.

Reginald Aubrey Fessenden

Reginald Aubrey Fessenden was the inventor of radio telephony. His telephone consisted of putting a microphone in the aerial circuit of a transmitter whose oscillations were generated by a high-frequency alternator. The current in the aerial circuit was too heavy to be handled

Dr. R. Goldschmidt, Inventor of the Goldschmidt Alternator.

by the microphone, and much trouble was experienced in this direction. With the vacuum tubes now used, the microphone problem has solved itself. Fessenden has devoted much attention to the development of a system of wireless telegraphy known by his name, which resembled and was the forerunner of Alexanderson's alternator, and has also carried out important experiments in wireless telephony. He has been a contributor of articles on wireless telegraph and telephony to many technical journals.

Fessenden was born at Hilton, Canada, October 6th, 1866. He was educated in New York and Port Hope, Ontario. Inspecting Engineer to the Edison Company, New Jersey.

Rudolf Goldschmidt

Born on March 19th, 1876, at Neu-Bukow, Mecklenburg, Germany, Prof. Dr. Rudolf Goldschmidt is one of the outstanding figures in the development of long-distance radio communication. Educated at the Wismar Municipal School, he studied engineering at Charlottenburg and Darmstadt Technical High School. His practical work started with the position of engineer in the laboratory of the A. E. G., or German General Electric Company, in Berlin, beginning 1900. He was then chief laboratory engineer and designer in Prague from 1901 to 1902, followed by the position of chief engineer and designer at Cromptons and Co., Ltd., Chelmsford, England, from 1902 to 1905, and a similar position with the British Westinghouse Electric & Mfg. Company, Manchester, 1905 to 1907. Then he became lecturer at Darmstadt Technical College in 1907, where he practiced as a consulting engineer and also pursued the development of several inventions, chiefly occupying himself with the invention and design of high-frequency alternators for wireless telegraphy. In 1911 he established two large radio stations for communication between Tuckerton, N. J., and Eilvese, Germany. The high-frequency alternator bearing his name is in use to some extent for long-distance radio communication.

Professor Alfred N. Goldsmith

Prof. Alfred N. Goldsmith is best known to amateurs as the author of a book on radio telephony. He has written many other books, including "Elements of Physics," "The Transmission of Cathode Rays through Thin Partitions," and is author of a portion of "Radio Phone Receiving," of this series; "Radio Engineering at the College of the City of New York." Dr. Goldsmith is the editor of the "Proceeding of the Institute of Radio Engineers." He was chairman of the Standardization Committee of the Institute of Radio Engineers (1915), Secretary of the Institute (1918-1919), and member of Board of Directors of the Institute also, he is a Fellow of the Institute of Radio Engineers, Fellow of the American Institute of Electrical Engineers, Member of the American Physical Society, and member of the Federal Radio Telephone Commission.

During the war he conducted, in 1917-1918, as Technical Director, the United States Signal Corps School of radio and multiplex Telegraphy in the College of the City

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of New York of which he is director of the radio engineering activities. He was also associated with the U. S. Naval Radio Compass School.

Dr. Goldsmith is now director of Research for the Radio Corporation of America. He has been a very active force in the Institute of Radio Engineers. Address: The College of the City of New York.

John Hays Hammond, Jr.

John Hays Hammond, Jr., son of the well-known mining engineer, is the inventor of a radiodynamic torpedo, a torpedo which moves through the water by itself with no direct human agent, yet can be guided and accurately controlled by an operator on shore through the medium of radio control. Young Hammond has worked on radio controlled torpedoes and other moving bodies for many years past. He has also invented the thermite incendiary shell. He was the originator of the system of aero coastal patrol, comprising aeroplanes equipped with wireless, which has received the endorsement of President Wilson, the Secretary of Navy, and the Secretary of War. Hammond invented the system of aerial radio surveying and mapping which has been adopted by the Bartlett Expedition for Polar Basin Surveying.

This young man is the author of a four-volume treatise on the Art of Teledynamics. He is treasurer of the Institute of Radio Engineers, and Manager and Chairman of the Committee on Admissions; Associate Member of the American Society of Mechanical Engineers; Delegate to the London International Radio Telegraphic Conference, 1912, and member of the American Institute of Electrical Engineers. He received the honorary degree of Doctor of Science at George Washington University, June, 1919.

Hammond was born in San Francisco, April 13th, 1888. He was educated at Preparatory Schools in England and the United States. Graduated from the Yale-Sheffield Scientific School, 1910. Address: Hammond Radio Research Laboratories, Gloucester, Mass.

Heinrich Rudolf Hertz

Hertz has often been referred to as the Father of Wireless. This title, however, is somewhat erroneous, for while it is true that Hertz discovered and pointed out the propagation and the detection of electromagnet waves through space, it remained for Marconi to conceive the idea of making these waves speak the dot-dash language of the telegraph code. It was this latter achievement that really brought radio communication into existence. At any rate, Heinrich Rudolph Hertz is generally looked upon as the founder of the art of radio communication—and he did lay the foundation—even though he did not realize, at the time he performed his memorable experiments, what would eventually be done with the very waves with which he worked.

Born at Hamburg, Germany, on February 22, 1857, Hertz died at Bonn on January 1st, 1894, just a few years before Marconi put the Hertzian waves to work. He was graduated at the University of Berlin, and was the favorite pupil of Von Helmholtz. In 1885 he became professor at the Technical College of Karlsruhe, and it was there that his epoch-making investigations were begun. In brief, Hertz discovered that when a condenser, charged with electricity, is allowed to discharge across a spark gap, it sets up electrical waves which may be intercepted and detected at a distance. For the purpose of detecting the electromagnetic or Hertzian waves, Hertz made use of a piece of wire bent around to form a ring with a small gap inserted so as not to have it quite continuous. As the Hertzian waves are intercepted, tiny sparks are seen to jump across the gap of the resonator, as this ring device is called. In 1889 Hertz received a call to succeed the famous Clausius at Bonn University. In July, 1888, his most important memoir on electromagnetic waves in air was published, and at once attracted general attention to his work.

Frederick A. Kolster

Closely associated with the work of the United States Government so far as radio is concerned is the name of Frederick A. Kolster. Born in Geneva, Switzerland, in January 13th, 1883, Kolster was educated at the public schools of Cambridge, Mass., and at Harvard University. He assisted John Stone Stone during 1902-1908, and took an active part in radio engineering up to 1912. He then joined the scientific staff of the Bureau of Standards and has been closely associated with the radio work of the U. S. Government. He is the inventor of the decrement, with which the sharpness of tuning of a radio instrument is determined. He has worked on and contributed towards the present efficiency of directional radio systems. Kolster was attaché to the American delegation representing the United States at London International Radio Convention in 1912.

Professor Arthur Korn

Professor Arthur Korn of the Polytechnical High School, Berlin-Charlottenburg, is best known as the inventor of a system of telegraphic transmission of photographs, and in 1907 the first photograph was transmitted by means of his system from Munich to Berlin, a distance of 600 kilometres. Inventor of a system of telautography, as this arrangement is sometimes called, and author of "Elektrische Fernphotographie und Teleutographie," published in 1911, in collaboration with Dr. Glatzel. Prof. Korn has done much to blaze the way for the present systems of image transmission by radio now coming into use.

He was born at Breslau, Germany, May 20th, 1870. Studied at Leipsig and Paris in Mathematics and Physics. Professor of Physics at the University of Munich, 1903-8 Address: Charlottenburg, Berlin. Schluterstrasse 25.

Dr. Irving Langmuir

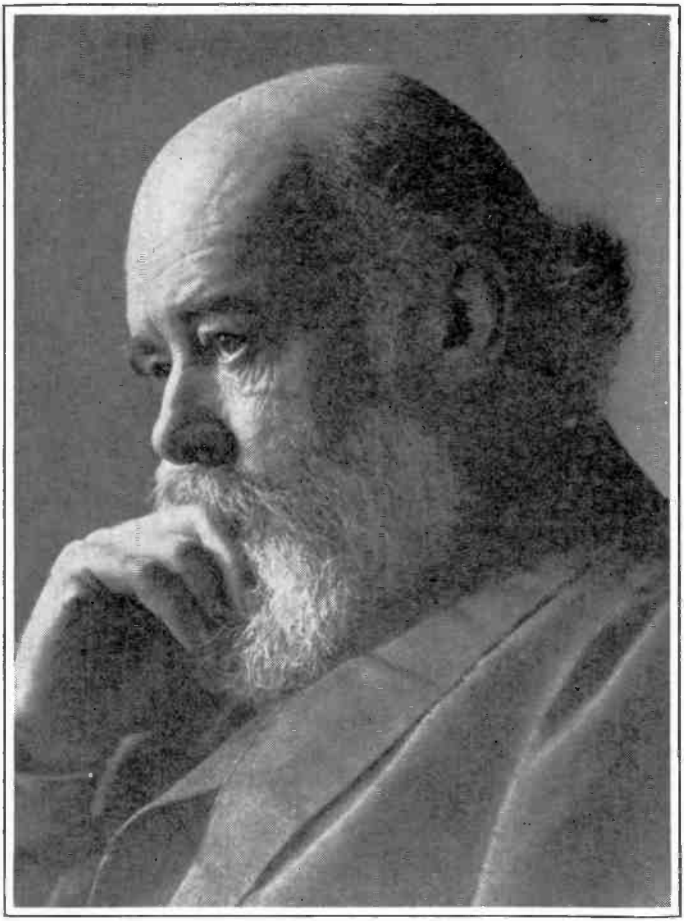
During the war, while serving as metallurgical engineer engaged on submarine problems, Dr. Langmuir developed several successful detecting devices used by the United States Navy. He has published many scientific works and contributed to various scientific journals.

Since 1909 Dr. Irving Langmuir has investigated in the Research Laboratories of the General Electric Company at Schenectady, N. Y., various radio telephone and telegraph apparatus, tungsten lamps, electric heating devices, pure electronic discharge apparatus, and so on. He has propounded a theory for the electronic structure of all matter which is so plausible that it has received serious consideration in the scientific world, revolutionary as it is.

Dr. Langmuir was born in Brooklyn, N. Y., on January 31st, 1881. He was educated at the School of Mines, Columbia University, and graduated in 1903 as metallurgical engineer. He undertook post-graduate work at University of Göttingen under Professor Nernst. Returning to America, he became Instructor in Chemistry at the Stevens Institute of Technology, 1906-1909. Address: General Electric Research Laboratory, Schenectady, N. Y., 6 Stratford Road, Schenectady, N. Y.

Marius Latour

Few men are as versatile as Marius Latour of France, who has worked in radio, aviation, and many other fields of pure and applied science. Born in October, 1875, in the southwestern portion of France, he was educated at the University of Paris and the Ecole Superieure d'Electricité, Paris. For many years he was consulting engineer to the General Electric Company of our country. Latour has worked on the helicopter problem, as well as submarine signalling. He has also worked on generating machinery. High-frequency alternators have attracted his attention and secured his efforts. As far as essentials are



Sir Oliver Lodge, the man who discovered the principle of tuning.

concerned, his high-frequency alternators follow the same general lines as those of Goldschmidt. Then the three-element vacuum tube has received considerable study by Latour; indeed, back in 1904 he set forth the principle of reception of continuous waves by means of beats. During the war Latour engaged in research work in the French Signal Corps laboratories under General Ferrié. His system of eliminating interference produced in telephone lines by neighboring high power transmission lines, has been introduced throughout the whole of northern France.

Sir Oliver Lodge

Sir Oliver Lodge—his is a household word. He is well known as a great physicist, and more recently by his psychic investigations. Still, not everyone realizes what an important part he has played in the development of wireless. He has contributed such things as his investigations on lightning, the seat of the E. M. F. in the voltaic cell, the phenomena of electrolysis and the speed of the ion; the motion of the ether near earth, and a masterly study of electromagnetic waves and wireless telegraphy. He has written an internationally read book on the theory of ether, called "Ether of Space," another on the atom and numerous others on important scientific matters. He was the inventor of tuning. His early patent for syntonic or tuned wireless telegraphy was acquired by the Marconi Company.

Sir Oliver has been President of the British Association, President of the Physical Society, and an active worker in the Society for Psychical Research. He was Knighted in 1902.

Born at Penkhall, Staffs, June 12th, 1851, Sir Lodge was educated at Newport (Salop) Grammar School, and studied privately for several years. He entered University College, London, in 1873, and graduated D.Sc. 1878. His professional career includes reader in natural philosophy at Bedford College for Women, and Assistant Professor of Physics in University College, London, for several years, and then Professor of Physics in University College, Liverpool, for nineteen years. He was the first Principal of Birmingham University in 1900. Address: Marie Mount, Edgbaston, Birmingham.

Guglielmo Marconi, G.C.V.O., LL.D., D.Sc., M.I.E.E.

Senatore, then just plain Guglielmo Marconi, for he still had to earn his laurels, first interested himself in the problem of wireless telegraphy in 1895. He visited England in 1896, and took out the first patent ever granted for a practical system of wireless telegraphy by the use of electric waves. His earliest experiments in England were made at Westbourne Park. Shortly afterwards, Marconi saw Sir W. H. Preece, and at the latter's request, made some experiments for him and the British Post Office officials. Some further experiments were made in May, 1897, in the Bristol Channel, wireless communication being established between Lavernock and Brean Down, a distance of nine miles. At the invitation of the Italian Government, Mr. Marconi subsequently went to Spezia, where a land station was erected, which was kept in con-

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stant communication with two Italian battleships working over a distance of twelve miles.

The Italian Government conferred upon Marconi the honour of knighthood, for his achievement, and his system became the basis of the radio system now used extensively in Italy.

On his return to England, further experiments were conducted between Salisbury and Bath, a distance of thirty-four miles. On July 20th, 1897, the Wireless Telegraph and Signal Co., Ltd., later known as the Marconi Wireless Telegraph Co., Ltd., was established, and two permanent stations were put up. In July, 1898, the Dublin Express gave day by day a wireless telegraphic report of the yacht races during Kingstown Regatta week, and proved the usefulness and facility with which the system can be applied to commercial purposes. Later Mr. Marconi established communication between Queen Victoria's residence at Osborne House, Isle of Wight, and the Royal yacht Osborne, and her late Majesty was kept apprised of the progress made by the then Prince of Wales during the process of recovery from a serious accident. In December, 1898, Marconi installed apparatus to provide communication between the South Foreland Lighthouse and a lightship on the South Coast. Marconi read a paper on "Wireless Telegraphy" before the Institution of Electrical Engineers in 1899.

Early in 1901 telegraphic communication was established between two points more than 250 miles distant, and at the end of that year Marconi transmitted signals from Poldhu, in Cornwall, to St. John's, Newfoundland. In February, 1902, he received on board the S. S. "Philadelphia," in the presence of the officers, good messages

Guglielmo Marconi was a mere boy when he conducted the first experiments in space telegraphy. Although Maxwell had discussed the probable existence of electric waves in space and Hertz showed that they actually existed neither of them thought of using the waves for communicating from country to country.

on the tape recorder when at a distance of 1,500 miles from the transmitting station, and sound signals in his telephone receiver at over 2,000 miles. In December, 1902, the station established at Cape Breton, Nova Scotia, under a contract with the Canadian Government, for trans-atlantic wireless telegraphy, was put into communication with the Cornwall station at Poldhu, Great Britain, and inaugural messages were transmitted to H. M. the King of England, H. M. the King of Italy, and others, and to the *Times*.

In October, 1903, during the voyage of the R. M. S. "Lucania," Marconi established communication between this ship and the Marconi stations at Glace Bay, Canada, and Poldhu, Cornwall, England, and a bulletin was published and issued daily to each passenger. A powerful station at Clifden, on the West Coast of Ireland, was opened early in 1907, for the establishment of commercial communication with the American continent, through the Glace Bay, Nova Scotia, station.

Marconi's work has been recognized by many governments and seats of learning: he has been decorated by the King of Italy and the late ex-Czar of Russia; he is an honorary doctor of many universities including Oxford, Glasgow, Aberdeen, Liverpool, and Pennsylvania, besides having received the freedom of the principal Italian cities. In 1909, in conjunction with Professor Braun, he was accorded what is perhaps the highest distinction that can be obtained by any scientist—the Nobel Prize for Physics. In 1914 he was elected a senator in the Italian Parliment, being formally introduced to the Assembly on March 27th, 1915. On July 24th, 1914, the King bestowed upon him the Honorary Knighthood of the Grand Cross of the

Victorian Order. He also holds many scientific awards granted by various societies and institutions, of which we may quote as a comparatively recent instance his presentation by the Royal Society of Arts, on April 12th, 1915, of the Albert Medal, annually granted for distinguished services to science.

Immediately on the declaration of war by Italy, Senatore Marconi placed his services at the disposal of King Victor, and was given the rank of Lieutenant in the Italian Army. He has been employed on important military missions to England by the Italian Government, and on July 29th, 1916, was promoted Captain "for exceptional services." At the beginning of September in the same year he was transferred from the Italian Engineers Service to the temporary Commander in the Navy. Senatore Marconi visited the United States, 1917, as member of the Official Mission sent by Italy to the U. S. A. Government. The world-famous University of Columbia invested their distinguished visitor with the honorary degree of Doctor of Science on June 6th, 1917. The Franklin Institute of Philadelphia conferred their Franklin Gold Medal upon Senatore Marconi on May 15th, 1918, for his service to humanity. On June 26th, 1919, Senatore Marconi was appointed by H. M. the King of Italy Plenipotentiary Delegate to the Peace Conference at Paris and in this capacity signed the Peace Treaties with Austria and Bulgaria. At the end of 1919 Senatore Marconi was awarded the Italian Military Cross. In addition to being Chairman of the Board of Directors of the Marconi Company, Senatore Marconi is Chairman of the Banca Italiana di Sconto and of the Lloyd Sabaudo Steamship Company.

He was born in Bologna, Italy, April 25th, 1874. He is Irish on his mother's side. He was educated at Leghorn and Bologna, Italy.

James Clark Maxwell

James Clark Maxwell was a great experimenter and mathematician. He was one of the great admirers of Faraday. He translated the ideas of Faraday, who discovered induction between two separated wires, into precise mathematical measurement, as a student in Cambridge. He evolved many theories on electricity and magnetism. He discovered that wireless waves traveled at the same speed as light, and indeed, are similar waves of longer wave length, and was responsible for finding much regarding the true nature of electricity. He edited the electrical research works of Henry Cavendish and wrote articles on the atom, attraction, diffusion, and ether.

Maxwell held the chair of natural philosophy in Marischal College, Aberdeen, from 1856-60, and for eight years the chair of physics and astronomy in Kings College, London. As First Professor of Experimental physics in Cambrige, he directed the planning and equipping of the Cavendish Laboratory. For half his life he was one of the foremost natural philosophers. At fifteen he made his first contribution to science with a paper accepted by the Royal Society of Edinburgh and wrote at 18 years of age, two more, one of which laid the foundation of one of his future singular discoveries.

He was born in 1831. He studied at Edinburgh

Academy and the University of Edinburgh. He graduated from Cambridge.

Alexander Meissner

Born in Vienna, Austria, Alexander Meissner studied at the Technical High School and University of Vienna. He joined the laboratory of the Telefunken Company, Berlin, in 1907, and since that time has taken a very prominent part there in the development of the technique of radio communication. He is responsible for the introduction of the flat-coil, musical quenched sparks, timed sparks, high frequency machine, Telefunken compass, interference reception with the detector, direct current cathode valve relay for the reception of dots and dashes on a paper ribbon, the generation of oscillations with three-valve tubes, the back coupling for the reception of beats, and so on. All in all, Meissner's contributions to the radio art are certainly important and remarkable.

Greenleaf Whittier Pickard

The contributions of Greenleaf Whittier Pickard to the radio art are of prime importance. Born in Portland, Me., on February 14th, 1877, Pickard was educated at Westbrook Seminary, Lawrence Scientific School, Harvard, and Massachusetts Institute of Technology. Pickard has made a special study of radio telegraphy and telephony and has taken out many United States and foreign patents for radio inventions, among which are a crystal detector and a radio compass. He began his radio work at the Blue Hill Observatory, Milton, Mass., under a grant from the Smithsonian Institution. He became associated with Harry Shoemaker in 1901, and joined the engineering staff of the American Telephone and Telegraph Company in 1902, remaining there until 1906. As early as 1902, Pickard developed a practical system of radio telephony and obtained fair speech transmission. He is the inventor of a novel method of reducing static interference which was extensively used by the United States Navy for transatlantic reception during the war.

Valdemar Poulsen

Valdemar Poulsen initiated in 1903 a method of generating continuous electrical waves, known as the Poulsen arc. This differed from the ordinary electric arc, such as is used in lighting, by its use of a copper and a carbon terminal in an alcoholic solution. Around one terminal was wound a coil of wire which produced a powerful magnetic field. This arc was much more effective than the old method, and is still used to this day in powerful Navy stations.

Poulsen was given a gold medal in 1907 by the Danish Society of Sciences. His publications are: "Une Methode pour Produire des Oscillations non Amorties et leur Emploi dans la Telegraphonie sans Fil" and "La Téléphonie sans Fil: Rapport Official au Congress International des Applications Electriques," Turin, September, 1911 (Copenhagen, 1912).

He was born at Copenhagen, November 23rd, 1869. He studied at the University of Copenhagen, 1889-1893. He entered the technical department of the Copenhagen Telephone Company in 1893, and for a number of years superintended electrical testing operations. He holds the Medal for Merit in gold, with the crown. He collaborated with Professor P. O. Pedersen for many years and was a member of the Board of the Telegrafonen, Ltd., 1902-16.

W. H. Preece

Whether it is luck or modesty even to a fault, it is often the case that men who have contributed much to a given art are entirely forgotten. Their names remain unknown, while others who have taken up their ideas and developed them become famous, and receive all the credit for what is not altogether their true achievements.

Take the case of W. H. Preece, of England. A telegraph engineer of no mean ability, Preece conceived the possibility of telegraphy without wires, by means of the induction method, long before Marconi began his experiments. As far back as 1886, Preece pointed out the possibility of telegraphy through space without physical connection. However, as we know now, the inductive method is very limited in its range, and the scheme came to little or nothing. Yet it did create in Preece's mind a firm belief in the possibility of wireless communication, and for that reason he was ready and willing to listen to Marconi when the latter came to England with an idea that seemed, on the face of it at least, just about as wild as the average perpetual motion scheme. It was in 1896 that Marconi succeeded in interesting Sir W. H. Preece in his method of communication. Preece was then engineer-in-chief to the British Government Telegraph service, and for the previous twelve years had interested himself much in the development of wireless telegraphy by the inductive-conductive method. In June, 1897, Sir Preece gave a lecture to a large audience at the Royal Institution in London on "Signalling through Space without Wires." He devoted considerable attention to Marconi's method and it was largely due to his advocacy of Marconi's wireless telegraph that the young Italian was enabled to interest the proper authorities and financiers in his work. So, in large measure, Sir Preece's work must not be overlooked, not only for what he himself contributed to the art, but more particularly for his support of young Marconi who faced a skeptical world.

Dr. Michael L. Pupin

Professor of Mathematical Physics and Director of the Research Laboratory of Columbia University since 1891. Pupin's is a well-known name in and out of radio circles. He is an inventor of great note. Pupin developed electrical resonance before the introduction of wireless telegraphy. He received patents for electrical selection and licensed them to the Marconi Company in 1903. He has made and developed many inventions in telephony and telegraphy, and many of his improvements are known throughout the world by his name. He is best known for the loading coils or Pupin repeaters, as they are called, which first made clear, loud, long-distance wire telephony possible. He has recently been engaged in the development of a new method of electrical selection or tuning in wireless telegraphy, and has done much research in wireless telephony.

Dr. Michael L. Pupin was formerly President of the Institute of Radio Engineers. He was born in Serbia on October 4th, 1858, and came to the United States in 1874, graduating from Columbia University in 1882. He continued his studies at Cambridge, England, and Berlin.

Major-General George Owen Squier

Major General Squier is not only our Army's radio leader, but also our leading army radio expert. He is Chief Signal Officer of the United States Army, and he has made several valuable contributions to the progress of wire and wireless communication.

Major General George Owen Squier discovered that trees are capable of use as effective antennae for receiving wireless messages back in 1904, and published a paper entitled "The Absorption of Electro-Magnetic Waves by Living Vegetable Organisms." He also wrote "Tree Telephony and Telegraphy." He wrote many papers on wireless telegraphy, especially a treatise in 1911 on multiplex telephonic and telegraphic waves guided by wires. This consisted of sending and receiving several messages at the same time. Some years ago he discovered a method of "wired wireless" in which, when the radio receiving set is plugged into an ordinary electric light socket, the electric light wires are used as a form of antenna. He has devoted special attention to the use of wireless telegraphy in military operations.

General Squier was formerly military attaché to the American Embassy in London. He studied at Johns Hopkins University, Baltimore, and graduated as Doctor of Physics in 1893. He was a research student under the late Professor Rowland, and in the laboratory of the late Sir William Preece at the British General Post Office at the time that Marconi conducted his early demonstrations before the officials of that organization.

Major General Squier was awarded the Elliott Cresson Gold Medal for his researches in multiplex telephony in 1912. He presented a paper on "Cable Telegraphy" to the Physical Society of London during June, 1915, advocating the adaptation of Wireless Engineering methods to ocean cables. He became a member of the National Academy of Sciences, 1919; was awarded the Franklin Medal, by the Franklin Institute of Philadelphia, Pa., 1919, and was awarded the Distinguished Service Medal, U. S. Army, 1919. His address is Chief Signal Officer of the Army, War Department, Washington, D. C.

Nikola Tesla

Nikola Tesla is one of the world's foremost electricians. Early in life he began to take interest in arithmetic and physics. He graduated from Carlstatt in 1873, and devoted his energy to electrical studies and investigations. He went to Graz, where at the Polytechnic School, he prepared for work as Professor in mathematics and physics. While there he was so struck with the objections to the use of commutators and brushes that he made up his mind to remedy that defect in dynamo-electric ma-

Nikola Tesla, whose researches in high-frequency currents have aided radio engineers in designing the sets of today. Tesla has done much work to show that the wireless transmission of power is possible.

chines. He came to America about 1882, where he captured the attention of the whole world with his fascinating experiments on high-frequency electric currents. Since 1890 he has devoted himself almost entirely to studies of alternating currents of high frequency and very high potentials. He invented the alternating current induction motor which is widely used for fans and machines, as well as certain features of radio spark transmitting sets. Tesla has spent years in conducting experiments which will ultimately enable us to transmit power and to light lamps without the aid of wires.

He was born in Smiljan Sika, Dalmatia, in 1857.

Roy A. Weagant

The inventor of a new method for eliminating static interference, Roy A. Weagant, has contributed in good measure to present long-range radio. The long aerial, miles in length, which he used in his experiments in Florida, has been duplicated commercially at the new Radio Corporation of America's great trans-atlantic power transmitting and receiving station at Rocky Point, Long Island.

Weagant became interested in wireless through witnessing some of the experiments in Hertzian waves of Sir Ernest Rutherford, under whom he studied physics. He was born in Morrisburg, Ontario, Canada, in 1881. He was educated at Stanstead College, Stanstead, Quebec, Canada, and McGill University, Montreal, Canada. He graduated after taking an electrical engineering course, in 1905. He gained engineering experience with the Montreal Light, Heat and Power Company, the Westinghouse Electric and Manufacturing Company of Pittsburg, Pa., and the De Laval Steam Turbine Company. He is a Fellow of the Institute of Radio Engineers and former member of its Board of Directors and Standardization Committee.

Professor Max Wien

Professor Max Wien is distinguished as the originator of the quenched spark. The quenched spark gap has several distinct advantages over the ordinary open gap. The closely packed disks of brass with their mica washers leaving only a fraction of an inch for the sparks to jump, effectively silence the disagreeable crashing noise and radiate considerably more energy.

Professor Wien devoted considerable attention to the study of electro-magnetic waves and their propagation. He made a special study of physics under Helemholtz and others and assisted Roentgen of X-ray fame, in 1891-93. He was born in Königsberg in 1866.

Professor Dr. J. Zenneck

To Prof. Dr. J. Zenneck of Germany goes the credit for writing one of the best books on radio communication ever written. It has been translated into English and is considered one of our very best reference works on radio. Born April 15th, 1871, in Wurtemberg, Prof. Dr. Zenneck was educated at the Theological College at

Tubingen. Abandoning theology, he studied mathematics and natural history, and natural history particularly during 1889-94. He studied natural history in London and elsewhere. Subsequently he devoted himself entirely to physics. From 1895-99 he was assistant in the Physical Institute in Strassburg. Zenneck engaged in making tests with radio telegraphy in the North Sea during 1899 and 1900. He was lecturer and assistant professor of physics in the Technical College, Danzig, 1905, Brunswick, 1906. In 1909 Zenneck joined one of the largest chemical works in Germany. He became professor of physics at the Institute of Technology, Danzig, 1911, Munich, 1913. During part of the war Zenneck was technical adviser to the Atlantic Communication Company which then operated the Sayville wireless station.