THE WIRELESS AGE

OCTOBER, 1913

ABOUT OURSELVES

WITHOUT preliminary flourish we beg to introduce The Wireless Age.

Now an introduction is at best an awkward thing, and it becomes far more so when it is one-sided. For an impression must be made on the new acquaintance, and in trying to do this it is so easy to appear very egotistical, which is the polite name for stupidity, or take a chance of not doing ourselves justice.

By doing ourselves justice we do not mean that our readers are to hearken while we call their attention to what we consider meritorious in our pages, for that is one thing we want them to decide for themselves. A clear conception of our aims and purposes, a friendly spirit and a reasonable appreciation of our efforts to please, is all we seek.

Our Aims and Purposes

What we have in view for our subscribers will be spoken of presently; just now we have a very pleasant duty to perform. We want to thank our friends for their loyal support, their kindly criticism, and even for the occasional tirades of good-natured abuse, that have been aimed our way.

That we claim friends may appear paradoxical in view of this being the first issue of The Wireless Age, and as we are to acknowledge a great number of them a word of explanation may be timely.

Just one year ago we had an idea that a certain proportion of the American public would welcome a magazine devoted to wireless telegraphy. We set about to discover just how large an audience we could address, providing we reached each individual concerned with radio communication. From the best sources of information we could command, one hundred thousand seemed to be a fairly accurate estimate. Surely, here was an audience worth addressing, for careful and painstaking investigation had shown us that while practically all of these people were engaged in serious experimenting, or were devoting their energies to advancing the commercial phases of the art, they had no adequate medium of expression, had little opportunity of learning what their co-workers were accomplishing, and had been depending principally upon a few scattered text books, new and old, for a way around the difficulties they encountered.

It was to fill this noticeable gap that our magazine entered the field. We called it The Marconigraph, an illustrated monthly magazine of wireless telegraphy.

From a very inauspicious beginning, this little publication—"pamphlet," some of the early scoffers called it—grew steadily in scope and influence, plodding onward and upward through a maze of discouragements and with little to reward its sincerity of purpose or the arduous labor its publication entailed. It was a long while before expressions of appreciation began to drift in.

Our First Bouquet

HOW well we remember the first indication of the kind! We (speaking personally for the moment) had dropped into the offices of a New York newspaper, intent upon correcting an inaccurate news item relating to wireless that had found its way into print. Explaining our mission and calling attention to the true facts in the case as detailed in a copy of The Marconigraph carried along for that purpose, we were assured of a retraction and courteously invited to meet the Exchange Editor. In passing, it may be well to explain that this official's duty is to search all manner of publications for news items and suggestions of value to the paper; in a phrase, to keep his finger on the pulse of the world for the good of the paper. This man listened carefully to all we had to say about our sincerity of purpose and our willingness to aid in distributing accurate information on wireless matters through the daily press of the country. In conclusion, we offered him a copy of The Marconigraph. Declining the proffered number with a warm smile that in itself was a handsome reward, he pointed to a copy then lying on his desk, adding that it had arrived in that morning's mail and would receive attention in its regular order. This looked encouraging, for there were but a few magazines and papers on the desk, in contrast to heaps reposing in nearby waste baskets and scattered about the floor. We glanced apprehensively at these, which called forth another smile.

"No, your little publication does not meet that fate," he volunteered. "I have carefully read every issue since the first one, and I am happy to say that The Marconigraph has been a source of inspiration in more than one instance. Furthermore, I trust you will continue to keep us on your mailing list, for after our little chat I am going to watch it even more carefully. And if it is worth anything, you have my assurance that I will suggest its value to other men of my calling."

Further Encouragement Added

THIS, the first expression of appreciation we had heard, meant a great deal to us, but when a little later we began to receive letters from our readers commenting on this and that, asking for information on definite phases of the art and suggesting articles that would interest them—then we felt that our initial purpose had been realized. We had a definite place in the activities of a certain proportion of the people we had set out to reach, and recognition as a standard semi-technical publication. Once started, the letters poured in steadily until we had a considerable collection. Some of these letters proved very valuable to us, for they told us what our readers wanted and where they thought we were lacking. The mere fact that these letters were written, that the writers were sufficiently interested in our development, proved to us that we had friends—a goodly number of them.

We hope to retain them during the life of The Wireless Age and add a great many more to the list.

Whether in the past we have lived up to the standard set by our readers, we cannot say. We have tried. What we are sure of, though, is that we have made a very definite amount of progress. We did not reach each one of the hundred thousand we set out to—not half, nor a quarter of that number—but our circulation books to-day show a volume of paid subscribers that gives us a very comfortable feeling. It was this feeling that led us to attempt some great strides forward.

Hence the passing of The Marconigraph and the creation of The Wireless Age, broader in scope, larger in volume, and, we trust, more interesting and instructive in contents.

What we purpose to give you is the best wireless magazine that money and brains properly applied will produce. There will be highly technical articles for the engineer, practical suggestions for the commercial operator, helpful hints for the advanced amateur and carefully considered instruction for the novice. The new stations, new instruments and new methods of commercial operation will be dealt with each month and genuine radio achievement will be impartially chronicled. By this, we do not mean that we will attempt to record everything that is, and has been, done; for this is almost beyond human possibility and, if it were possible, hardly desirable. All we promise is to use our best judgment in selecting what we consider to be valuable discoveries and practical applications of wireless to the problems of the day, presenting them to our readers with little, if any, comment.

We will not confine ourselves to strictly educational articles. We shall attempt to entertain as well. Good fiction, well illustrated, and narratives seething with human interest will appear regularly. We will also make it a point to cover the features of commercial wireless that are of absorbing interest to holders of wireless securities.

THIS is one point about which there has been some misunderstanding in the past.

We have been accused of recording only the achievements of the Marconi system to the exclusion of all others. It has been said that we purposely ignore "other companies operating in the commercial field." To the best of our knowledge there is only one commercial wireless company in the United States conducting a regular message traffic every day in the year. If there are any others, we would like to learn what they are doing. If they are doing things worth

Clearing Away the Fog

while, we will tell the public about them. Anything we consider worthy of mention will be chronicled; we will be unbiased in our columns—but we shall insist upon verification of everything contained in communications of this nature.

It may as well be understood from the start, however, that we are going to be intensely loyal to the Marconi Company. The reason for this is plain. As it stands to-day the Marconi Company is an organization years ahead of any possible competitors. With very few exceptions the vessels of the merchant marine of this and every other country in the world are equipped with Marconi apparatus, in communication with Marconi land stations, and operated under the traffic system perfected only after years of experience and the expenditure of vast sums of money. To others who have accomplished good work in wireless we offer our sincerest admiration, but the powerful commercial institution made possible by the genius of Marconi, his co-workers and those who offered financial support will always receive first consideration. Which is eminently fair in view of the fact that Marconi activities are many times greater than those of all the others combined. The sole purpose of The Wireless Age is to record the progress of the art of radio communication, so you may expect to hear a great deal about the Marconi Company.

One of our critics in the days of The Marconigraph said that we were "constantly cramming the Marconi system down the throats of readers." What if we did? And what if we continue to do so? It's good for him and all the others. Every sincere experimenter, engineer or commercial man is naturally interested most in what the leaders in the wireless field are doing. Marconi and wireless are synonymous words, and Marconi development is pre-eminent in wireless affairs. However, let it be understood that we will recognize the work of others, for we know that their affairs may be of interest too. In short, we expect to cover all wireless activities to the best of our ability.

Our Limitations and the Remedy

We do not hope to please everyone; there never was a periodical of any importance published that did not have at least one reader who was fully convinced that things would be greatly improved if he were the editor. It is very likely that a number of our readers are going to feel that way about The Wireless Age. Those are the ones we want to hear from, for the man who refuses to let other people form his opinions for him usually has something to say. If there are things you don't like about our policy, the articles we publish, or if you feel that we have overlooked opportunities, tell us about it. You have our assurance that your letters will receive careful attention.

If we can get the right kind of letters we will publish them, whether favorable or unfavorable. Experience has proven that there are a number of deep thinkers in the wireless field, men who appreciate the value or original thought and research and find new ways, new possibilities, in connection with their work. If we can assist these men by printing information that will aid them in the smallest degree, we will be in the way of realizing some of our ambitions. But we cannot be expected to guess what they want to know.

We are firmly convinced that many of our readers are working along original lines. Perhaps they are experimenters of the higher order, sincere workers who are more than anxious to give their fellow men the benefit of knowledge acquired through painstaking research, but their modesty restrains them from mentioning what they have learned. To these men we say that no matter how trivial a discovery may appear, it is likely to be of a very great assistance to some other experimenter struggling along under difficulties, and if we can become the medium for an exchange of ideas among all classes of wireless men our educational work will be greatly augmented.

How You Can Help Us

HAVE the courage to make your convictions public; don't be afraid of ridicule. Every man bringing to the world a message worth while is misunderstood because it is human nature to reverence the past and be oblivious to new truths. Pythagoras was misunderstood, and Socrates and Luther and Copernicus and Galileo and Newton and Marconi, and every wise human that has added something to the knowledge of the world. The thing to do is to know *why* you think as you do think, explain it clearly to your fellow men, and you will gain the respect of all—if not at once, surely later on.

Once again, this is our editorial policy: To record interestingly the development of radio communication and to assist progress in the art by publishing all the instructive material we can secure.

We will make every effort in our power to prepare this material ourselves. Any assistance outsiders may give us will add just that much to the value of a magazine published solely to add something to the knowledge of each individual reader. THE EDITOR.

Realizing the Trans-Ocean Scheme

TWO miles out from the old historic city of New Brunswick, N. J., on a road that follows the banks of the Raritan river and the Raritan canal lies the transmitting half of the new wireless station to communicate with a similar station in Wales. Approaching the site from the south one sees a beautiful meadow streatching from the road to the canal bank. In this meadow are located the powerhouse, the auxiliary transmitting office and the first set of two masts. To the west of the road the land rises sharply for about a thousand feet and then runs nearly level for a mile or more. Looking up this rise the two cottages for the chief engineer and the assistant engineer are to be seen, and, further up the hill, the hotel which will accommodate the engineering force, the few operators required to work the auxiliary receiving apparatus and the riggers who keep the aerials and the mast system in shape.

The powerhouse is now beginning to look like a building, for the concrete work is completed up to the first story and ready for the brick work. The foundations for the motor generators are well under way and the steel girders and beams for the first floor are being placed. The observer is particularly impressed by the permanent and fire proof nature of the work on all of the buildings.

The auxiliary operating building, located about a hundred feet north of the power house, has the brick work completed to the roof and awaits the steel and roof tile to finish the work on the structure proper. All of the buildings at the station are being constructed of rough tapestry brick, laid up with a wide joint in black mortar. With red tile roofs and an attractive design they make a handsome appearance.

The two cottages are situated well back from the road among fine trees and, as they are above the highway, command an excellent view of meadow, canal and river. The porches are wide and big doors connect with the living rooms; the latter can virtually be made parts of the porches when it is desired to do so. The surrounding country is beautiful and the summer months will be appreciated by the engineers lucky enough to obtain positions at the station. Open fire places add to the coziness of the living room, while the sanitary arrangements are to be the best obtainable. When the station is completed a road will wind up the hill between the cottages and among the trees and shrubbery to the front of the hotel which is in course of construction.

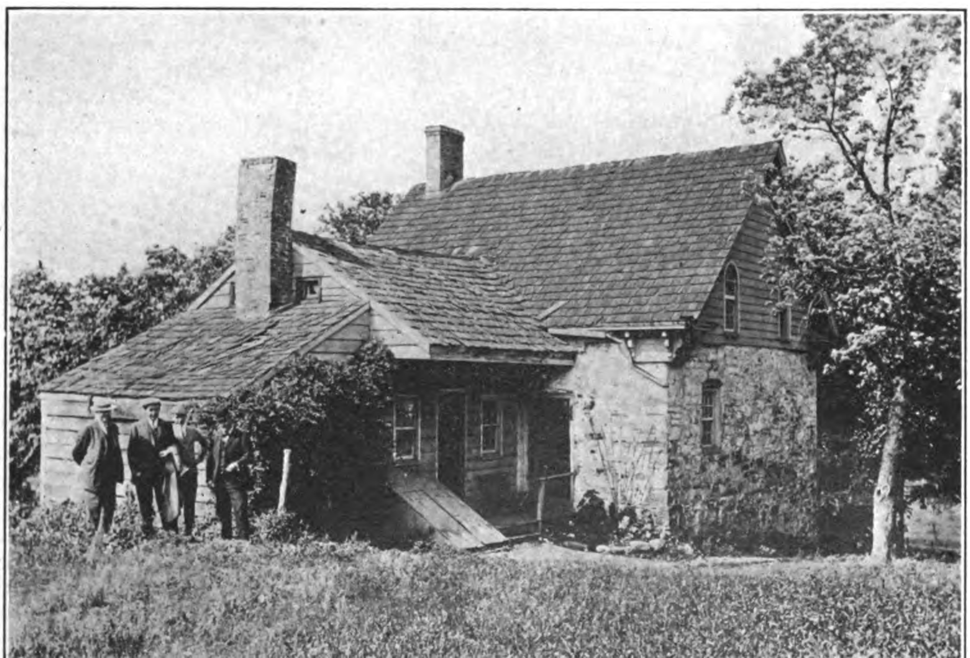
Far in the rear of the hotel are the temporary bunk houses for the laborers with accommodations for about seventy men. These living structures are more useful than beautiful, and, with their outdoor fire places and eating tables, give the appearance of a home for summer campers.

The non-arrival of steel has been holding up the structural work on all of the buildings. Among the building materials lacking are the steel sections for the masts. However, some mast sections are in transit from the manufacturers and will soon be shooting skyward. Practically all of the mast foundations are completed and forty-seven of the fifty-two mast anchors are ready to take the stays. A hoisting engine has arrived for hoisting the wooden topmasts which are assembled in the first two sections. All of the mast sections, bolts, etc., as well as the workmen, will be hoisted by the engine. The working force numbers only seventy-five men because of the delay in the arrival of materials.

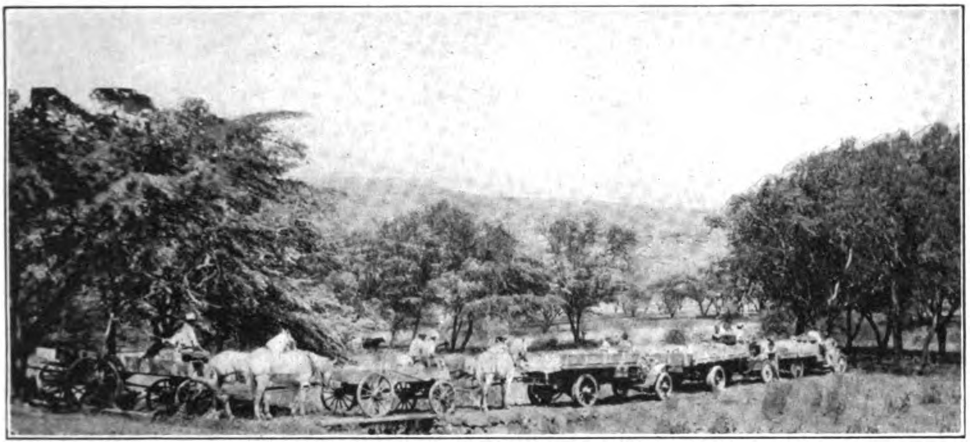
An important feature of the sanitary arrangements was the establishment of good water supply and sewerage system. On the hill far above the hotel has been sunk a well which has a flow of good water. There was a drouth in the neighborhood last summer, but it was possible to obtain water at all times from the well. A gasoline pump lifts the water high enough to fill the tanks in the wagons which carry it to the mast foundations for concreting.

An old historic farm house, long since in its prime, is being utilized as the construction office. The house has stood for more than one hundred and fifty years and, judging from the appearance of the huge hand hewn timbers, will stand for another century or so. In Revolutionary days this dilapidated house was a mansion of importance, having been at one time the paymaster's office of the Revolutionary Army; and rumor has it that Lafayette for a time had his headquarters in the building.

A lively demonstration occurred on the occasion of Mr. Marconi's last visit to this country. When he was looking over the station near New Brunswick, he was met by a delegation of the Italian



An Historic Farmhouse, Over 150 *Years Old and Good for Another Century of Service, is Being Utilized as the Construction Office at the New Brunswick Transmitting Site. Back in the Days of the Revolution this House Did Service as the Army Paymaster's Office.*

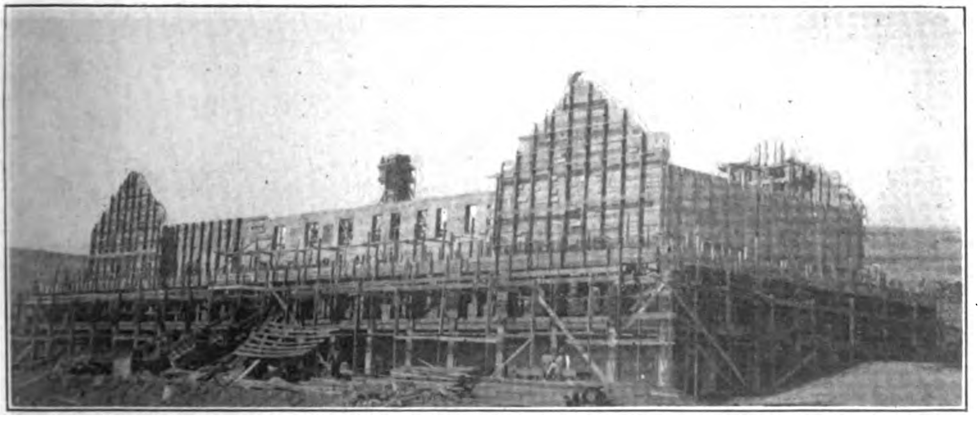


Three Motor Trucks and a Number of Teams are Used to Haul Material for the Honolulu Stations

workmen. He talked to them in their own language about the wireless stations and created much enthusiasm among the men regarding the work. An attempt was made to photograph the men at work, but when the camera was pointed at them they ceased their efforts and assumed artistic poses.

The crisp fall days add considerably to the attractiveness of a trip to Belmar, the receiving half of the New Jersey station to work with Wales. The summer crowds have left this resort, but the beauty of the woods and farms remain. It is an attractive road that runs from the station at Belmar to the property of the Marconi Company. The way leads along the Shark River, a famous salt water inlet, which has been dotted all summer by sailboats and launches. The countryside looks rather deserted as one travels to the Marconi Station. At the station, however, the busy season is still on and there is life aplenty.

The road leads along the top of a bluff overlooking the river. The living quarters are located on the bluff, while the operating house is at the foot of the hill close to the river. From the operating house the receiving aerials will rise to the first mast, located on top of the hill. Crossing the road at nearly right angles, and stretching westward for almost a mile, they will be carried on the top of six masts, each 300 feet high. The back ends of these aerials will be carried down at an angle of thirty degrees, being insulated near the mast top,



The Hotel Built at Marshall, Cal., for the Accommodation of the Operators is Nearing Completion and having steel running ropes attached. These ropes come down to the anchors, which consist of a pillar fifteen feet high with heavy iron weights free to slide up and down on them.

These weights balance the pull of the wires and are calculated to keep a definite tension in the aerial wires at all times, so that when the wind blows or sleet incrusts the aerials, the spans between the masts will sag down and the counter weights rise, keeping the tension constant. This straining pillar anchorage, as it is called, is an ingenious device which is a new departure in cable suspension. All of the heavy steel cables for staying the masts are in transit to the property and will be on the ground by the time the first of the mast sections arrive. The foundations for masts and anchors have been completed.

Approaching the property from Belmar, the hotel is on the left side of the road. It stands on the high ground, and from the porches one will be able to see over Shark River and out to the ocean. The building construction is the same as at New Brunswick; that is, red brick with concrete and red tile roof. The hotel will accommodate about thirty-five men. It is 168 feet long and is completed up to the second story. The cottages are located, one on each of two points of the bluff, to the east of the road, and at some little distance from the hotel. The work on these living quarters is more advanced than at the hotel, for the brick is all in place and the cottages are ready for the roof steel and the tile.

The operating house, down on the narrow strip of beach below the bluff, is progressing well, even though some trouble was experienced in making the foundation water tight. This trouble was due to the nature of the soil, for the entire hill side above the house is full of springs and the ground is always saturated with water. This condition will be of advantage when the grounding system is put in. The fifth building of the group will be a lighting plant equipped with a twenty-five horse power heavy oil engine, driving a 125 volt, direct current generator with a duplicate steam equipment for emergency use. Work on this building is in progress.

It seems there is always something to hold up construction work and at Belmar one of the incidents which contributed to this end was a strike by the laborers. The situation, however, did not become acute, as it was well handled by the construction superintendent, who soon had the situation well in hand. Since that time the work has been uninterrupted.

A large force will be required to handle the operating work and much will be done to make the hotel and grounds attractive as a place to live. The boating on Shark river will be a pastime in the summer, while tennis and other sports will be encouraged. In fact a jolly little community will soon be thriving in the section which is now cluttered up with building materials.

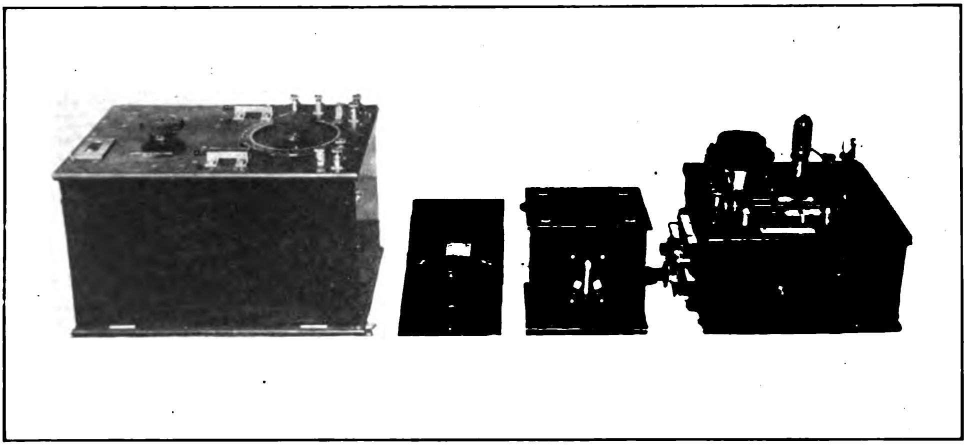
$100,000 STATION IN ILLINOIS

One of the largest wireless stations in the world will be established at the United States Naval Training Station at Lake Bluff, Ill. Captain E. R. Clark, commandant, has announced that $100,000 will be expended in its construction. The station will be able to communicate directly with San Francisco and New York.

SUBMARINE SYSTEM SUCCESSFUL

Christian Berger, of Hungary, the inventor of the signaling system for submarines, recently made a visit to Newport, R. I. Mr. Berger supervised the installation of his system on the submarines now building at Quincy, Mass.

The Berger method is a marked success, say the authorities who have conducted trials in this country, and the apparatus has been perfected by the inventor until communication can be established between immerged vessels within a radius of seven miles. It is said that the system will be installed on many battleships of the American navy. Count Szechenyi, husband of Gladys Vanderbilt, is interested in the Berger system.



From Left to Right, the Radio-Goniometer, Angle Divider, Test Buzzer and Tuned Receiver

The Direction Finder

An instrument which has made it possible to tell the exact points of the compass from which distress signals are being sent, also enabling navigators to avoid collisions with other vessels.

ANOTHER positive step toward safeguarding the lives of persons aboard ships at sea was taken when the Marconi radio-goniometer, or direction finder, was invented. This was shown during a recent test of the device on the steamship Northland, of the Eastern Steamship Company, on a trip from New York to Portland. The successful outcome of the test means that it will now be possible to tell the exact points of the compass from which distress signals are being sent, without regard to weather conditions, and that the captain of the rescue ship will be able to set his course immediately, and arrive alongside the disabled craft, in some cases, many hours before he could reach the scene without the aid of the invention.

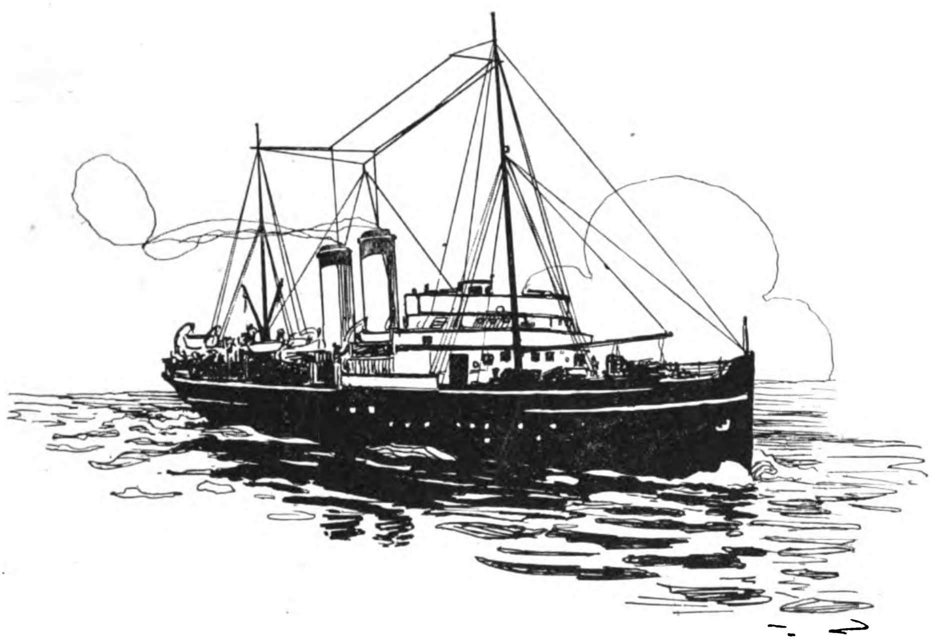
Inventors have studied for a considerable number of years to perfect a device that would indicate the directions from which wireless signals arrived. Various attempts were made to bring about the invention of the apparatus, but without success. It is now an established fact, however, that the question of furnishing this important aid to navigators has been solved by the development of the Marconi-Bellini-Tosi system. In 1905 Mr. Marconi took preliminary steps toward inventing a direction-finder, and in September, 1907, Messrs. Bellini and Tosi had succeeded in patenting an invention which proved adequate. In this invention the main principle is the use of two directive aerials at right angles to each other, and of an instrument called the radio-goniometer, by which their indications are compared.

The primary object of the invention is to enable the navigating officer of a vessel to take bearings of wireless telegraph stations, with a view to finding the position of his ship, or avoiding collisions with other craft. It is not asserted in behalf of the direction finder that the bearings taken with it exceed, or even equal in accuracy, those taken with an accurate optical instrument under favorable conditions. It is claimed, however, that reliable bearings may be obtained by means of the instrument when direct bearings cannot be taken because of unsettled weather, or for other reasons. Bearings may be taken within two or three degrees under reasonably good conditions. Under adverse conditions they may be taken within five degrees. In order to take bearings it is not necessary to swing the ship.

The power of the wireless station from which signals are being received governs largely the range of the installation. It is from ten to fifty miles, or more.

Aerial wires, distinct from those used for the main wireless installation of the vessel, are required for the direction finder. Two loops of wires of equal size, suspended vertically and crossing each other at right angles, are the essential features of the aerial system. As a rule the loops are in the form of a triangle of wires suspended by their top corners through insulators from a triatic, or other fore and aft stay, or from a sprit, gaff or bracket on one of the masts. Their horizontal base wires cross the ship at an angle of forty-five degrees on either side of its centre line and at right angles to each other, the two bottom corners of each triangle being ordinarily made fast through insulators to stanchions at the side of the ship. Connecting wires are taken to the instruments from the centers of the horizontal base wires of the triangular aerials, which are split by an insulator at their point of intersection. The range of the installation suffers to some extent if these connecting wires are very long, in addition to which the possibility of injury to the wires decreases the reliability of the system. Therefore it is advisable to keep the distance between the instruments and the center of the aerial system as short as is practicable.

The instrument indicates the angle which the direction of the station makes with the center line of the ship. It shows the line on which the wireless transmitting station lies. It does not, however, show in what direction along that line. For instance, it may indicate a direction twenty degrees off the port bow, but it does not distinguish between this direction and that which is diametrically opposite to it, namely, twenty degrees off the starboard quarter. To use geometrical language, it shows the direction, but not the sense. There will, however, seldom be any doubt as to whether the ship is approaching or receding from a land station, and, indeed, in most cases there is only one possible way of interpreting the indication of the instrument, as by the reverse interpretation the ship would be found to be somewhere inland.



Sketch Showing the Arrangement of the Aerial Used with the Direction Finder

If there is any ambiguity, two successive bearings taken of the same station, while keeping the ship on a fixed course, will place the matter beyond doubt, and will at the same time give the ship's distance from the station by the method ordinarily in use for that purpose. In the same way the ship's position may be found by taking simultaneous bearings of two fixed stations.

An obvious application of the direction finder is to find out whether the ship is on a course which will take it inside or outside a lightship or isolated lighthouse. A few signals from the lightship or lighthouse will settle the question as certainly as if the light were visible. Similarly, when making a harbor, a few signals from a station in the harbor will show immediately if the ship has drifted to one side of the entrance. When trying to locate another vessel while going slow in a fog, the indication of the direction finder would show by a steadily increasing strength of signal if the other ship were approaching, but might leave a doubt as to whether it was approaching on the port bow or overhauling on the starboard quarter. But a wireless query as to her course, addressed to the other ship, would remove the doubt at once.

Mr. Marconi, in his early attempts to perfect a direction finder, showed that a horizontally bent aerial would radiate and receive most strongly in a direction opposite to the free end. He also demonstrated that the relative intensities in various directions, when plotted out, gave a polar curve of a certain shape. A demonstration was soon afterward given by which the direction of arriving signals was found by swinging round such an aerial until the position of maximum strength of signals was found; or rather, in the actual experiment, by connecting the receiver in turn to several similar aerials arranged radially. The indications furnished by this method, however, were only approximate, and the type of aerial used did not provide a complete solution of the problem. G. S. Brown, as far back as 1899, had taken out a suggestive patent for a directive aerial, which was subsequently further developed by Andre Blondel in 1903. This aerial bears an important relationship to the latest development in the invention for finding directions.

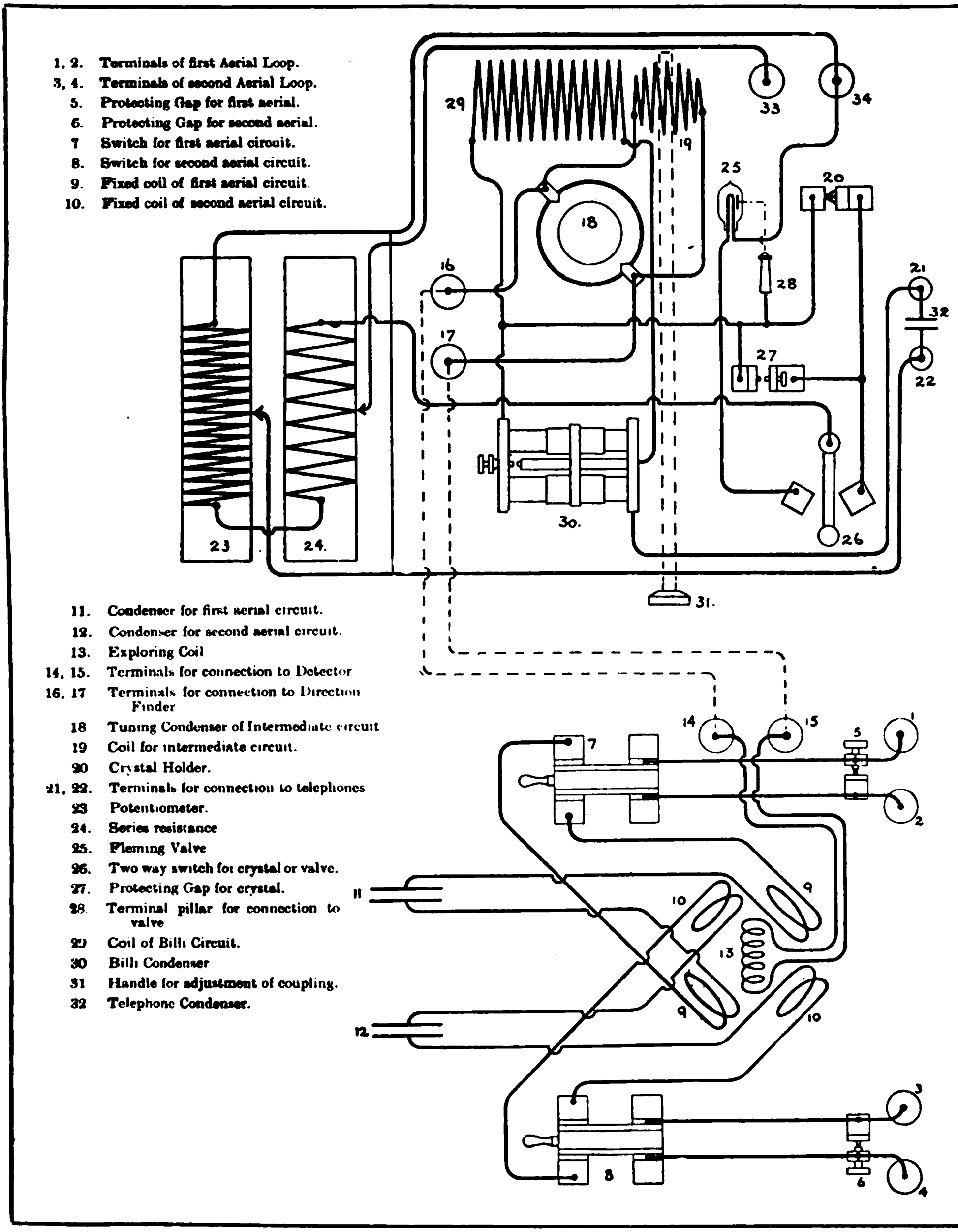
The direction finder, as it is to-day, consists electrically of two main parts, the aerial circuits and the detecting circuits. The aerial system is made up of two closed oscillatory circuits which are insulated from each other throughout and also from earth. Each of these oscillatory circuits consists of an aerial loop, in series with which are inserted a coil of wire and a condenser; the condenser is inserted in the middle of the coil of wire, for symmetry. The two aerial loops, which are of equal size, are suspended in vertical planes crossing each other at right angles. The two coils of wire are also of equal size and also cross each other at right angles in vertical planes. They are contained in a box, together with their respective condensers, which are made variable for the purpose of tuning the aerial circuit to various waves. One handle varies the two condensers simultaneously. Inside the crossed coils, a third coil called the exploring coil is mounted on a vertical spindle by means of which it can be set at various angles with reference to the fixed coils. The detecting system consists of a pair of telephones, and a crystal of carborundum, in a series with a potentiometer and battery, which are required to bring the carborundum into a sensitive condition. The detecting system is contained in a separate box, and is connected by wires to the exploring coil, which picks up the signals from the aerial circuits and hands them on to the detector, where they are rendered audible in the telephone.

Each aerial loop is a directional aerial which receives best when its plane is in the direction of the sending station. If its plane is at right angles to the direction from which the signals are coming, it receives nothing. In intermediate positions it receives signals, the induced current due to which varies as the cosine of the angle between the plane of the aerial loop and the direction of the sending station. Except in the case when one of the aerials is in a plane exactly at right angles to the direction from which signals are coming, currents are induced in both the aerials, their relative strength depending on the direction of the sending station with reference to the planes of the two aerial loops. These currents pass through the corresponding crossed coils in the direction finding instrument, and produce in the space enclosed by them two magnetic fields at right angles to each other. The two fields, whose relative strength depends on the relative strength of the currents induced in two aerials, combine to form a resultant field at right angles to the direction from which signals are coming. The exploring coil will consequently receive the strongest signals when its plane is at right angles to that of the resultant field; or in other words, when its plane is in the direction from which signals are coming. A pointer attached to the splindle on which the exploring coil is mounted indicates the position of the latter, and consequently the direction of the sending station. It has been assumed that the crossed coils are in the same planes as the crossed aerials. If the instrument is moved from this position the positions on the scale which represent the crossed aerials remain the same, so the pointer indicates correctly with reference to them.

The testing instrument consists of an oscillatory circuit composed of a condenser and a coil of wire, the wave length of which can be adjusted by a switch to either 600 or 300 meters. This oscillatory circuit is excited by means of a buzzer and battery which are switched on by the same switch that sets the wave length. The aerial connecting wires are taken past the coil of the testing circuit at equal distances, so that the two aerials are equally excited by it. If the aerials are in every way identical, as they should be, the direction finder will show a direction corresponding to the position of the testing coil with reference to the aerial connections. This is ordinarily arranged to give a direction along the course of the ship, which is 0° on the scale of the direction finder. If there is a bad connection in one of the aerials, the introduction of the resistance due to it reduces the current in that aerial and consequently alters the direction shown by the direction finder; and if the insulation between two ends of one of the aerials becomes bad, the same effect is found. When one of the aerials becomes earthed, the phase of the current in it is altered, with the result that a rotating field is produced in the direction finder, and no point can be found in which there is no sound in the telephone. The type of buzzer employed is one in which a non-inductive shunt is connected across the magnet coils, with a view to reducing the sparking at the contacts and consequently making the interruption as sudden as possible. The current which works the buzzer is passed through the coil of the testing circuits, and the electro-magnetic energy so stored is released by the sudden interruption of the current which discharges itself into the condenser, and sets up oscillations in the circuit.

The exact position of the aerials naturally differs on each ship, and is mainly a matter of convenience. Deviation, owing to the ironwork of the vessel, is practically non-existent, unless the conditions are quite exceptionally unfavorable. If it exists it is a constant factor that can be allowed for. It is generally convenient that the instruments should be in the wireless cabin, chiefly for silence, and in order to be in touch with the ordinary installation for calling up shore stations, or to disconnect the direction finder, and so protect it before transmitting on the ordinary aerial. But it can equally well be installed in the chart house, or any other position convenient for a navigating officer, which is connected with the wireless cabin by telephone.

Whatever position be fixed upon, the wires from the aerial system are led directly to the radio-goniometer box, which contains two very accurately paired air condensers with an adjusting handle and the radio-goniometer proper. One condenser is inserted in the circuit of each aerial and both aerials are thus tuned simultaneously. When the instruments have been adjusted to any arriving wave, its direction, or rather the plane of its direction, is indicated directly by turning the index handle of the radio-goniometer till the position of exact signals is found. The accuracy with which the direction can be determined depends almost entirely upon the care with which the observations are taken, as the error due to the instrument does not



Connections of Direction Finder with Tuned Receiver exceed one degree. Any error in laying out the aerials will appear in the result, because they are the base line with respect to which the observations are made. Under ordinary conditions, however, bearings can be taken within two or three degrees and the error should never exceed five degrees.

One of the occasions on which the direction finder can be used to advantage will be in time of fog. It is essential, say, for the commander of a ship to determine whether the vessel is on a course which will take her inside or outside of a lightship or isolated lighthouse. A few signals from the lightship will settle the question as surely as if lights were visible. On the other hand, a ship's position can be found either by taking bearings of two fixed stations simultaneously, or by taking two bearings of the same station at an interval of time, while keeping the ship on a fixed course. It is possible that in time of fog it will become the custom for each ship and lighthouse to send out a pre-arranged series of signals. If a ship, however, wishes to take the bearing of another ship or station within range, it can call up the latter by the ordinary wireless installation, and ask for a few signals for the purpose.

The test of the direction finder on the Northland was made under unfavorable conditions. The wireless cabin on the vessel is centrally located between two smokestacks on the boat deck and the height of the aerial above the cabin is only about forty feet. These conditions made the installation of the special antennæ difficult. They also made the vertical and base lines of the wire triangles very short, decreasing to a considerable extent the efficiency of the set. Despite these drawbacks, signals were received on the direction finder from the Marconi station at Siaconsett, Mass. These signals were accurately measured and the bearing of the Northland from Siaconsett was determined by means of the direction finder at a distance of forty-two miles. The signals from Siaconsett were strong and were good for approximately twenty to twenty-five miles more. About twelve observations were taken with various ship and shore stations in both daylight and darkness, at distances ranging from five to forty miles. In each case the results obtained were compared with the navigating officers' charts and compass. The readings were pronounced correct. A wireless message, telling of the successful result of the test, was sent to Mr. Marconi.

An inspector of the American Marconi Company, who was aboard the Northland during the test, spoke as follows regarding the invention:

"We will imagine that we are on a ship going along at the rate of fifteen miles an hour. The operator on board our ship receives a message that another ship making twenty-five miles an hour is near us. He cannot tell whether the ship is ahead, astern or abeam. Now, with the radio-goniometer equipment he receives the exact location of the other vessel, and the danger of that vessel running us down is removed, as our captain can easily change his course sufficiently to allow the faster vessel to pass in safety

"On the trip up from New York we made several tests along the same lines and, by using the apparatus after I had secured the position and bearings of the Northland from a certain point, I compared my figures with the captain's compass and charts and found that we were absolutely correct.

"The apparatus will be particularly valuable in foggy weather, as ships will be able to know their position at all times. On many vessels the captains lay their course for the Nantucket light vessel, and after they have made the light vessel they trace their course to another point. Often they run inside of the lightship and often they miss sighting the light vessel. That danger is removed by the radiogoniometer, as the Nantucket light vessel is equipped with the wireless."

Hoodoo Jenkins' Cowardice

A Fiction Story

By **WALTER S. HIATT**

If since the day you were born your existence had been a series of mishaps, often resulting in injury and even death to others, and you were asked to take charge of the wireless equipment of a dirigible balloon, what would you do? That is the problem presented to Hoodoo Jenkins. The story tells how he worked it out.

"WELL, my hearty, will you come with me?"

The person who put this question to Hoodoo Hero Jenkins was Mademoiselle Marie, lady aeronaut. Scheduled to give an exhibition of plain and fancy air navigation at a New Jersey seacoast fair, she had discovered at the last moment that the wireless man engaged to complete the exhibition by sending messages from the sky had failed to appear. Whereupon Jenkins had been routed out of the crowd, presented to this wonderfully striking young woman, and offered one hundred dollars to fly with her in her dirigible balloon runabout.

Jenkins, short, tough as a cypress tree, face fairly shining with hope, stood uncertainly and looked into the handsomest pair of eyes that he had ever seen. They were blue, sea blue, blue-grass blue, full of bold beauty, yet softened by an indefinable, indefinite flash of modesty lurking in them.

It seemed to him that he would give his soul for the asking to the tall owner of that pair of eyes; which made it hard to refuse her request. Besides, he needed that hundred badly. But what could he do? From experience, he knew that should he go up in that balloon a fatal accident would happen, one that would probably result in the death of the fair aeronaut.

"But I'd rather not," he replied lamely to her still questioning eyes. "I don't like the looks of the sky. There might be an accident."

A gleam of insolent scorn flashed out of her eyes and burned him to the quick.

"So you're afraid, my dear little one; that's the way the wind sets? Fear not! I assure you that I'll take good care of you." The men holding the ropes laughed at this sally. The blood rushed to the face of the operator; but he still hung back.

"I'm afraid—for you," Jenkins explained simply, in a low, earnest undertone.

Mademoiselle Marie's face lighted with a certain pity. She had nothing but scorn for the unmanly excuses.

"Oh, please come," she begged; "the crowd is waiting."

"You see I'm not very lucky—" Jenkins interposed, desperately trying to tell her why she should not fly with him.

But Mademoiselle Marie, unaccustomed to refusals, would not listen. She had in the brief moments of the conversation observed the evident admiration of the man for her, and so she now unceremoniously took him by the shoulders and bundled him into the car.

Jenkins had wanted to tell her that he had lost every job he ever held because of the accidents that happened to the ships he had sailed with. Every ship he had set foot on, except submarines, had blown up or broken up or burnt up or run ashore or been run down. That was why he was out of a job now. Superstitious, the captains wouldn't have him any more, although he had the reputation for always doing the best he could in time of danger. That's how he got the name of the Hoodoo Hero.

While his heart wanted to tell all this to Mademoiselle Marie, his lips said: "All right, I'll go." So soon as he said these words, Jenkins' face illumined with a bright smile. He hoped for the moment that nothing would happen. Hope was his strong point.

The blue eyes of Mademoiselle Marie danced joyfully. She would now be able to give in all of its perfected completeness her famous exhibition.

"Fine!" she exclaimed in her picturesque slang. "Just move along to your seat. You'll find your instruments in order, I guess. Let's give these rubes a run for their money and then we'll drop over to a roof garden in New York tonight and have a bite to eat all by our lonelies."

Jenkins' face grew brighter yet with hope when he heard this. He resolved that if he could escape an accident this time, and enjoy with her the promised evening, he would cheerfully accept all the overwhelming catastrophes that might come ever afterwards.

Mademoiselle Marie gave some quick orders to the helpers, took her place at the steering gear, made a few deft motions with her hands, and soon the earth began dropping beneath them. A wild cheer broke from the upturned faces of the vast crowd of people below; the continued cries growing fainter as they quickly swam upward at a gentle angle.

Reaching the thousand-foot level, Mademoiselle began her convolutions; she dropped the dirigible up and down, spun about in lazy circles for a few minutes to show the crowd the ease with which she could manipulate her machine; darted here and there with seeming recklessness, and slid dizzily down on a great S until Jenkins could see the rushing to and fro of the frightened crowd. As she reached the tail end of the S, while the crowd stampeded to get out of the way of the falling projectile, she righted and sharply wound upward along the twisted track.

"Look at the boobs," exclaimed Mademoiselle Marie, turning her pair of twinkling eyes in Jenkins' direction. "They're afraid of having this machine fall on them. My, how they'd like to see us fall and break our necks! How would you like to fall?" she asked mischievously, with a mocking curl of her firm rosy lips.

"Oh, I'm not afraid with you," he replied. "You certainly are some aeronaut. But please do be careful." There was no need to tell her just how afraid he was, nor why. The proverbial bad luck would come soon enough without coaxing it along. Then, too, it might make her nervous to suggest his trail of misfortunes.

"I promised you I'd be careful and bring you back safely to earth and I will, little boy," cried Mademoiselle Marie, as she toyed with the self-starter and threw the switch open. An answering roar told him that the propeller was revolving swiftly. At the same time the machine quivered and they rushed upwards again. A peep at the barograph a few minutes later told him that they were past the first thousand-foot mark. She held her planes at a dangerous angle as they sped on, upwards. She was giving the spectators their money's worth and at the same time, he fancied, amusing herself by trying to frighten him. Assuming a composure he did not feel, Jenkins leaned over the rail and glanced anxiously at the land as he observed the hot, stifling vapor of the early afternoon, warning of weather changes. He could see the shore line indistinctly, where the flat land met the flatter sea.

When the dirigible must have been but a mere fleck of cloud to the people below, Mademoiselle Marie brought the planes to a level and began circling on even keel.

"Now you can do your part of the job," she announced. "Just put your fist on the sending key and tell the operator waiting down there that we are now some 4,500 feet high and that Mademoiselle Marie sends greetings to the rubes and invites them to call on her."

The Hoodoo Hero dropped the aerial radiator over, received an answer to his call, and clicked off the message.

The land operator gave his O K, but before signing off sent this:

> FAIR MANAGER SAYS TO HURRY WITH THE REST OF YOUR PERFORMANCE, AS THE WEATHER IS THREATENING. CROWD MAY LEAVE.

Jenkins repeated it to his companion. "Tell him we will try to give the water act and a full performance," she said, with a brisk toss of her head that made her hair glisten like gold in the white light.

With a Swift Movement He Leaped Into the Angry Waters

The rest of the performance included a gliding stunt over the sea, which could be properly seen only from the grand stand overlooking the beach. This feature, intended only for the eyes of those who had paid an additional fee, consisted in disappearing entirely in the sky in a landward direction and then, while the crowd was wondering if she was lost for good, to double back and suddenly reappear from the unobserved sea side of the crowd.

She rapidly explained her trick to Jenkins. "Have you got the nerve to get out of sight of land?" she demanded, with a steadfast gleam in her eyes.

"I'd rather not. It's not quite safe to go so high with a storm threatening," he objected. "Oh, bother!" she exclaimed, in a tone eloquent of her annoyance. "It advertises my act. Of course, if ——"

Jenkins saw that she was about to use the despised word, "coward," and he could not bear to have her say it.

"All right, go ahead," he interrupted, briskly.

Mademoiselle Marie grasped the steering wheel firmly; again the motor roared and the propeller whirred and tore at the air. Up, up, up they went into that brassy sky until the earth disappeared from view. Then they soared about and sped seaward. They ran thus for perhaps twenty minutes. Jenkins kept on his head 'phones and listened in to the messages flying along the coast. The noise of the motor made hearing difficult, but he managed to catch one message from the Caronia, fifty miles out, telling the Baltic that it was raining cats and dogs, with promise of a blow. "The bottom is falling out of the barometer," it added.

Jenkins shouted this message to Mademoiselle Marie.

"I should worry, brother," she replied. "We're almost far enough out now, so we'll begin dropping soon."

They sped on in silence, the air growing colder with every turn of the propeller. The white light, too, began to shade. Presently Jenkins' ear caught an ominous sound. The engine skipped an explosion. Pale as death he glanced at his fair companion. Intent on steering, she had not noted it. Jenkins, still afraid of that cold, disdainful word "coward" on the curl of her lips, waited for further warning. Listening intently, he heard the engine skip three beats in quick succession. Now he was certain. The Hoodoo Hero was again on the job. Ten to one they were running on the dregs of the gasoline tanks.

He looked quickly at his partner. There was an answering gleam in her eyes—not one of alarm or of fright, but of recognition. She had heard too. It was plain to both that soon their flight would come to an end. How and when? It was a detail hardly worth considering. He saw that Mademoiselle was preparing to drop, possibly hoping to reach land before the last of the gasoline puffed away.

"Hold her steady," he cried, with a warning gesture. A new note of command rang in his voice, the note that had won for him the "hero" part of his title.

His instruments crackled the call of the land operator with whom he had been in communication, and told him to get motor boats out to sea to search for them in case they had to abandon the dirigible. He received his O K, none too soon. Already the beats of the engine were coming more and more intermittently.

"Now you can volplane!" he shouted to the pilot. "I've sent a message that will give a real thrill to that crowd you were so anxious to interest."

"Nix on the sarcasm, Bill," and she smiled in that wonderful way of hers.

The glide was abrupt, yet not so steep as to send them tumbling through space at the first sharp gust of wind they met. Soon they began to meet shifty air currents, and then the sea appeared as a dark flat surface far below them, faintly disturbed by tiny tossing caps of white. The shore line seemed like a huge, endless cable cast adrift.

Could they make that shore line before their carrier, robbed of its motor power, and heavily weighted, settled into a sea that soon would be raging?

Jenkins looked at the woman and she looked at him. Neither could answer that dreadful question. But if the silken bag of gas overhead would only breast the wild winds, Jenkins thought he knew a way to keep Mademoiselle Marie afloat until help came.

"Don't be afraid, there's a chance yet," she called, seeming to divine his thoughts.

A grim smile crept about the lips of Jenkins as he heard her use that word "afraid." He would show her how much afraid he was. He had not been called "hero" for nothing, even if it had the "hoodoo" qualification.

Just then the wind gave a decided answer to the question of reaching that straggling shore line. It broke from off the land in a diagonal direction from the south, carrying them rapidly off shore. Jenkins took another look at the sea, where the rollers were now beginning to pile up under the first blasts of a yoke-of-oxen gale. A tiny motor boat was racing along, vainly trying to follow their course.

Then, as the runabout kept dropping lower and lower, splashes of spray began to leap up and snatch at them; the wind fell off and veered, carrying them again inshore.

"O joy!" shouted Mademoiselle Marie, with a laugh in which there was a catch. A new danger had arisen.

For just as the wind began to seem favorable, the peril from the vicious waves presented itself. With the dull thud of a piece of lead, a cross wave broke aboard and drenched them.

Jenkins saw a greater one flying towards them. Death was in it. The weight in the machine must be lightened. "Good bye, sister!" he called, flinging off his coat.

She reached over and grabbed him. "If you go, I go too!" Admiration was shining in her deep blue eyes.

"I'm some swimmer—for a coward," he answered, trying to twist a choking sob into a laugh. With a swift movement he threw her to the bottom of the car and leaped into the angry waters. As he sank, he saw the lightened car sweep onwards toward the shore.

The hungry maw of the sea reached out and grabbed him, tossed him up like a ball, rolled him over and over, and dragged him down like a bucket in a well. Then, gasping for breath, his eyes struggling for light, he came up in the hollow of a great wave. Again he was churned and rolled and smashed, carried in the grasp of a myriad-fingered monster. After a world of night, he rose upon the crest of a wave for an instant. He saw the runabout gliding shoreward to safety. With a tired sigh he closed his eyes.

A long while afterward he was vaguely conscious of muffled voices and a strange rocking motion. His eyes opened and he discovered that he was being borne up the beach by a group of life guards. He felt himself lowered to the soft, warm sand.

Two arms stole about his neck. The blue eyes of Mademoiselle Marie looked into his; their lips met. The Hoodoo Hero struggled to his feet, as if prodded with a live wire.

"Say, how about those eats all by our lonelies?" he demanded.

"Surest thing you know," came the response in a tone that suggested a long series of cozy dinners à deux.

Annual Meeting of English Marconi Co.

At Which a Final Dividend of Ten Per Cent Was Declared—A Policy on Radiotelephony Outlined—Nearly a Half-Million Dollars Was Set Aside for a Reserve Fund, and Development Along Broader Lines Was Announced

REPORTS of the world-wide progress and development made by the Marconi system, of interest to the public as well as to the stockholders of the corporation, were brought out at the sixteenth ordinary general meeting of the English Marconi Company held recently in the Whitehall rooms in the Hotel Metropole, London. The plans for development include the formation of a new Brazilian company and the Betulander Automatic Telephone Company. It was announced that the directors of the English Marconi Company had recommended the payment of a final dividend for the year 1912 of ten per cent. on both classes of shares, and that they had also appropriated $486,600 for a reserve account.

Reference to Imperial Scheme

Interest and applause marked the meeting. Mr. Marconi, chairman of the Board of Directors, in his remarks, referred to the contract entered into by the English company with the British government regarding the imperial wireless scheme and said that when he had addressed the stockholders on a previous occasion on the same subject he would not for a moment have believed that the spirit of fair play in this country could have reached so low an ebb. Godfrey C. Isaacs, managing director, mentioned the criticism which had been aimed at him and thanked the stockholders for their loyal support throughout. In referring to wireless telephony Mr. Isaacs stated that "until the Marconi Company is prepared to say exactly what definite results in a practical way can be obtained from wireless telephony it will remain silent."

The Company's Share Transactions

In his opening remarks Mr. Marconi spoke of the report of the directors. "We have endeavored in that report," he declared, "to dispose of the misunderstandings which seem to have prevailed in some directions respecting the patents and shares in associated companies, and I hope we have now made it quite clear that there is no such thing in our accounts as profits derived by means of writing up shares."

Mr. Marconi said that he wanted it understood that the company does not buy and sell shares, in the meaning which is generally given to those terms. "Such share transactions as we enter into are closely allied," he declared; "in fact it would be difficult to separate many of them from business which would come under the heading of contracts. To give an example; speaking in a general way, we may enter into an agreement to erect certain stations or do certain work, all of which, of course, is the legitimate business of our company, for which it may not be convenient at the time to pay us in cash. In such cases we may receive payment in shares. In due course we will dispose of a number of these shares and turn them into cash. The fact, however, is that the money which we have received for those shares is a payment for contracts executed, services rendered or whatever the particular consideration may have been. If we are fortunate enough to dispose of shares higher than the par value or the price at which they have represented payment to us, so much the better for our profit and loss account. During the past year, as is well known, and as we have stated in our report, we benefited in this way, and accordingly we think it prudent to take advantage of the occasion and allocate £100,000 ($486,600) to a general reserve account."

Mr. Marconi's remarks regarding the imperial wireless scheme were greeted with cries of "hear, hear." He declared that he would not have believed that "for such considerations which obtained in connection with the whole of this campaign a British industry such as ours should have been so imperilled." He continued as follows: "I would remind you that wireless telegraphy has become an industry of considerable importance, and we are, and for many years have been, the only company maintaining British supremacy throughout the world in this industry, and always in the keenest competition with foreign companies. We manufacture on a very large scale in this country and give employment to an immense number of British subjects. I think that it should not be easily forgotten that, while this company is carrying on a remunerative business for its stockholders and establishing a large industry, it is also accomplishing work of the highest importance for civilization by facilitating and cheapening telegraphic communication between England, its colonies, and foreign nations, besides greatly reducing the peril of ships at sea. Has it been our fault and have we been deserving of the treatment to which we have been submitted because we have been the only company to maintain British supremacy in this wireless industry?

The Action of Parliament

"It has required the most strenuous efforts on the part of our managers and administrators to protect our interests abroad during all this period, and I am glad to say that we have succeeded in doing so. But it must not be supposed that much of the programme which we had in immediate contemplation when we addressed you last year has not suffered some delay. Our accounts speak of the progress which we have made, but that progress would have been far greater to-day had it not been for the circumstances to which I have just referred. When our tender for the construction of the imperial stations was accepted in March last year, we considered, as we had every right to do, that we had entered into a definite contract requiring only such minor modifications, if any, that we might be willing to agree to in the actual wording of the agreement itself and to the formalities of ratification by Parliament. I use the word, 'formality,' for I cannot learn of any instance when a contract has been negotiated by a number of government departments, all of which were in continuous consultation, each putting forward proposals and suggestions and doing its utmost to obtain everything it could reasonably demand and support, and, finally, all being parties to the striking of a definite bargain. I cannot learn of an instance where Parliament has ever before had recourse to the sledge-hammer power which it possesses of placing a private enterprise in such a position that its only alternate to making further concessions demanded of it would be the imperilling of its reputation and business throughout the world.

Plans of the Brazilian Company

"Such has been the anxious and responsible position which your directors have had to face, and it is therefore with no small degree of relief and satisfaction that we have been able to inform you that, notwithstanding Parliamentary intervention, we do not believe that the altered conditions of the contract will prove of any material disadvantage to the company—but thanks only to the strong position which our company holds. We have also great hopes that the company, having emerged successfully from such a severe and ruthless attack, its reputation abroad will have been not only maintained but enhanced."

Mr. Marconi declared that the business of the company continued to make most satisfactory progress. He said that since 1910 the company had been making efforts to open telegraphic communication between Europe and Rio Janeiro and other centres of the Brazilian Republic. The president of Brazil, he declared, had signed a concession for this enterprise for a period of fifty years. He spoke optimistically of the formation of the Brazilian company. "At the earliest possible moment," he said, "we shall form a new Brazilian company which will purchase from us our long distance rights together with this concession, and every effort will be made to construct the stations with the least possible delay. The new company will no doubt enter into an agreement with the American company by which the station to be built at Para will conduct a service with New York and other parts of the United States. We hope that this work will be the start of a network of stations opening up cheaper telegraphic communication between the South American States, Europe, the United States, and other parts of the world, which should not only secure to this company a substantial, increasing and lasting revenue, but add considerably in value both to our interests in the American and other of our subsidiary companies. We regard the completion of these negotiations as the laying of the foundation stone of one of the most important edifices in the world of wireless telegraphy which will further cement the business which the company is creating independently of any competition and irrespective of all patent rights."

Subsidiary Companies Doing Well

The progress of the subsidiary companies is very satisfactory, Mr. Marconi declared. He said that "we are each year coming nearer to the time when, with the completion of long distance stations either under construction or about to be constructed, we shall realize the principal source of profit and the one to which we attach most importance to be derived from wireless telegraphy." He remarked that the construction of the long-distance Norwegian station had been commenced and commented favorably on the assistance which the Norwegian government was giving to aid carrying on the work.

The increased business of the Marconi International Marine Communication Company, Limited, necessitated the issue of more of the authorized capital of that company. "The business of the company is sound and continually increasing, and I have every hope that the dividend for 1913 will show an increase over the ten per cent. paid for the preceding year," declared Mr. Marconi. "I have reason to believe that the directors of the company intend in the future to pay six-monthly dividends, an interim at the end of the year, and a final upon the completion of the accounts."

Growth of the Russian Company

To such an extent has the business of the Russian Marconi Company grown that it has been necessary to increase its capital and it is planned to make a further increase. Consent was obtained from the Russian government, Mr. Marconi said, for an increase of 600,000 rubles ($309,000) and authority has been asked for a like sum. He added that there was a plan in contemplation to convert the shares into shares in a trust company, in order to have a market for them in England. In Australia a new subsidiary company has been formed and considerable business has been transacted by the English company with the Italian government, which is giving a full measure of support to the Marconi enterprises.

A hint regarding the plans of the company to expand in the future was given by Mr. Marconi in the following words: "We have other important negotiations pending about which, however, we cannot give any particulars at present. Shareholders may rely, however, that, as and when they are completed, full information will be immediately communicated to them."

Mr. Marconi believes that there is a good business future for the automatic telephone. He declared that "your directors resolved to avail themselves of the opportunity of securing the patent rights of what they are advised and believe to be the best automatic telephone. That a very considerable business is to be done in automatic telephones there is no doubt, and the world-wide organization which we possess should be an asset of considerable importance to the development of such a business." The Betulander Automatic Telephone Company will purchase from the English Marconi Company the patent rights and take over the contracts and negotiations which have already been entered into in various countries. The system will be shown in operation at Marconi House, where visitors will have an opportunity to inspect it.

In speaking of the growth of wireless telegraphy Mr. Marconi said: "Although there is no doubt that wireless telegraphy is in a condition of rapid development, I think that it can safely be said that this method of communication is based, and will continue to be based, on the production and utilization of electric waves. Now there is no mystery about electric waves, to my mind. They can vary in length and intensity, or they may be continuous or discontinuous.

Spark and Continuous Systems

"There seems to be a prevalent misconception in the lay mind that continuous waves are in some way essentially different from the discontinuous waves produced by what are called spark systems. Such a view is quite erroneous. The Marconi Company possesses methods of its own which permit it to utilize when and where it may think desirable either a spark system or a continuous wave system, and this was demonstrated to the members of the Advisory Committee appointed by the government during the tests carried out for them between Clifden and Glace Bay. My system of continuous waves is now installed and in working order at the Transatlantic station at Clifden. Important tests are now being conducted, but considerable work and time are required before it will be possible to determine in a definite manner whether the continuous wave system possesses advantages for long-distance transmission over the discontinuous, or what is called the spark system. In any event I think it well to make quite clear that this company possesses efficient methods for utilizing either system. As in the past, we have this year applied for several, and what I believe to be, valuable patents which embrace further important improvements in the transmitting and receiving apparatus."

What Others Have Tried To Do

Mr. Marconi next spoke of trans-ocean work, saying: "I should like, without in any way desiring to belittle the attempts made by others, to establish communication by means of wireless telegraphy across the Atlantic Ocean to point out to shareholders that the achievement of telegraphing across the Atlantic is not such an easy matter as it may appear, and I think that the public, and even distinguished inventors, have erred on the side of optimism with regard to what they expected would shortly be done.

"During the last few months we have read in the public press that communication was shortly to be established between Europe and America by means of the Poulsen or Goldschmidt system. I should like to remind you that Professor Fessenden, writing in the Electrician, issue of February 22, 1907, said that in January, 1906—that is well over seven years from this date—he received messages in Scotland from Massachusetts with an expenditure of less than one kilowatt of electrical energy. Again, the Poulsen Company, in the Electrician of November 15, 1907, nearly six years ago, stated: 'The engineers of the company are very confident that they will succeed in printing transatlantic messages, and are positive that they will not be limited to telephonic reception.' Then again, with regard to the De Forest system, we have the following extract from the Electrical Review of April 6, 1906—seven years ago: 'The daily press announces that the De Forest Wireless Telegraph Company has sent messages from its station at Coney Island to Ireland, a distance of 3,200 miles. On one night 1,000 words were transmitted, of which 572 were received and recorded.' It is further added that when the correct pitch to use for Ireland has been ascertained, commercial work will be started across the Atlantic. It is then proposed to send messages from San Francisco to Ireland, with two relay stations.' None of these systems I have just mentioned has yet succeeded in establishing a service of any kind across the Atlantic, notwithstanding these statements which were made six or seven years ago."

Prudence in Business Policy

The financial affairs of the company were touched upon by Mr. Marconi as follows: "In view of what I said at the meeting last year, no doubt there was some little disappointment at our not declaring a second interim dividend in December last, and also that we should have decided to recommend a final dividend for last year of ten per cent. on both classes of shares, which, as you know, represents seventeen per cent. for the preference and twenty per cent. upon the ordinary. The unforeseen circumstances, however, which occurred since my last address have dictated a policy of prudence with which I feel sure shareholders will not quarrel."

In explanation of the establishment of the reserve fund of $486,600 Mr. Marconi says that "In a new industry such as ours developments are continuous and lead frequently to sudden and substantial demands upon our resources." He declared also, that "we have thought it wise, therefore . . . to carry forward to the next account £146,000 ($730,436.)"

In concluding his remarks regarding the financial affairs of the company Mr. Marconi said: "The final dividend of the year must, of course, be declared at the general meeting, when the accounts have been passed by our auditors. At the end of each year, however, we should be in a position to estimate approximately the profit earned during the year, and so decide upon any interim dividend which should be declared and paid at that period. By adopting this course, assuming our business continues to progress as we hope, distributions would take place six-monthly."

Mr. Marconi then took occasion to defend and praise Mr. Isaacs. "Your managing director, Mr. Godfrey Isaacs," he said, "has been subjected to a great number of most ungenerous insinuations which never could have been made by any one personally acquainted with him and which could not be and are not believed by any one who knows him, or who has worked with him. But it would appear in this country, as in most others, when politics is introduced, an atmosphere prevails in which there would seem to be let loose some pernicious element destructive of the equilibrium of an otherwise well-balanced mind.

"I think Mr. Isaacs merits the most sincere congratulations of the shareholders on having carried on the business so successfully during the past year under the great difficulties which I have rereferred to, and considering what a great amount of time was taken up in defending the interests of the company and even in protecting his own honor and reputation, all of which he has done so effectively."

Mr. Marconi next made a motion that the report of the directors and the statement of accounts be submitted, approved and adopted. He called upon Mr. Isaacs to second the motion and the latter said:

Mr. Isaacs' Tribute to Mr. Marconi

"It would be idle for me to pretend for a moment to you that the troubles which we have gone through during the past year have not been of an extremely painful nature to me, and it has required all the assistance, the support, the confidence, the loyalty and the encouragement which I have received, firstly from our illustrious chairman; secondly from every single member of my board; thirdly from every manager and head of department throughout the whole of this great Marconi organization, and fourthly, and to which I attach no small degree of satisfaction, the immense number of letters which I have received from stockholders not only throughout this country, but I think I may say throughout the whole world, in which they have expressed their deep sympathy and their absolute confidence. Under these circumstances, and largely due to these circumstances, one has been able to face a condition of things which became well nigh intolerable."

Mr. Isaacs mentioned the activities of Mr. Marconi and said that he had taken out within a comparatively recent date a number of important patents which "I feel sure are going to play a part at least as important, if perhaps even not more important, than the patents which he has taken out in the past." Mr. Isaacs continued as follows: "We shall no doubt see further important developments in which we are engaged, and which we look to him to continue to pioneer, and I am confident that so long as he is with us, we, the Marconi Company, will continue to pioneer that great science of which he is the inventor. We all know that, through Mr. Marconi's genius, when we go to sea we are able to receive telegrams with our morning cup of tea from those whom we have left behind.

Wireless Telephony Coming

"I am not very fond of prophesying, but I am going to venture on this occasion to prophesy that the date is not far distant when with our cup of tea in the morning we may hear the ring of the bell and, taking our telephone from its hook, we may talk to those whom we have left at home; we may tell what sort of a night we have passed and learn what sort of a night they have passed, and be able to speak of the disposition we may feel toward our coming breakfast. The Marconi Company has not made it a habit, and I think in that they have perhaps been influenced by the modesty which we all learned to love so much in our chairman—to boast at any time of the work it was doing or contemplated doing. I suppose you have all read, as I have frequently read, paragraphs in the papers speaking of the wonderful things which were being done by those whose names perhaps most of you do not know, in connection with wireless telephony. Well, all I want to tell you is that whatever you have read in the papers as having been done by wireless telephony, the Marconi Company has done more. We shall perhaps at an early date be able to turn wireless telephony to practical commercial account, and it will then be time enough to speak.

"Some of our shareholders have, perhaps not unnaturally, been a little disappointed—or shall I say a little impatient—in connection with the progress, which was a little slower than they would have liked, of one or two of our associated companies; but I would ask you to remember that in an industry of this nature a little time is required in any country for the development of that industry and to turn it to profitable commercial account. I would ask the shareholders to bear those facts in mind. There are innumerable difficulties to be surmounted, particularly when you remember that for the most part one has to negotiate with governments abroad and who are much the same as the government we have here. Government departments do not move very quickly. A little time is required for those companies to pull themselves together and to become profitable investments, and a little patience is accordingly wanted from those who hold the shares. I would ask for that little indulgence in so far as it is possible for such of our associated companies which have not yet entered the dividend-paying stage. I had intended to endeavor to give some assistance to certain of those companies by paying visits to them. I had arranged to leave early this year and spend a little while in America and a little while in Canada. I had also intended spending a little time in Spain, but the circumstances which we have had to meet during the last twelve months made it quite impossible for me to leave London."

Pension Scheme For Employes

Mr. Isaacs said that the directors of the company had almost completed arrangements for a pension scheme for the benefit of the members of its staff. He echoed the remarks of Mr. Marconi regarding the satisfactory progress of the company's business and said that "our principal attention is directed to the creation of what we believe will be the most profitable side of wireless telegraphy in the shape of constructing and conducting long-distance telegraph services throughout the world." He declared that the realization of that end was coming nearer and nearer. "In the course of a little time," he said, "when many of the stations which are now under construction, and in a little time more when many of the stations which are about to be constructed are completed, you will realize that we have created a sound, substantial and profitable business, which will be entirely independent of whether or not others are able to introduce something which Mr. Marconi has not previously thought of in connection with wireless telegraphy."

Considerable amusement was caused by a question put by Reginald C. Corry, who asked for information regarding how the "rumor managed to get about that there was a question of something between thirty and forty per cent. dividend being declared at this meeting." Mr. O'Brien, a member of the firm of Grenfell & Company, official brokers for the English Marconi Company, said that he had no knowledge of such a rumor.

Mr. Woodward, a shareholder, said that he wanted to congratulate Mr. Isaacs and the members of the board "on having had the courage to maintain the dividend simply without any increase on the present occasion, putting by such a large sum as £100,000 ($486,600) to reserve." He followed this statement with the remark that he hoped "as a small stockholder in this company that, if you do see your way to increasing the dividend a little in the future, you will only take that step if you see your way to maintaining the increased dividend."

Mr. Marshall, a shareholder, said that he had noticed that there was a contingent liability upon the shares in associated companies of £51,000 ($248,-166). "Are those shares at a premium or at a discount or would any of the money be lost at the present price of the shares?" he asked.

He was answered by Mr. Isaacs who said that "in our opinion they are fully worth their par value at least." He said that he believed that they would soon be quoted at a fair and reasonable premium. "The amount represents calls which have not yet been made because the money has not been required," he declared. "It is in conjunction with work which is being carried out and from which we hope to obtain a substantial revenue by and by."

The following resolutions were adopted:

The Directors Thanked

That a final dividend for the year ending December 31, 1912, of ten per centum on the 250,000 cumulative participating preference shares be paid on October 1, 1913, to the members who are on the register as present holders thereof.

That a final dividend for the year ending December 31, 1912, of ten per centum on the ordinary shares be paid on October 1, 1913, to the members who are on the register as present holders thereof.

That the retiring directors, Commendatore Guglielmo Marconi, Alfonso Marconi, and Captain H. Riall Sankey be re-elected directors of the company.

That Messrs. Cooper Brothers & Company be re-elected auditors for the coming year.

Mr. Marconi announced that "an interim dividend in respect of the year 1913 of seven per centum on the 250,000 cumulative participating preference shares will be paid on October 1, 1913, to the members who are on the register as present holders thereof."

After a resolution expressing the thanks of the shareholders to the directors for their management of the affairs of the company had been adopted, the meeting adjourned.

The Report of the Directors

THE report of the directors for the year of 1912 showed that the gross profits of the company amounted to £537,243 4s. 11d. ($2,614,225.63). The gross profits of the preceding year amounted to £214,407 1s. 4d. ($1,043,-304.79). The total cost of shares and patents shows an increase over the figures of the preceding year of £347,596 0s. 4d. ($1,691,402.22). This is explained in a great measure by the addition of shares in the American company, which were acquired at par. As compared with the preceding year, the total par value of shares shows a decrease of £480,139 19s. 6d. ($2,336,356.95). This decrease is due principally to the readjustment of the capital of the Argentine company. There has also been a change in the management and directorate of that company. The construction of a high-power station in Argentine has been started, with the view of establishing direct wireless service between that republic and England.

In referring to the American Marconi Company, the directors call attention to the fact that that company declared a dividend of two per cent. for the year ending January 31, 1913. Reference is made to the stations in course of construction at San Francisco and the Hawaiian Islands. "It is hoped that before the end of the year," the directors declare, "we shall see a wireless telegraph service in operation between the United States and Japan, which will then be extended to the Philippine Islands and China. The contract with the Norwegian government having been ratified by the Norwegian Storthing, a further transatlantic station will be erected immediately to conduct a telegraph service direct with the north of Europe."

The report notes, too, that "important negotiations are in progress with South American states, which should result in the construction of additional stations in the United States in the early future, and open up direct wireless service between North and South America." Mention is made of the fact that automatic sending and receiving apparatus has been supplied at the stations, by means of which it is possible to transmit messages at the rate of at least 100 words a minute.

New types of stations, including one for transportation by cart or motor car, and another for transportation by horses or camels, have been added to the equipment of the English company. Another new type of station supplied is to be used as a permanent station where space is limited. Important orders have been received from the British and other governments for field-station apparatus. The total sales of this kind of apparatus have nearly doubled during the year 1912.

The old contract for the construction of the imperial stations is no longer considered binding, the directors declare, and a new contract has been made.

"Notwithstanding all that has been stated and published in recent times respecting the continuous wave system of wireless telegraphy," the report asserts, "experience has not yet proved that that system will be capable of conducting a long-distance telegraph service as efficiently as the slightly damped spark system at present in use. Mr. Marconi has invented what your directors believe to be the simplest and most economical method of generating, transmitting and receiving continuous waves, and he alone has been able to transmit messages across the Atlantic by a continuous wave system, of which a satisfactory demonstration, and the only one, was given to the Advisory Committee appointed by the government." Further tests are being made, the directors say.

It is expected that the high-power station, in course of construction at Carnarvon, will be opened for service during the present year. It will be used to conduct a direct service with New York.

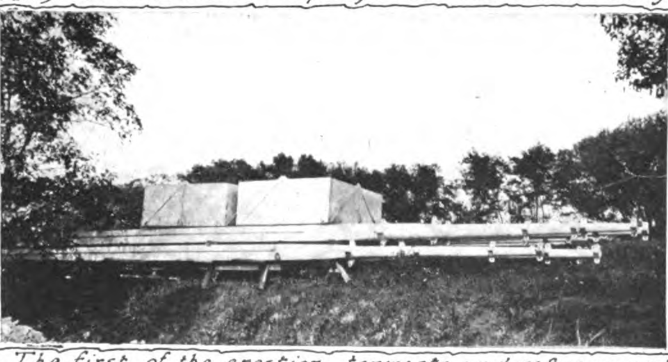
"The successful arrangements," says the report, "made in April, 1912, for placing share capital of the American company have recently been made the subject of legal proceedings by Mr. O. Locker-Lampson, M.P., and Mr. P. E. Wright against the company, your directors and other persons. Within the last few months, and shortly before the issue of the writ, these gentlemen acquired two and one shares, respectively, of the company. Mr. Locker-Lampson has since increased his holding by twenty shares. No relief is claimed against the company, which is merely joined as a nominal defendant." The report asserts that the apparent object of the suit is to impeach the action of the directors and other persons in connection with the share capital arrangement.

The report also notes that the suit for infringement of patents against the National Electric Signaling Company was heard in New York last June, and that Guglielmo Marconi gave evidence.

Progress at the High Power

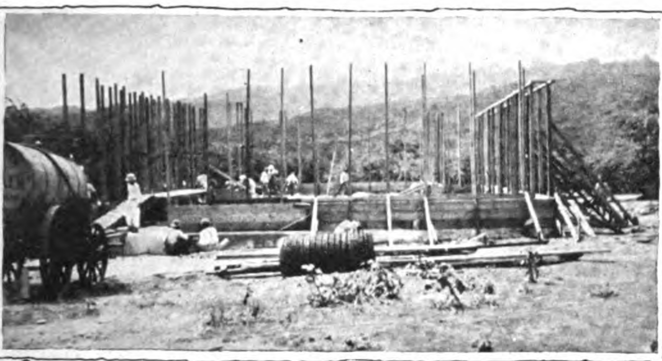
The Operating Building at New Brunswick, where all the Edifices combine sightliness with utility

A blast at the Marconi Company's Honolulu Stone Quarry

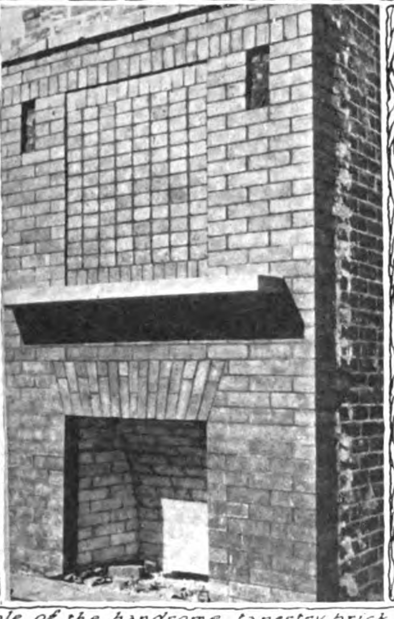


The first of the erection topmasts and cages, upon their arrival at New Brunswick

Stations told in Pictures



Operating Building at Honolulu receiving site, as it looked six weeks ago.



A good example of the handsome tapestry brick fireplaces in the Operators' Homes lending an air of coziness to the living rooms

Completing the first floor of the Assistant Engineer's Cottage at Marshalls, a fine type of the Modern fireproof bungalow.

Elementary Engineering Mathematics

As Applied to Radio Telegraphy

By WM. H. PREISS, R. E.

ARTICLE I

The Necessity for Mathematics

1. An important tool for the experimenter, whether amateur or professional, is a working knowledge of the essential principles of mathematics. So often has this subject been taught as philosophy—an exercise in thinking—that many men have labeled it "theoretical" as distinguished from practical. But is this just when mathematics is necessary common sense applied to laboratory observations?

For example, with its help the dimensions of inductances or capacities can be predetermined to any degree of accuracy, and that extremely elusive quantity, the "equivalent radio-frequency resistance," can be calculated from the reasonance curve. Then, too, all general statements of the conditions of a circuit with regard to damping, wave length, voltage and current can be obtained from mathematical equations.

2. At first glance, the principles appear as numerous and as codified to the uninitiated as the combinations and form of the radio operators' telegraph code do to the layman. Yet the principles are few in number and written in a simple manner. For instance, the processes of arithmetic, addition, subtraction, multiplication, division, raising to a power (evolution), and finding the root (involution)—are the only operations used in algebra up to quadratic equations.

Algebraic Language

3. To give an idea of the power and exactness of mathematical method, we consider the following important problem:

In direct current work we are chiefly concerned with the resistance, voltage, and current in a circuit. Ohm's Law, which states that the voltage is equal to the product of the current and the resistance, gives us a direct relation between these quantities. If we call the voltage E, the current I, and the resistance R, we express Ohm's Law in simple algebraic language by $E = R \times I$. We have represented quantities by letters and connected these letters by the sign of equality, according to a physical law, which gives us the true engineering *algebraic equation.* What at first arrests our attention is the simple form such an expression takes. We are next impressed by the fact that it gives an answer for any number of cases where we know all but one of the quantities involved. For example, suppose the resistance of a wire to be equal to 5 ohms and we desire a current of 2 amperes to pass through it; what is the voltage we must apply at the terminals of the wire? In practice such a problem often arises.

Example—

$$E = R \times I$$
$$E = 5 \times 2$$
$$E = 10 \text{ volts.}$$

This equation gives solutions to two other possible questions with regard to a direct-current circuit where two of the three quantities are known:

(a) Given the voltage and the resistance, what current would flow? Dividing both sides of the equation $E = R \times I$, by R we arrive at the form,

$$\frac{E}{R} = I$$

Suppose the voltage is equal to twelve

volts, and the resistance is three ohms, then substituting in the equation 12 for E, and 3 for R, we get the value of the current I.

$$\frac{12}{3} = I$$

$$I = 4 \text{ amperes}$$

(b) Given the voltage applied and the current flowing, what is the resistance of the circuit? Dividing both sides of the equation $E = R \times I$ by I we arrive at the form

$$\frac{E}{I} = R$$

Suppose the voltage is equal to one hundred and ten volts, and the current is equal to one-half an ampere; then substituting 110 for E, and 0.5 for I, we get the value of the resistance R

$$\frac{110}{0.5} = R$$

$$R = 220 \text{ ohms}$$

(This is the case of the ordinary 16 c. p. 110-volt carbon incandescent lamp.)

4. *This representation of quantities by symbols and numbers (to which may be assigned values to fit the particular case), equated to another set of symbols and numbers, is the algebraic form of representing experimental facts.*

For instance, Coulomb's Law states that the attraction between two electrically charged bodies varies directly as the product of the charges and inversely as the square of the distance between them. *One quantity varies inversely as another quantity, when the first quantity is decreased by an increase of the second quantity.* For example, as the time between sparks in a radio transmitting set decreases, the pitch of the note of the received signals increases. The square of the distance means the product of the distance by the distance. Calling the charge on the first body q_1 (the subscript (1) indicating the first body) the charge on the second body q_2, the distance d, and the force F; then the algebraic expression of this law becomes:

$$F = \frac{q_1 \times q_2}{d \times d}$$

The reader must accustom himself to look upon the symbols of algebra as a most convenient and valuable shorthand method of writing physical quantities, such as voltages, charges, distances, etc., and not merely as letters of no meaning.

Operations of Algebra

5. Before taking up the processes of algebra, the conventional symbols should be well understood. Besides the use of letters to represent quantities, symbols are employed which represent operations; for example, the operations indicated by +, —, × and ÷. These are familiar from their use in arithmetic. Generally speaking, the multiplication sign (×) is omitted between letters that form a product, and no sign is used at all; while the division sign (÷) is dispensed with and the fractional representation indicated, as in arithmetical fractions.

$a \times b \times c$ is expressed abc

$a \times b \div c$ is expressed $\frac{ab}{c}$

Although several letters written together indicate a product, several numbers written together indicate an addition. For instance, the number 524 represents the addition of 500, 20 and 4; and not $5 \times 2 \times 4$. If we wish to represent $5 \times 2 \times 4$, a dot (.) is used instead of the × sign between the *factors* (quantities which form the product). The compactness of this method of indicating multiplications and divisions, and the ease with which formulæ given in this form may be handled and remembered, are immediately apparent, for instance, when important relations, such as the induced e. m. f. in the armature of a generator, are expressed.

Example—

$$E = \frac{N\ C\ ns}{10^8} \text{ volts}$$

Where E is the induced e. m. f. (*Electro-motive force*) in volts in the armature of a generator, N is the magnetic flux from one pole, C is the total number of conductors on the armature, n is the number of revolutions the machine makes during a second of time, s is the number of armature sections in series, and 10^8 is a number which changes E to volts.

6. The use of a small letter *n*—representing an *integer* (whole number)—placed to the right and above a quantity, indicates that the quantity is to be taken *n* times as a factor.

$$a^4 = a\ a\ a\ a$$

and is read a to the fourth *power*. The *n* (in this case the number 4) is known as the *exponent* or *index*. When the exponent is 2 or 3, we speak of the quantities as *squared* or *cubed* respectively.

7. The use of a radical sign ($\sqrt{\ }$) covering a quantity, with an exponent *n* above the angle, represents a number which, when raised to the *nth* power, gives the quantity.

$$\sqrt[3]{8} = 2$$

for 2 raised to the third power equals 8

$$2 \times 2 \times 2 = 8$$

This expression is read the third root, or *cube root* of eight. The radical sign used without an index indicates the second or *square root* of the quantity is to be taken.

8. The order of operations is the same as in arithmetic; that is, if we have an expression we perform the operations from left to right, remembering that $\times$ and $\div$ take precedent over $+$ and $-$, that is, are performed first. In the example

$$4 + 6 \times 10 - 25 \div 5$$

we first perform the multiplication 6×10, then add to the product 4, then perform the division $25 \div 5$, and finally subtract this quotient from the previous sum.

9. The parenthesis ( ), the brackets [ ], and the braces { } placed at the beginning and end of a series of quantities, indicate that the operations within these inclosures must be performed before any outside operation is to be applied. They imply that the quantities inclosed are to be treated as a single quantity.

$(a + b)\ c$ means a must be added to b, and the sum multiplied by c.

$(a - b)\ (c + d)$ means that b must be subtracted from a, and the difference multiplied by the result of adding c and d.

10. A straight line over quantities is equivalent to a parenthesis around them.

11. We may have complicated expressions built up as follows: A bracket incloses among other things a brace, which in turn includes among other things a parenthesis. The procedure is to work *from the inside out,* evaluating and removing the parenthesis, brace and brackets in that order.

For example evaluate the following:

$$g - \{f + [\ (a - b)\ c - d]\ e\}$$

removing the parenthesis

$$g - \{f + [ac - bc - d]\ e\}$$

removing the brace

$$g - \{f + ace - bce - de\}$$

removing the brackets

$$g - f - ace + bce + de$$

Representation of Quantities by Letters

12. The algebraic expression contains a collection of figures and letters. Those quantities, the values of which we know, are usually represented by the first portion of the alphabet a, b, c, etc.; while those to be calculated (that is unknown quantities) are represented by the last letters of the alphabet, x, y, z. For instance, the power or rate at which energy is being expended by a direct current circuit is the product of the voltage across the terminals and the current flowing in the circuit.

$$X = E\ I$$

Thus, if we know the value of the voltage E, in volts, and the current I in amperes, we can calculate the power X in watts.

If an induction coil is used across a ten volt battery line, and an ammeter in the line reads 5 amperes, what is the rate at which energy is being supplied to the coil?

$$X = E\ I$$
$$X = 10 \times 5 = 50 \text{ watts.}$$

Terms

13. If we have an expression in which the various quantities are connected by + or — signs, these quantities are called *terms.*

A term is composed of one letter or several letters connected by a combination of multiplication and division operations. If one of the factors of a term is a number, this number is called the *numerical coefficient.* In the term $3a^2b$, 3 is the numerical coefficient. Coefficients are always written in front of the term. When we have two terms each of which contains the same letters, raised to the same respective powers, the terms are called *like terms.* To be like terms they must be alike with regard to letters and indices, but may have different coefficients. Thus the expression

$$2\,ab^2cx + 3\,a^2bcx + 6\,ax^2 - ab^2cx$$

contains four terms, two of which are like terms. The importance of like terms will be made clear when we reach the various processes of algebra; for by means of this fortunate class of terms complicated expressions are easily reduced to elementary forms.

Negative Quantities

14. The reader is familiar with the fact that, starting at any point on a line, he may consider points forward or backward; or starting at any epoch in time, he may compute past or future time; or starting at a zero in temperature he may read temperatures above or below zero. Thus we have in actual experience two opposite ways in which quantities can be reckoned from a zero or starting point. Let us call quantities in the direction of increase + and note the effect of going in the opposite direction on the value of this quantity. If we went forward five feet from a zero point on a line and back three feet we would be two feet in advance of that starting point, or at a position + 2 feet. In other words going back is equivalent to subtraction, and indicated by —. If we went back another five feet we would be three feet behind the zero or in a position — 3.

15. Thus, besides the common meaning of addition and subtraction, + and — have an additional meaning, that of *distinction between magnitudes of opposite kinds.* The size of a quantity, regardless of its sense, is called its *absolute value* or magnitude. For example, 5 feet or 20 seconds do not indicate a measurement from a fixed zero.

16. A striking example of the existence of magnitudes in opposite directions is found in the heterodyne device employed for receiving radio waves of undamped or slightly damped characteristics. It consists of an arc and an antenna circuit inductively coupled to a receiving circuit. The arc and antenna circuits differ in frequency, by the frequency of an audible note. For example, if the frequency of the incoming signals in the antenna circuit is 200,000 oscillations per second (corresponding to a 1,500 meter wave length) and we desire to receive them with a pitch, due to 1,000 vibrations per second, the arc is tuned to a frequency of 199,000 or 201,000 oscillations per second. The difference of wave length of the antenna and arc is 7½ meters.

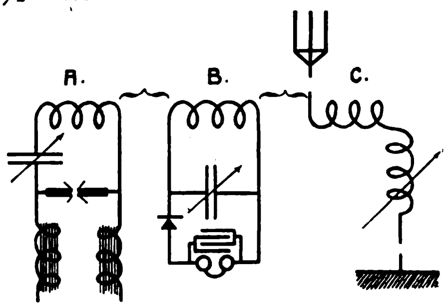


Fig. 1

The currents in the A and C circuit (Fig. 1) are periodically in the same, and then in opposite directions. These currents induce a voltage in the B circuit which depends for its direction on the direction of the currents in the A and C circuit. When the currents in the A and C circuit are both in the same direction, that is are both + or both —, the induced voltage in the B circuit (due to their algebraic sum) produces an amplified current in the B circuit. When the currents in the A and C circuits are in opposite directions, that is, one is + and the other — the induced voltage in the B circuit (due as before to their algebraic sum) produces a much reduced current in the B circuit. This phenomenon is known as *beats,* and gives a method of receiving undamped oscillations (with any desired note) without breaking them up mechanically. Beats are the physical result of recurrent opposition or assistance of alternating currents, as indicated by the algebraic fact that the signs of the two currents (currents in circuits A and B) are sometimes alike, and sometimes different.

17. These (—) quantities are called *negative quantities,* but this name cer-

tainly does not do them justice. They are perfectly real and tangible. For example, a voltage which drives a current in one direction along a wire is just as real as a voltage which drives a current in the opposite direction, although the voltages are called + and —.

18. This discussion of magnitudes with direction leads us to the principles of addition and subtraction; for since a series of positive (+) quantities increase the resultant magnitude, and negative quantities decrease the resultant magnitude, to add a minus quantity we subtract its absolute magnitude, and to subtract a minus quantity we add its absolute magnitude.

Addition

19. *The rule may be stated that to add a term to an expression affix it with its sign unchanged to the expression to which it is to be added. If we are adding one expression to another we affix to the first expression each of the terms of the second expression with their respective signs unchanged.*

20. In most practical cases, the expressions to be added contain like terms; that is, terms containing the same letters, the latter being raised to the same respective powers.

Example—

$$\begin{array}{rl} \text{To} & 2\,a^2b - 3\,cx + d^3 \\ \text{add} & 7\,a^2b + cx \end{array}$$

We notice that there are two pair of like terms. When we have like terms we group them together and add their coefficients, for since

$$3a = a + a + a \text{ and } 2a = a + a$$
$$3a + 2a = a + a + a + a + a = 5a$$

Therefore the problem reduces to

$$9\,a^2b - 2\,cx + d^3.$$

21. In general when adding several expression together, the expressions are arranged according to the ascending or descending powers of some letter. They are then written in horizontal rows with like terms in vertical rows. For example,

$$\begin{array}{rl} \text{To} & 3\,ab + 7b^2 + 2a^2 \\ \text{add} & 3c^2 - 4a^2 + 4b^2 + ab \\ \text{and} & b^2 - 9c^2 + 6a^2 \end{array}$$

First arrange the terms according to the descending power of some letter, say *a*. Then place the expressions one under the other, with like terms in vertical rows. Then add the coefficients of the terms in the vertical rows.

$$\begin{array}{lllll} +\,2a^2 & +\,3ab & +\,7b^2 & & \\ -\,4a^2 & +\,ab & +\,4b^2 & +\,3c^2 & \\ +\,6a^2 & & & -\,9c^2 & +\,b \\ \hline +\,4a^2 & +\,4ab & +\,11b^2 & -\,6c & +\,b \end{array}$$

(Note $+ 3c^2$ added to $- 9c^2 = - 6c^2$)

The advantages of clearness cannot be overestimated, especially in cases where long expressions enter.

Subtraction

22. *Since subtraction is the inverse operation of addition, we may formulate the rule, that, to subtract a term from an expression, affix the term with its sign changed to the expression. If we wish to subtract a second expression from a first, we affix each of the terms of the second expression, to the first, with their signs changed.* This is equivalent to changing the signs of the terms of the second expression and adding the result to the first expression. Furthermore, if we have several expressions that are to be subtracted from a given expression we change the signs of the terms of these several expressions and add the result to the given expression.

Example—

$$\begin{array}{rl} \text{From} & 9a^2 + 6\,ab + c^2 \\ \text{Subtract} & 3a^2 + 4\,ab + c^2 \\ \text{And} & 5c^2 - d \end{array}$$

Changing the signs of last two expressions, arranging like terms in columns and adding, we get

$$\begin{array}{llll} 9a^2 & +\,6\,ab & +\,c & \\ -\,3a & -\,4\,ab & -\,c & \\ & & -\,5c & +\,d \\ \hline +\,6a^2 & +\,2\,ab & -\,5c & +\,d \end{array}$$

[This is the first of a series of articles on mathematics by Mr. Preiss The second will appear in an early issue.]

Prince who has Wireless Piano

Photo. Underwood & Underwood.

The Prince of Monaco and His Yacht Hirondelle. Photograph Taken During His Recent Visit to New York

WIRELESS operators in New York harbor and at other points along the Atlantic coast were mystified recently by hearing strains of music wafted through the air, coming from a source which no one was able to determine. The mystery was solved when the steam yacht Hirondelle, bearing her owner, Albert I. Prince of Monaco, and a wireless outfit connected with a piano-like attachment, arrived off Sandy Hook.

After the craft had entered the harbor she sent out a radio request broadcast that all vessels within range give attention to the concert about to begin. Then followed selections which included the "Marsellaise" and "America." Operators on the water and at land stations for miles around, including those at the Brooklyn Navy Yard and other places, heard the music and, at the conclusion of the programme, sent their thanks through the ether.

The Hirondelle, after leaving Monaco early in the summer, went to the Azores, then to Halifax. She cruised for a time about the Grand Banks and then set out for New York. She arrived several days sooner than she was expected, and therefore the aerial concert came as a surprise. Several vessels bound for New York had reported hearing siren strains as they neared the coast, and in the proximity of the Hirondelle they found the explanation of the mysterious music.

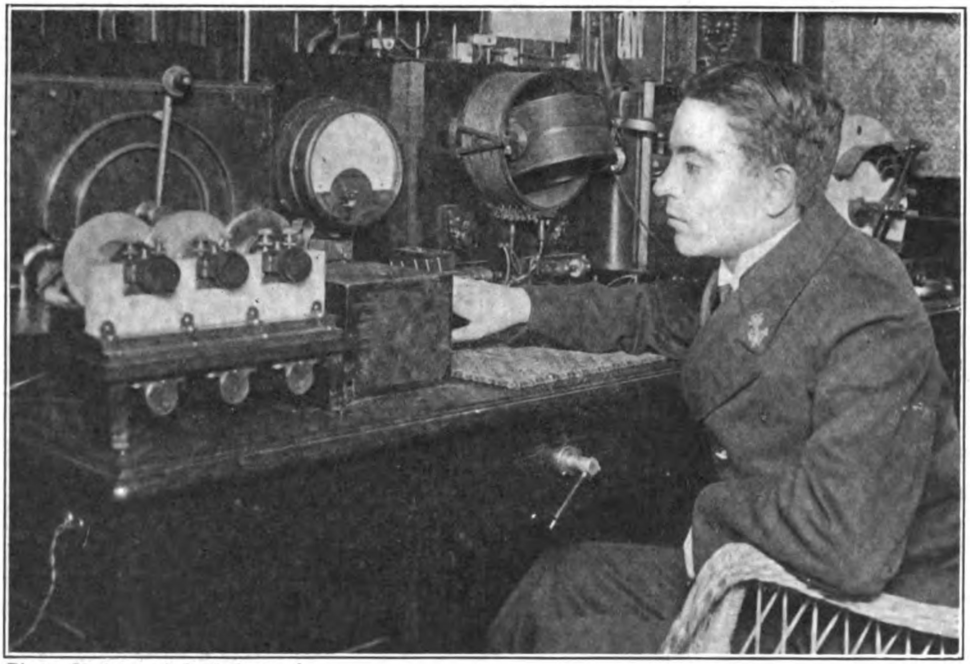
Equipped with appliances which have been used in solving the puzzles of nature, the Hirondelle is a veritable wonder craft. The wireless piano, however, is the crowning feature of all the amazement-producing things to be found on the vessel.

The wireless system in use on the Hirondelle employs a continuous current with a high pressure of 1,500 volts, which charges the condensers without a transformer. It has a revolving sparker, a series of small wheels. The spark is only a tenth of an inch in length and is always the same for the different powers. The whole apparatus is remarkably compact, for both the sending and receiving appliances easily are placed on one small table. The primary coil consists of one spiral and in the secondary coil are forty turns or spirals.

With this system, which is called an impulsive one, it is possible to get high frequency oscillations. The vibrations are so many that often it is impossible for the ear to perceive them and the note to be heard. The inventor has put on the sparker another oscillatory circuit, and a variable condenser. He can thus lower the frequency of the system. The use of a variable condenser in the second circuit makes it possible to get different frequencies, which may be tuned to musical notes. The variations are made by striking a bank of ten keys, arranged in the form of a keyboard of a piano.

The operator, Pierre Boutteville, sitting at the table, can let his fingers stray on a piano. The system on board is really a remarkable one. We are able to communicate fifteen hundred miles, and so, in crossing the Atlantic, are not likely to be out of touch with land for very long."

Erect of figure, with an air of abounding vitality, the Prince is the typical yachtsman and sportsman. His beard, slightly touched with gray, is the only evidence of his sixty-five years. His eye is clear and kindly, his step light and elastic. Harpooning whales, shooting big game and wooing the sea in all kinds of



Photo, Underwood & Underwood.

The Wireless Piano Aboard the Prince of Monaco's Private Yacht and Pierre Boutteville Who Plays the Instrument

over them and by certain adjustments can get twenty variations. This is a stock of notes enough for a Paderewski. From the wireless piano of the Hirondelle have come "God Save the King," national anthems and even waltzes from such sprightly operas as "The Merry Widow."

"It always causes astonishment," said the Prince, in speaking of the wireless music, "and we have been asked at sea if the music could possibly be made in this way. Yet it is all very simple. The harmony is produced as easily as playing weather have kept him lithe and strong.

He is a teetotaler and does not smoke. The recipe which he has for keeping young is work and sport. He always is busy. The head of a principality, in which is glittering Monte Carlo, he is also a biologist and an oceanographer. He is the author of scores of books.

The Hirondelle is a steel twin screw steam yacht, with an auxiliary brigantine rig. She carries unusually lofty masts, which seem to dwarf the single funnel. The yacht is 291 feet over all, thirty-six feet in beam and has a draught of seventeen feet eight inches. Her lines indicate that she is a very dry vessel indeed, with her high top gallant forecastle and the raised after deck. She has a clipper bow and her lines are trim and graceful. On the flag is the coat of arms of Monaco, with the Latin motto "Deo Juvante" (With God Aiding). Below decks there is every evidence of strength and careful workmanship. There are substantial bulkheads, with heavy doors. The crew, under command of Captain d'Arodes, of the French navy, consists of fifty men and the total number of persons on board is sixty-eight, including officers, scientists, photographers and artists. Not only has the Hirondelle every appliance which modern naval architecture has prescribed for a yacht, but it has special apparatus, which represents inventive talents of a high order. Among them is a machine for sounding, invented by the Prince himself, by means of which the seas have been measured for a depth of 5,200 meters, or about three miles. Here also are contrivances for bringing up water from great depths for analysis. There are nets with which the strange denizens of the uttermost depths are drawn to the surface.

The yacht has a laboratory which is filled with an array of bottles and jars. The creatures of the depths are studied here and preserved for further examination at the museum which the Prince established at Monaco.

One of the significant facts which the explorations of the Hirondelle expedition has revealed is that there is a constant vertical migration in the ocean, and that forms of life which scientists have believed could only live near the ocean floor are constantly coming up near the surface. They travel very slowly in order to get accustomed to the variations of pressure. Those which are brought up by the nets from the depths usually collapse and die because of the too surden change.

There are many new forms of life to be seen in the laboratory. The Prince spends much of his time in the laboratory studying the phosphorescent fish and the other strange forms which come under his observation.

HEARS MUSIC 225 MILES AWAY

Raymond H. Shaw, of East Washington street, Rutland, Vt., who for some time has experimented with wireless telegraphy, recently heard a wireless telephone message while listening to a wireless telegraph message sent out from a Southern station.

The receivers used in the wireless telegraph and wireless telephone service are the same. While Shaw was listening to the faint click of the faraway telegraph instrument he was surprised to catch the words, "My country, 'tis of thee—" to the familiar tune of "America." Further listening revealed that the tune was being played on a phonograph in the Metropolitan wireless telephone tower in New York City. The air-line distance was more than 225 miles.

THE SHARE MARKET

New York, September 19.

During the past week Wall Street has seen a marked change for the better; industrial issues have been stronger, and the trading has increased to a degree that seems to warrant the assertion that the long period of stagnation is at an end.

Marconi issues have been featured prominently in the curb trading, and have remained steady during the last few days. American Marconis are quoted about the same as last month, and the English issues show but a fractional decline, mainly due, the brokers say, to the rumor that a higher dividend than ten per cent. would be declared at the annual meeting. Canadian issues remain about the same, with trading light, owing to the fact that buyers are awaiting some indications of what the forthcoming meeting will disclose.

Compared with other industrials, Marconis are well supported and show a higher average market price. The brokers are optimistic, and a number of them are predicting steady advances under the relieved conditions of the share market.

Bid and asked prices to-day:

American, 5¼-5½; Canadian, 2¾-3⅛; English, common, 19½-21; English, preferred, 16¼-17½.

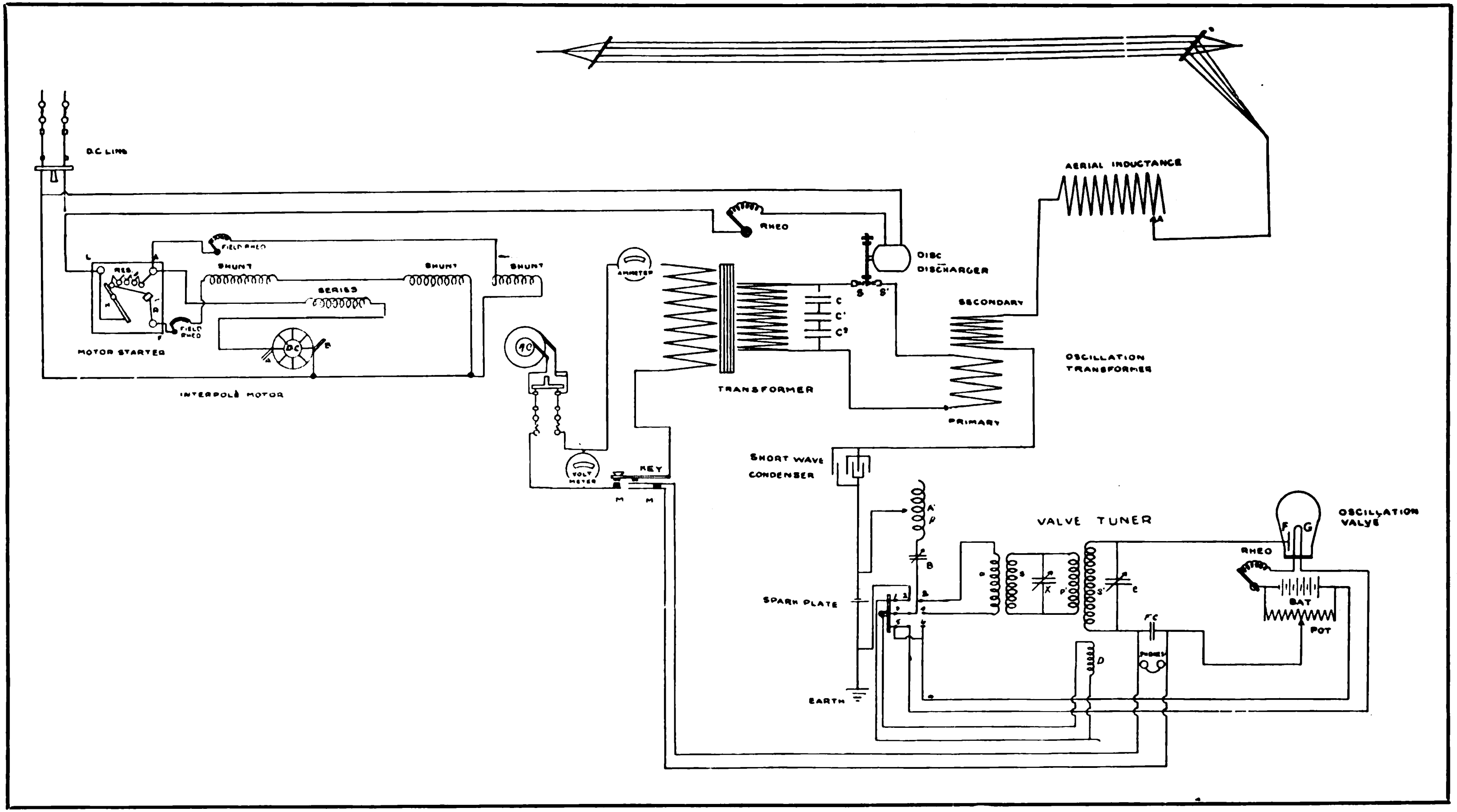

D.C. LINE
MOTOR STARTER
RES.
FIELD RHEO
SHUNT
SHUNT
SHUNT
SERIES
D.C.
INTERPOLE MOTOR
RHEO
AMMETER
A.C.
VOLT METER
KEY
M
M
TRANSFORMER
C
C'
C²
S
S'
DISC DISCHARGER
AERIAL INDUCTANCE
SECONDARY
PRIMARY
OSCILLATION TRANSFORMER
SHORT WAVE CONDENSER
SPARK PLATE
EARTH
VALVE TUNER
B
X
D
FC
PHONES
RHEO
BAT
POT
F
G
OSCILLATION VALVE

Fig. 6

OPERATORS' INSTRUCTION

CHAPTER IV

Disc Discharger Sets—Figure 6 indicates the complete circuits of the Marconi 240 cycle discharger transmitting set in conjunction with the valve tuner.

Motor Starter—The motor starter is of the regulation Cutler Hammer type and, as it has been previously described, there is no need of further explanation. The motor of the motor-generator differs in that it has an interpole winding. That is to say, the series winding of the motor is in series with the armature and has field poles of its own, while the shunt winding is made upon a separate set of field poles. The series poles are known as interpoles because they are placed between the shunt poles.

The object of the interpole winding is to give sparkless commutation with a varying load, and to maintain as near as possible a uniform speed. Briefly, the reason for obtaining sparkless commutation may be explained as follows: The interpole field coil destroys the current due to the self-induction of an armature coil as it passes through the neutral field; consequently when the segments which are connected to this coil pass a brush, there will be no sparking.

Moreover, the magnetic flux produced by the interpoles oppose the flux of the shunt poles, resulting in a decrease of the total flux surrounding the armature, and, as previously explained, if the flux about a motor armature is decreased an increase in speed is secured. Thus a very steady speed regulation is maintained, which is especially desirable in wireless telegraph sets. By referring to the drawing it will be noted that the series winding is placed between two shunt windings. This was done to give the student an idea of how the machine is wired up in actual practice.

Generator Fields—A simple shunt winding, above the A. C. armature is indicated. This, in turn, is directly connected across the D. C. line (through the starter). It will be noted that one side of this shunt field is connected to the A. post of the Cutler Hammer Starter. This is done to prevent current flowing into the generator fields before the motor is started.

The Transformer—The transformer is of the open core type and is substantially the same as the one previously described.

Condensers—The condensers are shown at C, C^1 and C^2. It will be observed that there are three sets in series and by so connecting the potential strain on each is considerably reduced. These condensers consist of flat plates of glass coated with tin foil which are immersed in oil.

In case of the 2 K. W. 240 cycle set thirty-six glass plates are used. There are three banks in a series, each bank consisting of twelve plates in parallel.

Spark Gap—It will be noted that the spark gap (or disc discharger) is mounted directly on the shaft of the motor. The disc has studs projecting through it which are spaced at a uniform distance around the periphery.

The stationary electrodes, two in number, are shown at S and S^1. When this gap is in operation a spark discharge takes place when one of the rotating studs comes opposite the two stationary members. Since the studs are uniformly spaced a certain number of discharges take place per second, and if the revolutions are of a certain number per minute an even succession of discharges will take place, the gap emitting a pure musical note. The advantage of this gap lies in the fact that it gives a high note which is easily read through atmospheric disturbances. It also keeps the spark electrodes cool, thereby keeping the antennae radiation constant.

Particular care should be taken in the adjustment of the spark to keep the actual distance between the stationary electrodes and the fixed electrodes so that there will be a very small air gap. The effective sparking distance, however, will be greater than the air gap would indicate, as the spark will start discharging as the moving electrodes approach the stationary electrodes.

In some cases the spark gap is rotated by a shunt wound D. C. motor, the speed of which is regulated by means of the rheostat as indicated in the drawing. The discharger may also be mounted on the shaft of the motor-generator. A note of greater regularity is thus secured.

Oscillation Transformer—The oscillation transformer shown in the drawing is of the inductive coupled type known as type B, consisting of a fixed inductance sliding in and out of the primary inductance. The number of turns in use in the primary are determined by the position of the variable contact L. The wave length of this circuit then can be increased or decreased by increasing or decreasing the number of turns included by the variable contact.

Aerial Tuning Inductance—The aerial tuning inductance is indicated at A. It affords a wide range of wave lengths in the open circuit and is used on both the 300 and 600 meter adjustment.

The Coupling—The degree of coupling between the open and closed oscillatory circuits is varied by drawing the two helices apart; thus any degree of coupling is secured and the emission of two wave lengths readily reduced to one.

The Spark Plate—The spark plate consists of two brass plates separated by a thin sheet of mica, making a very minute spark gap around which is connected the aerial and earth binding posts of the valve tuner. The plate is connected in series with the earth lead and should be placed as near to the actual earth connection as possible. The spark plate should be watched from time to time to see that it is not short-circuited by carbon deposits.

The gap also gives a free discharge path for the antennae to earth, affording protection during severe electrical storms.

The Valve Tuner—The complete circuits of the valve tuner are shown to the right of the drawing.

The triple pole double throw switch, as indicated, not only serves the purpose of disconnecting the receiving apparatus from the antennae while sending, but also enables the operator to change from a broad adjustment of the apparatus so as to receive signals of varying wave length with very little manipulation of the tuner; or to connect to the tuning side wherein a great degree of separation of wave lengths can be produced.

When the switch is thrown to the right, the open circuit of the receiving apparatus comprises the antennae inductance A^1, connected to a multiple point switch, a variable condenser B in series with it, and a fixed inductance P, which constitutes the primary of the oscillation transformer. The aerial inductance A^1, popularly known as a "loading coil," enables the wave length of the open circuit to be increased or decreased as desired, while the variable condenser, B, is used to alter the wave length of the open oscillatory circuit, its small values being for the shorter wave lengths. The variable condenser, B, is arranged so that, when turned to the right as far as possible, it short-circuits itself and is thereby cut out of the circuit.

It will be noted that all the adjustments of wave length in the open circuit are made by the inductance, A^1, and the variable condenser, B.

An intermediate circuit consisting of the fixed inductance, S, the variable condenser, X, and the fixed inductance, P^1, is placed in inductive relation to the inductance, S^1, in the local detector circuit, and also to the fixed inductance, P, in the open oscillatory or antennae circuit; that is, the coil, S, is inductively coupled to coil P, and coil S^1 is inductively coupled to coil P^1.

It will be noted that the period or wave length of the intermediate circuit is varied only by means of the variable condenser X. The two fixed inductances, S and P^1, comprising the intermediate circuit, are mounted on a shaft so that the coupling between them and their associated circuits can be varied simultaneously by turning a graduated hard rubber knob.

The Local or Detcctor Circuit—The local or detector circuit comprises the fixed inductance, S^1, the variable condenser, E, the fixed condenser, FC, around which are connected the head phones and the oscillation valve.

The Oscillation Valve—The oscillation valve consists of a plate, F, and a filament, G, used in connection with the rheostat, Rheo, the storage cells, Bat, and the potentiometer, Pot, which is in shunt with the cells.

Operation of the Set—When the tuner which has been described is in operation its action is as follows: The high frequency oscillations induced into the antennae from a distant transmitting station traverse the aerial inductance, the secondary coil of the transmitting oscillation transformer, the loading coil, A^1, the variable condenser, B, and the primary of the oscillation transformer, P. The magnetic flux produced in the primary, P, sets up corresponding oscillations of high frequency in the intermediate circuit through coil S, which are increased in amplitude by adjusting the intermediate circuit to resonance with the open circuit by means of the variable condenser, X.

Since the oscillations produced in this circuit traverse P^1, currents of high frequency are set up in the inductance, S^1, and thence through the local detector circuit. The valve acts as a rectifier, allowing the high frequency oscillations to pass in one direction, with the result that the closed oscillatory circuit is traversed by a series of direct current impulses which actuate the head phones, producing audible signals.

This rectification takes place in the space between the hot filament to the cold plate. As in other detectors it is found that if a very small electro-motive force is caused to pass through the rectifying space in the bulb, it materially increases the sensitiveness of the detector; consequently a potentiometer of about 300 or 400 ohms resistance is shunted across the same storage cells which supply the current for lighting and filament, F.

By means of the potentiometer the amount of current flowing through the head phones, and the fixed space between the cold plate and filament of the valve, can readily be adjusted to any given amount. For best working and for securing the most sensitive results, a certain degree of heat from the filament is necessary; consequently the rheostat, marked Rheo, is included in series with the battery to the lamp filament, so that the glow of the filament may be increased or decreased as desired.

As stated, the fixed space between the hot filament, F, to the cold filament, G, is conductive to impulses in one direction, while those coming in the opposite direction will either be stopped entirely, or reduced to such an amount that they are practically negligible. It will readily be seen that only one-half of the oscillations produced in the local or detector circuit are allowed to pass. The other half has been, practically speaking, annulled.

The variable condenser, E, connected across the inductance, S^1, enables the wave length of the local circuit to be increased or decreased within certain limits. This variable condenser is of small capacity. A condenser of large capacity could not be used at this point. The description which has been given covers only the tuning side of the set.

"Standby" Circuits—When the double pole double throw switch is thrown to the left and the antennae and earth connections are thrown on to contact 1 and 3, it will be observed that the intermediate circuit, and also the primary circuit, P, are disconnected and a special primary winding, D, is connected into the open circuit. D is an inductance of fixed value wound closely around the inductance, S^1, of the local detector circuit. This gives a tight coupling and adjusts the apparatus to receive a number of varying wave lengths with little adjustment of the tuning appliances. Contacts

5 and 6 close the battery circuit to the lamp filament.

When the transmitting key is depressed the triple pole switch is raised, breaking all contacts; as a result the tuning circuits are disconnected from the antennae and the earth and the current is cut off from the filament of the oscillation valve. In addition to closing the primary circuit of the sending transformer the transmitting key has an extra pair of contacts, M and M^1, which short-circuit or shunt the head phones of the receiving apparatus. Hence, just before the primary circuit to the sending transformer is closed by the key, the head phones are shunted, thereby affording protection from the inductive influences of the transmitting spark.

To repeat again, when the triple pole switch is thrown to the left, "broad" tuning is secured and a wider range of wave lengths can be received without manipulating the tuning appliances to any great extent. On the other hand, when the switch is thrown to the right, the tuning circuits are connected, thus making it possible to differentiate sharply the various wave lengths.

The Intermediate Circuit—The reason for obtaining such a degree of selectivity in the intermediate circuit lies in the fact that, owing to the absence of a great amount of resistance, it is a circuit of low damping; therefore it does not matter how "broad" the currents traversing the open circuit are because they will induce in the intermediate circuit oscillations of corresponding wave length, but of relatively low damping, i. e., "sharper waves." Hence it will readily be understood that it will be easier to separate signals of various wave length and avoid interference. This statement is only true when the coupling between the intermediate circuit and the associated circuits is fairly loose.

Range of Wave Length—The range of wave length to be obtained in the various circuits of the valve tuner, when connected in the regular manner (Figure 6) is as follows:

	Meters
Open circuit	300 to 1675
Intermediate circuit	250 to 1515
Detector circuit, when using the small condenser	760 to 1515

A table showing approximately the wave length adjustment of the intermediate circuit at various positions of the variable condenser as indicated by the scale follows:

INTERMEDIATE CIRCUIT

Condenser Scale.	Wave Lengths in Meters.
0	250
.5	345
1	500
2	550
3	775
4	940
5	1040
6	1150
7	1260
8	1360
9	1435
10	1515

Generally speaking, this tabulation holds good for all valve tuners produced by the Marconi Wireless Telegraph Company of America to date.

Procedure for Determination of Wave Length—If the operator desires an approximation of the wave length of a distant transmitting station, he should throw the three-blade switch on the valve tuner to the right-hand position and adjust the circuits to resonance at a very loose coupling (about ten degrees on the coupling bnob). The reading on the variable condenser is noted, and by referring to the table which is published the wave length is obtained.

The Type E Tuner.—Figure 7 indicates the circuits of the type E tuner, a number of which are at present distributed

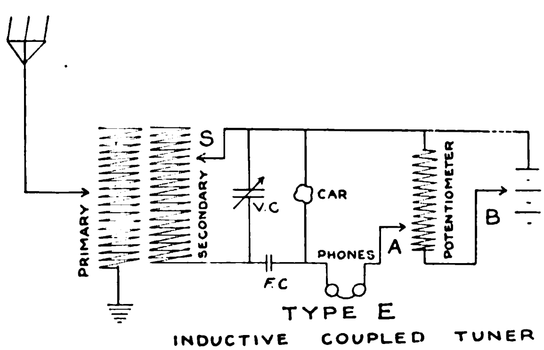


Fig. 7

throughout the Marconi Service. It is an inductively coupled arrangement, and the primary coil is in series with the antenna circuit to the earth. The sliding contract enables the amount of inductance inserted in series with the antenna to be varied as desired. As a result the wave length of the open circuit can be increased or decreased to suit the frequency with which the incoming signals arrive from a distant transmitting station.

The secondary coil slides in and out of the primary and is so arranged that the mutual induction between the two coils can be easily varied by placing the coils together or by drawing them apart. The turns of the secondary coil are in reality connected to a multiple point switch and are represented by a sliding contact.

A variable condenser, VC, is connected across the inductance of the secondary coil, making it a resonant closed oscillatory circuit. The fixed condenser, FC, known as a "stopping condenser," prevents the battery current from flowing through the secondary inductance.

A carborundum crystal, Car, is in series with the closed oscillatory circuits and acts as a detector of the oscillations in that circuit. As stated in a previous paragraph, it is found that a very small E. M. F. from the battery increases its sensitiveness. A potentiometer is used to vary the battery current flowing through the crystal and head-phones (by means of variable contact A).

Operation—When oscillations traverse the primary coil, magnetic lines of force rise and fall about its turns which intersect or cut through the turns of the secondary coil, setting up in it corresponding high frequency currents which are made audible in the phones by the carborundum crystal. By using the variable condenser, VC, the closed circuit is made a resonant circuit and currents of large value are set up in it.

A portion of the energy so produced in that circuit is drawn off by the carborundum crystal and made audible as described.

The student should thoroughly understand that when making use of loose coupling between the primary and secondary circuits, i. e.: when the secondary is drawn out of the primary, the variable condenser, VC, connected in shunt with the secondary of the receiving transformer, must be used in order to effect an efficient transfer of energy. For elimination of interference, and for sharper tuning, the secondary coil is moved out of the primary and the condenser, VC, varied. The period of the local circuit can also be regulated by the sliding contact. Thus any degree of coupling can be obtained and the set as a whole adjusted for any of the waves emitted by a distant transmitting station.

Range of Wave Length—With the average antenna, wave length adjustment up to 2,800 meters may be had in the open circuit. The closed or detector circuit can be adjusted from 200 to 2,800 meters.

300 *and* 600 *Meter Adjustments*—In some of the 240 cycle, 2 K. W. transmitters it is found that the leads from the condensers to helix and spark gap are of too great length to obtain a 300 meter wave adjustment in the closed oscillatory circuit. In order to efficiently transfer energy from the closed to the open circuit at least one turn of inductance should be included in the primary of the oscillation transformer. Since this is not obtainable, a separate tank of oil condensers is connected in series with the regular tank of three units, consequently the total capacity is reduced and the wave length is correspondingly diminished. It is then possible on the 300 meter adjustment to secure one or two turns in the primary of the oscillation transformer. This hookup is clearly shown in Figure 8.

When working on the 600 meter wave the extra tank of condensers is disconnected from the closed oscillatory circuit and the regular tank used. The connections of the secondary of the transformer are removed and connected to the regular tank as shown by the dotted lines; or, if it is so desired, a short circuiting strap can be placed across the extra condenser when working on the 600 meter wave adjustment. It will be observed that when using the 300 meter wave, a short wave condenser is used in series with the open circuit, and the extra tank of condensers to permit of the 300 meter wave in the closed circuit.

In addition to giving a 300 meter ad-

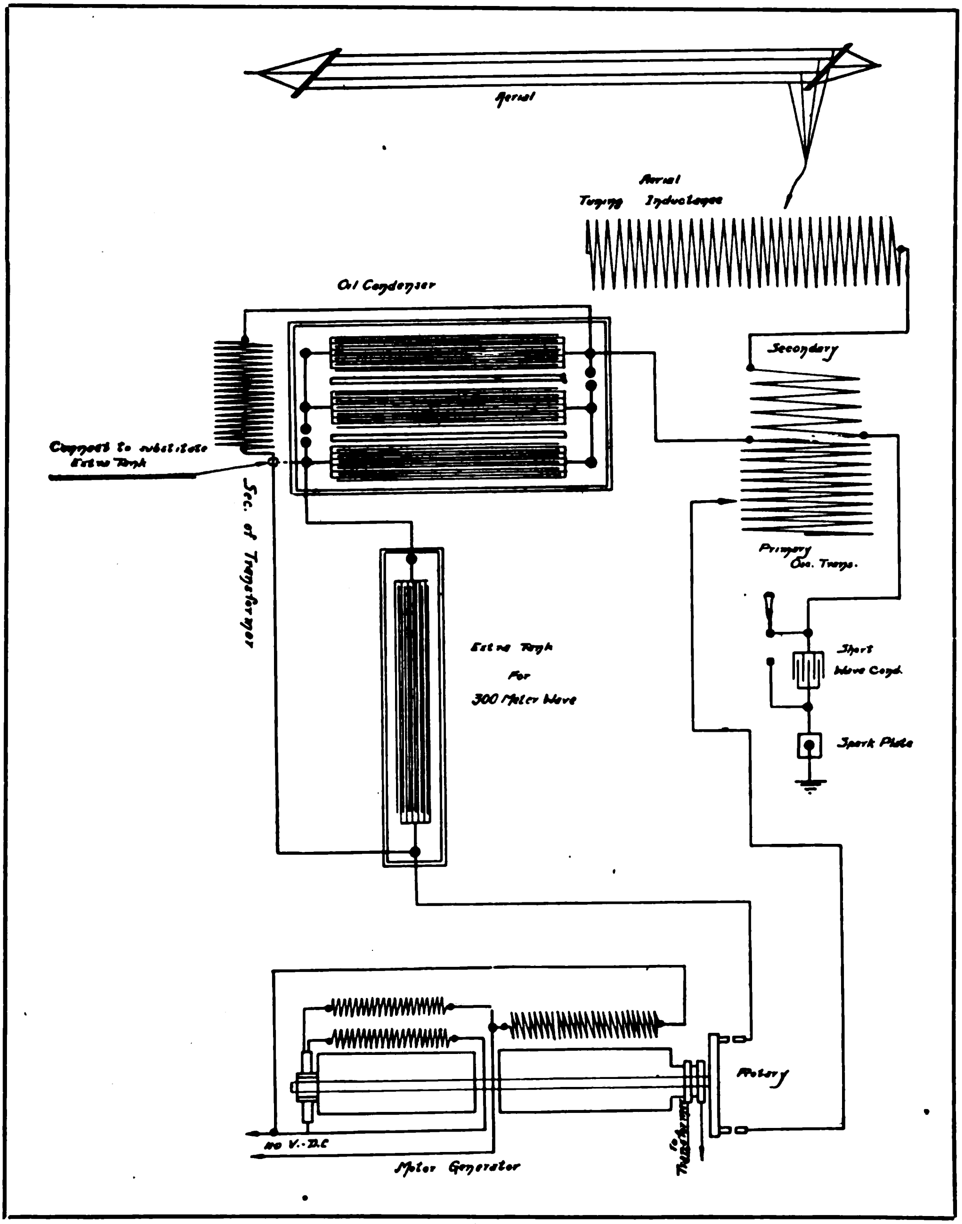


Fig. 8

justment in the closed oscillatory circuit, this tank also serves as an emergency condenser in case one of the units in the regular tank should be punctured. Under these conditions, when working on the 600 meter wave it will not be necessary to dismantle a punctured unit. After it has been found, however, it should be disconnected from the remaining units and replaced by the extra tank of 12, which is generally used with the 300 meter wave.

Figure 8 is a clear exposition of the high frequency circuits of a modern wireless telegraph transmitter and should be thoroughly studied by the learner. It gives further understanding of the elementary circuits of the motor-generator.

(*To be continued*)

My Trip to the Icefields

by

David Sarnoff

AFTER due reflection, I have decided that I am not very different from the average wireless man who follows the sea. This in spite of the fact that I have come to acknowledge a more serious trend of mind, and an alarming increase in waist measure since my duties have kept me on shore; but that is mainly due, I think, to the heavier responsibility of inspection rounds and a more regular mode of living, each in their proper order. The spirit of adventure, the fascination of visiting remote corners of the earth, coming in close touch with the wonders of Nature, the spell of the sea—all of these remain with me. At heart I am still the operator who some little time ago sailed gaily forth to the icefields, willing and anxious to take a trip that has more than once ended disastrously. But then, as now, I loved travel for travel's sake.

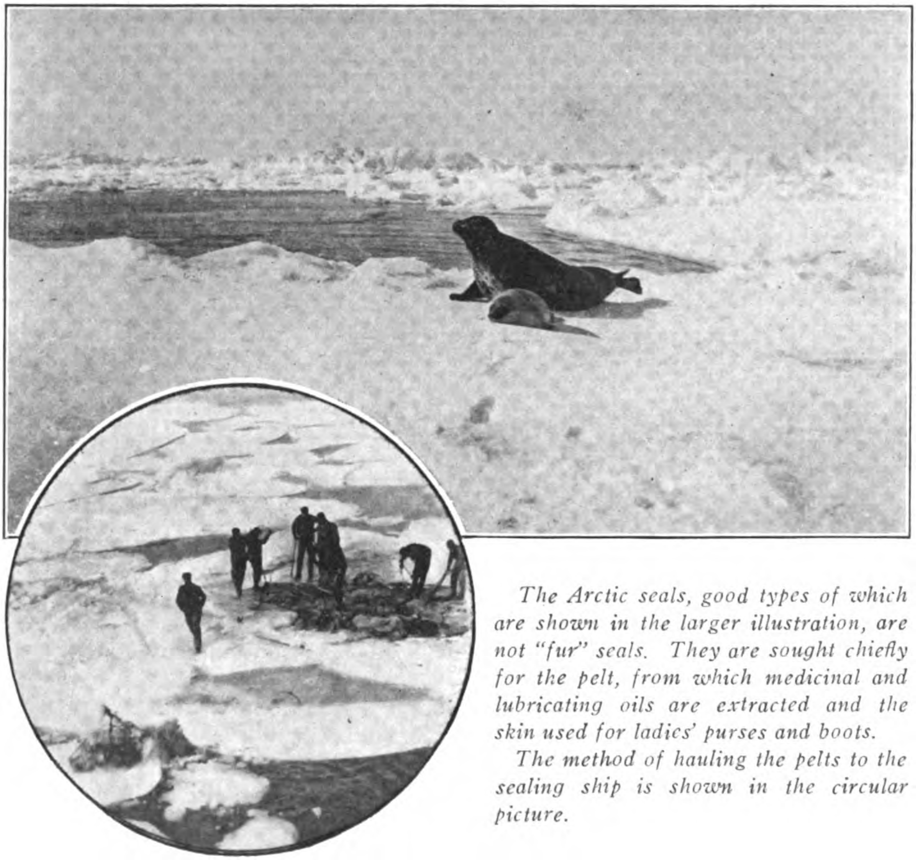
Someone has told me that my experiences on that trip would prove interesting reading, so I have set them down on paper. If my effort proves futile it is not the fault of the material; the responsibility lies with a pen that is far from graphic.

It may be well to mention here that these experiences of mine are not in the least exaggerated; they are all extracted from my diary. I have always kept a diary, more as a matter of reference than for entertainment. With very few changes I present the record as it was jotted down during the trip.

Preliminary to the actual story of my trip, let me explain the reason for it by glancing at the industry that only recently felt the need of wireless—seal fishing. Seal fishing is one of the most important industries of Newfoundland, a considerable percentage of the population depending upon it for their livelihood.

Early in the spring of each year upwards of twenty sealing vessels depart from St. Johns for the Arctic regions in quest of these sea-animals. The ancient type of sealing vessels, famed in song and story, are no longer used on these expeditions, having been supplanted by the modern "ice-breaker," a vessel especially constructed to withstand the heavy strain of forcing a path through the ice to reach the seals.

There are several types of seals, differing in name, in appearance and in natural habits. The methods of procuring differ also. The reader will be giveh a description of the several classes of seals a little later.



The Arctic seals, good types of which are shown in the larger illustration, are not "fur" seals. They are sought chiefly for the pelt, from which medicinal and lubricating oils are extracted and the skin used for ladies' purses and boots.

The method of hauling the pelts to the sealing ship is shown in the circular picture.

None of the seals found in the Arctic regions are, as is commonly supposed, "fur" seals. The fur seal is found in the Behring Straits and Alaska. The Arctic seal is sought chiefly for its pelt, which, when separated from its carcass or body, consists of the skin together with fat or blubber ranging from three to four inches in thickness. From this fat is extracted the finest of seal oil, which is refined and utilized for medicinal purposes. Seal oil is also used as a lubrication for fine machinery. Once the skin has been stripped of its fat it is salted and dried for use in the manufacture of seal skin boots and many other necessities of life.

The exact location of seals in the icefields is a matter upon which every captain has his own opinion. They are usually found several hundred miles north of Newfoundland, but it is a matter of great difficulty to navigate the vessels through the heavy ice to locate the main "patches." A peculiar characteristic of seals is that they travel together in great numbers, and it is no extraordinary occurrence for a sealing vessel to miss the main bodies and return home but lightly loaded, if not empty-handed.

Should one vessel be fortunate enough to locate a large body of seals there is generally sufficient for several ships, and it is then that the fortunate master is desirous of spreading the glad news to vessels of his own line.

In these days two sealing vessels tell each other of their success or failure when separated by several hundred miles of ice and icebergs. Twenty years ago this would have been a wild dream. The genius of Marconi made this possible, and the owners of sealing vessels were quick to realize the worth of wireless, both as a business adjunct and for its humanitarian value. Many are the tales of woe and suffering, death by starvation and exposure among those who in the past braved the dangers of the icefields in craft often battered by the heavy floes of ice or lost in the terrible storms without a chance to advise others of their plight. Many a time a dozen vessels lay but a few miles away, yet they may as well have been a million miles off.

Wireless has to a great extent stripped the industry of its danger. It has now become a necessary part of the sealing steamer's equipment and is looked upon as indespensable in obtaining the seals and for safe navigation.

Love of adventure is part of the make-up of the average young man; in the wireless operator it is usually developed to a fine point, for when news comes that the Marconi Company has equipped several sealing vessels, the thought of a trip to the perilous Arctic would seem especially attractive, judging from the number of applications for employment. Under such extraordinary conditions men are not "told" to go; a call for volunteers is posted.

A pleasant smile greeted me when I entered the manager's office offering myself as a volunteer. That official asked if I had read the stories of Peary and Dr. Cook, wanted to know if I objected to being frozen twice a day and was generally cheerful over the whole matter. But nothing, except his refusal to accept me, could or would prevent me from going; and after listening to a brief outline of what was expected of me, I pledged allegiance and left a short time afterward for the steamer which carried me to St. Johns.

The vessel to which I was assigned was the Beothic, belonging to the old Newfoundland sealing firm of Job Brothers.

Installing the wireless outfit and aerial wires aboard this vessel proved to be rather a chilly process, for the temperature, even at the St. Johns wharves, was considerably below the zero mark. This done, we set sail for Newfoundland's islands—"outparts" they are called—to pick up the sealing crew.

For the most part the sealers who make up these expeditions are fishermen who live by the spoils of the sea, and when not sealing are engaged in cod or salmon fishing, an industry of which Newfoundland can proudly boast. Education at these places is so limited that it is almost unknown. But though the majority are illiterate, these hardy fishermen are honest, hard working and thrifty.

They join the sealing expeditions on the condition that the crew receive one-third of the value of the fat obtained on all seals caught; this share is equally distributed among the entire crew, which in this instance numbered 271 strong.

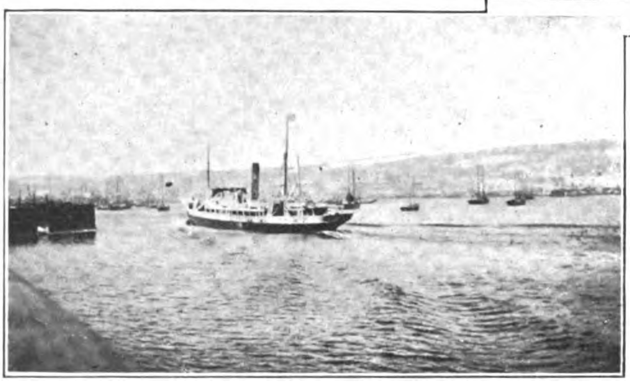
While the share per man is governed by good or bad luck, more sealers apply for berths than there are vacancies and the selection is left to the captain of the vessel. Bools Island, an outport situated about 150 miles north of St. Johns, was our chief place of recruits.

As soon as our vessel was sighted the men started over the ice to meet her, each man carrying his all in a box temporarily converted into a sleigh. The women and children followed in their wake, so that they might, in their simple way, bid these breadwinners Godspeed for a journey the return from which is ofttimes problematical.

The spectacle of these women and children walking across the ice and close up to a gigantic liner, which crashes through and breaks into smithereens tons and tons of ice, is indeed impressive.

After collecting our full complement we returned to St. Johns, to await in day upon which we were to start in company with all other sealing vessels on the long search. This day is not optional; it is regulated by the laws of Newfoundland, which provide that seal hunting is permissible only between March 15 and May 1 of each year, for the reason that the young seals are born on the 1st of March of each year and must be two weeks old before man is permitted to kill them.

The day of departure was set for Monday, March 12, and ranged along the shores of the City of St. Johns was the entire population, which had turned out to wave a farewell to the seal hunters. The city was wild with excitement. On every hand discussions were heard as to who would be the first through the outlet from St. Johns Harbor to the mighty Atlantic. Restricted by two large mountains on either side of the harbor, the shores of the outlet are separated by a distance so small that only one vessel can pass in or out at one time. To add to the excitement of the chase the sealing vessels race as they depart, each vessel endeavoring to pass through the narrows first; the race is closely watched by the excited mobs on shore and many bets are made on the result.



On the day of departure the entire population had turned out to wave a farewell to the seal hunters.

To me it was an exciting moment when, at six o'clock on the day mentioned, the signal was given, and simultaneously all vessels moved forward to the accompaniment of blowing of whistles, ringing of bells and cheers from the thousands of people lined up along the water front.

To me it was an exciting moment when, at six o'clock on the day mentioned, the signal to start was given and simultaneously all vessels moved forward to the accompaniment of the blowing of whistles, ringing of bells, shouting from the crew, waving of flags, and cheers from the thousands and thousands of people lined up along the water front.

The race is on, some dozen vessels are almost within arm's length, and in their frantic attempt to clear the narrows first a collision seems inevitable. Then the Beothic, our ship, pushes her way forward and swings through the narrows first, leaving the others behind. Although this means nothing so far as future luck is concerned, the mere fact of being on the victorious ship fills me and all the rest of the crew with joy and an ovation is given to the skipper.

After the abatement of all this excitement, I critically viewed my shipmates, who were to be my sole companions for six weeks or longer, and without reaching any particular conclusions or forming any opinions I returned to my wireless cabin. There I called up the wireless station at Cape Race, and after establishing communication with it and several neighboring vessels, I turned to my bunk to gain the necessary rest from an exciting and novel day's experience.

We encountered heavy ice from the start; our progress was extremely slow, and I received many bumps while lying in my bunk during the night. The following morning only one of the other steamers, the Bellaventure, was in sight, each vessel having its own route.

To pass through the heaviest floes of ice it is necessary to "butt," which simply means going full speed ahead until the resistance of the ice becomes too great to make further progress possible. Then the engines are reversed and the vessel moves back a short distance and repeats the process, each time cracking the ice and forming a "lead" through which to proceed. The lower part of the bow of these ice breakers is round and, instead of going through the ice, it slides up upon it, crushing enormous sheets by its own weight. It can be easily seen that the force of two steamers "butting" into the same sheet of ice produces quicker results than if only one was struggling against it, and for this reason it was arranged with the captain of our neighboring vessel to have the two ships travel close together. Some distance was covered in this manner before each of us took our separate routes.

This "butting" process is indeed a shaky proposition, for each time that the vessel crashes into a new pan of ice the impact is felt throughout the ship; and but for its staunch construction, in the way of extra heavy steel plates and a specially designed bow, the result might not be unlike that which befell the ill-fated Titanic.

Outside of the presence of our neighboring vessel, nothing was in sight but a pure white surface as far as could be seen, dazzling and causing a dull ache in the observer's eyes. The decks were crowded with the sealers, despite the biting cold. After a time I made the acquaintance of a young man who seemed as strange on board as myself, and after a preliminary chat he told me that he was our doctor. Having just graduated from college and desiring both professional and adventurous experiences he had welcomed the opportunity to join the expedition. It was a relief to meet this young Newfoundlander, for I immediately recognized that here lay my only chance for a congenial shipmate.

This being the first time a doctor as well as wireless equipment and wireless operator were carried to the ice-fields on board this vessel, we were looked upon as curiosities and afforded an endless subject for discussion amongst the crew. As for the wireless equipment, this was viewed with no undue degree of skepticism and distrust, not only by the crew but by the master; to the latter the entire equipment seemed too mysterious an arrangement to permit of any special faith in its reliability. Strange as it may sound, the master of this vessel, the chief executive of this cargo of human lives, later to be joined by a cargo of sealskins the value of which runs into the hundred thousands, was one of the most illiterate men I have ever met, unable to even sign his own name. Yet he had no peer in navigating seal craft and in locating the seals, according to one of the oldest sealers, who assured me that "the Cap'n knows every piece of ice by sight and some to speak to."

Although these sealers are an English-speaking race, their mode of expression must be best understood by their own kind, for at first I found it difficult to fully understand their speech with any degree of accuracy. I was promptly christened the "Coni Man"—the name Marconi apparently being too difficult for them to handle. What they longed most for was information as to whether any of our neighbors were faring better than ourselves in the way of seals. The wireless man being the only one who could possibly shed any light on this vital question, I was repeatedly accosted throughout the voyage with the question, "Any bit of fresh news dis marnin', Coni Man?"

When I could not relieve their anxiety with definite news they decided, at least among themselves, that "dem sparks" was not all that "it was cracked up" to be. However, these early disappointments on their part were not evidenced in any marked manner, and no discourtesy was shown to the "Coni Man." In fact these poor sealers showed me every consideration and, it is pleasant to recall some of their sterling characteristics, which, though crudely manifested, showed the kindliness of spirit which that type of man always entertains towards one whom they consider to be of a higher order of intelligence.

The first two days did not disclose any signs of seals and they were devoted to a continuous struggle with the heavy ice, which did its best to prevent the mighty Beothic from making any great headway. With the assistance of our neighbor, the Bellaventure, however, we were able to make a trifle more progress than we should have otherwise. But the best of friends and ships must part, and on the third day the captains of the two vessels decided to separate and follow different routes, or "leads," as they are called by the sealers. We were separated by scarcely more than a few miles, when the captain of the Bellaventure signaled that he wished to come near us again.

This seemed strange, but when the

The wireless equipment was viewed with skepticism and distrust, the crew deciding that "dem sparks" was not all that "it was cracked up" to be.

One of the stokers become quite friendly with a "white coat" seal.

two vessels got within hearing distance the reason was megaphoned across. The wireless outfit on the Bellaventure was out of commission, and it was requested that I go over there, locate the fault and remedy it.

The ships were then about a thousand feet apart and at a standstill. I confess I lacked the courage to risk my avordupois on the ice, and I viewed the prospect with considerable apprehension. I recalled falling through the ice in my youthful days when ice-skating and felt sure that I was to renew my acquaintance with the frigid water under this ice too. It was probably this inward fear—which I wouldn't have that admitted for the world—that led me to extend an invitation to the doctor to accompany me on my walk across the ice. Much to my surprise, he consented to go with me.

We were dressed in the usual sealing attire—sealskin boots, with spikes on the bottom to grip the ice, goggles over eyes to prevent snow-blindness—and carried in our hands a gaff, a pole about six feet long to the end of which is attached an ordinary iron boathook. These gaffs are always carried by the men while on ice and serve as a support as well as a guide. The hook is stuck into the ice before a step is taken, thus avoiding soft or "slob-ice," which if stepped upon means a ducking.

The doctor and I, in our attempt to walk over the ice, must have furnished a good deal of amusement to the sealers on board, for we were continually picking each other up. After an awful struggle, which was in no way alleviated by the ostensible mirth of the crew, we managed to land aboard the Bellaventure.

We were greeted with supercilious smiles and satirical queries as to our love for walking over ice. Nevertheless we were welcome arrivals, and after some five or six hours the wireless gear was again in commission and the vessels once more came to a halt, permitting the doctor and myself to descend to the ice and depart for our own good ship.

It was late in the day and the atmosphere was extremely cold; the ice in spots was broken; huge patches of slob ice were in evidence. Under such conditions the only way to make your distance is to jump from one pan of ice on to another, disregarding temporarily the water between the sheets of ice. This may seem a very simple process, but you have my word for it that a special race of people must have been designed for just this stunt, this race being no other than the Newfoundland seal hunters. They will jump on a piece of ice, no matter how small it may be, and keep their weight on it just long enough to get away to the next sheet. Being extremely deficient at this art, both the doctor and myself soon found ourselves in an uncomfortable as well as an extremely dangerous dilemma. At every second step we fell into the water, grabbing at a sheet of ice en route, which, after we had mounted it, promptly broke in half and floated off, separating us from each other. In but very few moments we were both played out and lay grasping on the individual ice cake which happened to hold us for the moment. The crews of both vessels kept shouting directions, suggesting which way to make for, but this only added to our confusion. At the moment which seemed above all others the most inauspicious, the captain of the Beothic, realizing our plight, committed what was in my opinion a gross indiscretion. He set the bow of the vessel straight for us and ordered full speed ahead. It will be a long time before I shall forget the sight of the big vessel bearing straight down upon us, smashing the very sheets of ice upon which we stood! To be caught between two heavy sheets of ice and jammed into a jelly was not exactly encouraging and, besides, did not conform to my ideas of a proper and fitting end for a young and industrious citizen.

The only way to make your distance is to jump from one pan of ice to another, disregarding temporarily the water between.

But the captain realized our dangerous position in time and probably chuckled as he reversed the engines to full speed astern. Then he sent a dozen or more sealers—regular "ice-trotters"—to our rescue. In scarcely a minute two of these men had us in their clutches and began passing us along from one man to another, adding a final touch by actually carrying us on board. Our safe arrival was marked by an ovation, which, if designed to add to the discomfiture of one who would and couldn't, cretainly fulfilled its purpose.

But all these and many more experiences were to be expected. In the next installment it will be shown the dramatic part the ethereal waves performed.

This is the first of a series of articles by Mr. Sarnoff relating his experiences in the Arctic. The second will appear in an early issue.

STORM WARNINGS TO SHIPS

The United States Department of Agriculture, through the Weather Bureau, has inaugurated a plan of supplying a regular daily weather bulletin to all vessels and radio stations within range of the naval radio station at Radio, Va., and Key West, Fla. Each night, a few minutes after ten o'clock, the two big naval radio stations make a broadcast distribution of a weather bulletin, which deals particularly with wind conditions and barometric pressure, and gives special warning of severe storms along the coast. Other naval radio stations will continue to distribute weather information and forecasts, as they are at present doing, but the new broadcast distribution will be exclusively through the two big radio stations.

The daily bulletin consists of two parts. This first part announces in code letters and figures the actual weather conditions at eight o'clock in the evening (75th Meridian time) at certain points: Sydney, Nantucket, Atlantic City, Hatteras, Charleston, Key West, Pensacola and Bermuda. The same part of the bulletin contains a special forecast of the probable winds to be experienced 100 miles or so off shore. In the second part are the storm warnings and forecasts, which will cover a period of forty-eight hours from the time of issue. At the end of the forecast is appended a statement of the location and movement of any barometric depressions that may be likely to affect the winds over the ocean.

STATION ON PIKE'S PEAK POSSIBLE

A wireless station, to be one of the links of a chain of such stations which will connect the Atlantic and Pacific coasts, may be established on the summit of Pike's Peak as the result of a trip made by Seretary Franklin K. Lane, of the Department of the Interior, who was the guest of the management of the Cog road.

Although the trip was made primarily to look over the watershed, its purpose was also to determine whether the summit of Pike's Peak would be a fit place on which to build a powerful wireless station, which will connect the two oceans and be used solely by the United States government. As a result of Secretary Lane's visit, the Weather Bureau, which was maintained by the government for so many years in the summit house, may be re-established.

WIRELESS TROUBLES AFRICANS

Wireless telegraphy is interfering with the happiness of natives of Central Africa, for it has deprived them of an unfailing supply of wire to be worked up into ornaments and weapons. Several mines, operated by European capital in Central Africa, have recently abandoned their wire-telegraph lines from railroads to the mines, and established communication by wireless.

Maintenance of the wire lines has been difficult, because of the demand for the wire by native belles, and also because of the occasional wanton destruction of pole lines.

The Engineering Measurements of Radio Telegraphy

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ARTICLE I

In this, the first of a series of articles by a well-known authority, several formulae to be used in the construction of laboratory standards of capacity are given; equations covering the influence of the combinations of capacity, inductance and resistance on the behavior of circuits are furnished; a method for measuring capacity by means of the Wheatstone bridge is discussed and the apparatus described in detail. The errors of the method, their elimination and probable accuracy are shown.

THE precision of measurement and the soundness of the theory underlying the measurements in any branch of engineering may be said to be a measure of the scientific and technical standing of that profession. For it is only in so far as guesswork is replaced by calculation and measurement, empirical methods by logically exact procedure, that a division of technology finds an extended sphere of usefulness. The early days of any branch of engineering always display ignorance of underlying physical principles and crude methods of measurement. Both are usually masked by a pretense of mystery and claims that the obtaining of exact data is not "practical." Fortunately for radio engineering, it may safely be said that such an era of literal groping in the dark has come and gone, and that there is no excuse for failure to obtain quantitatively exact measurements.

It is the aim of the following series of articles to place before those actively interested in radio communication a practically complete series of methods of measurements dealing with the widely diversified electrical constants of radio apparatus. A knowledge by the reader of the principal laws of electricity, and of commonly used electrical machinery, is presupposed. The methods described have been chosen from an engineering standpoint, only those which are made in radio stations or in laboratories intended for the development of commercial apparatus being fully considered. Those of purely scientific interest, or those requiring especially elaborate experimental facilities, will be merely cited.

The three most important elements of the usual circuit in which flow radio frequency currents are (concentrated) capacity, inductance and resistance. They determine the electrical behavior of a circuit under the action of any definite type of impressed electromotive force. The logarithmic decrement, or the associated quantity, the damping, of the circuit is a function of these three; but it is of great importance in radio circuits, and special means of determining it are used. The wave length, or the related quantity, the frequency, of the circuit, is also a function of these three, and again can be directly measured by special methods. Passing to the electrical means of linking circuits for purposes of energy transfer, measurements of the various coefficients of coupling—direct, inductive and capacity couplings—will be considered.

Having established definite methods of determining these fundamental electrical constants, methods of testing separate pieces of radio apparatus will be treated. The separation of the losses in each instrument, from the power plant to the antenna insulators, are to be discussed. Under this heading many of the highly special types of radio apparatus will be considered; for instance, arc and spark-gap dischargers, transformers, radio frequency alternators and relays for break systems.

A number of tests of receiving apparatus will follow. Critical quantitative tests of the sensitiveness, ease of adjustment and holding of sensitiveness of the various detectors will be treated.

And, finally, over-all efficiency station tests, the consideration of antenna types and ground connections, and some transmission tests will be given.

I.—MEASUREMENTS OF CAPACITY.

General Considerations.

1. *Calculation of Capacity of Definite Systems.*—Since it is necessary to construct standard capacities, and desirable to know in advance their approximate value, the following formulæ are of value:

(a) Capacity of a Sphere, radius u, placed in air, and distant from the ground, the capacity in microfarads (abbreviated μf),

$$c = \frac{u}{900{,}000} \qquad (1)$$

(b) Capacity of a cylindrical wire, length v cm., radius u cm., stretched vertically and distant from the ground, in microfarads,

$$c = \frac{v}{900{,}000 \log \frac{v}{u}} \qquad (2)$$

Note.—The logarithm here given is a natural logarithm, and is obtained by multiplying the usual logarithm to the base 10 by 2.3026. Unless otherwise stated, all logarithms hereafter referred to are to the base e—that is, natural logarithms.

(c) Capacity of the same wire, but stretched horizontally s cm. from the ground, in microfarads,

$$c = \frac{v}{900{,}000 \log \frac{2s}{u}} \qquad (3)$$

(d) Capacity of a flat circular plate, radius u cm., in air distant from the ground, in microfarads,

$$c = \frac{2u}{900{,}000\pi} \qquad (4)$$

(e) Two parallel thin plates, area f sq. cm., with the small separation of s cm., in microfarads, neglecting edge correction, dielectric constant K,

$$c = \frac{fK}{(4\pi)900{,}000\, s} \qquad (5)$$

(f) Capacity of two circular plates, radius u cm., separation s cm., thickness w cm., dielectric constant of separating medium K, with partial edge correction, in microfarads,

$$c = \frac{K}{900{,}000}\left[\frac{u^2}{4s} + \frac{u}{4\pi}\left(\log\frac{16\pi u(s+w)}{s^2} - 1 + \frac{w}{s}\log\frac{s+w}{w}\right)\right] \qquad (6)$$

(g) Capacity of y semi-circular plates. arranged as in (f), in their position of maximum capacity—that is, interleaved (taking only the capacity between pairs of adjacent plates).

$c = \left(\frac{y-1}{2}\right)$ times (the capacity of two similar circular plates as given by (f) above). (7)

(h) Capacity of two coaxial cylinders, length v cm., outer radius of inner cylinder u_1 cm., inner radius of outer cylinder u_2 cm.

$$c = \frac{v}{2\left(\log\frac{u_2}{u_1}\right)900{,}000} \qquad (8)$$

2. *Calculation of Capacities in Series and Parallel.*—If the individual capacities—c_1, c_2, c_3, etc.—are connected in parallel, the total capacity of the system (neglecting the connecting wires and the capacities between the condensers) is given by the equation,

$$c = c_1 + c_2 + c_3 + \text{etc.} \qquad (9)$$

If the same capacities are connected in series, the total capacity under the same conditions as before is,

$$c = \frac{1}{\frac{1}{c_1} + \frac{1}{c_2} + \frac{1}{c_3} + \text{etc.}} \qquad (10)$$

3. *Electrical Behavior of Capacity.*—Suppose a capacity of value c to be placed in an alternating current circuit, frequency n, angular velocity ω,

$$(\omega = 2\pi n)$$

The reactance of this capacity is,

$$X = -\frac{1}{2\pi nc} = -\frac{1}{\omega c} \qquad (11)$$

The current which passes through this capacity when an electromotive force E (R. M. S. value) is applied is,

$$I = \frac{E}{X} = \frac{E}{-\frac{1}{\omega c}} = -\omega cE \qquad (12)$$

(In this equation, the minus sign signifies that the current "leads" the electromotive force.)

4. *Equivalent Impedance, Reactance and Capacity of Combinations of Capacity, Inductance and Resistance in Series.*—The first case we shall consider is that of a capacity c in series with a resistance r. The equivalent resistance is r, the equivalent capacity c, and the impedance is

$$Z = \sqrt{r^2 + \frac{1}{\omega^2 c^2}} \qquad (13)$$

For a capacity c in series with an inductance l, the reactance is

$$X = \omega l - \frac{1}{\omega c} \qquad (14)$$

and the impedance has the same value. The impedance of a capacity c, an inductance 1, and a resistance r, all in series, is

$$Z = \sqrt{r^2 + \left(\omega l - \frac{1}{\omega c}\right)^2} \qquad (15)$$

In each of the above cases, if we divide the impressed alternating electromotive force E by the corresponding impedance for reactance, where no impedance is given), we obtain the current I, *for a steady state*. Considering equation (15) further, the current under a given impressed voltage will be greatest when the impedance is least. Assuming constant resistance in the circuit, the impedance Z is least when

$$\omega l - \frac{1}{\omega c} = 0 \qquad (16)$$

which is the condition for resonance to a forced alternating current.

5. *Equivalent Impedance, Reactance and Capacity of Combinations of Capacity, Inductance and Resistance in Parallel.*—The first case to be considered is a capacity c in parallel with a resistance r. It is of importance, because in many wave-meter arrangements detectors or resistances of other kinds are shunted across the variable condenser. The equivalent resistance is

$$r_e = \frac{r}{1 + \omega^2 c^2 r^2} \qquad (17)$$

The equivalent capacity is

$$c_e = \frac{1 + \omega^2 c^2 r^2}{\omega^2 c^2 r^2} \qquad (18)$$

The impedance is

$$Z = \frac{r}{\sqrt{1 + \omega^2 c^2 r^2}} \qquad (19)$$

Consider now a capacity c in parallel with an inductance l. The equivalent capacity is

$$c_e = \frac{1 - \omega^2 lc}{\omega^2 l} \qquad (20)$$

and the reactance is

$$X = \frac{1}{1 - \omega^2 lc} \qquad (21)$$

An arrangement, to which we shall have occasion to refer when giving a method of constructing an artificial antenna which closely duplicates in behavior actual antennæ, involves a capacity c_1 in parallel with and inductance l and a capacity c_2, the latter capacity and inductance being in series. The reactance is

$$X = \frac{\omega^2 lc_2 - 1}{\omega c_2 + \omega c_1(1 - \omega^2 lc_2)} \qquad (22)$$

The arrangements given under sections 4 and 5 are shown in order in Figure 1. It is to be noted that in all these cases the forced alternating current through the desired combination can be found by dividing the impressed voltage by the impedance (or reactance, where the impedance is not given). That component of the current which is in phase with the voltage can be found by dividing the voltage by the equivalent resistance, and that component of the current which leads the voltage by 90° can be found by multiplying the voltage by ω times the equivalent capacity. It is, however, to be noted that these formulæ cannot be used to obtain the *natural* frequency or wave length of the corresponding circuit. Formulæ for this latter purpose will be given under measurements of wave length.

6. *Conditions of Measurement of Capacity.*—Capacities may be measured at high or low voltages, and at audio frequencies (that is, between 20 and 20,000 cycles per second), or radio frequencies (above 20,000 cycles per second). The distinction here given between audio and radio frequencies is solely one of convenience, and is not meant to imply that radiation is confined to currents of radio frequencies, though usually such is the case, practically speaking. It is generally found that capacities are apparently larger at high voltages than at low voltage, because of the brush discharges increasing the equivalent jar surface, and because of heating and the consequent increase of conductivity of the dielectric. And, in general, capacities are apparently less at radio frequencies than at audio frequencies, because of the altered distribution of charge in the plates of the condenser.

We pass now to a series of measurements of capacity under these various conditions.

7. *Measurement of Capacity at Audio Frequencies and Low Voltages* (using the Wheatstone Bridge).

(a) *Arrangement of the Apparatus.*—In Figure 2 is shown a diagrammatic representation of the apparatus used. S is a source of alternating or pulsating current. r_1 and r_2 are non-inductive resistance s, c_x is an unknown capacity, and c_n is a standard known capacity. T is a telephone receiver or other device which is is sensitive to small alternating currents.

The actual arrangement of the apparatus is as shown in Figure 3. The fluctuating current source S is the buzzer M. This buzzer has a third terminal U, so that both of the interrupter terminals are accessible from the outside. The buzzer itself is operated from the battery V, controlled by the rheostat R. Connected across the interrupter is the condenser C_t and the coil P. P is the primary of an ordinary telephone induction coil, and therefore a fairly high voltage is produced at the terminals of S, the secondary. A, B is an ordinary slide wire bridge with special wire, and the remainder of the apparatus is as explained above.

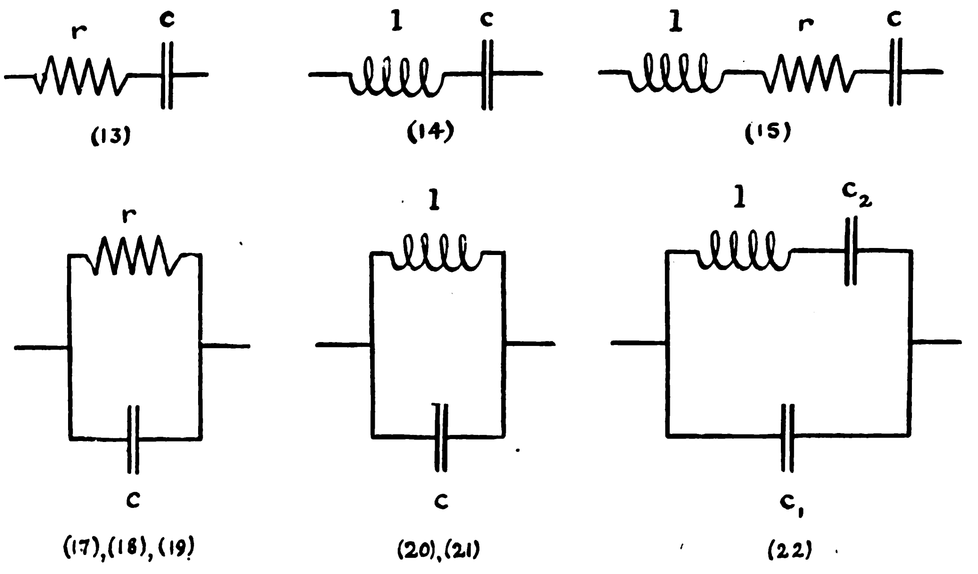


Fig. 1

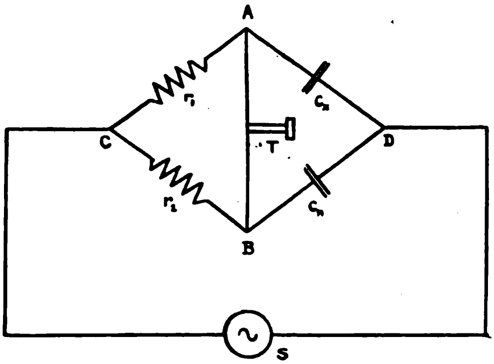


Fig. 2

In Figure 4, a photograph of the assembly of the apparatus is given. To the left, the box containing the buzzer, the telephone induction coil, the battery circuit rheostat and the primary circuit condenser are seen. The bridge itself in in the foreground, with the telephone receiver directly behind it. The box of standard capacities is at the right, just back of the bridge. In the background are a number of different types of air and solid dielectric condensers which were tested.

(b) *Theory of the Method.*—If no sound is heard in the telephones, the potentials at A and B are the same. That is, the drop of potential along AC is the same portion of the total drop along CAD as the drop of potential along CB is of the total drop along CBD. But the drops of potential are proportional to the corresponding reactances or impedances of the included portions of the circuits. Hence, from equation (13) above,

$$\frac{r_1}{\sqrt{r_1^2 + \left(\frac{1}{\omega c_x}\right)^2}} = \frac{r_2}{\sqrt{r_2^2 + \left(\frac{2}{\omega c_n}\right)^2}}$$

which can be readily simplified to

$$c_x = \frac{r_2}{r_1} c_n \qquad (23)$$

So that, if r_1 and r_2 are appropriately adjusted, or c_n is varied, silence will be attained in the receiver, and the unknown capacity can be calculated from equation (23).

(c) *Procedure.*—The experiment should be performed in as quiet a room as possible. The tone of the buzzer is preferably higher than that of the usual buzzer, because of the increased sensitiveness of the ear to high-pitched notes. The balance point for silence is first roughly located by moving the contact up and down the slide wire. If no balance point is found, either a connection is open at some point of the bridge or the two capacities which are being compared are not nearly enough equal. It is always desirable to have them not very far from equality; that is, their ratio should not be greater than one to four or four to one. Otherwise the accuracy of the measurement is decreased.

To locate the silence point, it is usually desirable to find two points, one on each side of it, where the intensities of sound in the telephones are equal in the two cases. The balance point is then taken half way between these points. If the bridge wire is known to be of uniform resistance per unit length, the resistances r_1 and r_2 can be replaced by the lengths m and n, the ratio of which will be the same as the ratio of the corresponding resistance. If this is not the case, the bridge wire must be separately calibrated on a usual Wheatstone bridge, so that the resistances of various lengths of it are known. If care is taken not to damage the slide wire by rough handling, such a calibration will usually not be necessary.

(d) *Detailed Description of Apparatus.*—In this measurement it is desir-

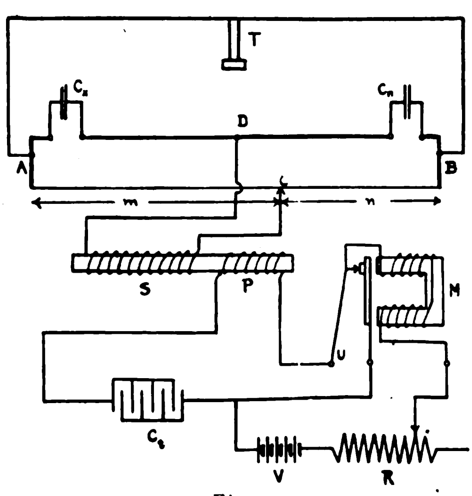


Fig. 3

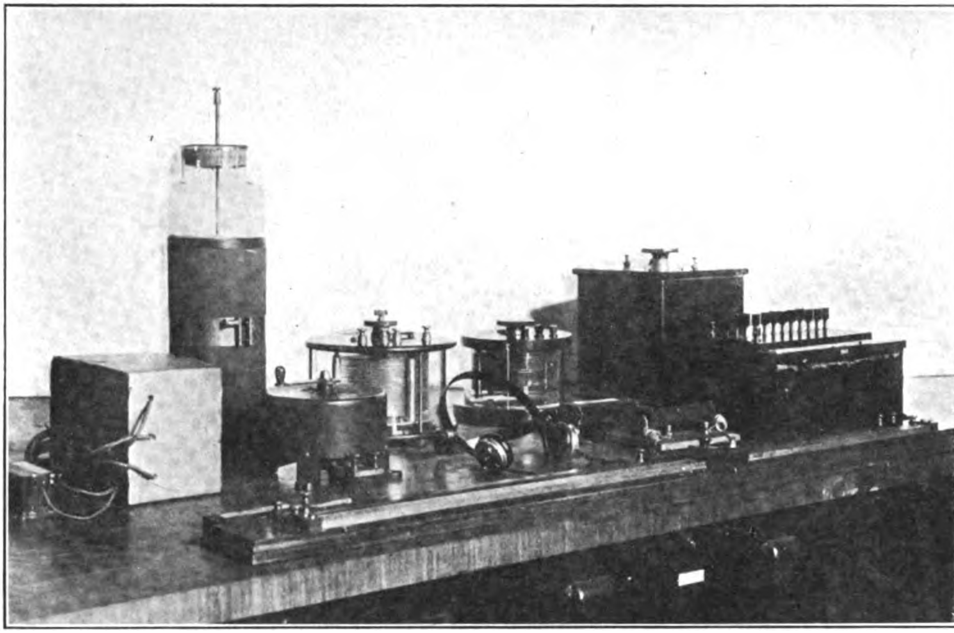


Fig. 5

able for high sensitiveness to use a slide wire of large resistance. A meter of 0.003 inch "Therlo" wire, having a resistance of 104 ohms, was used. The buzzer was a small, high-pitched one, the battery voltage was 10, and the regulating resistance R was 12 ohms. The condenser c_t was 2 microfarads, and the telephone induction coil was a No. 5 Western Electric induction coil, resistance of primary being 0.39 ohms, and of the secondary 149.2 ohms. If the reactance of a capacity of 0.1 μf is calculated at 500 cycles, it will be found to be about 3,300 ohms, so that for maximum sensitiveness in measuring a capacity of this order of magnitude the bridge wire should have a resistance of about 6,700 ohms. The reason for this statement is that maximum sensitiveness of a Wheatstone bridge arrangement is attained when the impedances of the four arms of the bridge are equal. Of course, a bridge wire of so high a resistance would be too fragile, so that for more accurate measurements a post office type of box Wheatstone bridge must be employed. To avoid the serious error of the distributed capacity of the coils of such a bridge, the resistance coils of higher values must be made up of a number of smaller resistances connected in series. In this way the distributed inductance of the set of coils is less than that of a single coil (see equation 10, above). Another method of obtaining a high-resistance bridge wire, of low capacity, is to use specially prepared uniform graphite resistance rods in place of a metallic wire. Such rods will usually require a preliminary resistance calibration, because of their lack of homogeneity. Any fairly high-resistance telephone of good sensitiveness suffices for this measurement. It should, however, fit tightly to the ears, because even when the buzzer is placed in a large box packed in cotton waste or felt its sound is still audible. And it may be mentioned that other sources of alternating or fluctuating current may be used with equal success and convenience in these measurements. For example, ordinary alternating current, properly controlled by lamp-board resistances, or rotating commutator so arranged as to charge the condenser C_t periodically and permit it to discharge through P, may be employed.

The capacity of the various portions of the bridge to ground may introduce a slight error in these measurements, This error may be partially eliminated by connecting the point C to ground, and not tonching any metallic part of the circuit with the fingers while taking readings.

And, finally, it is desirable to have the same dielectric in the standard condenser and the unknown condenser; because, otherwise, dielectric hysteresis being unequal in the two condensers, it will be impossible to get an absolute silence point. In such cases, the best that can be obtained is a minimum of sound.

(e) *Errors of the Method, their Elimination and Probable Accuracy.*—The errors and disadvantages of the method are the lack of sensitiveness of the ear to very faint sounds, dielectric losses in the condensers causing difficulty in getting complete silence, the inductance and capacity of the resistance arms of the bridge, and the capacity of all connecting wires. These errors can be minimized by finding the silence point through taking readings equidistant from it on both sides, by employing an air or oil dielectric for the condensers, by using straight wires or rods of high specific resistance for the resistance elements, and by having all connecting wires as short as possible and far apart. As an example of a typical measurement, the following may be instanced:

c_x Paper dielectric condenser, nominal value $= 0.1\ \mu f$.

c_n Edelman standard mica dielectric condenser, capacity (according to the Reichsanstalt) $= 0.0992\ \mu f$.

At balance point:

$$m = 48.1 \pm 0.1 \text{ cm.}$$
$$n = 51.9 \pm 0.1 \text{ cm.}$$
$$c_x = \frac{n}{m} c_n = 0.1036 \pm 0.0004\ \mu f.$$

Accuracy of the measurement $= 0.5\%$.

This is the first of a series of articles on engineering measurements, by Dr. Goldsmith. The second will appear in an early issue.

NEW NAVY STATION AT CAIMITO

Work will soon be commenced on a large wireless station which will be constructed by the United States at Caimito, in the Canal Zone. When completed it is expected to make wireless communication with Washington, D. C., possible at all hours of the day and night. The station will be officially known as the Darien Radio Station, and will be in charge of the Navy Department. It will be even larger than the one at Arlington, Va.

All of the three masts will be 600 feet high, whereas at Arlington one of the towers is 600 feet in height and two are 450 feet high. The bases of the towers will be about 180 feet above the sea level, and they will be arranged in a triangle, approximately 900 feet on a side. The sending and receiving radius will be nominally 3,000 miles, so that communication may be held direct with the Arlington station, instead of by way of Key West, as at present.

The present stations at Colon and Balboa will be continued in use to handle messages for ships using the canal, and the Caimito station will be used exclusively for official business of the government.

10,000 MILES BY WIRELESS

A wireless communication was sent more than 10,000 miles by means of the flagship Australia, which was traveling from Durban, South Africa, to Albany, Queensland. A message from the Governor of New Zealand to Lord Gladstone at Pretoria was sent from Wellington to the high-power station at Sydney, thence to Perth, and thence via the Australia, in mid-ocean, to Cape Town and Durban.

SERVICE ITEMS

John Young, auditor of the American Marconi Company, has sailed for Scotland, where he will spend a vacation. He is accompanied by his wife.

* * *

N. E. Albee, who was manager of the Marconi station at Tampa, Fla., has been placed in charge of the Cape Hatteras station. R. I. Young, who was assistant to Albee, has succeeded him as manager of the Tampa station.

* * *

John R. Irwin, who is well known as a wireless operator, has been appointed superintendent of the Northern district of the Pacific coast division of the American Marconi Company. He will make his headquarters in Seattle, Wash.

Prize Money for Ideas About Wireless

IN order to induce readers interested in wireless telegraphy and telephony to exchange ideas and relate what progress they have made in the art, THE WIRELESS AGE will start two prize contests. The contests are open to all, whether subscribers or non-subscribers to THE WIRELESS AGE. Four prizes will be given every month for new ideas and suggestions, accompanied by drawings, regarding wireless apparatus and how to bring about improvements in it. For the best descriptive articles, accompanied by photographs, of wireless apparatus, stations or any thing that pertains to wireless communication feats, four prizes will also be given every month.

Three prizes of $10, $5 and $3 each, and one prize of a year's subscription to THE WIRELESS AGE will be awarded for the best ideas and suggestions, with drawings, submitted. Two prizes, of $5 and $3 each, and two prizes of $1 each, will be awarded for the best articles. describing station equipment, with photographs. THE WIRELESS AGE reserves the right to publish any of the contributions received, regardless of whether or not prizes have been awarded for them.

Contributions should be written on one side of the paper. It is desirable to have typewritten manuscripts, double spaced, and India ink should be used in making the drawings. Sketches should be forwarded with suggestions whenever possible, even if they are rough. Articles submitted should not exceed 1,000 words. In order to obtain proper consideration, contributions should be sent to THE WIRELESS AGE as soon as posible.

Almost every student of wireless has ideas which are of interest to other students. If, in the course of experimenting, you have made discoveries that will tend to throw new light on the art, send an account of them to this magazine. They may, perhaps, appear trivial to you, but it is possible that they will prove of considerable value to other readers, who have been experimenting along the same lines. Through the publication of these ideas there will be established what may be termed a co-operative information bureau on wireless subjects.

Everyone is able to discuss intelligently that which absorbs considerable of his attention. Wireless operators, therefore, will welcome an opportunity to tell all about their outfits. It is advisable to include the dimensions of the apparatus in a description of the outfit. If you made the outfit yourself that fact will also be of interest. Do not hesitate to send in details of your apparatus because it is small; a description of the outfit might prove very interesting.

It is not necessary that competitors in these contests should own or operate outfits themselves. Contributions from persons who, while they do not own outfits, are interested in the science will be welcomed.

The competitors should also bear in mind that the details of an article contribute in no small degree to its interest. If you have an outfit that you made yourself, tell how the idea of taking up wireless first came to you. Relate the difficulties you had in making the apparatus. Of course, the main interest in the article is in the apparatus itself, and every part of the outfit should be described. After you have completed your article, read it over carefully to correct errors of statements, grammar and spelling.

There is an unlimited field for persons ambitious to win prizes in the contest for ideas and suggestions. If you have no ideas in mind at present, examine carefully all parts of your apparatus and pick out the defects. It is likely that a little time and thought spent on the outfit will reveal possibilities for improvement which had not previoussly occurred to you.

WIRELESS ENGINEERING COURSE

ERRATA

In the September issue of The Marconigraph, in the chapter on thermo meters, in the wireless engineering course, the expression, "between the poles of a perminate magnet," appears. The expression, "perminate magnet," appears also in another section of the article. In each case "perminate" should have read "permanent."

By H. SHOEMAKER

Research Engineer of the Marconi Wireless Telegraph Company of America

CHAPTER X

Electrical Oscillations

ELECTRICAL oscillations may be defined as alternating currents whose successive maximum values gradually decrease to zero. Like alternating currents, they can be produced at almost any frequency. Fig. 10 of the preceding articles is a graphic representation of alternating current produced by a generator or dynamo. In this case the successive current maximums are the same, and their value will depend on the voltage, resistance or self-induction of the circuit.

Fig. 44 is a graphic representation of electric oscillations produced by the discharge of a condenser. Fig. 45 is a circuit diagram of an oscillation circuit. K is a condenser which can withstand very high voltages, L is an inductance and S is a spark gap. All three of these elements are connected in series to form a complete circuit except the spark gap S. If the condenser K is charged by means of a transformer or other suitable device, its potential will rise until a discharge takes place across the spark gap S. When this discharge takes place the spark gap is rendered conducting and the current flows through the circuit, which oscillates as shown graphically in Fig. 44.

X X′ is the time axis and Y Y′ the axis of current values.

O is the origin or starting point of the oscillations and corresponds to the instant the discharge across the gap S starts; a b represents the maximum value to which the current rises in the time o b, which is one-fourth of a complete period. The current now decreases to zero at the point c corresponding to one-half of a complete

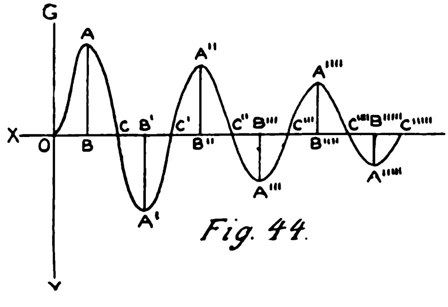


Fig. 44.

period. It now reverses in direction and again increases in value to a maximum represented by a′ b′, corresponding to three-fourths of a complete period. It now decreases again to zero, corresponding to a complete

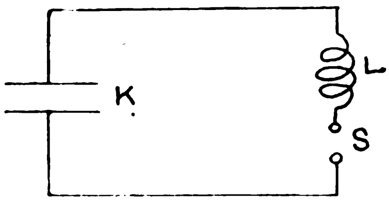


Fig 45

period. This process repeats itself and each successive maximum has a smaller value until it reaches zero, where all action stops. This series of oscillations is called a wave train. The oscillations are said to decay, due to the fact that the condenser contained a definite amount of energy before the discharge took place, and each time the current passed through the circuit a certain amount of energy was lost or dissipated by the resistance of the circuit.

As the resistance of the circuit increases, the difference between the successive maximum current values increases, and the number of oscillations of the wave train decreases. The oscillations are said to be damped.

If the resistance of the circuit is greater than a certain critical value, then the oscillations will be entirely damped out and the condenser will discharge in one direction only. In this case the circuit is said to be dead beat or aperiodic, and the current flow can be represented graphically by Fig. 46; it rises in value until it reaches a maximum and then decreases until it reaches zero.

The time for a complete discharge will depend on the resistance of the circuit and the capacity and self induction, and is independent of the voltage to which the condenser is charged. The time period of the discharge of condenser, whether oscillatory or aperiodic, depends on the three quantities, viz.: self induction, capacity and resistance of the circuit. It is independent of the voltage. The current value, however, depends on the voltage and the ratio of the capacity to the self induction.

If the circuit has iron or other magnetic material having a variable permeability, then the time period will be dependent on the current, which in turn is dependent on the voltage. Iron is never used in high frequency circuits for this reason; and also for the reason that it is a poor conductor.

The relation between the time period and the resistance, self induction and capacity can be expressed by simple formula where the values remain constant with different values of current, which is the case in practice.

Let T = the complete time period of the oscillations.
n = the frequency.
π = 3.1416.
L = the self-induction in henrys.
K = the capacity in farads.
R = the resistance corrected for frequency, in ohms.
I = the maximum current value in amperes.
i = the instantaneous current value at any instant.
λ = the wave length of the oscillation in meters.

If R is greater than $\sqrt{4L/K}$ there will be no oscillations and the discharge will be aperiodic or unidirectional.

If R is less than $\sqrt{4L/K}$, then there will be oscillations and

$$2\pi = \sqrt{\frac{1}{KL} - \frac{R^2}{4L^2}} \qquad (1)$$

In nearly all practical cases R is so small that is can be neglected entirely so fas as the frequency is concerned.

Then,

$$2\pi n = \sqrt{\frac{1}{KL}}, \text{ or } n = \frac{1}{2n\sqrt{LK}} \qquad (2)$$

$$T = \frac{1}{n}, \text{ therefore } T = 2\pi\sqrt{LK} \qquad (3)$$

The wave length (λ) is the distance a free wave of frequency (n) will travel in time (T). It is used to measure the free wave produced in space by the electrical oscillations, rather than to measure the oscillations.

It has been found by direct experiment that these waves travel 3×10^{10} cm., or 3×10^8 meters, per second (300,-000,000 meters).

Therefore,

$$\lambda = \frac{3 \times 10^8}{n} \text{ met., or } \lambda = 3 \times 10^8 \times T \text{ met.}$$

From the foregoing it will be seen that the frequency can be readily varied by varing either K or L or both, and that it is inversely proportional to the $\sqrt{LK}$. This quantity $\sqrt{LK}$ is called the oscillation constant, and the wave length (λ) is proportional to this quantity.

The reader should fully understand these fundamental relations, for they are of great importance in wireless telegraphy. As the frequencies used in wireless telegraphy are of the order 1,000,000 (10^6) to 100,000 (10^5), and even lower in some cases, the values of L and K are small, being of the order of a few thousand millionths of a farad (10^{-9} farads) and millionths of a henry (10^{-6} henrys) or micro-henry.

The micro-farad is used as the unit of capacity and the centimeter as the unit of inductance, 1,000 centimeters being equal to one micro-henry. It is desirable to put equation 2 in the form for solution with these units, viz.: micro farads and centimeters,

$$n = \frac{5.033 \times 10^6}{\sqrt{LK}} \qquad (4)$$

Where K is in micro-farads and L in centimeters.

1 Micro-farad $= 10^{-6}$ farads

1 Centimeter $= 10^{-9}$ henrys

By equation (2)

$$n = \frac{1}{2\pi\sqrt{LK}}.$$

where L is in henrys and K in farads, therefore,

$$n = \frac{1}{2\pi\sqrt{L\,10^{-9}\,K\,10^{-6}}} = \frac{1}{2\pi\sqrt{LK\,10^{-15}}}$$

or,

$$n = \frac{1}{2\pi\sqrt{10^{-15}}\sqrt{LK}} = \frac{1}{2\pi\sqrt{10^{-3}}\sqrt{10^{-12}}\sqrt{LK}}$$

Which can be put in the form,

$$\frac{\sqrt{1{,}000} \times 10^6}{2\pi\sqrt{LK}}$$

$$\frac{\sqrt{1{,}000}}{2\pi} = 5.033$$

Therefore,

$$n = \frac{5.033 \times 10^6}{\sqrt{LK}},$$

and for approximate values we can say,

$$n = \frac{5 \times 10^6}{\sqrt{LK}},$$

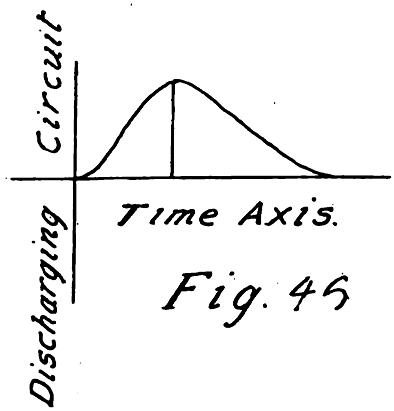


Fig. 49

While the resistance of the circuit does not affect the frequency unless it is great, it does affect the character of the oscillations and the number in a wave train. If we could measure the successive maximum currents in a wave train we would find that,

$$\frac{I}{I_1} = \frac{I_1}{I_2} = \frac{I_2}{I_3},$$

etc, where I is the first maximum, I_2 the second maximum, and I_3 the third maximum, etc. The Napierian logarithm of this ratio is called the logarithmic decrement.

If ϵ is the base of the Napierian logarithms than we can say,

$$\frac{I}{I_1} = \frac{I_1}{I_2} = \frac{I_2}{I_3} = \epsilon\,\delta$$

where δ is the logarithmic decrement or,

$$\delta = \text{Log.}_\epsilon \frac{I}{I_1} = \text{Log.}_\epsilon \frac{I_1}{I_2}$$

We can also write,

$$\frac{I}{I_1} = \frac{I_1}{I_2} = \frac{I_2}{I_3} = \text{etc.} = \epsilon\,\frac{a\,T}{2}$$

where a is a quantity called the damping factor.

The quantity

$$\frac{a\,T}{2} = \frac{a}{2\,n} = \frac{R}{4\,n\,L} = \delta$$

If we substitute in

$$\frac{R}{4\,n\,L}$$

the value of n, which is

$$\frac{1}{2\,\pi\,\sqrt{L\,K}}$$

we get the equation

$$\delta = \frac{\pi\,R}{2} = \frac{\sqrt{K}}{\sqrt{L}} \qquad (5)$$

It will be seen that when R is constant, δ is proportional to

$$\frac{\sqrt{K}}{\sqrt{L}}.$$

Therefore we can make the decrem.nt small by making K small and L large, or by reducing R. In practice we are limited in several ways and must therefore compromise on these values. The order of the actual values in use will appear later.

By the use of formula 5 the number of oscillations in a wave train can be determined; for if δ is known, then (m) the number of oscillations in a wave train, when the last current maximum bears a certain ratio to the first, can be determined by the formula.

$$\frac{I}{I_m} = \epsilon\,(m-1)\,\delta$$

or,

$$\text{Log.}_\epsilon \frac{I}{I_m} = (m-1)\,\delta$$

where I_m is the current maximum of the *m*th oscillation.

We must assign a value of

$$\frac{I}{I_m}$$

so that I_m is a certain percentage of I.

For instance, if I_m is .2% of I, then

$$\frac{I}{I_m} = \frac{1}{.02} = 50.$$

Therefore,

$$\text{Log.}_\epsilon \frac{I}{I_m} = \text{Log.}_\epsilon\, 50,$$

and,

$$\text{Log.}_\epsilon\, 50 = (m-1)\,\delta,$$

or,

$$2.3026\,\log_{10} 50 = (m-1)\,\delta,$$

and,

$$2.3026 \times 1.69897 = (m-1)\,\delta,$$

or,

$$3.935 = (m-1)\,\delta.$$

Therefore,

$$m = \frac{3.935 = \delta}{\delta}.$$

$$\delta = .02 \text{ then } m - 195.$$

If δ = .02 then m = 195.

There will therefore be 195 semi or 97.5 complete oscillations before the last one is reduced to .02 of the first.

The full proof of these equations and their derivation will be found in chapters I and III of Principles of Electric Wave Telegraphy, by J. A. Fleming. The reader is advised to study this matter so as to become familiar with all the terms and their meaning.

(To be continued)

This course commenced in The Marconigraph, issue of December, 1912. Copies of previous lessons may be secured. Address Technical Department, THE WIRELESS AGE.

Donald Perkins—Hero.

Snapshot of the Heroic Wireless Operator Taken by a Passenger Aboard the Ill-Fated Steamer

FAITHFUL to his duty, even as he faced death, Donald C. Perkins, chief wireless operator on the steamship State of California, lost his life when the vessel crashed onto a reef in Gambier Bay, Alaska, on August 18, and sank, carrying with her, according to newspaper reports, thirty-two persons.

Before he went to his grave, Perkins succeeded in sending the S. O. S. signal, which brought another steamship to the aid of the survivors. "Jack" Irwin, of the American Marconi Company, declares that Perkins was entrapped in his cabin and drowned, while newspaper stories are to the effect that he was struck by a falling mast and killed.

The ill-fated vessel was going at full speed when she struck the rock, which was uncharted. A large portion of her bottom was torn off, letting in a mountainous deluge. Three minutes afterward she sank. The disaster came without warning at half-past eight o'clock in the morning, and many of the passengers who perished met death in their staterooms.

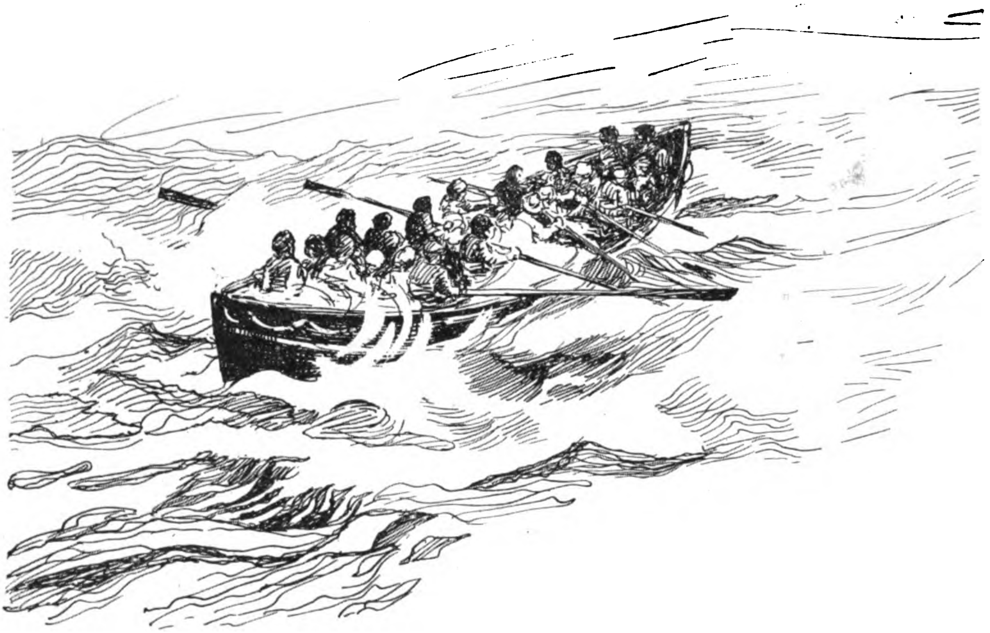
In the three minutes before the State of California went to the bottom, Perkins, by sticking to his post, was able to send out his distress call, which was picked up by the Jefferson, of the Alaska Steamship Company, only a short distance away. When the rescue ship arrived on the scene, the survivors were in lifeboats and liferafts. It was broad daylight, and it was easy to pick them up. It was seen at once that there was no possibility that any of the missing reached shore.

Ten of the rescued passengers had suffered so severely from exposure that they were hurried to a hospital at Juneau, ninety miles from the scene of the wreck. First Officer Abernathy and four men were left with the wreck, in the vain hope of saving any of the missing.

The State of California was one of the best-known vessels on the Pacific coast, having been for a long time in the passenger trade between Puget Sound and San Francisco. She was built in Philadelphia in 1879, and was of 2,276 gross tonnage. The vessel was in command of Captain T. H. Cann, who had command of the steamship Valencia on her last trip to San Francisco from Seattle. He was transferred to another ship when the Valencia reached that port, thus barely missing being on the steamship when she went ashore at Cape Beale, B. C., January 22, 1906, with a loss of 117 lives.

The State of California had been placed temporarily on the southeastern Alaska run during the Spokane tourist season, and had made only three Alaska trips. Regular travel to Skagway has been unusually heavy because of the Shushanna gold stampede. In fact, the vessel carried nine horses for that camp, all of the animals perishing in the wreck.

The ship had an uneventful voyage from the time she left Seattle until the accident occurred. She made the British Columbia port of Prince Rupert, as well as the American ports of Ketchikan, Wrangel and Petersburg, and had headed into Gambier Bay when she struck the reef.



Gambier Bay is accounted one of the most dangerous pieces of water in Alaska. Last year the Admiralty Trading Company built a cannery there and made a contract with the Pacific Coast Steamship Company, by which the latter was to handle its business. The bay had not been navigated by large vessels until last year, and it is said that it has never been officially surveyed.

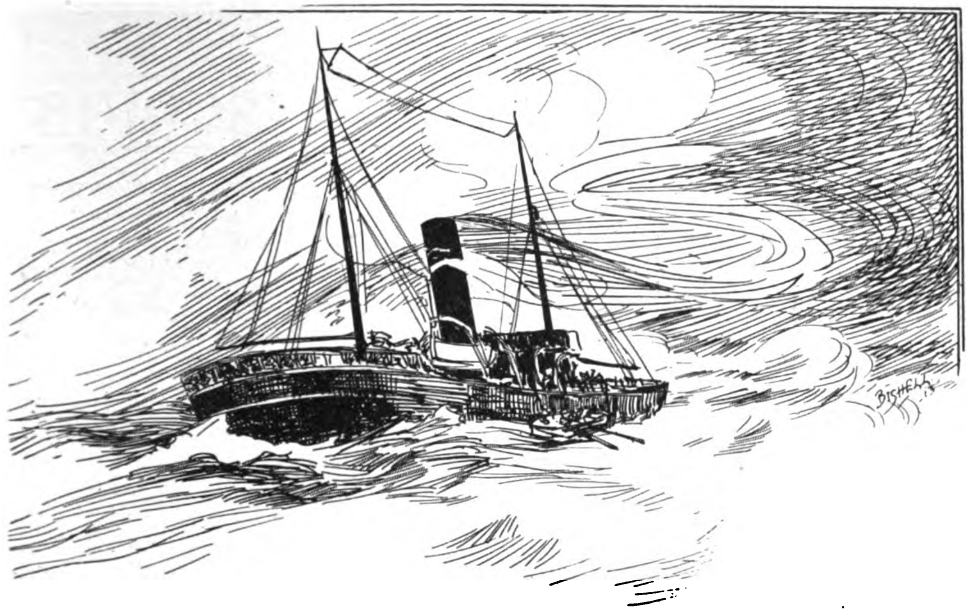
A reef must be skirted for a long distance, and big boats have very little room in which to turn. The State of California went to her doom a few minutes after leaving the cannery. The death-dealing rock is at the very entrance to the harbor.

It is not definitely known just how many passengers were on board the vessel. She had fifty-six on leaving Seattle, but she is known to have picked up twenty more from the ports at which she touched, and have discharged ten.

"Jack" Irwin, who, it will be recalled, received the Marconigram giving the first news of the Republic disaster, has written as follows to the WIRELESS AGE, telling of the heroism of Perkins:

"Regarding the death of Perkins, it will be of interest to you to know that he has received considerable credit for the way in which he handled the wireless end of this disaster. The press has enrolled him as a wireless hero. It appears that at the time of the disaster his assistant, W. Chamberlain, was on duty, Perkins being asleep. When the vessel struck the main set was put out of commission, due to the fact that the inrush of water extinguished the fires.

"Perkins rushed from his cabin in his pajamas, took charge of the wireless, adjusted his auxiliary set and commenced to call for help. In the meantime, he ordered Chamberlain on deck to assist in launching the lifeboats. There was a lifeboat immediately in front of the wireless cabin, which they were unable to launch. When the vessel later took a list to port this boat broke adrift and jammed fast the door of the wireless cabin. This



made Perkins a prisoner; but, notwithstanding his peril, he continued to send the S. O. S. signal.

"I think you will agree with me that we should be proud to have had a man of his caliber in our service. Perkins was a clean cut young fellow."

Perkins was born in Madura, South India, August 17, 1888. Love of adventure induced him to take up wireless, and he entered the Marconi service on the Pacific coast December 20, 1912. His home was in Berkeley, Cal., where his nearest relative, Miss R. Perkins, resides at No. 2431 College avenue. He had never married.

The wreck was productive of several dramatic incidents. Mrs. Nellie Ward, wife of Assistant Manager E. C. Ward, of the Pacific Coast Steamship Company, was drowned after reaching the deck from her stateroom. Her daughter, Lillian, was struck by a falling mast and died several hours later on board the Jefferson, after having suffered agonies on a liferaft.

Of the three lifeboats launched, the survivors said, one was useless, having been smashed by falling wreckage, and one was carried down by the suction of the boat. The first survivors to reach Seattle from the wreck brought details of the death of Mrs. H. C. Riordan, of Chicago, eighty-four years old. R. E. Baker, a water-tender, who rushed on deck as the cabins filled, found boat No. 4 with a few persons in it, among them Mrs. Riordan.

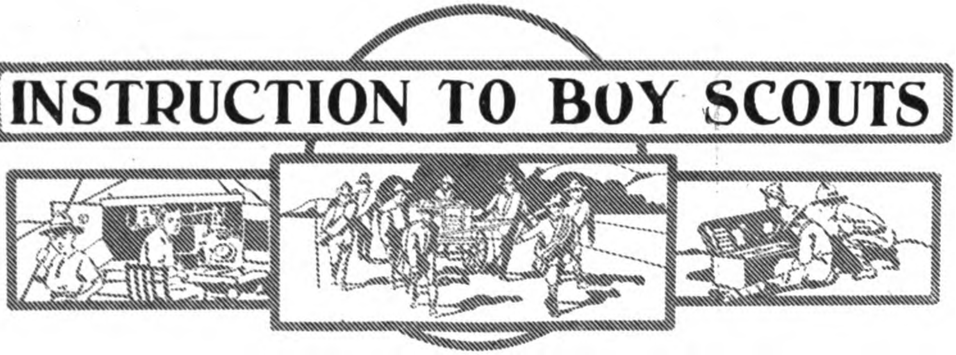
"The water was just up to the boat, but in the excitement it had not been loosened from the fastenings which held it to the deck," he said. "I grabbed an ax and cut it loose, and as the steamship sank it floated, but the afterdraft sucked it down. I caught a piece of wreckage and tried to save Mrs. Riordan, but she went down before I could reach her."

Officers of the Pacific Coast Steamship Company, which owned the wrecked vessel, estimated the financial loss at $200,000.

It has been definitely settled that Perkins' name will be added to those which will appear on the memorial fountain in New York. This fountain will be placed at the base of the campanile of the new Barge Office. The design and the site have both been acted on favorably by the Municipal Art Commission, and Park Commissioner Stover will push the matter.

There will be inscribed the following words: "Erected in Memory of Wireless Operators Lost at Sea at the Post of Duty."

INSTRUCTION TO BOY SCOUTS



By A. B. COLE

WIRELESS telegraphy has become such an important factor in signal work among the Boy Scouts that THE WIRELESS AGE will, beginning with this issue, present a series of articles on the art, prepared especially for the Scouts. The Boy Scout movement, since its inception, has made rapid strides, and the use of wireless telegraphy has been widely adopted in the organization. The great interest in the Boy Scout movement was shown when 30,000 Scouts met at a rally held recently in Birmingham, England. Boy Scout experts from all over the world were at the rally to give detailed explanations to the public and to the younger Scouts regarding the preparations necessary to pass the higher tests which are open only to first class Scouts.

At the reunion of the veterans of the North and South at Gettysburg last summer, the Boy Scouts of America were able to show what service they were able to furnish for others. The policing of the big camp was under the direction of the regular army, and the sanitary arrangements were under the direction of the American Red Cross Society. The large crowds, however, could not have been handled so well if it had not been for the assistance given by the Boy Scouts. Officials of the camp even went so far as to declare that the boys alone prevented chaos on several occasions. The Scouts did good work in caring for veterans who were exhausted or overcome by the heat. Hundreds of veterans were attended by the Scouts, and the physicians and nurses said that they would have had many difficulties to overcome if it had not been for the aid rendered by the boys.

THE WIRELESS AGE will publish not only a full elementary course in the principles of wireless telegraphy, but also a complete description of several portable outfits, designed especially for field service, so that our readers may build their own outfits. In this and several succeeding issues will be explained the essential principles upon which wireless telegraphy depends, and it is suggested that this be followed just as carefully as the description of the actual construction of the sets, since accurate knowledge of the elements of electricity and magnetism is essential to the successful operation of a wireless telegraph set.

Chapter I

ELECTRICITY AND ITS LAWS.

Since the art of wireless telegraphy involves, to a large extent, the various principles and laws of electricity, we must fix the latter firmly in mind before we can fully understand those governing wireless communication.

Although the exact nature of electricity is not definitely known, many laws have been derived governing the applications of electricity; we are more familiar with it from the standpoint of results than from a knowledge of what it really is.

Electricity travels equally well up hill and down hill, in any direction, and,

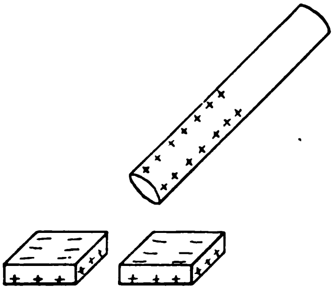


Fig. 1.—Static Charges of Electricity

to use a familiar phrase, travels "like lightning," for lightning is, in reality, a manifestation of electricity. The rate at which electricity travels has been found to be approximately 186,000 miles per second. At this rate of motion the circumference of the earth might be encircled in a small fraction of a second.

Electricity traverses some materials more readily than others. Those which offer the least resistance to its passage are called *conductors,* while those which impede its flow to a marked degree are termed *insulators.*

The actions of electricity may be grouped into two general classes—those where it remains practically in one place are termed actions of "static" electricity, and those in which it is in motion are classed as actions of "current" electricity. In either event the electricity is the same, and obeys the same laws, but the grouping is simply a matter of convenience for the study of its principles.

STATIC ELECTRICITY.—Electricity is rather uniformly distributed through all space. Its presence may be discovered by rubbing a glass rod with a piece of silk or flannel cloth. If the rod is then held over a number of small pieces of paper it will attract them toward itself. After the paper pieces have been attracted so as to touch the rod it will be noticed that they are quickly repelled. (See Fig. 1.)

This indicates that a change takes place in the pieces of paper as soon as they touch the rod, and causes us to believe that an opposite force from that which attracted them also exists.

Two opposite kinds of electricity exist; these are called negative (—) and positive (+), respectively. Like charges, or small quantities, of electricity repel each other, and, unlike charges, attract each other.

All materials have more or less of both kinds of electricity upon their surfaces. When a glass rod is rubbed with a piece of silk cloth, the negative charges move from the surface of the rod to the surface of the silk, and the positive charges on the silk pass to the rod, which is then positively charged. When the rod is brought near the bits of paper, this charge acts through the intervening space and charges their nearer sides oppositely—that is, negatively—by attracting the negative charges residing in them, and charges their under sides positively by repelling their positive charges.

The electrical condition which exists when the charged rod is held over the pieces of paper is shown in Fig. 1. As soon as they rise so far as to touch the rod, the negative charges on their upper surfaces are neutralized by an equal number of positive charges from the surface of the rod. This condition is shown in Fig. 2. Only positive charges remain on the paper pieces, which are, consequently, repelled from the rod, for it is still positively charged.

RELATION BETWEEN STATIC AND CURRENT ELECTRICITY.—When static charges are formed in rapid succession, so many may accumulate that their attraction for some oppositely charged body is almost irresistible, and the charges are neutralized by the passage of an electric spark between the two points. This shown in the well known action of lightning. In this case we have an accumulation of static charges in clouds, which suddenly neutralize some opposite charge in other clouds or in the earth, and this is ac-

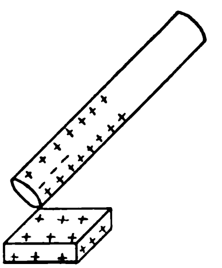


Fig. 2.—Static Charges of Electricity

companied by a flash of lightning, which is a manifestation of the passage of an electric current through the air.

Another example of the relation between static charges and current electricity is the primary cell.

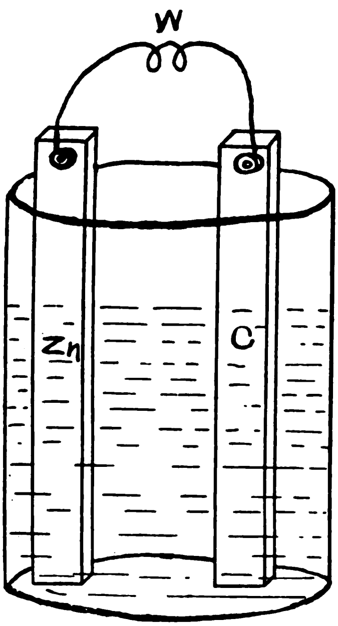


Fig. 3.—Simple Primary Cell

PRIMARY CELL.—A primary cell consists of two unlike conductors, immersed in some solution which has a stronger chemical action on one than on the other. Such a cell is illustrated in Fig. 3, where the conductors are in the form of plates, one being zinc (Zn) and the other carbon (C). The solution in the glass jar may be dilute sulphuric acid. The acid acts on the zinc, dissolving it, but has no action on the carbon plate.

When a wire (W) is connected to both the zinc and carbon plates, or electrodes, as shown, the zinc becomes positively charged, due to the action of the acid upon it, and a rapid succession of charges pass to the carbon through the solution, returning to the zinc through the wire (W). This rapid flow of charges is known as a *current* of electricity.

It will be observed that the zinc electrode is positively charged in the solution, while that portion extending above the solution is negatively charged, since the current flows back to it through the wire.

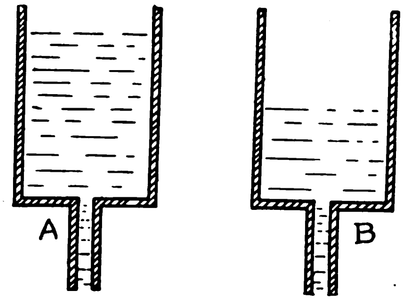


Fig. 4.—Hydraulic Analogy of Electromotive Force

That part of either electrode which projects above the solution is called a *pole* of the cell. For this reason the zinc is the positive electrode, but the negative pole; and the carbon plate is the negative electrode, but the positive pole.

The wire (W), or any other conductor which may be connected to the poles of a cell, through which the current flows, is termed an electric circuit.

Various materials are employed in the construction of primary cells. In some, zinc and copper form the electrodes; in others, zinc and lead, and various other combinations are employed.

UNITS OF MEASUREMENT.—That force which causes the current to flow between the electrodes and around the circuit (W) is the electrical pressure, or electromotive force, which is abbreviated E. M. F., and is measured in a unit called a *volt*. The E. M. F. is similar to the hydraulic pressure at the lower ends of the pipes leading from (A) and (B) in Fig. 4, which represents the level of water in two tanks. It is easily seen that the pressure at the lower end of the pipe leading from (A) is greater than that in the outlet of (B). Likewise, cells may exhibit more or less pressure.

The E. M. F. of a cell is largely dependent upon the kind of electrodes used, and also upon the solution. Thus, a cell composed of zinc and copper electrodes immersed in a sulphuric acid solution has an E. M. F. of 1.1 volts; while if carbon is substituted for the copper, the E. M. F. may be 1.5 volts.

The quantity of current flowing past a point on the electric circuit, or the intensity of the current, is measured in *amperes*. If the circuit connected to the poles of a cell is of copper wire of large diameter, a current of greater intensity will flow through it than if the wire is of a small diameter; just as in the hydraulic system illustrated in Fig. 5, a greater quantity of water will flow out of tank (A) through the outlet pipe of large diameter than will flow from tank (B), which has an outlet pipe of small diameter. The larger pipe offers less resistance to the flow of the water, and likewise a large wire offers less electrical *resistance* to the flow of current through it.

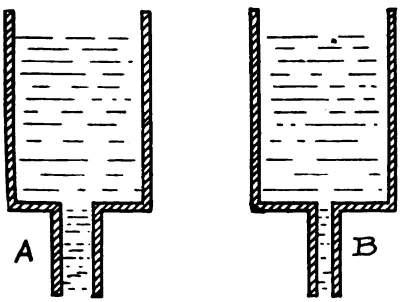


Fig. 5.—Hydraulic Analogy of Current

The resistance of wires or other electrical conductors depends also upon the materials of which they are made. For example, an iron wire, ten feet long and one inch in diameter, would have a much greater electrical resistance than a wire of the same dimensions made of copper. Resistance is expressed by a unit known as the ohm.

Conductivity is the reciprocal of resistance. A wire which offers a high resistance to the flow of current through it does not conduct well, and so has low conductivity. The following table compares the conductivities of a number of materials. It will be observed that silver has the highest conductivity or the lowest resistance of any of the common metals, while mercury has a low conductivity and, consequently, a high resistance. The unit of conductivity is the mho (ohm spelled backwards). If a circuit has a resistance of 7 ohms, it has a conductivity of one-seventh mhos.

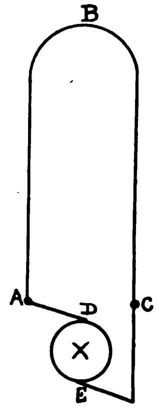


Fig. 6.—Application of Ohm's Law

CONDUCTIVITIES OF MATERIALS.

Material.	Relative Conductivity.
Copper (soft)	100
Copper (hard)	98.1
Silver (soft)	104.9
Silver (hard)	98.1
Gold	76
Aluminum (soft)	54
Iron	10
Lead	8.3
Mercury	1.6

The resistance of pure water is extremely high, but salt water is rendered a very fair conductor by virtue of the dissolved salt.

When one ampere has flowed through a circuit for one hour, the volume of current which has passed is called one *ampere* hour. The same volume would have passed if two amperes had flowed for one-half hour, or if 10 amperes had flowed for one-tenth part of an hour.

The unit of electrical energy is the *watt,* which is that work done per second in a circuit through which one ampere is flowing at a pressure of one volt; 746 watts represent one electrical horsepower, and through this relation electricity and mechanics are directly connected.

OHM'S LAW.—Probably the most important and most useful rule or law in all electrical engineering is known as *Ohm's Law.* It shows the relation between E. M. F., resistance and rate of current flow. If we know any two of these quantities, it is a very simple matter to determine the third by means of this law. Ohm's Law is expressed $I = \frac{E}{R}$, where (I) represents intensity, or rate of flow of current, in a circuit, in amperes, (E) is the E. M. F. at the terminals of the circut, measured in volts, and (R) is the resistance of the circuit in ohms.

The practical application of this law is illustrated in Fig. 6, where the wire (ABC) terminates in two points (A) and (C), and where the resistance of the wires or leads [(AD) and (CE)] connecting these points to the source of current supply is very small, in comparison to that of the circuit (ABC). (X) represents the source of current supply, which, we will assume, has a very low resistance.

Then, if the E. M. F. at the terminals (A) and (C) is 100 volts, and the resistance of the circuit (ABC) is 50 ohms, 2 amperes will flow around the circuit, since by Ohm's Law $I = \frac{E}{R}$, or $I = \frac{100}{50} = 2$.

Or, if we wish to force 5 amperes around the circuit (ABC), whose resistance we may assume to be 10 ohms, an E. M. F. of 50 volts would be required, since by Ohm's Law $I = \frac{E}{R}$, or $5 = \frac{E}{10}$. Hence $E = 50$.

To consider a different case, if the E. M. F. at the terminals of circuit (ABC) were 200 volts, and the current flowing around the circuit were found to be 5 amperes, the problem would be to determine the resistance of the circuit. Simply substitute the known quantities in the formula, and the resistance required will be found to be 40 ohms, since $I = \frac{200}{R}$, or $5 = \frac{200}{R}$. Hence $R = 40$.

This is the first of a series of instruction articles for Boy Scouts. The second lesson by Mr. Cole will appear in an early issue.

UNIQUE METHODS OF INSPECTOR

With a recently invented instrument of great delicacy, Henry C. Gawler, United States radio wireless inspector of the New England district, is able to trace with remarkable accuracy any operator who is interfering with naval or commercial stations. An instrument, composed of two flat sticks, joined together by a pivot, and which can be closed almost to the size of one, the ends being connected with cable wire of delicate construction and embracing thirty tiny wires, forms this simple tracer.

From the top of any roof or at any wireless station, Gawler can locate the general direction of wireless .waves. From that position he goes to another station nearby, and from observations taken there does a little geometrical computation, getting the general location of the station. Then he goes as near to his station as possible, and by means of a hand instrument, about the size of a watch, locates the exact spot where the wireless waves are generating.

Wireless as a Commercial Fact

From the Inventor's Testimony in the United States Court in Brooklyn

GUGLIELMO MARCONI

PART III

IN 1894 I was studying under a tutor. In 1895 I attended scientific lectures. I think one was given by Dessau, and some others by Prof. Righi, and one or two by Prof. Rosa, on general electrical engineering, but not on Hertzian waves or anything to do with transmission of waves through space. Prof. Rosa was instructor in physics in the government technical school at Leghorn, near my home. Before that I was at the secondary school in Leghorn. When I left school I was about eighteen.

I found that the technical education at that school was not sufficient or up to date, considering the special interest I had taken in that subject, and therefore my father engaged special tutors to give me a course in advance of what was taught. I was in the habit of studying on physics in books and magazines. I never studied Fleming's books on alternating current. I am sorry to say, I did not read any of Fleming's works. I first saw Jones' translation of Prof. Hertz's work, published in 1893, I think, after I came to England in 1896 or 1897 or 1898. It was after I filed my first application for a patent. Of course, I do not mean to say that I was not acquainted with the general research and results described in that book. I do not think I ever read Dr. Lodge's "Lightning Conductors and Lightning Guards." I do not think I ever read his "Modern Views of Electricity." I read parts of a book by Martin, entitled "Inventions, Researches and Writings of Nikola Tesla," published in 1894. I think I read the Scientific American once or twice.

I did not read any of the contemporaneous writings of Dr. Lodge, because my language was another language. I have spoken English all my life, but it is not my language. All my education was in Italy. If I had had Lodge's work before me in English I certainly would have got it and read it; but all my scientific thought and education was carried out by means of the Italian instructors and by means of Italian publications. I venture to say that, in Italy, Lodge did not have that position which he had in England, or perhaps in America. In Italy great attention was given to Hertz, Righi and others, and not to Lodge. I know the works of Hertz; the subject-matter of the inventions and discoveries of Hertz were translated into Italian, and I read the Italian publications. I first heard of Dr. Lodge's work in the direction of wireless telegraphy after I had applied for my patent.

I saw an account of Hertz's work in German, "Wiedermann's Annalen." It had a few pictures. I saw them in 1894 or 1895. I knew that if Hertz's oscillator or radiator and a Hertz receiver were to be responsive in a most efficient manner, the greatest distance apart, they were to be tuned together—the electrical oscillation should have the same period. The circuit had to be a certain length or a certain size. When I was using plates or wires of certain dimensions those plates had to be of a certain length. If you were using a loop they would have to be of a certain size. That was all I knew about it at that time.

A straight wire has both capacity and inductance, and I could change the inductance by cutting off part of the wire. That was the only way I adjusted the period in my early apparatus. I did not at that time use any coils of wire. My antenna, in 1896, varied from six to thirty or forty feet. If I wanted to change the period I let it down and cut it off at the bottom.

I first used an inductance coil in the antenna about the end of 1898. In regard to the transmitter, it slows down the period of the electric vibration of the system, and also causes it to radiate more slowly. It gets rid of its energy at a slower rate. The result of that is that the energy remains in the system longer, and that the energy is radiated more gradually in a great number of waves. While, again, according to the principles of tuning, it simply depends upon the accumulative effect of a great number of waves or impulses properly tuned. That coil enables an ordinary detector, a vertical wire, to give out a greater number of waves than if it were not there. It has been used to a considerable extent, especially in the later apparatus, in which it is necessary to time the oscillations accurately.

* * *

Without the grounded antenna, the maximum, as I remember, was about three-quarters of a mile, with large plates of one and three-quarters, when reflectors were used to concentrate the waves in a given direction. The greatest distance I have actually transmitted messages, using grounded antenna and upright wires, is, I think, over six thousand miles—from a station at Clifden, Ireland, to another station at Buenos Ayres, in the Argentine Republic.

* * *

When the ordinary classical Hertz transmitter is used, radiation is what we call free in space, proceeds across space in the same way as the light of a lamp or the sound of a human voice. When the transmitter is connected to earth, half the wave is transmitted through the ether of space and the other half through the ether of the earth. Professor Zenneck and others have given diagrammatical illustrations of what is believed to occur in that case; but the result is that when a transmitter is connected to the ground these waves seem to be able to follow the curvature of the earth, and to surmount or pass over other obstacles, such as hills or mountains, which may intervene between the transmitter and the receiving stations.

* * *

I first arrived in England in February, 1896. Mr. Preece was engineer-in-chief of the General Post Office. I met him socially in March. I told him I had this invention for transmitting messages without wires, and he evinced a considerable interest in what I was doing, and said it was just what the government wanted, because his system of induction, which he had tried, was not available for communication with lightships or with ships, which, according to his idea, was the chief use which wireless telegraphy was destined.

When I talked with Preece in May, 1896, he told me the system he had been working with was a failure. He had telegraphed two or three miles; something like that. I telegraphed nine. He had two base lines, two miles, on each side, and I had a little wire, about twenty or thirty feet high, perhaps higher than that, at each of my stations. Preece, being a reasonable man, knew perfectly well that if the problem were to communicate with a ship you couldn't have a wire extended two miles on a ship, because there was no ship two miles long. Wherefore, I was more useful than him in having an apparatus which could be placed on a ship. I give every credit to Sir William Preece; when he saw that, he was quite fair to put his system in the background on account of it. He got the Post Office to witness my experiments, and he spoke about these tests in his lectures, and he assisted me with his influence in showing what I had done; but he gave me no financial assistance, because, perhaps, the government does not do that. Then, also, I did not require it.

I first installed a wireless apparatus in London in February or March, 1896. The antenna was made of wire, attached to a small wooden mast, a broomstick or something of that kind—a bamboo cage. It was about six or seven feet high. The transmitter was thirty or forty feet from the receiver. I had a wave length of about 150 feet. I was getting radiation, and I was getting electric magnetic effect at the same time.

I know that I am getting radiation, dependent on the apparatus I am using. If it is an apparatus that radiates, I know I am getting the radiation within a wave length, as I am getting it at a hundred miles; but if it is an apparatus that does not radiate, I may still get an effect if I am close enough.

* * *

In the London *Times* of September 23,

1896, is an article saying that on Salisbury Plain I had succeeded in producing electric waves and reflecting them from one parabolic mirror to another one and one-quarter miles distance. No antenna was used in the tests. This reflector apparatus has been used for military purposes or communication between, or tests between, ports or between places of that kind. It is the only apparatus I had available at that time. I have no doubt but that it could be made much better.

That apparatus had certain properties which the government were anxious to test. They were rather afraid of these waves spreading all around, and they were very keen to see something that would send the electric waves in one direction only. It was with them, perhaps, a matter of taste. For that reason these experiments were carried out.

* * *

In my patent, 11,913, a coherer is described. Upon the receipt of electrical oscillations from a distant transmitting station, the action which occurs in such a receiver is a considerable reduction of its resistance on the receipt of an impulse, but it is also established that if a succession of impulses are received, the resistance is still further reduced until the tap occurs, which restores it to its high conducting state. I conducted numerous tests of that fact many years ago.

I had a coherer in a circuit, including a cell and a sensitive galvanometer. I produced impulses upon that circuit by the interruption of a direct current in another circuit. And I remember that, assuming that the resistance of the coherer was initially 100,000 ohms, a first impulse or a disturbance would reduce it to, say, 40,000; the second would reduce it to 30, a third to 25, and a fourth probably to 22 or 20, according to a curve, which I did not ascertain, but which showed that each successive impulse tended to progressively reduce the resistance of that coherer.

* * *

There is a phenomenon there in regard to these coherers which is not very well understood. It varies its resistance in accordance with the voltage applied to it. If the voltage applied to its end, due to electric waves, is great, it will come down in resistance a certain amount, and then the next wave will reduce it, perhaps, a little more, and the third wave still more, until the current passing through is sufficient to make the relay to come over and close the circuit. That is the way I think it acts.

* * *

In the specification of a former patent granted to me, No. 586,193, I described a receiver in which the ends of an imperfect contact in a local circuit were connected, one to earth and the other to an insulated conductor. According to this invention, the conductor is no longer insulated, but is connected to a capacity which may be the earth, through the primary of an induction coil, while the ends of the imperfect contact are connected to the ends of the secondary, one of the connections being through a condenser. I did it in order to use an induction coil or transformer which would give a higher potential at the terminus of the coherer, and make it better, it being understood that the coherer I was then using was a high-resistance coherer. The conductor was connected to an impedance coil, which impeded the transmission of waves between its top and the earth, and, due to the fact of electro-magnetic induction, threw a great part of that energy into the turns of the coil connected to the coherer and the other circuit.

Popoff's apparatus, prior to my patent, was a receiver for recording atmospheric electricity and the effects of thunderstorms or lightning. Well, unless something in nature sent him impulses—and those impulses never come in the form of intelligent messages—I do not see where he was to receive his signals from. I do not think his receiver was capable of taking Morse signals. It is easy enough to record the effect of a lightning flash, but it takes much more accuracy to correctly interpret the signs of the Morse telegraph.

* * *

The magnetic detector disclosed in my patent was conceived in Newfoundland, early in December, 1901. I made the sketch in my notebook the 13th of January, 1902. I disclosed it to quite a few of my friends in New York, I think, in January.

* * *

In the installations which are operated

to-day, at both transmitting and receiving stations, they use vertical grounded antennæ. The matter of connecting one end of the spark producer to an antenna and the other end to the ground, whether inductive or direct connection, at the transmitting and receiving stations, I consider essential, if you are going to have a wireless telegraph at all, so far as my present knowledge goes.

* * *

I have experimented with crystal detectors for many years; I have used them for practical purposes for two or three years. The crystal detector operates by a variation of resistance. If it is not connected in circuit with a battery, I think it opposes a resistance to the current flow in one direction, and does not oppose it in the other direction, the result being that the electrical oscillations are to a certain extent rectified, made to go in one way, which enables an ordinary telephone or other receiver to be directly affected. The conductivity of those crystals, according to my own observations—and I think it is also confirmed by the observations of Professor Pierce, of Harvard—the conductivity is a function of the voltage applied to them. That is to say, if double the voltage is applied to them, more than double the current goes through, provided the voltage is of right value. The crystals do change their resistance undoubtedly. That can be easily proven. In the case of the electrolytic receiver, a variation of the resistance takes place, due to either the thermal effect or the electrolytic effect, or both.

* * *

I am absolutely certain it was myself who first telegraphed across the Atlantic. The exact date was the 12th of December, 1901. The signal that was repeated often was three dots. Between 1901 and 1905 I was not using sufficient power to transmit messages during the daytime. It requires more power than at night, and the power available during the day, during the earlier part, was not strong enough to carry it through. In the first tests it was about twenty-five kilowatts. The energy used at Cape Cod for the transmission of the President's message I don't think was more than ten kilowatts. Messages may be sent very irregularly by day, with as low as ten kilowatts, as an exception, but I do not think they could be sent regularly with ten kilowatts for three thousand miles. At night a distance can be covered very much greater than the normal distances. I don't think the message I mentioned as being six thousand miles was a freak message. It was a distance that could be done by night, and practically every night—every time it was tried by night. At the receiving station at Buenos Ayres the antenna was supported by a kite or balloon.

* * *

The Italian government has established a high-power station at Coltano, Italy, for the purpose of communicating with Italian colonies in East Africa, and also for making wireless telegraph tests. The station was erected by myself and by my assistant, and has been working for about two years. The corresponding station is situated at Massaua, in East Africa, not very far from Aden, and a further receiving station is situated at Mogadiscio, in Italian Somaliland. The station at Coltano has been sending regularly messages by day and night to a station at Massaua, which is situated, I should say, more than 2,500 miles from Coltano, the range between them being nearly all over waste land, desert land and high land, which it is ordinarily admitted is not very favorable to the transmitting of electric waves and wireless messages. A letter, dated the 29th of December, 1912, addressed to the Marconi office in Rome, and signed by the Minister of Marine, the head of the navy, whose department is responsible for the working of those stations, states: "In reply to your request, I declare that during the period of hostilities with Turkey the radio telegraph station at Coltano has carried out a regular service by day and by night with the radio telegraph station at Massaua, and by means of this station with the station at Mogadiscio," signed by the minister, Leonardi Cattolica.

In this Italian apparatus, the condenser has one spark gap, instead of two. It is certain that it did include a condenser circuit, which was oscillatory, and a radiator, consisting of an elevated conductor, connected to earth at the other end. It can use anything from twenty kilowatts to about three hundred. The antenna is two hundred and thirty feet. In the tests, I believe there were three different forms of receiver used. I was not at the receiving station when those tests were carried out, but I knew the receiving station had a magnetic receiver; they had crystal receivers, and they had the Fleming valve.

* * *

In the first transatlantic signals, in December, 1901, I had three or four kinds of detectors. One was the ordinary coherer, which has been described here, with a tapper and a coil. Another was a carbon microphonic detector, which was connected in circuit with the aerial, the earth and a telephone; and the other one, which I recollect and which was the most successful one, was one consisting of an imperfect contact between two pieces of carbon, this contact being made by a globule of mercury. That was a form of detector which had been employed before in the Italian navy. Of course, it was connected in the ordinary way to an aerial and to earth.

* * *

The amount of power in the aerial does not necessarily mean that it is all radiated. Some aerials radiate better than others; but I will assume that conditions are equal; for the sake of hypothetical argument, I should say that 200 kilowatts would give nearly twice as much, go nearly twice as far as 40, but not quite; 1.7 about of the distance. That is what my experience has determined.

* * *

A single wave is taken from a rise of potential or a rise of current, which comes up to a maximum, comes down, and returns to where it started. A train of waves is a succession of those waves, each one attached to the other in proper phase. Damped waves are usually waves which start with large amplitude, and gradually decrease in amplitude until they die off, in the same way as the hum of a bell when it is struck you will hear the sound dying off, unless it is struck again, while a continued wave is like a note given off by a violin string or by a whistle, which can be sustained. In wireless telegraphy I hold that a detector does not act in consequence of the effect of the first wave. It might do so if the waves are extremely strong—if the first wave is very much stronger than what is necessary—than what would be necessary for covering that distance, assuming you are utilizing the train of waves; but I think that what does happen is that a small amount of energy goes through the coherer from the first wave, and a little more from the second wave, until it reaches a critical condition, at which it suddenly breaks down. Of course, the circuit has got to be made in such a way at the receiving end that the oscillations go on oscillating as long as possible, in order that their potential be maintained, or, if possible, increased, and in order, also, that their effect should be continued on the detector for what is, to us, a very short time, but which, electrically, is a fairly long time.

* * *

I do not know that we have a thorough understanding as to what happens between two clouds. They say that pilot sparks occur in the air, or something goes on, before the main discharge takes place, which enables it to take place. Whether it takes a million volts or a micro-volt—that is a millionth of a volt—the principle involved, to my mind, is the same.

Up to a certain electrical pressure, nothing happens. And beyond a certain critical pressure the electricity goes across. That is not the case with my coherers. Some of the oscillations go through it before, and I think the effect helps the following oscillations to further reduce the resistance until it is reduced sufficiently to pass enough current or turn on enough current to actuate the receiving instrument. Of course, if you are using a telephone, no doubt the effect of these currents is heard as one click. With a relay, the total effect of a current is brought into play, and when the tune comes over you see the action or hear the second current which is brought into play. In a discharge of lightning, I do not think there is any cumulative effect due to oscillation between clouds, because I do not think there are any electric oscillations between two clouds; certainly not until the discharge has taken place.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with india ink. Not more than five questions of an individual can be answered. To receive attention these rules must be rigidly observed.

A. C. G., Springfield, Mass., asks:

(1) Why is it that a transformer will take less current with a rotary spark gap (non-synchronous) than when using the old type of gap?

Ans.—For the reason that the condenser is not discharging across the spark gap for the same length of time as when the ordinary gap is employed.

When the studs of the rotary separate the spark discharge is cut off, and the condenser consumes less current when not discharging across the spark gap. This may not be true in all cases.

(2) Can you give me data on a transformer, open core, that will draw 10 amperes, using 20 points on the gap, and running at a speed approximately 1,800 R. P. M. Power to be used is 110 volts, 60 cycles?

Ans.—Primary core 3 inches diameter, 25 inches in length, covered with Empire cloth, and wound with two layers of No. 10 D. C. C. wire. Secondary, 38 pancakes, each 1/8 inch thickness and having 1,125 turns of No. 30 S. C. C. wire.

(3) Can you furnish me with the address of a manufacturer who makes the enclosed wire?

Ans.—You may be able to secure this wire from the Ansonia Electric Co., Ansonia, Conn.

* * *

W. O. H., Cleveland, Tenn., sends us a sketch of a "T" type flat-top aerial, and desires to know if he should connect all the wires together at the extreme ends of the flat tap. He also states he receives Arlington signals at night very plainly, but not in the daytime.

Ans.—The wires should be connected and soldered together at the extreme ends. If you desire to receive principally the signals from Arlington we would suggest you bring the lead-in wires from one of the ends, making the antenna of the inverted "L" type.

* * *

Ithaca Wireless Club, New York, asks more than five questions, which breaks our rule. We cannot answer more than this number in any case, so have selected five.

(1) What is the power used at Nordeich, and what type aerial is used? Give its vertical height.

Ans.—We are unable to answer this question fully. Complete information may be had from International Bureau at Berne, Switzerland. Nordeich's call letters K. N. D. Range, 500-600 kilometers. Wave length, 600 meters.

(2) Is the aerial at Clifden directional towards America or the European Continent?

Ans.—Towards America.

(3) What wave length does Glace Bay use, and what are its usual working hours?

Ans.—6,600 meters with 24-hour service.

(4) What power is to be used in a transmitting set at the new Marconi station in New Jersey?

Ans.—300 kilowatts.

(5) Compare the arc as used by the Federal Company and the quenched spark gap used by the "Debeg" Company, giving advantages and disadvantages?

Ans.—This is a rather difficult matter to answer specifically. The Federal Company claim that 18 to 20 per cent of the energy supplied to the transmitter is put into the antenna, while the "Deberg" Company claim efficiencies up to 50 per cent. The question is all the more difficult, as a Poulsen arc emits undamped oscillations, while the quenched gap produces feebly damped oscillations in the antennæ circuit. Their characteristics are therefore dissimilar. It would not be fair to promulgate an opinion. Enormous distances have been claimed for the Poulsen transmitter, but as the majority of such work has been done at night time the results cannot be authentically recorded.

* * *

N. S., Ithaca, N. Y., asks:

(1) What is the power, the wave length and hours of service at Glace Bay Transatlantic Station?

Ans.—300 kilowatts; 6,600 meters; 24-hour service.

(2) What is the power and wave length used at Clifden? When and with whom does it do transatlantic work?

Ans.—Power and wave length approximately the same as that of Glace Bay. Works with Glace Bay only.

(3) Please give material and dimensions to make a condenser having .0001 M. F. capacity?

Ans.—A simple condenser having .0001 M. F. capacity (we presume you desire this for receiving purposes) may be constructed of two concentric brass tubes, the outer tube 7 inches in length by 3/4 inch diameter, and the inner tube 7 inches in length by 5/8 inch in diameter, both separated by a cylinder of hard rubber sufficiently thick to allow them to slide one over the other. The resultant capacity will approximate .001 M. F.

(4) Please explain the Heterodyne as put out by the National Electric Signaling Company?

Ans.—The circuits of the Heterodyne, as used when employing crystal detectors for receiving, are shown in Fig. 1.

Briefly, the Heterodyne works on the following principle: When two wave trains of slightly different frequencies are superimposed on the same antenna the phenomena known as "beats" take place. Suppose, for example, a wave train produced in the receiving antenna from a distant transmitting station has a frequency of 200,000 cycles, and we superimpose from a local source of energy (at the receiving station) 201,000 cycles, we will then receive 201,000 minus 200,000, or 1,000 beats or pulses in the antennæ circuit. These in turn are reproduced in the head-phones. The result thus obtained is equivalent to the spark frequency ordinarily employed in radio work. It is found that a greater amplification of the signals takes place when beats are thus produced.

The action may be more readily explained by reference to Fig. 1.

Here A, B, C is the open oscillatory circuit of the receiving transformer; D, the local detector (including inductance, condenser, detector, etc.), and E, F, G the arc circuit, giving forth undamped oscillations whose frequency may be varied either by E or F.

The arc is supplied with direct current from a generator, H.

The complete arc circuit is coupled to the antennæ circuit at C.

The manipulation is as follows: When the operator desires to receive signals from a distant transmitting station, the frequency of the arc circuit is adjusted to, say, 1,000 cycles above or below the frequency of the incoming signals in A, B. C. It is evident that undamped oscillations from the arc constantly traverse A, B, C, and, by their very nature, are inaudible in the phones of the D circuit. But when the antennæ is likewise, and at the same time, excited by damped oscillations from a distant station the inter-action of the two frequencies produce 1,000 electric pulses of greater intensity than if antennæ were not excited by E, F. G.

The detector in the local circuit D is of special construction.

The device as yet is not commercially practicable but of intense scientific interest.

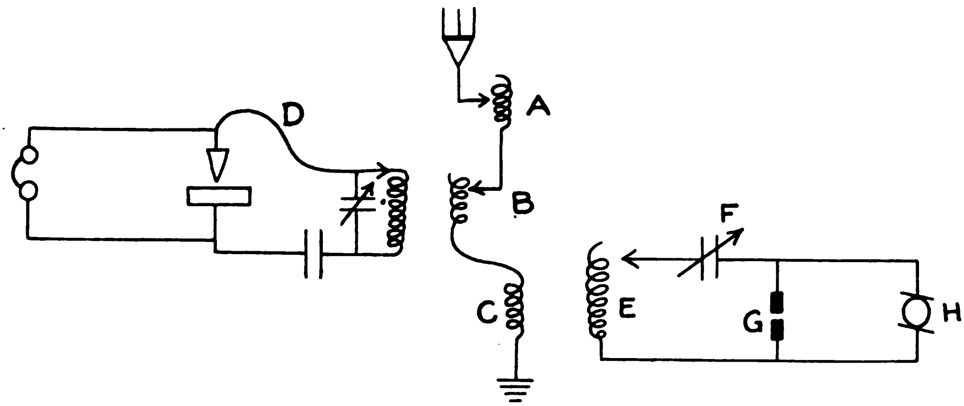


Fig. 1

(5) After Arlington sends at 10 P. M. a succession of figures follow. Could you please tell me what they mean? And what does "Q. V." mean?

Ans.—After Arlington sends the time signals at 10 P. M. it is followed by a code message expressing the actual weather at 8 P. M., 75 meridian time. This is followed by the weather conditions at various points on the Atlantic coast. These points are represented by letters as below:

S.................... Sydney.
T.................... Nantucket.
A.................... Atlantic City.
H.................... Hatteras.
C.................... Charleston.
K.................... Key West.
P.................... Pensacola.
D.................... Bermuda.

A bulletin begins with the letters U. S. W. B. for U. S. Weather Bureau, and the weather conditions follow: The first three figures of the report represent the barometric pressure in inches (.02 = 30.03), the next figure, the fourth in sequence, will represent the direction of the wind to 8 points of the compass: 1,—North; 2,—Northeast; 3.—East; 4,—Southeast; 5,—South; 6,—Southwest; 7.—West; 8,—Northwest; 0,—Calm. The fifth figure will represent the force of wind on the Beaufort scale.

Herewith example of the code:

U. S. W. B.—S, 96465; T, 91674; A, 94686; 899886; C, 01214; J, 02622; P, 03613; B, 00065.

TRANSLATION

Station.	Pressure.	Wind Direction.	Wind Force.
Sidney	29.64	SW	5
Nantucket	29.16	W	4
Atlantic City	29.46	NW	6
Hatteras	29.98	NW	6
Charleston	30.12	N	4
Key West	20.26	NE	2
Pensacola	30.36	N	3
Bermuda	30.00	SW	5

This is followed by a wind forecast for the coastel waters of the Eeastern part of the United States and the Gulf of Mexico.

The signal which you believe to be "Q. V." is in reality "Q. S. T." It is an international signal signifying a general call to all stations.

* * *

H. H. S., Chicago, sent us a rather long description of his radio station situated in Chicago in the heart of the skyscraper district, and says he is not able to send or receive more than one-half mile.

Ans.—After looking over the sketch you send we are quite satisfied, providing your appartus is properly hooked up (you sent no sketch of the connections), your antennæ is shielded by the steel in the skyscrapers about you. Still, you should be able to receive more than one-half mile. Go over the connections of your set thoroughly, making sure you have the proper hook-up.

* * *

A. R. M., Minot, N. D., asks:

(1) How is the wave length in meters of a wireless telegraph transmitting station obtained?

Ans.—By means of a wavemeter, consisting of a calibrated inductance and capacity.

(2) Will an aerial 50 feet high, composed of 650 feet of No. 14 B. & S. copper wire, having a capacity of approximately 200 meters, conform to the radio law?

Ans.—We do not know. You have not given us the shape nor type of the aerial.

* * *

H. A. F., Richmond, Va., sends us a sketch of two types of antennæ, asking us which is the better for radiating the energy of his 1-kilowatt set.

Ans.—We prefer the inverted "L" type, as with the "V" type shown with such a small angle between the flat top and the incoming leads, serious reactions will take place between the two, resulting in a decrease in efficiency.

(2) I have a rotary spark gap for this set. Disc is 6 inches in diameter, with eight plugs perpendicular to the face. Would it be an improvement to double the number of plugs and at what speed should the disc be revolved?

Ans.—No; it certainly would not be an improvement. The disc is already too small. We prefer a disc 12 inches in diameter with eight points and a speed of about 2,800 R. P. M.

(3) I have a commercial operator's license, and would like to secure a commercial license for my station in order to communicate with commercial stations. How can I procure such a license, and is there any expense attached to it?

Ans.—You would not be allowed such a license, as no commercial station would care to communicate with you.

(4) In which direction will the aerials shown in my sketches be directed?

Ans.—The "L" type will radiate SW. The "V" type NE.

* * *

W. S., New York City, inquires:

(1) Kindly tell me the best way to connect a 6-wire aerial at both ends, the aerial being 60 feet long and 75 feet high, for receiving purposes only?

Ans.—We do not understand the query. We suggest that you bring the incoming leads in from one end and connect all wires together at the opposite end.

(2) Do you think a "lead-in" 60 feet long would have any effect on the aerial as far as receiving is concerned?

Ans.—Of course not.

(3) Using this aerial, how would you connect the following instruments?

(A) One loose coupler.

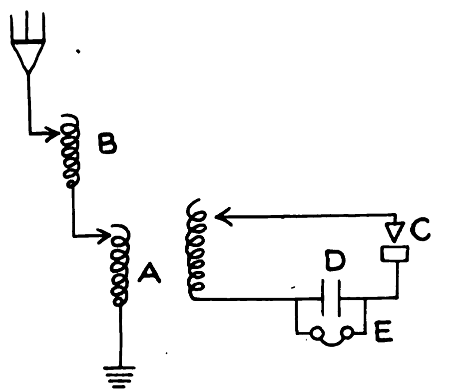
(B) One single-slide tuning coil used as a loading coil.

(C) One silicon detector.

(D) One fixed condenser.

(E) One 2,000-ohm head set.

Ans.—Herewith is a sketch:



(4) Do you think with the above instruments I should be able to get the time signals sent out by the Arlington Station?

Ans.—You have not furnished us with dimensions of the tuning coil; but, offhand, yes.

* * *

A. N., Dark Harbor, Me., asks:

(1) Kindly state approximate wave length of my set. The aerial, 50 feet long, 85 feet high, lead-in wire 25 feet long, helix 1/4 kilowatt, Clapp Eastham type, 2-quart leyden jars, hig-wire ammeter, 3-inch spark coil.

Ans.—The natural wave length of your aerial is approximately 200 meters, which may be increased to 300 meters by the helix.

(2) My ammeter reading is about 150 to 175 milliamperes. Is that sufficient to send through trees for 2½ miles?

Ans.—One-fifth of an ampere is a mighty small antenna current, but about all that you may expect with this set. It should reach 2½ wiles without difficulty, provided the station receiving the signals is equipped with a sensitive receiving set.

(3) How many batteries are needed for the carborundum detector, and in which direction should the current flow?

Ans.—One cell shunted by a potentiometer of 300 ohms is generally sufficient. You can best determine by experiment the proper direction for the flow of current.

* * *

W. J. S., Shenadoah, Pa., asks:

(1) Will the Fleming oscillation valve work with the following apparatus: Receiving transformer, primary, 4⅜ inches in diameter, wound with No. 24 bare copper wire; length of winding, 5 inches, 150 turns.

Secondary, 3¾ inches in diameter, wound with No. 33 S. C. C. wire; length of winding, 5 inches; 500 turns; Murdock variable condenser, maximum capacity, .0005 M. F. Clapp Eastham fixed condenser and 200-ohm doublehead phones. These to be used with battery potentiometer and rheostat, shown in the diagram published in the "Marconigraph" for February, 1913.

Ans.—We thank you for your complete description, and you will find that the Fleming oscillation valve will perform its functions quite well with the above described apparatus.

* * *

W. J. F. C., St. Louis, Mo., asks:

(1) I have an antennæ 350 feet long and 150 feet high, composed of six wires, 2 feet apart, with lead-in from the center. Is this antennæ of wrong design?

Ans.—No. However, if you desire to receive a longer wave length I would suggest that you change it to the inverted "L" type.

(2) As the operating room is under one end of the antennæ, should the "lead-in" be brought from that end, or can it come from the center of the antennæ?

Ans.—You should bring your "lead-in" from the end nearest the station.

(3) What kind of spreaders and design of connections do you advise when long ones are used (30 feet or so).

Ans.—From an electrical and mechanical standpoint, we would not advise spreaders of such dimensions. You will secure no increase in efficiency with spreaders of such length. The present spreaders of 18 feet are quite sufficient, and all that is necessary is to insulate these from the halyards supporting them.

(4) Wouldn't four wires, spaced about 8 feet apart, be better than six wires 3 feet apart?

Ans.—No. The best efficiency is usually obtained with the separation between wires of not more than 2 feet.

(5) When the "lead-in" is brought from the center doesn't it cut down efficiency if it is too long and has bends in it?

Ans.—We cannot answer this question definitely, as there are many factors in the case not mentioned. You will find the best results are obtained when the antennæ is of symmetrical design, and it is always better not to have the incoming leads abnormally long.

E. P. K., New York City, inquires:

(1) What is my approximate wave length for sending when I employ an aerial 70 feet long, consisting of three No. 14 copper wires, the lead-in being 40 feet in length and the ground wire about 10 feet? The aerial is about 75 feet above the ground. My sending instrument consists of a 1½-inch spark coil, a one-section Murdock condenser, a zinc spark gap, or rotary gap, and a helix wound with about 20 feet of No. 6 aluminum wire.

Ans.—You must understand our calculations of your wave length are only approximations and are not to be taken as absolute. The natural wave length of your antennæ is about 155 meters and the helix may increase it to 200 meters.

(2) The inquirer encloses a sketch of an aerial split into two parts—one-half used for receiving and the other half for sending. The description is too long to print. He says that when the set is adjusted for receiving on one antennæ, and he connects in the second antennæ, the signals disappear, and he cannot bring them in no matter how much he moves the slides on his tuner. The sending portion of the aerial is 70 feet long and the receiving portion 100 feet. They are separated from one another by insulators.

Ans.—This is rather unusual and of interest. Offhand, when the unused portion of the antennæ is connected in the circuits are undoubtedly thrown out of resonance. You should, however, be able to readjust the circuits to resonance; and since you are unable to do so, it would seem that reactive effects are taking place between the "lead-ins," effectively destroying the signals. It may also be that the second antennæ grounded.

(3) What is the minimum and maximum wave length I can secure when receiving if I employ a 100-portion foot of my aerial, making use of a two-slide tuner, the core of which is 11 inches long, 5 inches in diameter, wound with No. 20 D. & S. enameled wire. The lead-in is about 60 feet and the ground wire about 10 feet. I also use a variable condenser with nine plates, each 4 by 5 inches, a fixed condenser, silicon antimony and carborundum steel detector, superior 2,000-ohm type.

Ans.—We have made some tests and find that you will be able to receive wave lengths up to 2,800.

(4) I employ No. 14 B. & S. copper for the lead-in. Is this all right? or should I use a thicker grade of wire? If so, what number?

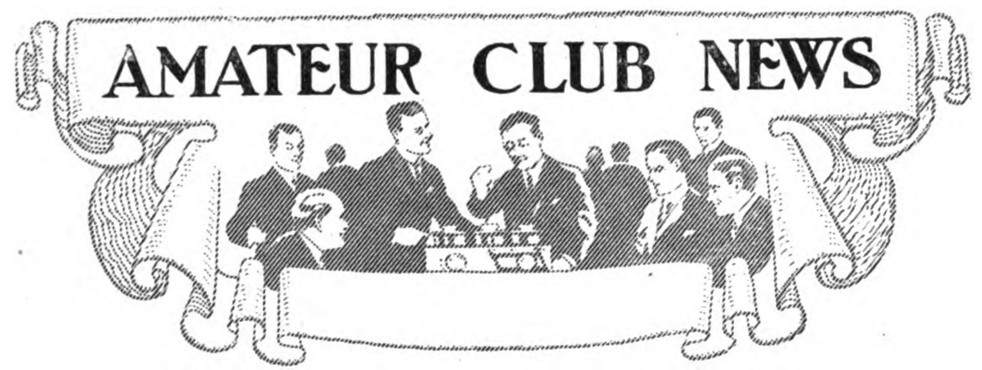
Ans.—No. 14 wire is rather light. Your incoming leads should be of No. 8, either bare or rubber-covered wire.

(5) Would a rotary spark gap increase the efficiency of my sending set, or increase my range?

Ans.—No.

We cannot answer the remainder of your questions, as it is an absolute rule to answer no more than five.

Our readers will greatly facilitate the work of this department if their questions are made clear and exact. The details that are often omitted may be the very ones that determine the answer.



AN EFFECTIVE RECEIVING SET

A cabinet wireless receiving outfit that can be used for field as well as station work is owned by Alfred J. Seeley, of Philadelphia, Pa., who says he is able to receive messages from United States wireless stations at Key West, Fla.; Cape Cod., Mass.; Arlington, Va., and Colon in the Canal Zone. In addition to communicating with these stations, he has talked with other long distance points and receives the time twice a day.

Alfred J. Seeley and His Field and Station Combination Outfit

The set includes a Murdock loose coupler, two perikon detectors, one De Forrest audion detector set and two thirty-one plate Clapp-Eastham condensers, operating with fixed condensers by means of a fan switch for a perikon detector circuit. It also has a thirty-stud variation loading coil, two and one-half inches in diameter and fourteen inches long wound with double silk-covered wire.

The antenna of Seeley's outfit is made up of four 7/22 stranded phosphor bronze wires, two feet apart. They are 125 feet in length, eighty-six feet high at one end and thirty-four feet above the roof at the other.

GREAVES TALKS TO MINNESOTA ASSOCIATION

Amateur wireless operators will be interested in what took place at a meeting of the Minnesota Wireless Association held at Minneapolis, Minn. V. Ford Greaves, of the United States Wireless Inspection Department, who was present, asserted that it was not the intention of the government to interfere in undue measure with the activities of amateur wireless operators. He said, however, that special licenses would not be given unless there was an excellent reason for doing so.

Those at the meeting learned from Greaves that a new examination has been made ready. To some of the amateurs who had heard of its features, it appears formidable.

An instance of how an operator in the first radio district attempted to operate secretly was related. The operator used an aerial which was not visible. The inspector, however, by using a loop and "listening in" on house tops in the vicinity of where the operator was working, was able to locate the offender.

NEW CLUB IN CAPITAL

A club, composed of amateur wireless operators, has recently been formed in Albany, N. Y., to further the science of radio communication, and to bring together amateurs who are operating stations in Albany and vicinity. The idea of such a club assumed definite form in Albany when a small group of operators obtained permission from the Board of Education to use a room in the Albany High School for semi-monthly meetings. Burr V. Dietz led the movement, and the formation of the club was guided by Professor F. P. Huested, head of the science department of the Albany High School.

The first meeting was attended by ten persons. A constitution was drawn under the direction of Edward Long, an enthusiastic wireless amateur. "The Hudson Valley Wireless Association" was decided upon as a name for the club.

Under the guidance of Professor F. P. Huested and Professor Brien O. Burgin and an active set of officers, the club made rapid strides. Only those operating a station or expecting to enter the field were admitted to membership. In order to help the members who were having difficulty in obtaining necessary efficiency from their instruments, the club elected Clayton B. Le Gallez, a member well versed in the science of radio telegraphy, as engineer. It is his duty to call each member's station and give assistance and advice if necessary.

The club has not been working along the lines of wireless telegraphy alone. Two of its members have also made advanced experiments in wireless telephony. Clayton Le Gallez and Burr V. Dietz have both been working on a new type of wireless telephone. Other members have been engaged in research work along various lines of radio communication.

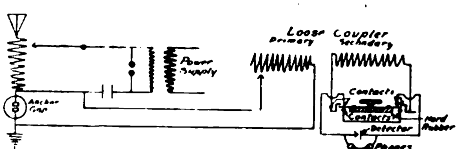
It is the desire of the club to standardize radio communication in Albany, and to place all operators under rules and regulations, so that messages will be uniform. The adoption of the Continental code, the international standard of radio communication, is urged.

It is aimed to make the meetings of the association of an instructive nature, sound technical advice being given by experts from the outside, and theses on practical problems being prepared by members. Some of the amateurs are entering upon the science as a vocation, and a few are engaged in commercial work.

At a recent meeting, an illustrated lecture was given before the club by Mr. Beebe and Mr. Pohlman, representatives of the Schenectady Wireless Club.

BREAK KEY FOR LOOSE COUPLER

For readers using a loose coupler, a break key, devised by H. W. Dickon, of San Francisco, Cal., will be of interest. The accompanying diagram is self-explanatory, and it can be seen that when the key is pressed down the detector is cut out of the circuit and shunted at the same time. When released the detector is put back into the circuit.



BREAK KEY FOR LOOSE COUPLER

The land rubber contact holder should be fastened directly under the key knob, and the contacts should be of spring brass and phosphor-bronze.

THAW NEWS BY WIRELESS

The news of the escape of Harry K. Thaw from Matteawan was received in Chester, Vt., by means of the wireless station of Vincent LaFountain, which he constructed himself.

The first National Conservation Exposition was formally inaugurated in Knoxville, Tenn., by a wireless message from President Wilson.