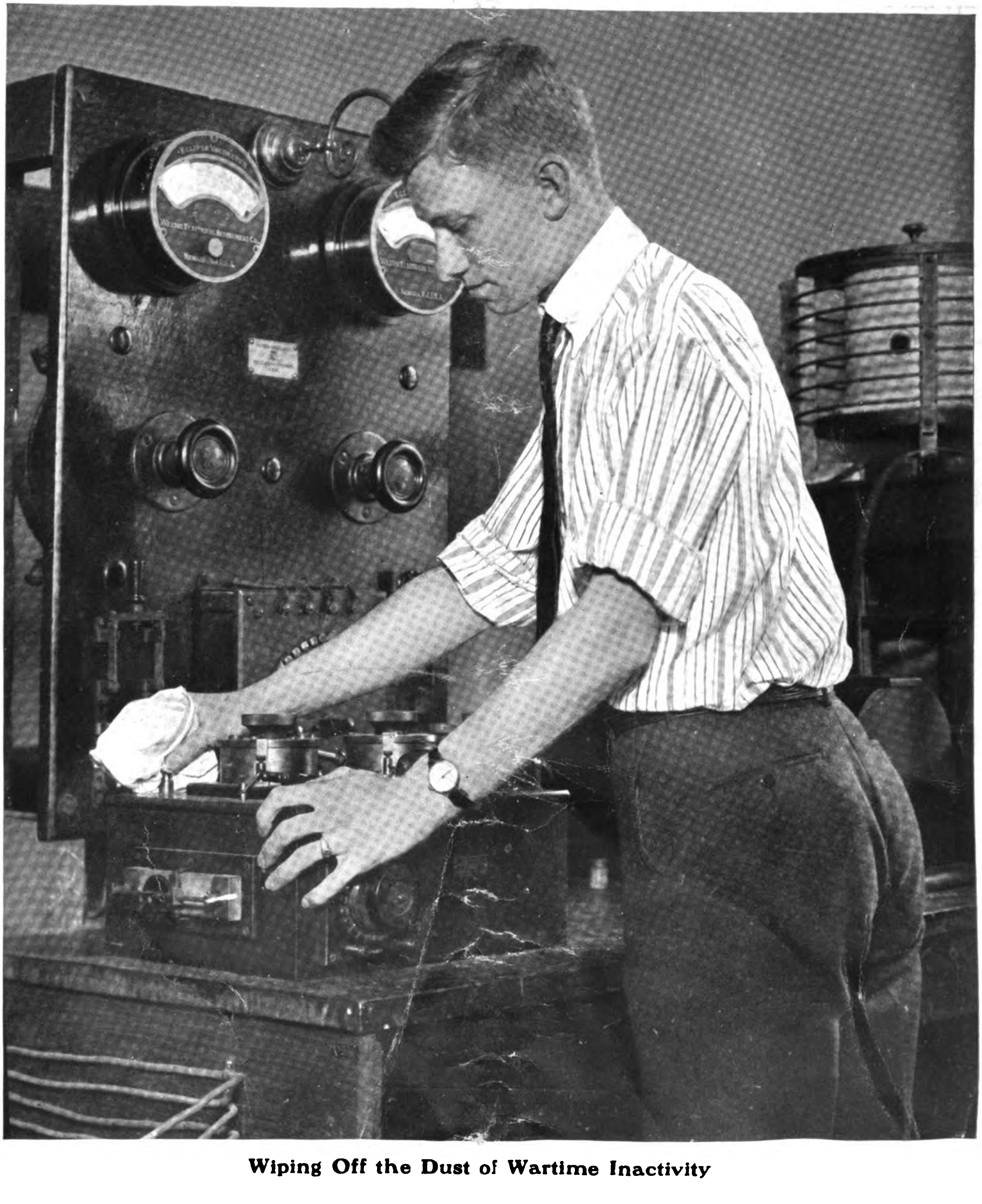
August, 1919 20 Cent

The WIRELESS AGE

Volume 6 Number 11



Wiping Off the Dust of Wartime Inactivity

How the Wireless Worked on the NC-4. The Trans-Atlantic Flight Described by Ensign R

The Speed of Electricity—By Prof. Kennelly. The Method of Measuring the Velocity of Wireless Sign

HATS OFF TO THE NAVY

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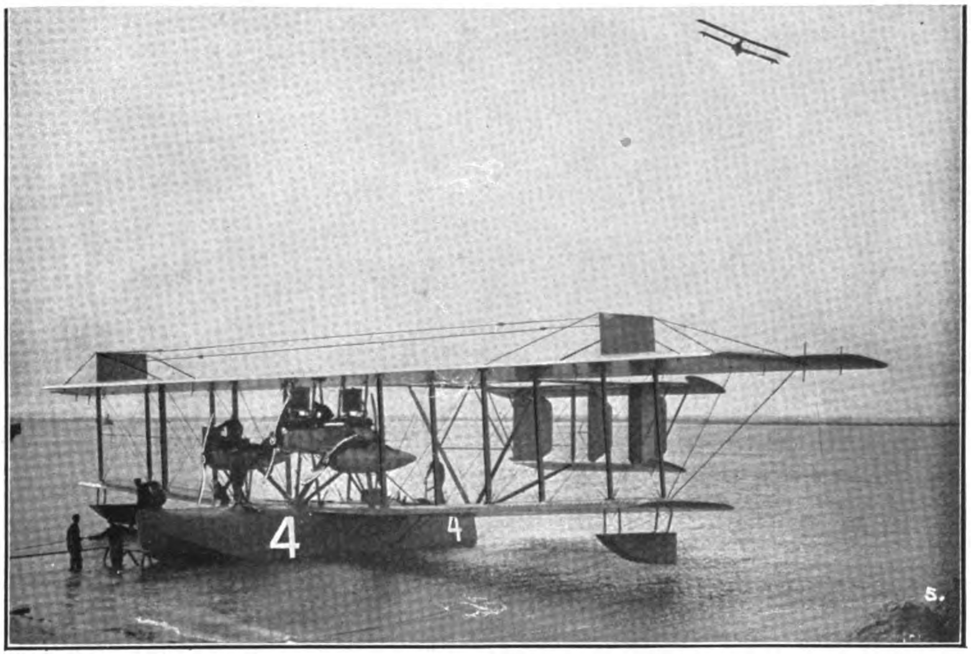
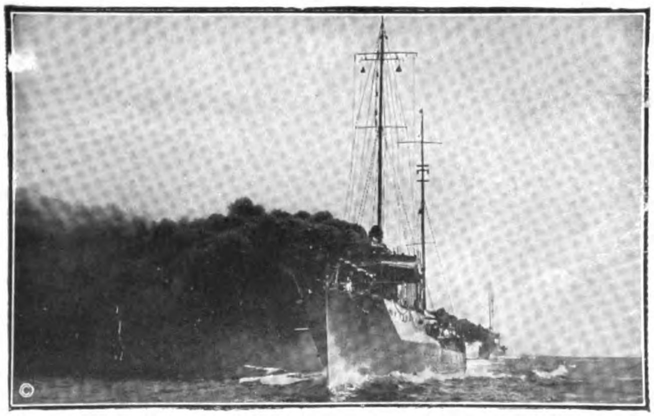
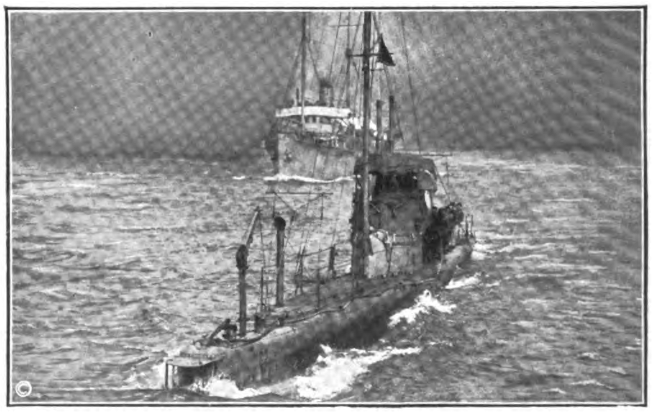
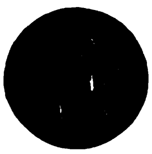
Extract from New York World, June 3, 1919.


NC-4—ELECTROSE Equipped.


U. S. S. Cassin and U. S. S. McDougal Working Up a Smoke Screen—ELECTROSE Equipped.


U. S. S. G-2—ELECTROSE Equipped.


Medal and Diploma received at World's Columbian Exposition, Chicago, 1893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The Wireless Age

Edited by J. ANDREW WHITE

Vol. 6 — No. 11

Contents for August, 1919

Index of Equipment

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THE WIRELESS AGE

WORLD WIDE WIRELESS

Allies Undamped Wave Sets Fooled German Airmen

AMERICA and the Allies outwitted German airmen by means of the wireless telegraph. A captured German army order made public by the army air service shows the importance which the German military leaders attached to wireless, also that they were anxious to duplicate it. The order reads:

"The enemy has found it possible to use wireless installations for undamped waves in his aeroplanes. So far few fittings of this type of apparatus have been captured by us, and in order to enable us to make use of this as soon as possible and also so as to save millions which would have to be spent in experiments, it is every one's duty to see that all wireless telegraph fittings from captured airplanes are saved as completely as possible. Even the smallest pieces will be collected, as a tyro cannot recognize the value and importance of small parts to the expert.

"In view of the importance of these fittings for our own wireless telegraphy, sums paid for this salvage will be high."

The order was dated June 6 last year. It indicates that the Allies were far ahead of the German radio experts and that Germany was prepared to spend millions to bring her equipment up to a point where it would be equal to that of the Allies.

This is one of the reasons why the American aviators when forced to land on German territory burned up all their machines and equipment. In fact, the order shows that Germany did not know the United States had developed the practical wireless telegraph and telephone for airplanes until long after it had been in use.

Airplane radio telegraph sets of the continuous wave type were used by the Allies as early as the spring of 1917.

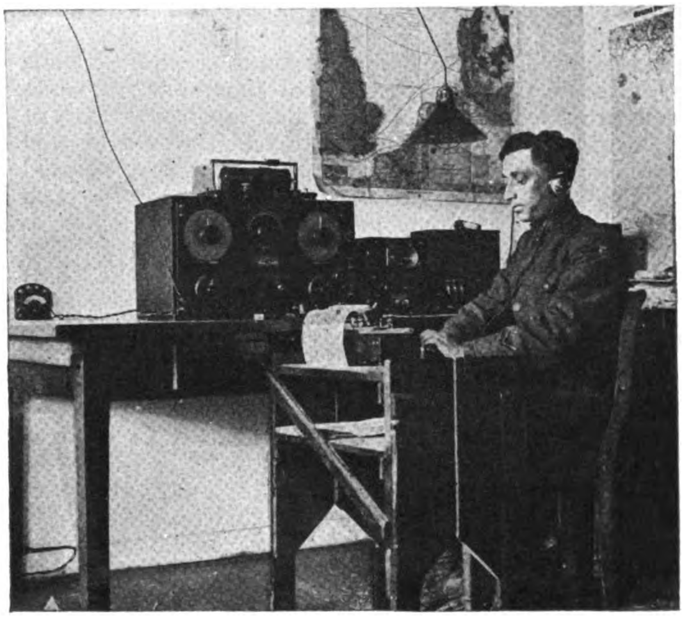
British South Pole Expedition to Use Wireless

A SIX years' polar expedition by British explorers and scientists to the South Pole, in which an aeroplane will be utilized in accomplishing the final stages of the trip, is to be started in June, 1920. The proposed expedition, under the leadership of John L. Cope, F. R. G. S., who accompanied the Shackleton expedition as surgeon and biologist, will be known as the British Imperial Antarctic Expedition. Its objects are:

1. To ascertain the position and extent of mineralogical and other deposits of economic value.
2. To obtain further evidence of the distribution and migration of whales of economic value.
3. Generally to extend the knowledge of Antarctica, especially with a view to obtaining further scientific data of economic importance.
4. To investigate the meteorological and magnetic conditions of the Ross Sea area and at Cape Ann in connection with their influence on similar conditions in Australasia and South Africa respectively.

While the expedition is to be gone six years, it will not be cut off from contact with the civilized world, because it will take along a fairly powerful wireless set.

The famous exploration ship Terra Nova will take the expedition to the southernmost parts reachable.



Copying press on high wave lengths at an A. E. F. station at Neuweid, across the Rhine

Magnifying Sound Four or Five Million Times

A MAN'S voice can be made as loud as the cannon's roar; it can be heard two or twenty miles. The ticking of a watch can be amplified until it sounds like breakers on an ocean cliff.

In the stadium at Golden-Gate park the ticking of a watch was made audible all over the grandstand while an athletic meet was in progress. Captain Robert W. A. Brewer, an experimenter, moved off 2,000 feet and spoke quietly to his dog, and the dog couldn't be held. A wireless station recently received a telephoned message from Europe, and through its amplifier startled duck hunters in the marshes eight miles away.

Wireless Compass Station Established at San Diego, Cal.

OFFICIAL announcement is made that the Navy Department will establish a radio compass station at San Diego, Cal. This will permit inbound naval or merchant shipping to adjust compasses through information flashed from the Point Loma Station.

The Future of Wireless and Aviation

SPEAKING at a luncheon of the Aldwych Club recently, Godfrey Isaacs, managing director of the British Marconi Company, told of a new plan his company had for enabling aviators to tell where they were. After mentioning the wireless direction finder, Mr. Isaacs said:

"A further development had given them a new transmitter, which would project into the air a wide divergent beam, something like a searchlight without the light, which would extend over any area required, or, if it was desired, a concentrated beam over some small place, and those beams would convey to the men in the sky automatically the name of the place they were passing over.

"Assuming that a man was passing over the town of Guildford; from the moment he traversed the region over which this beam was playing he would receive the signal, 'This is Guildford,' and would continue to receive that signal as long as he was over Guildford and no longer. In the same way, if he was passing over Windsor Forest he would be told, 'This is Windsor Forest,' and when he came to his aerodrome a beam would tell him 'This is Hendon Aerodrome!' In that way he thought that one of the greatest dangers to pilots in fog and in darkness was disposed of.

"It required very little imagination to see, a little while hence, some thousands or tens of thousands of names being projected into the skies, so that in whatever part of the world an aeroplane might travel, it would be told continuously and automatically where it was. It would be as easy to learn in the skies where they were as in a railway train when they looked out of the window to see the name of a station.

"Similarly these beams could be equipped to lightships or to buoys in fixed and defined positions, so that even when passing over the sea one would know exactly where one was. When that position of things had developed pilots would no longer lose themselves, wherever they might be."

Enlarging on the commercial possibilities of wireless, Mr. Isaacs said:

"A cable required a very big capital outlay, its cost of maintenance was very considerable, and its capacity for traffic was limited. The cost of a wireless telegraph station was moderate, the cost of maintenance was small, and the capacity for traffic was practically unlimited.

"Wireless to-day could do 150 words a minute simplex and 300 words a minute duplex. It would require but a very small mechanical improvement to double and quadruple that number of words transmitted by wireless." He was quite satisfied that so soon as wireless traffic needed the greater speed of transmission mechanical improvements would be introduced, and they would get something in the neighborhood of 600 words a minute.

Wireless Telegraphy on Board British Ships

LORD SOMERLEYTON'S bill to make further provision with respect to wireless telegraphy on British ships has been issued. It provides that every sea-going British ship registered in the United Kingdom, being a passenger steamer or a ship of 1,600 tons gross tonnage or upwards, shall be provided with a wireless telegraph installation, and shall maintain a wireless telegraph service which shall be at least sufficient to comply with the rules made for the purpose under this Act, and shall be provided with one or more certified operators and watchers.

The Board of Trade may exempt any ships if they are of opinion that, having regard to the nature of the voyages or other circumstances the provision of a wireless apparatus is unnecessary or unreasonable. The Board of Trade, in consultation with the Postmaster-General, shall make rules prescribing the nature of the wireless telegraph installation to be provided, of the services to be maintained, and the number of operators and watchers to be carried. If this section is not complied with the master or owner of the ship shall be liable in respect of each offense to a fine not exceeding £500, and any such offense may be prosecuted summarily, but if the offense is prosecuted summarily the fine shall not exceed £100.

"Passenger steamer" shall mean a steamer which carries more than twelve passengers.

New Wireless Station to Be Built in Cincinnati

CAPTAIN J. P. GRAY, of Washington, a member of the U. S. Coast Guard service, recently visited Cincinnati to make a preliminary survey of possible locations for a Government wireless station there. It will be used for the army, the Weather bureau and other departments.

Dutch East Indies Get Wireless Station

ACCORDING to the Dutch East Indian Commercial Review, a wireless station is now being erected in the Dutch East Indies to transmit messages from Holland direct to the East Indies without relay. The Review says: "The receiving station for the wireless communication between Holland and the Dutch Indies will be erected at Boxmeer (North Brabant), the sending station near Apeldoorn (Gelderland). The station near Apeldoorn gets six masts, 210 meters high. The distance between Holland and its D. E. I. colonies is 11,000 kilometers and this distance will be reached without substations."

Wireless Aids President Wilson in Governmental Work

INDICATING that the public business—or at least some of the public business— was not to suffer while he was away, President Wilson signed appropriation bills aboard the George Washington and a wireless was sent the White House that they had become law.

Such action has been approved by the Attorney-General, and was taken by the President when the first Urgent Deficiency Bill was passed.

The ship is American territory. The White House has become a floating one.

Wireless Telephones Aboard Merchant Ships

EXPERIMENTS in wireless telephony from a merchant vessel, conducted recently aboard the steamship Parismina as she was on her way back from Colon to New Orleans, met with great success.

Should the experiments prove wholly successful, the wireless telephone may supplement the wireless telegraph, now a part of the equipment of practically every ship that goes to sea. Officers in charge of the tests have not yet made a report but it is understood that the experiment bore out the fondest hopes of those in charge.

The messages, from reports, were picked up perfectly at shore stations and the voice was heard as distinctly as is the every-day telephone conversation on shore.

Replies as received from radio operators at sea showed that the voice was distinctly heard, even at long distances.

In the Wireless Room With Marconi

THE Italian who has most appealed to the American imagination, however, is Guglielmo Marconi, says Isaac Marcosson, in the Saturday Evening Post, "I did not meet him until after the outbreak of the war, but I saw him many times and in varied circumstances—at sea, in London, and in Rome. Marconi is slight, nervous, emotional. He speaks English fluently and his wife was English. He is one of the most accessible of men and from long experience knows the interviewing ropes.

"In war as in peace his greatest invention has an immense value. Without wireless some of the most vital phases of the great struggle would have been impossible. The historic S O S call of distress, flashed across the troubled seas, is the world's supreme life saver.

"Marconi made possible one of the unique experiences I had in the war," the writer notes. "In July, 1917, we were fellow passengers on the old American liner St. Paul, then bound from New York to Liverpool. Then—as throughout the war—the wireless room on a steamer was a sacred and inaccessible domain. Only the ship's officers were allowed to enter it.

"One night when we were in the heart of the danger zone—and the submarines were then at their worst—Marconi came to my stateroom and said: 'Would you like to hear how some of the German lies sound in the air.'

"He referred to the German Admiralty wireless reports that were sent out nightly with the news of Teutonic successes.

" 'Yes,' I responded.

" 'All right,' he replied; 'let's go up into the wireless room.'

"We climbed up a slippery ladder and found ourselves in a tiny room where the operator sat at his instruments with the receivers at his ears.

"Instinctively Marconi took the receiver from the operator's head and put it on his own. The master of wireless was on the job.

"Then handing the receiver to me he said:

" 'You can now hear the whole world at war talking.' "

"I listened. To me it was simply a jumble of dots and dashes. Yet that melange of sound was Germany, England, France, America and Italy throwing the fateful news of the day out into the unplumbed spaces."

Marconi and Gabriele d'Annunzio, the Italian poet-soldier, are close friends, Mr. Marcosson observes. Each has a sense of humor strong even in misfortune. Marconi lost an eye in an automobile accident in France and D'Annunzio lost one in aerial combat.

"During the trip to which I have just referred Marconi showed me a telegram which he had recently received from the poet, which read, as I recall it:

" 'We are now two souls with but a single pair of eyes. D'ANNUNZIO.' "

Wireless Whims

IT will be a great day when wireless telephony is so perfected that a man can have a receiver in his hat and be managed by his wife all the time.

"We were much jammed by strong wireless signals not intended for us," Captain Alcock said of the great ocean flight. Big field up there. Great newspapers will have a fleet of planes on the roof where we now have pigeons, and alert young aviator-reporters on dull nights will get an order something like this: "Jones, take the Blurb 4-11-44, tethered at the northeast corner of the building, go up a couple of miles and see if you can pick up a bit of live news."

A miscellaneous collection of wireless apparatus lay on a counter in an electrical store which is the rendezvous of New York wireless amateurs, and a salesman explained that it was pre-war apparatus which was being sold out at special prices.

An amateur stood gazing at a loose coupler which would have been the pride of any amateur a few years ago. The salesman, seeing the interested look of the amateur, approached. "Would you like to buy that loose coupler cheap?" he said. With a sudden look of scorn the seemingly interested amateur replied:

"Naw! I outgrew that stuff long ago. I was just looking at it as a matter of historic interest." And that is precisely the way things go with these ambitious young Americans who dabble in wireless.

Brooklyn Navy Yard Uses Radio Compass

THE radio compass device has reached such a state of development that navigators at the Brooklyn Navy Yard are enabled to give bearings to ships lost in fog off the Atlantic coast.

Left to right—Lieutenant Durrant, wireless operator; Major G. H. Scott, navigator; Major Cook (coatless), part of the crew of the R 34, the dirigible that crossed the Atlantic

The vessels wire the Naval Communications Office when they want assistance. Then, with the aid of several stations, the office fixes the ships' locations and they can proceed without waiting for clear weather.

Increased Wireless Service Across the Pacific

THE present capacity of naval radio transmission across the Pacific ocean will be increased to six times the present capacity by the installation of several automatic high speed sending and receiving apparatus on the San Francisco-Pearl Harbor lines and the opening of a second trans-Pacific radio circuit. Plans for the improved service have already been made in Japan according to the report.

The Speed of Electricity

By A. E. Kennelly, Dr. Sc., A. M.

Vice-President National Wireless Association
Professor of Electrical Engineering at Harvard University;
President of the Institute of Radio Engineers

THE speed of electricity is generally known to be very great, but when a specific question is asked as to what is the speed of electrical transmission of signals over wires, as in telephony, or over a wire and the ground, as in telegraphy, or over the ground alone, as in radio communication, it is very difficult to find a precise answer. Nevertheless, the answer to such a question is of great practical importance in certain engineering undertakings, such as the establishment of the longitude of a station by electric signals from another station whose longitude is already established. Moreover, the subject is of great intellectual interest. Its study has occupied the lives of many scientific investigators. The boundaries of this field of inquiry are far reaching and numerous. They touch upon relativity, the question of infinity in space and time, and the very framework of the known universe. It is only proposed to discuss here a very small part of this vast subject; namely, the speed of electricity insofar as it relates to electric signals, and particularly to radio signals.

Very Brief History

Prior to Maxwell's time, the speed of electricity over wires was considered as distinct from the speed of light, both experimentally and philosophically. It was realized that the speed of electricity was numerically of the same order as that of light; but the phenomena were regarded as independent. Wheatstone, in 1834, made some laboratory measurements, with a revolving mirror, on the delay of a spark discharge across a gap in the middle of a long wire loop, as compared with a spark across the sending terminals, from which the apparent speed of the current over the wire was 463,500 kilometers per second; but very different results were obtained in various repetitions of the experiment; so that this method of making the measurement was for a long time discredited.

Maxwell's theory, in 1867, of light as an electromagnetic phenomenon, changed the aspect of the question. Assuming that the theory was reliable, it became unnecessary to measure the speed of electrical currents, because the speed of light had already been measured with a fair degree of precision, and bid fair to be measured with yet greater precision in the future.

Maxwell's theory, when first enunciated, depended in a large measure for confirmation upon the corollary that the speed v of transmitting electromagnetic disturbances perpendicular to their wave front is

$$v = \frac{1}{\sqrt{k\mu}} \quad \frac{\text{cm.}}{\text{sec.}}$$

where k is the dielectric permittivity of the medium, or its "specific inductive capacity," and μ its magnetic permeability. This latter value is unity in vacuo and very nearly unity in all nonmagnetic substances. Consequently, if the permittivity of the medium were quadrupled, the speed should be halved. But the ratio of the velocity of light in vacuo to that in a nonmagnetic solid transparent medium, such as glass, is optically defined as its "index of refraction" ν so that the index of refraction of a transparent dielectric should be numerically equal to the square root of its permittivity k. In a fair number of instances, the agreement between measured values of ν and $\sqrt{k}$ was found to be satisfactory, especially when k was measured at relatively high frequencies.

Maxwell's theory also received support from the fact that it required the ratio of the units in the electrostatic and magnetic C. G. S. systems to be simple functions of the velocity v of electromagnetic wave propagation, or of light. Thus, taking the units of capacitance, if an air condenser had its capacitance measured in abfarads and also in statfarads, the number of statfarads should be v^2 times the number of abfarads. This ratio checked satisfactorily, and is now regarded as perhaps the most precise method of determining inferentially the velocity of light.

Sir Charles Wheatstone in 1834 added to the knowledge of electrical measurements by his research work and laboratory experiments

Hertz's experimental researches with electromagnetic waves have confirmed Maxwell's theory, and have established the belief that light is an electromagnetic wave disturbance, optically differing only from electromagnetic waves of the laboratory, in wave length or accompanying frequency.*

The velocity of light has been measured by optical methods† and the best mean result is generally taken as $v = 299{,}860$ km. per second, or 2.9986×10^{10} cm. per sec. The question as to whether this velocity varies with the wave length, has been hitherto answered in the negative, by various astronomical observations, so far as the wave

*The condition of polarisation of light is here left out of consideration. Radio waves are generally agreed to be not merely long-wave light; but also polarised light.

†Encyclopaedia Brittanica "Light," 11th Edition; also Bulletin of the Bureau of Standards, Vol. 3, No. 4, page 603, 1907.

lengths in or near the visible spectrum are concerned, and also so far as concerns the longer electromagnetic waves of the electric laboratory, by the fact that the best value of v obtained from the measurements of the ratios between electrostatic and electromagnetic units, at very low frequencies, are in agreement with the value of v obtained in optical measurements at luminous frequencies, estimated as lying say between 4×10^{14} and 10^{16} cycles per second.

Summing up the accepted beliefs concerning the speed of electromagnetic disturbances in straight lines, we may say that, for practical purposes, the velocity v is very nearly 300,000 km. per second, in vacuo or free space, and is independent of the frequency or wave length. In air, at standard temperature and pressure, the value of k is taken as 1.00055, as against unity for vacuum; so that the speed of transmission in air is taken as less than in free space in the ratio of 1.00028, or only about 3 parts per myriad. The difference between the speed of propagation in air or in vacuo is therefore relatively very small from an engineering point of view. In rarified air, the retardation of velocity is to be considered as still less, or the velocity is still nearer to v in vacuo.

Lord Rayleigh, noted for his discovery of argon, also contributed to the knowledge of electrical measurements by his discovery of the laws of "group speed" of waves

Velocity of Transmission Over Wires

Granting that electromagnetic disturbances move in the free space with the uniform speed v, as above defined, the next question is what is the speed at which they move over conductors?

The answer is that the speed of disturbances over conductors is always less than that in free space. If the conductors are, say, two parallel copper wires, insulated in and separated by a solid nonmagnetic dielectric of permittivity k, as measured as the proper frequency, then the speed of disturbance in the dielectric would be expected to be $\frac{v}{\sqrt{k}}$. But even if the dielectric medium surrounding the two wires is air, for which k is substantially unity, and their distance apart remains uniform, the speed of transmitting electromagnetic disturbances in the air would be v; but the speed of conducting the disturbance along the wires would be less than v; owing to attenuation or absorption of energy into the conductors, or into the insulators supporting the conductors; or finally into the air itself. In other words, the speed of transmitting electric signals over the wires would be less than the speed of transmitting electromagnetic-signal disturbances through the air alone, owing to loss of energy in the wires, or in the insulation. It is believed that if there were no loss of energy, the speed of transmitting the signals over the wires would be v, the same as the speed in a straight line through the air. Suppose, for example, that an electrical dot impulse, of rectangular wave form, is started off along a pair of parallel aerial telegraph line wires from the sending end. The impulse travels through the air guided by the wires. Owing to resistances losses of various kinds, the impulse attenuates, and also changes its wave shape as it proceeds, so that it arrives at the distant end, no longer as a rectangular wave impulse, but as a rounded wave rising gradually from zero to a maximum. The instant when the wave is considered to arrive at the receiving station would depend upon the sensitiveness of the receiving device. A highly sensitive receiver would be likely to register an earlier arrival than a receiver which only responded to the crest value of the incoming wave. The speed of transmission thus not only becomes lower than the speed of advance through the air; but it also becomes difficult to assign. The higher the linear resistance of the wires, the greater the capacitance of the insulators supporting the wires, and the greater the effective radiation resistance of the system, by which the energy in the advancing wave becomes dissipated, either in heating the conductor, or magnetising it internally, or charging the insulators, or radiating off sideways, the lower the speed of signal transmission would appear to be, as judged by the interval of time between an instrument at the sending station recording the starting of the wave, and a similar instrument at the receiving station recording its arrival. If, however, the wires could be made perfectly conductive and the insulators made completely nonabsorptive—so that there were no resistances and no energy losses—then we should expect to measure a speed of transmission of signals over wires equal to v the speed of advance through air. In practice, these ideal conditions are unattainable, and the apparent speed of signal transmission over conductors is always less, and sometimes much less than the speed v of waves in the dielectric, after allowing for its permittivity k. Consequently, the speed of signal transmission becomes an indefinite quantity, always less than v, but having its value dependent upon various considerations affecting the conductors, including also conditions in the receiving instrument.

Group Velocity of Waves Over Wires

If, instead of sending separate impulses or discrete signals over a pair of parallel wires, we send a train of simple alternating-current waves at a steady frequency, then the meaning of the phrase "speed of electric transmission over wires" becomes definite, but still slightly different from that of v the "speed of electric transmission through air." As was pointed out by Rayleigh, what is observed with alternating-current waves is the "group speed" of the waves, which is not identical with, and is less than, the speed of the wave disturbance. The difference is again due to the attenuation or decay of the waves, from losses occurring during transmission. The successively arriving waves are weakened by these losses, but they still remain sinusoidal in shape. The distortions in wave shape of simple alternating-current waves advancing over uniform aerial conductors, due to attenuation, are such as still leave the arriving waves of simple alternating-current form. The wave length of the train is apparently diminished, and the velocity of arrival is apparently diminished, but the frequency or number of waves arriving per second remains the same as the frequency of the waves delivered by the alternator at the sending end. The lower the resistances and losses of energy in transmission, the more nearly the group speed, or apparent velocity of motion, approaches the speed v of the wave disturbance for unguided waves in air. Moreover, the higher the frequency, the less the deviation of group speed from wave speed, other conditions remaining the same.

A crude analogy to the phenomenon of group speed retardation is presented in the case of waves of infantry advancing over a plain, and subjected to a progressive attenuation or destruction by gunfire. Each successive wave may, at regular intervals, start off and proceed throughout the journey with a uniform speed of, say, 3 km. per hour. If the distance to be traversed is just 3 km., the waves without any attenuation would take just one hour to make the journey. But with attenuation, the leading wave may be completely destroyed before it reaches its destination. If the speed of transmission is measured by the time that elapses before a wave registers its arrival, this group speed may work out very appreciably less than the actual 3 km. per hour at which the advance of each unit is being made. The case of electric wave transmission under consideration does not contemplate the extinction of entire waves, and the attenuation is a more gradual and regular process; but in both cases, the cause of the retardation is the same.

In laboratory measurements made on the speed of alternating-current waves over parallel wires in air, the group speed has been found to agree very closely with that of v, after allowance has been made for attenuation. A number of such measurements have been published.*

We may, therefore, sum up the matter of alternating-current wave transmission over uniform wires by saying that the observed group speed under favorable conditions can be brought very nearly up to v, and that in other cases where the conditions yet remain simple, the reduction in the apparent or group speed can be explained.

Speed of Transmission of Radio Waves

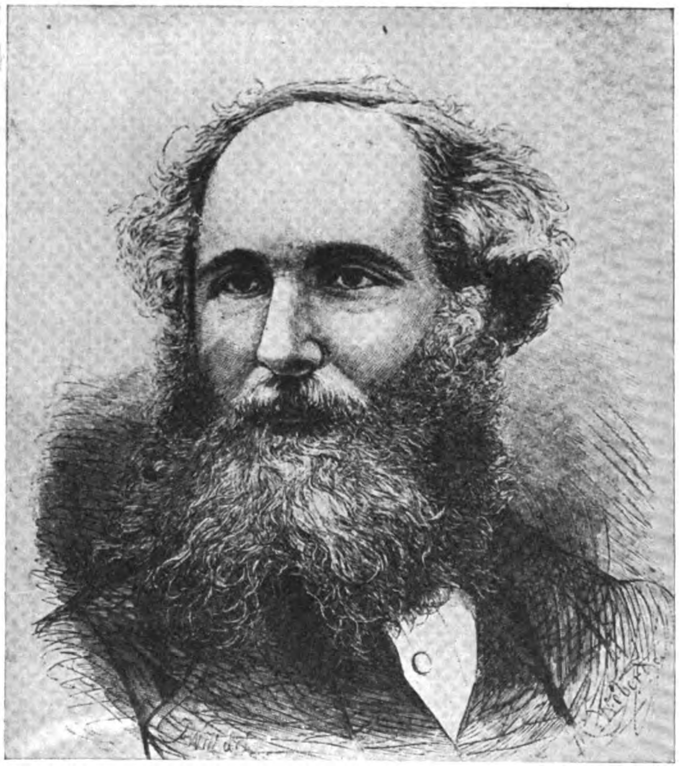
A long train of radio waves advancing hemispherically over the conducting surface of the sea may be regarded as a case of alternating-current transmission over a large conducting surface. If the sea were a perfect electric conductor, and if the earth were flat, and the atmosphere a perfect insulator of $k=1$ throughout, we should expect that the observed group speed of transmission would be identical with v the speed of wave transmission in space. The question is, what will be the speed over a spheroidal earth with actually imperfect conductivity in the land and sea, and imperfect insulation in the atmosphere? The curvature of the earth will have a certain retarding influence, owing to the interference of perpetually bending alternating currents, or what corresponds to diffraction† in optics. The imperfect conductivity of the surface and the imperfect insulation of the atmosphere involve losses of energy which probably tend to reduce the group velocity. Moreover, these factors are not independent, but mutually influence one another. Thus, the conductivity of the ground surface affects the diffraction, and so also does the question of conductivity in the upper layers of the earth's atmosphere.

*See a paper by Saunders "On the Velocity of Electrical Waves", in the Physical Review for 1896, Vol. 4, page 81. A good bibliography of the subject appears in this article.

†The Transmission of Electric Waves over the Surface of the Earth, by A. E. H. Love, F. R. S., Phil. Trans., R. S., Vol. 215, pp. 105-131, 1915. This paper contains a bibliography of the subject.

There seems to have been only one series of measurements, thus far published, concerning the group speed of radio signals. This series was made in 1913, by a French commission, in a determination of the difference of longitude between stations in Paris, France, and Washington, D. C., with the aid of radio signals.* The great-circle distance between these stations is given as 6175 km. The received radio signals were photographically recorded. The report states that the transmission interval of these waves was found to be 0.021 second. If we assume that this value is exact to the last decimal, the group speed would be $6175/0.021 = 294.050$ km./sec., which is approximately 2 per cent less than v. Probably all that we are justified in inferring is that the difference between the group speed and v was not great.

If the group speed of alternating-current radio signals traveling around the globe did not differ appreciably from v, then because the distance from any point on the earth to its antipodes is very nearly 20,000 km., it follows that the time required for the waves to leave a sending antenna, run around the world and reach the antipodal



James Clerk Maxwell who, in 1867, advanced the theory that light was an electromagnetic phenomenon

antenna, would be $\frac{20,000}{300,000} = \frac{1}{15}$th second. We must expect the actual time to be a little longer than this. Just how much longer, we cannot know assuredly until measurements over similarly long radio distances have been secured. At present, they are very difficult to secure. It will be surprising, however, if the semi-girdling time exceeds the v-time of 1/15th second by more than a few per cent. It is generally believed that the actual time is not very much greater than the v-time.

It is interesting to reflect that all the nations of the world are thus either actually, or potentially, in probable mutual radio connection within less than one-tenth of a second of time. On a strict v-time basis, they would certainly all be within one-fifteenth second.

It seems unreasonable to expect that we mortals can indefinitely continue to maintain differences of language, of customs, of laws, or of weights and measures, on the surface of a radio deci-second globe. In this thought there is brotherhood and mutual good cheer.

*Comptes Rendus, June 13th, 1916. Vol. 162, pp. 899-903.

Across the Ocean on the NC-4

The Personal Narrative of the Wireless Operator on the Naval Seaplane Which First Spanned the Atlantic in an Historical Air Flight

By Ensign Herbert C. Rodd

I EXPECT that it is up to me to tell, as best I can, just what happened in wireless when the NC-4 made the historic flight across the Atlantic.

The explanation of how the radio equipment was used, and the very great assistance it afforded us, presents no difficulty; but the thing which I find very hard to reconcile with this workaday job is bathing the task in the floodlight of an heroic action. I simply cannot view it that way. The wireless operation of the NC-4's equipment was carefully planned and easily executed; I must say at the start it required no special effort of the superhuman order, as many of the descriptive writers have pictured it. My principal impression of the part I played in the history-making episode is a sense of gratification that the selection of this task happened to fall on me.

The flight in itself was extremely interesting, and I can truthfully say that the success of the wireless communication exceeded all my fondest expectations. If I can convey in this article and its successors, exactly what was accomplished in radio communication during the flight, tell the tale without any embellishments and make the reader understand by inference, more than by power of descriptive writing, how fascinating the manipulation of the apparatus became, then I will feel that the purpose of these articles has been achieved.

Ensign Rodd

Let me first briefly describe the apparatus. The NC-4 had a 500-watt propeller-driven spark transmitter, a 5-watt battery-driven telephone transmitter, an aircraft type receiver and a radio compass equipment consisting of a revolving set of coils operating in conjunction with a compass control panel and an amplifier. Transmission and reception was arranged for either on an antenna stretched between the skid fins on the upper plane, or on a single-wire trailing antenna. The apparatus was located in the aft portion of the boat and was arranged as shown in one of the photographs accompanying this article.

In this photograph the reel of the trailing antenna may be seen to the extreme right. Alongside is the variometer assembly for the spark transmitter. A large special send-receive switch was mounted against the side of the boat; below this on the table may be seen the telephone transmitter and the switch by means of which the amplifier could be used in conjunction with the compass equipment or with the standard receiver. The wave length of 1,500 meters was the one arranged for most efficient operation of the compass. The inter-communicating telephone system was arranged so that the radiophone could be used by either Commander Read, located forward in the craft, or by myself as operator.

During the trans-Atlantic flight I kept a very complete log and this enables me to describe nearly everything that happened, right from the beginning. I am unable to give the exact wave length on which each communication was copied, but it may be generally understood in all that follows that 1,500 meters was used by the destroyers, except when I requested them to transmit on 1,200, 952 or 756 in order to eliminate interference. Communications from the NC-4 were transmitted on a wave length of 425 meters. As we passed each destroyer the time by the clock was immediately broadcasted on 756 meters and this information was then broadcasted by me on 425 meters.

Dispensing now with the earlier preparations preliminary to the actual attempt to fly across the ocean, it may be said that it was on May 6th at 3:30 in the morning when the radio installation on the NC-4 was completed. Within an hour we were expected to make ready for the start, but an unfavorable weather report came in and the flight was delayed, giving me the opportunity to spend most of the day in the boat selecting vacuum tubes for both the amplifier and continuous wave transmitter.

When Norfolk station began on the afternoon schedule, I took bearings, to make sure that the fixed condensers in the radio control panel were adjusted to 1,500 meters. A wavemeter had verified the adjustment, but no tests had been made with the station actually working. The variable condenser in the control panel had a capacity of but .0005; because of the extra weight of larger condensers a fixed capacity was shunted across each variable.

There had been no opportunity to test the radio apparatus in flight, and it looked very much as if the NC-4 would leave Rockaway without knowing whether things would function when the plane took the air. On the following day, however, the weather cleared and at 5 in the afternoon we had everything in readiness to make a test flight. The boat was taken out on the runway and just as we were about to slip down into the water the engineer officer put his foot through the generator's propeller, breaking both blades. This accident was due to the fact that the center engine was running and its tractor propeller had caused the air screw of the small generator to run at such high speed that it was not seen.

A most unfortunate accident also occurred at this time. Chief Special Mechanic E. Harry Howard caught his hand in the propeller, severing the member completely at the wrist. He showed a great amount of grit by refusing to be helped down from the plane, and so challenged our admiration that had it not been our last chance for the test flight, we certainly would have given it up for the day. It was rather rough on Howard to be eliminated from the flight at this late date and we all extended our deepest sympathy to him.

There was no time to be lost, however, as it was growing dark, and when I told the Navigator that it would probably take fifteen minutes to change the generator air screw, it was decided that we would leave without effecting repairs.

This flight gave me an opportunity to test the continuous wave transmitter with the station at Rockaway. The skid-fin antenna was used and the buzzer signals were easily readable in the air. I found, however, that the telephone did not work to full satisfaction, except when the plane had come to rest on the water with the motors stopped. This was the first time I had tried out the trailing antenna arrangements and the ease of operation of the metal reel surprised me. We remained in the air about two hours, which gave me the opportunity to hear a sufficient number of distant stations with the amplifier and warranted no worry on that score.

The following morning at 4:30 the eventful moment of the start arrived, for it was then that we were awakened and told to make our final preparations for the departure. At 8 o'clock everything was ready; all mechanical and electrical needs had been provided for and food and coffee in Thermos bottles had been put aboard. Especially thorough was the preparation for personal solace in the form of nicotine. Each man had been allowed five pounds for personal effects, exclusive of his flying equipment. Kit bags made of light balloon fabric were provided, and I feel quite certain that had these been weighed after they had been put aboard, they would have found that the limit was well exceeded on account of the generous stock of cigarettes supplied for each man. As a final touch, Captain Irwin presented members of the crew with four-leaf clovers.

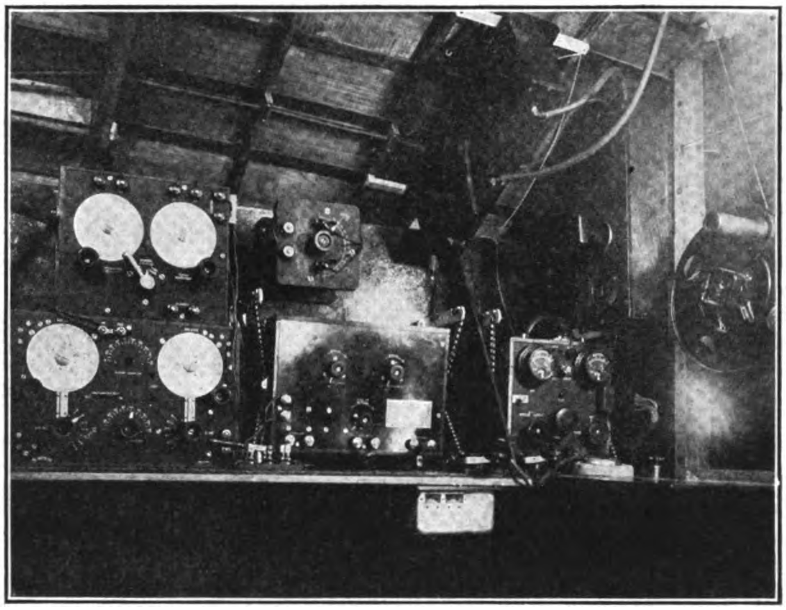
We left Rockaway at 10 in the morning of the 8th of May, my seaplane getting off just after the NC-3 and just before the NC-1. Several other planes accompanied us for a distance of perhaps 25 miles; these were equipped with moving picture cameras and recorded the early stages of the eventful trip.

It did not take me long to get down to business. The immediate result was nearly fatal, for I was ready to jump out of the cockpit with joy when, upon throwing in the field switch and depressing the key, a beautiful spark note greeted my ears through the head phones.

It was a great relief to know that everything was hooked up properly, for I had feared that in the rush, and because of the necessity of working outside of the hangars at night with a poor light, we might have mixed up our power leads. When I adjusted the variometer it showed a radiation of 3 amperes on the skid-fin antenna, and the NC-1 came back immediately, saying that my spark was good. A little personal touch was added then by a good-luck message which came to me through the ether signed by Wise, Jones, Parks and all the rest—radio electricians who had worked to get us in shape.

Twenty-seven minutes after we hopped off, all three of the NC craft had adjusted things and we were in communication with each other. Three minutes later New York and Boston broadcasted that the NC boats had started the trip to Halifax. It was then that I let out my trailing wire.

There seemed to be something doing every minute. Less than three-quarters of an hour after we had started there came a congratulatory and goodluck message from Admiral Coffman, Commandant of the Third Naval District. Within five minutes I received a long message via Rockaway which had come from Admiral Knapp in London, stating that the British Air Ministry had made arrangements to extend every facility and convenience to the NC flying boats at Plymouth when the trans-Atlantic flight had been completed. We were offered the Air Station in the Scilly Islands as a temporary repair or refueling point. I recall that at the time this message seemed a little far fetched, but with it came a feeling of appreciation of the undeniable cordiality of the British and their interest in our success.



The wireless apparatus located in the aft part of the NC-4. To the right may be seen the reel of the trailing antenna, alongside is the variometer; the send-receive switch is attached to side of boat; below that the telephone transmitter and switch for amplifier to be used in conjunction with compass equipment or standard receiver

Fire Island called a few minutes later and wished us good luck. We had then been in the air less than an hour and a half, and I told Rockaway "Everything O. K. 2,000 feet altitude." As I completed this message, I heard Norfolk transmitting on 952 meters, 400 miles distant.

About this time my deep cupped receiving helmet had become uncomfortable and I changed to one which employed ordinary bath sponges, a helmet which had been made at Hampton Roads by Lieutenant-Commander Taylor—one which I had used with great comfort and success during flights totaling several hundred hours. It might be of interest to note here that Commander Read wore the helmet which had been supplied throughout the entire flight, a very creditable performance because pilots have always worn this type of helmet with reluctance, showing a decided preference for the ordinary type which is much lighter.

We passed Montauk after one hour and fifty minutes of flying. It was here that I got a bearing on Philadelphia on the 1,500 meter wave length. It checked up roughly and the signals came in loud on the radio compass. This early indication that the direction finding apparatus was O. K. was very reassuring.

During the next hour I heard the NC-3 working with destroyers No. 1 and No. 2 which lay off Boston and were sending weather reports. New York also asked us to listen for his telephone at 1,200 meters, but it was not audible. Then I heard the operator at Siasconset station asking if we had anything for him. A message from Assistant Secretary of the Navy Roosevelt arrived a minute later.

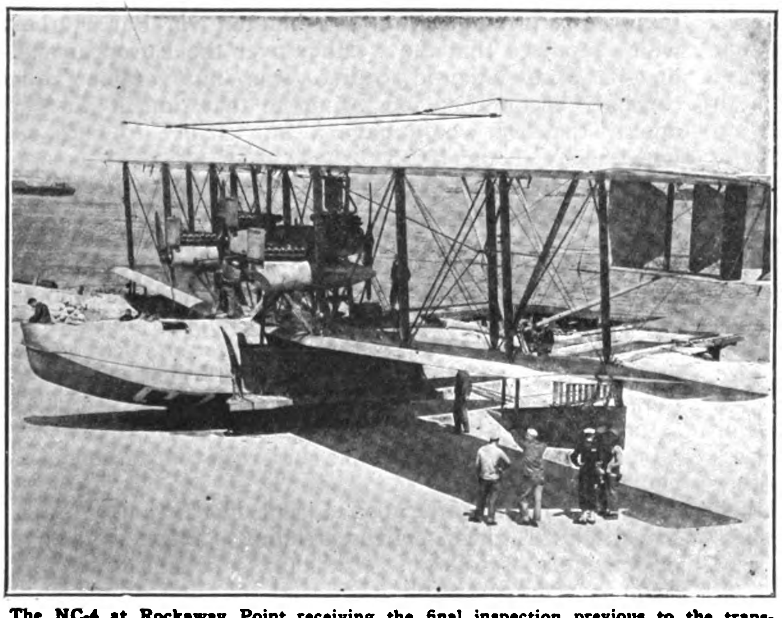
The next use of the apparatus was of a practical order, demonstrating its value in navigation. The 1 o'clock time tick from the high power station at Arlington came in strongly, and I switched on to the Navigator's phones so that he could check his chronometers. Immediately afterward the air station at Chatham requested our position, and relayed a message from the "Baltimore" at Halifax, giving weather conditions at that point. This report contained the disturbing information that an hour earlier the northwest wind had a velocity of 37 miles per hour. As this was an important matter for the information of the Navigator, I immediately sent it forward to him.

When we had been in the air four hours and a half the Navigator instructed me to inform the NC-3, our flag-plane, that we had passed over destroyer No. 1 and that we were now running on three motors. In spite of the loss of part of our propelling power we had been keeping up with the other planes, but for some little time it had been noticed that something which looked like oil was streaming out of one of the center motors. Had it not been for the leak here which drained the oil from the forward center engine, we would have made Halifax all right; but when that motor went dead it immediately became evident that with our loss of altitude, which had been rapid, we would not be able to fly far with only two engines in operation. So both center motors were cut off and we glided for landing.

I tried to send during the glide, but could not get a spark, so the destroyers were not informed that we were coming down. The air screw of the generator was located in the propeller slip stream and it was afterward determined that the generator screw turned only when the center tractor was running, showing that the air speed of the NC-4 did not influence the speed of the generator.

The accident which brought us down was the breaking of a connecting rod in one of the motors. A big piece was knocked out of the crankcase and it is still a matter for wonder that no one was hurt and that the pusher propeller was not injured by the flying bits of aluminum.

Immediately after the landing I was given a message to send in the event that I could raise one of the stations. It gave our latitude and longitude and stated that we would probably not require assistance. I called destroyers No. 1 and No. 2 at Chatham, but they were busy on higher wave lengths and I received no reply. I was not surprised at this, because all continuous wave transmitters tune very sharply on the receiving end, especially on the shorter wave lengths. Still, I thought that within an hour or two sombody would happen on our tune. All night long, whenever I noticed an opening, I sent out SOS signals. We were not in any danger but I figured the ordinary call might not attract attention. I kept up the sending on the buzzer, modulated with radiation varying from .5 to .8 ampere, according to filament input. There was no response.



The NC-4 at Rockaway Point receiving the final inspection previous to the trans-Atlantic flight

During the first five hours of the ensuing "taxi" in the light craft, there was a heavy sea running and it pitched the NC-4 about like a cockle-shell.

While we were on the water Bar Harbor and Cape Sable could be heard very plainly working the NC-1 and the NC-3. Communications from ships 300 miles at sea and the responses from stations at New York and Boston were also heard. The practicability of the radio compass was illustrated in one instance by an inquiry from a ship, supplemented by the statement that she had been without astronomical observations for thirty-six hours; New York replied that her signals were Q R Z, and Montauk could hear her on the radio compass.

Our first "casualty" then occurred, the engineer officer became slightly indisposed, necessitating his turning in. The "corpse" looked very comfortable as it lay stretched out on the grating with life preservers used as matresses.

We were able to make about eight knots running on the two outward motors, and although it would have been possible to shift the air driven generator to an outward strut in the slip stream of the propellers, the situation did not seem to warrant it. We were getting along nicely and in making this change I recognized the possibility of putting a foot through the wings or losing a set overboard.

Up to 10 o'clock that night the destroyers could be heard maintaining almost a continuous run of wireless conversation, inquiring whether the NC-4 had been seen and telling each other what course they were patrolling. Their signals came in so loud that they were heard by the Navigator in the cockpit forward, nearly fifty feet away. He suggested that I take bearings on them and determine which one was the nearest, but even though on the skid-fin antenna they could be heard strongly, the transmission was on 756 and 952 meters and the signals were inaudible on the compass coils. This was due to the fact that the range of the compass panel extended only about 200 meters above and below its wave length of 1,500 meters.

An hour after midnight we sighted a ship and signaled with the Aldis lamp, but received no answer. At another time we were within sight of a destroyer, but the operator was apparently not listening in on short wave lengths, for I signaled long and loud with a telephone set without any response. At two in the morning Siasconset's signals were coming in unusually strong, and for an hour I hailed the shore station continuously but could not get the operator's attention. Nor did anything happen when I called Chatham Air Station, but shortly after five in the morning we made the entrance of the channel at Chatham and it was only then that I heard the station there informing the destroyers that the Coast Guard Station had sighted the NC-4. We had established a long distance "taxying" record, having covered 125 miles in fifteen hours.

The boat from the air station came out to meet us and we reached the dock at Chatham two hours later. There we learned that two airplanes had been searching for us without success, probably because they were not carrying wireless operators.

A hearty reception awaited us at Chatham and the officers' mess turned out a breakfast that would be hard to beat. Having disposed of this welcome meal, we instructed the mechanics on the installation of a new motor and then turned in for a few hours needed sleep.

That evening Captain Eaton drove us to the village. It proved to be the town in which Commander Read had lived when a boy, and he pointed out the house occupied by his father, who had been pastor of the church, and he also recognized the school house which he had attended at the age of nine.

We stayed at Chatham for five days, experiencing a regular old Cape Cod Northeaster, with continuous rain and a wind that blew at the rate of 35 miles per hour. There was little to be done to the wireless equipment; in fact, the only attention required was charging the storage battery. This battery had run the 6-tube amplifier continuously for 22 hours, and the continuous wave set for 2 hours—approximately a discharge of 80 ampere hours—with no signs of deterioration. Visits to the plane and thorough inspections were daily occurrences, however, and everything was kept well covered with balloon fabric to protect it from the driving rain.

Although every assistance and encouragement was given by Lieut. (j. g.) T. A. Hoopes, radio officer at Chatham, I must confess that at the end of the fourth day I would have sold at a bargain price my chances of making a trans-Atlantic flight. NC-4 stock went up, however, when on May 13th we received a favorable weather report, supplemented by the information that the weather between Trepassey and the Azores was not favorable for starting. This relieved our anxiety that the other planes at Trepassey might get good weather and hop off without waiting for us.

The following morning, at ten minutes after 8 o'clock, we made a short flight to inspect the propellers and clear an oil line; during the eight minutes in the air I worked Chatham on the skid-fin antenna and was well satisfied that everything would function properly in the operation of the wireless equipment. At 9:07 a. m. we got away, and fifteen minutes later I heard in my head phones the news of our departure being broadcasted by wireless from Boston. A few minutes later the station at Fire Island called the C-5. This call came as a surprise to me, for though we had heard that the dirigible was contemplating a trip to Newfoundland, this was the first intimation that we had that she had started. Twenty minutes later we had passed over destroyer No. 1 and everything went along quietly for about an hour. Then Chatham inquired how much "gas" we had taken on and informed us that the C-5 had passed over that station at 10:10 a. m. A few minutes later I heard Bar Harbor call and tell me to stand by to receive a rush message from Washington, to be answered immediately and relayed to all parts of the world. It was a long weather report which he sent on 600 meters and afterward shifted to 1,400 meters.

This message was followed a half-hour later by a communication from Assistant Secretary of the Navy Roosevelt reading, "What is your position? All keenly interested in your progress. Good luck." In the short space of two minutes the following reply had been sent: "Thank you for good wishes. NC-4 is 20 miles southwest of Seal Island, making 85 miles per hour. Read"

Immediately afterward Chatham asked by wireless for a report for Commander Whiting, giving our total loading, amount of gasoline we were carrying and other details. Hardly had this communication been finished when Bar Harbor radioed a complimentary service message; it read: "Took three minutes for Roosevelt to send despatch to NC-4 and receive your reply. This beats all known records."

The next communication came about twenty minutes later; it was a weather report from Cape Sable. The operator at that station then told me informally by wireless that we looked fine as we flew over. I replied that his station had looked so good to me that I had taken a snap-shop of it, a detail apparently of great interest to him for he immediately requested me to mail him a print of the photograph if it was good. Unfortunately I had only an ordinary vest pocket Kodak with a lense not sufficiently fast, and the picture was a failure. Not knowing the operator's name, I take this opportunity of informing him of the reason why the souvenir has not arrived.

Shortly after noon I started working the Cruiser Baltimore at Halifax, telling them that we would land there for a few minutes, for at that time we expected to keep on to Trepassey. Within a half-hour we had flown over station No. 4 and received his position by wireless. The air then became very "bumpy" and as we were going into Halifax it became very difficult to remain sitting on the small stool with which I was provided; it was almost impossible to send decently. I had managed, however, to tell Bar Harbor that we would land soon and I must say that operator "DN" at that station was certainly a good man on the key; it was a pleasure to work fast with him.

We landed at Halifax without incident, having accomplished the run from Chatham in four hours. For this reason the storage battery still read high, but I observed the precaution of having it charged in the engine room of the "Baltimore." Our intention to remain at Halifax only a few minutes was set aside by the necessity for changing propellers. The type which had been used thus far on the trip was a new one, and the air screws already showed signs of weakening, so it was decided to make a change and to delay the flight to Trepassey until the next morning.

We made an auspicious start for Trepassey at eight minutes to 9 on the following morning, but lack of oil pressure in the center tractor motor forced a landing a half-hour later. It was then that I established communication with the "Baltimore" and the Camperdown station with the small battery set. This apparatus had failed to reach anybody at Chatham, but without any changes whatever in adjustment, it worked these stations very well at a distance which the Navigator told me was 18 miles. Camperdown station, however, could not hear the continuous wave telephone, probably because he had a non-oscillating circuit receiver.

After we had remained on the water for several hours I copied a message from Washington via Bar Harbor which reported that the weather over the European end of the trans-Atlantic course was unfavorable; this certainly encouraged us, for up to that time it did not appear that we would have a fair chance to take off with the NC-1 and NC-3.

We left the water at Story Head at 11:47 a. m., and for something over an hour Baltimore filled the air with message traffic with the station at Bar Harbor. When we were passing Cape Canso, about an hour and a half after our departure from Story Head, the "Baltimore" inquired our position, which I gave him. Immediately, the Canadian stations began to send out broadcasts, requesting all ships to restrict the use of their radio, and each in turn wishing the NC-4 the best of luck. Compass signals followed from destroyers No. 1, No. 2, No. 3 and No. 4, which were all audible and received without difficulty.

At two in the afternoon I sent instructions to destroyer No. 1, the Stephens, reading: "Request change in procedure as follows. As soon as seaplane is sighted, steam on course at full speed and continue course until next destroyer or station reports plane passing." Had this arrangement been in effect at Chatham, it would have solved our difficulties, for back there we had landed just between two ships.

A few minutes later I asked destroyer No. 3, the Robinson, for a weather report and received it in six minutes. Within a half-hour the same message had been sent to destroyer No. 2 and his reply was also received in six minutes.

It was ten minutes to 3 o'clock when we flew over destroyer No. 1 and at that time I was working with the Baltimore at Halifax. Captains Simpson and Lee both sent messages to Commander Read, who replied that he hoped that he had not kept them waiting too long. Immediately the response came back they were not the least bit tired.

At 3:25 in the afternoon we passed over destroyer No. 2, and twenty minutes later had left No. 3 behind. It was about this time that I saw my first iceberg. From a distance the bergs looked like sailing ships, an impression which was also held by Lieutenant Hinton until we had quickly covered the distance to them. I find in my radio log the entry "temperature getting low"—an observation which was made as we passed over the ice floes.

The multiplicity of interesting occurrences during this flight was again emphasized within an hour, when I copied the following message "Navy dirigible C-5 broke adrift from mooring at Pleasantville. Rip cord broke. No one on board. No casualties. Edwards proceeding in a northeasterly direction. Ten persons with instructions to attempt bring down with anti-aircraft fire." It was just about this time the pilots sighted her, but the fact was not communicated to me, so no report was sent by radio.

At 5 o'clock in the afternoon I intercepted a message which was a bit of a shock. We had just passed station No. 4 when I heard No. 3 on the Azores leg tell No. 8 that she could not arrive at the station until 1 a. m., that she was taking No. 3 position. This was our first intimation that the other planes were about to start on the overseas flight.

Ten minutes later our motive power again came into prominence and I sent a message to Commander Towers of the NC-3 at Trepassey requesting that arrangements be made to change our forward center motor. This engine was the one which was installed at Chatham and was of a low compression type. It was just as powerful as the high compression motor which we now asked for, but it was slightly less economical in fuel consumption, and a change seemed advisable.

Within half an hour we made our landing at Trepassey Bay. As we approached the harbor the Aroostook sent me a wireless message to be on the lookout for the NC-1 and NC-3 as we came in. As we had surmised, they had made their start overseas! But our great disappointment was somewhat mitigated when we sighted them, for we then saw that their noses were turned back to Trepassey.

As we glided down to the water with the center motor running I sent a message on the skid-fin antenna, punctuated by the mental hope that the mechanics would be ready and able to give us quick service so that the NC-4 would be ready to start for the Azores with the others.

Good service was forthcoming.

We landed at 5:39 in the afternoon. Immediately mechanics clambered aboard and worked like demons all through the night.

Little was needed in the way of attention to the wireless equipment. The battery was charged aboard the Aroostook, new brushes were put in the spark transmitter, and for rubber gaskets under the cover which had pulled out rubber tape was substituted. There was nothing else required but the elimination of many spare parts which we were carrying and wiping up the apparatus with 3-in-1 oil. Every pound of superfluous weight was removed; bulkhead doors were taken off, and we dispensed with heavy tools and an extra fresh water tank, for favorable weather reports over the entire course were received the following morning, and the start that night became certain.

At 6 in the evening of May 15th we left the water at Trepassey, making a landing a few minutes later to wait for the NC-3. The flag-plane came along within ten minutes took off on the great hop across the Atlantic.

The Aroostook was immediately heard broadcasting the time of our departure and requesting that it be passed down the line to all the destroyers.

(*To be continued*)

Wireless as an Aid to Aerial Navigation

By Roy A. Weagant

Chief Engineer, Marconi Wireless Telegraph Co. of America

ONE question which has been developed by the remarkable trans-Atlantic flights by aircraft is the great advantages to be secured by utilizing wireless equipment for purposes of air navigation. It is reported that Captain Alcock and Lieutenant Brown employed astronomical observation for obtaining bearings, but I think the flight itself illustrates how unwise it is to depend upon this means of navigating aircraft. It is reported that for hours the moon or stars could not be seen, owing to the dense fog and drizzle. Similar handicaps must be regularly expected, and it is therefore obvious that any consideration of the possibilities of cross-ocean flight on a commercial scale must make provision for navigating instruments that function without visual aid.

There are wireless instruments now available which provide for taking bearings under any weather conditions, and for their universal application it merely remains for the radio and aircraft engineers to get together and work out the details of design within the weight and space limitations imposed by heavier-than-air craft. The layman hardly appreciates that present day airplane wireless equipment was developed under pressure of a supreme emergency and that the apparatus has been adapted to the aircraft which existed, whereas under normal development airplane designers would have made provision for taking care of the wireless equipment features. We can expect normal development now, and there can be no question that under proper supervision air navigation will be greatly simplified and made exact by utilizing wireless aid.

The particular apparatus which makes this possible is the Bellini-Tosi directive system, otherwise known as the goniometer, direction finder or radio compass. The operation of this device is very simple. It comprises essentially two coils fixed at right angles and another coil which is rotated within the fixed coils. This exploring coil is connected to the wireless receiver and is moved through the arc of a graduated scale; when the signals are heard strongest in the operator's head telephone, the movable pointer indicates the direction of the incoming signal. The geographical direction is then secured by a glance at the compass. It may readily be seen, therefore, that if signals can be heard from two wireless stations offering a wide angle, say, Clifden, Ireland, and Lyons, France, the aircraft operator flying across the ocean has merely to make a simple triangulation to get his exact bearings.

The densest fog is no obstacle to the receipt of these wireless signals and it remains but to equip aircraft with long distance receiving apparatus to take full advantage of the aid of wireless in trans-ocean navigation.

In the two epochal airplane flights made thus far there has been no opportunity to determine the full value of the directive system of wireless. The American NC flying boats employed the device, but only with short range receivers, as the flight commanders expected to remain within easy receiving distance of the line of destroyers. Had long range receivers been installed the craft would not have had to depend upon these ships for bearings. The same is true of the Vimy airplane, and it will be interesting from a scientific point of view to compare results when in some future flight full advantage is taken of the obvious value of the long distance receiving apparatus.

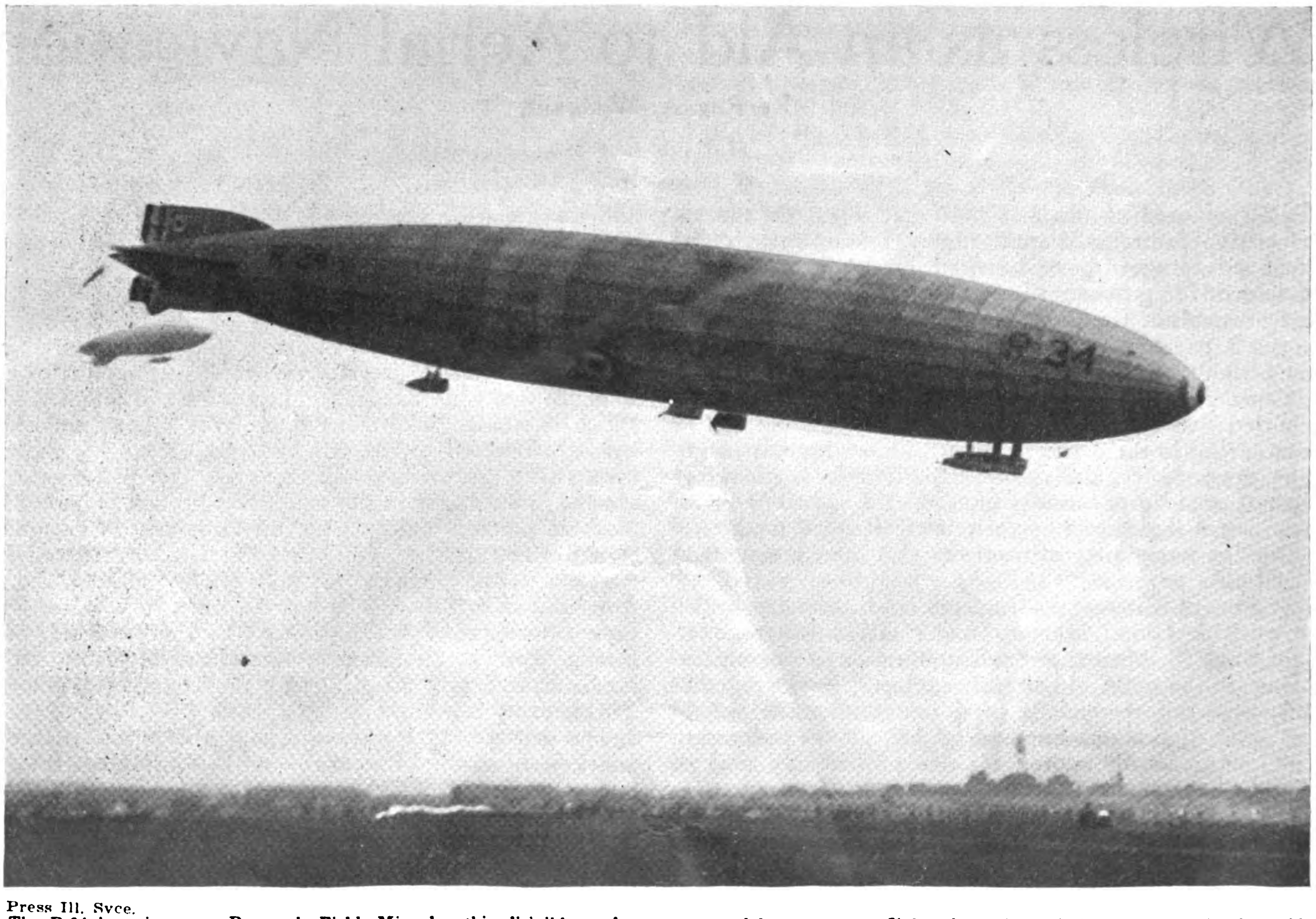
In the speculation regarding the eventual establishment of regular ocean crossings by airplane, account should be taken of the entire feasibility of setting up a wireless path or lane which will enable aircraft to remain on a course in weather when astronomical observation is impossible. To maintain such a path would require merely that three high power wireless stations transmit signals regularly at frequent intervals and that a wide angle be afforded by their geographical position; thus one station in America, one in Europe and one in Africa would be sufficient to guide aircraft on their courses both ways across the Atlantic. Maintenance of these wireless stations for that exclusive purpose would perhaps be prohibited by the expense, but in the not far distant day when trans-Atlantic aircraft will be making daily flights across the sea, the expense, equitably distributed among the air transportation companies, would be negligible. Up to that point, however, it is reasonable to suppose that arrangements could be made so that the three wireless stations could suspend other message traffic operations on the "sailing" days and maintain their paths of signals during the hours when the flying crafts are crossing the ocean.

It may be well to point out also that we have just begun to employ wireless transmitting apparatus on airplanes. In the course of normal development it is to be expected very soon that wireless telephone conversations will be held between aircraft and ships at sea. It then becomes a simple matter for the aviator lost in a fog to get the latitude and longitude from two vessels, determine their direction by the Bellini-Tosi system and know almost instantly his exact position. Another step which is certain of accomplishment is the utilization of wireless as a means of summoning aid if the aircraft is forced to descend on the water. The wind-driven generator which is now in universal use on airplanes does not function unless the craft is in full flight. A generator driven from the airplane engine is therefore essential so that wireless transmission may be effected when the craft is resting on the water. The design of a satisfactory engine drive and provision for charging storage batteries for use when the motor is not running presents no engineering difficulties. This problem, and several others which are not yet worked out to the full satisfaction of radio engineers, are comparatively minor matters when it is considered that in less than a year airplane wireless apparatus has been developed which has a sending range of 600 miles and ability to receive 1,400 miles. It but remains for wireless equipment to be recognized as indispensable for aircraft as it is for ships, a matter which will be appreciated by aviators when they have had the opportunity of properly employing it as an invaluable navigating means as well as a method of summoning assistance.

Wireless Direction Finder the Secret of Alcock's Success

HOW did Captain Alcock navigate his airplane across the Atlantic Ocean through more than a thousand miles of fog and sleet so successfully? How was his navigator, Lieutenant Brown, able to steer the machine to the exact point in Ireland that the two airmen had announced as the terminus of their flight?

"There is not one chance in a million of being able to reach the destination with such accuracy by the ordinary instruments of navigation," says Grover C. Loening,



Press Ill. Svce.
The R-34 hovering over Roosevelt Field, Mineola; this dirigible made two successful cross-ocean flights by using wireless as a navigating aid.

monoplane manufacturer. "Under the weather conditions experienced by Captain Alcock the airplane should have been miles out of its course.

"His story of the flight shows that winds were experienced first from the northwest and then from the southwest. With the fog and sleet that prevailed it was impossible for the navigator even to estimate the drift caused by these winds. His ordinary means of navigation were useless."

Reliable reports state that the apparatus installed on the Vickers biplane was built into the wings of the machine. It was absolutely independent of the other wireless apparatus.

The direction-finding coils were built into the wings, so that when the machine was pointed toward any wireless station signals would be received from that station. Should the machine veer to the right or left signals would immediately cease recording on the receiving apparatus.

So simple in operation is this apparatus that it is also unnecessary for the pilot to understand the signals being sent out. As long as he hears the signals in his telephone headgear he knows he is heading directly toward the wireless station chosen.

This, it is said, is exactly what occurred in the Vickers-Vimy bomber's flight across the Atlantic. The Clifden wireless station is the largest in Ireland, and is in constant communication with Glace Bay, in Canada. The Vickers crew throughout their voyage were able to hear this station, and thereby keep their machine directed toward it, and so overcome the effect of the side drift caused by the winds. This would explain why the machine finished its remarkable voyage right over the tremendous aerials of the Clifden station.

The Radio Compass and the NC Flights

THE NC-1 went to the bottom of the Atlantic and the NC-3 was forced to plunge into the sea during the historic flight from Trepassey Bay, Newfoundland, to Ponta Delgada in the Azores because the radio compasses on the two planes failed to record messages sent from a greater distance than ten miles, and not because they were forced down by storm and fog.

This statement was made by Commander John H. Towers.

Commander Towers's remark concerning the failure of the radio compass, or direction finder—something new to aerial navigation—was the result of a statement made by Commander Read, who had been asked how he happened to reach the Island of Flores under the same atmospheric conditions experienced by the pilots of the other planes.

"I call it just good luck," he said. "I got through the fog bank and caught one glimpse of land. Of course, I knew what the land was and headed for it. I never have been able to understand why the others had worse weather. One was to the north of me and the other to the south of me. Reports received by wireless indicated that the fog was less dense to the south. I was in the centre of the sandwich, so to speak."

"That is perfectly true," said Commander Towers in discussing this point. "Both Read and I were south of the course, which lay between the Islands of Corvo and Flores. When I was off Flores I too got one flash of the sun and made an observation, but I didn't trust it. Later, I wished I had as it would have saved us fifty-six hours in the water.

"It was about that time that the engineer informed me we had but two hours of gasoline and I decided to descend to the sea."

"Then you were not forced down by the storm or fog?" he was asked.

"Not at all," replied the commander after a slight pause. "The plane—all of them, in fact—could have withstood the storm and fog nicely. We came down because we didn't know where we were, and could not afford to take chances with so limited a supply of gas."

"But you were supposed to know by means of your radio compass."

The commander paused for a considerable time.

"I'll be perfectly frank with you," he said finally. "That was the whole trouble—not the fog and unexpected storm. But I want to say right here that the most valuable result of the flight, scientifically speaking, was the demonstration that the radio compass is most remarkable. It will make air travel over the ocean feasible.

"The difficulty did not lay in the fact that the compass

An unconventional portrait of the unfortunate Commander Grieve, in the safety suit which he wore when rescued. It will be recalled that, after being saved with Hawker, he remarked: "The future of navigation of the air undoubtedly lies with directional wireless"

was imperfect, but in the fact that under the system of installation on the planes it was confined to a radius of ten miles. With proper installation it would have recorded signals sent from a distance of 150 miles. We knew the limitations before we got to Halifax. We also were aware that it would require at least a week to make the necessary changes.

"We discussed the matter and decided that in view of the favorable weather reports we were not taking much of a chance in starting with the inefficient radio compass.

"So we started, ran into a storm, and two of us had to come down for the reasons I have given. If we had known just where we were we would have kept right on as we had gas enough for the trip. It was the compass alone which caused two of the three boats to fail."

"There is one impression I wish you would correct," he said. "Our wireless did not give out. We continually sent messages asking for aid after we had come down onto the water, but the ships and shore stations were so industrious asking our position that they couldn't hear us. We couldn't get a word in edgewise."

Getting back to the radio compass, the commander wanted to make it very plain that he advocates it strongly. He repeatedly said it was the greatest discovery yet made in aerial navigation, and as often asserted that with proper installation his would have met all requirements.

Inductively Coupled Transmitter for Extremely Short Wave Lengths

IT appears that a considerable amount of research work on extremely short wave transmitters has been carried on abroad. Many problems are encountered in the design of such sending sets. This will be evident from the following brief review.

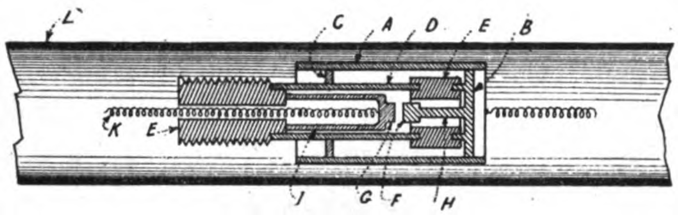


Figure 1.—Longitudinal section of the short wave inductively coupled transmitter

In the well-known Marconi type of coupled circuit transmitters, the primary circuit comprises three elements, (1) a condenser (2) an inductance, and (3) a spark gap. The energy which can be supplied per discharge to such a primary circuit depends upon the capacity of the condenser and the potential to which it can be charged, and therefore to obtain the maximum energy capacity the condenser should be of the greatest capacity possible.

The decrement of the circuit is proportional to the ratio of the high frequency resistance to the inductance. The losses due to the high frequency resistance are (a) losses at the spark gap, (b) losses in the condenser, and (c) losses in the conductors, a large portion of which is caused by eddy currents due to unequal distribution of the magnetic flux in the conductors. Practically these losses cannot be entirely prevented, but they can be greatly reduced by employing special forms of spark gap, air condensers, and a large amount of stranded copper in the conductors.

In order to make the decrement of the circuit sufficiently small, it is essential that the inductance be not too much reduced, and this necessitates that for any particular frequency the condenser shall have more than a certain capacity. For the frequencies usually employed in wireless telegraphy—1,000,000 down to 20,000—it is not difficult to arrange the elements of the primary circuit so as to insure sufficient energy capacity with small de-

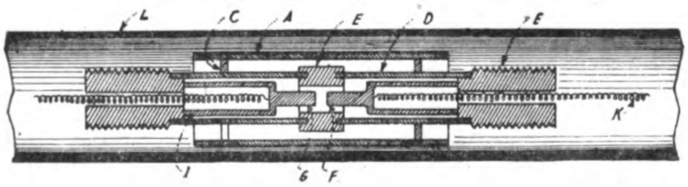


Figure 2.—Modified form, still having the three elements arranged symmetrically about a common axis

crement, but for frequencies of the order of 100,000,000—three meter wave length—it becomes very difficult to arrange the elements so as to insure a similar result. C. S. Franklin of London has devised a special transmitter in which each of the three elements of such a circuit is arranged symmetrically about a common axis.

Figure 1 is a longitudinal section through the common axis while figures 2 and 3 are similar views of modified forms.

In figure 1, A is a metal cylinder, one end of which is closed by a metal disc B, while the other end is closed by a metal ring C and a co-axial cylinder D mounted between insulating blocks E. The ring C can be slid within the cylinder A for tuning purposes. The cylinder D is filled with gas under pressure. F, G, are the spark electrodes, F being carried on a rod H secured to the center of the disc B, and G being carried by a third cylinder I. K, K, are choking coils through which the condenser formed of the cylinders D, I is charged. The circuit comprises the condenser formed of the cylinders D, I, the spark gap, rod H, disc B, cylinder A and the ring C. The antenna consists of one or more rods L arranged parallel to the common axis of the cylinders and close to the outer surface of the cylinder A, the closeness of the coupling depending upon the proximity of these rods to the cylinder.

In the modification shown in figure 2, there are two cylinders D, D, insulated from each other by blocks E, two rings C, C and two cylinders I, I. The oscillating

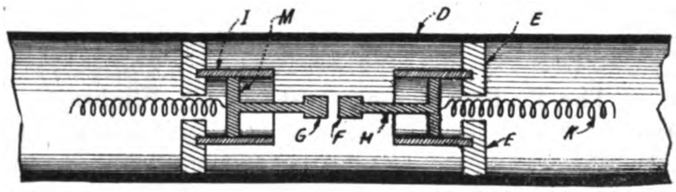


Figure 3.—The simplest construction and the most suitable for short waves

circuit here comprises the two condensers formed of the cylinders I, D, the spark gap, the rings C, C and the cylinder A.

In figure 3, which shows the simplest construction and that most suitable for very short waves, there are a cylinder D, and two cylinders I, in each of which there is a disc M supporting a rod H carrying an electrode, the three cylinders being of course, mounted on a common axis while the cylinder D, acts not only as one plate of the condenser, but also as the antenna.

The high frequency circuit can be traced in each of the three arrangements as follows: In figure 1, it runs from the spark terminal F through the rod H to the disc B, through the coupling cylinder A, to the disc C, to the cylinder D, by condenser action to the cylinder I, to the spark terminal G.

In figure 2, it runs from the spark terminal F, to cylinder I, by condenser action to cylinder D, to the disc C, to the coupling cylinder A, to the second disc C, to the second cylinder D, by condenser action to the second cylinder I, to the spark terminal G.

In figure 3, it runs from the spark terminal F through the rod H to the right disc M, to the right hand cylinder I, by condenser action to the coupling cylinder D, by condenser action from cylinder D to left hand cylinder I, to the disc M and through the left hand rod H to the spark terminal G.

It will be seen that the high frequency oscillations do not pass through any coils at all, the only inductance in the high frequency circuits being that of straight rods and cylinders, and it will be seen that all the parts enumerated are all coaxial with the spark gap.

Artom's Visual Receiver for Directive Wireless Telegraphy

THE detecting device in Artom's system is built somewhat in the form of a d'Arsonval galvanometer. The movable coil is traversed by rectified high frequency currents fed by directive aerials. The coils are disposed vertically and are free to turn around a vertical axis; their angular disposition is similar to that of the vertical planes containing the directive aerials. The coils are disposed as shown in figure 1, one beneath the other; they are rigidly connected and pivoted, or suspended in any other suitable manner.

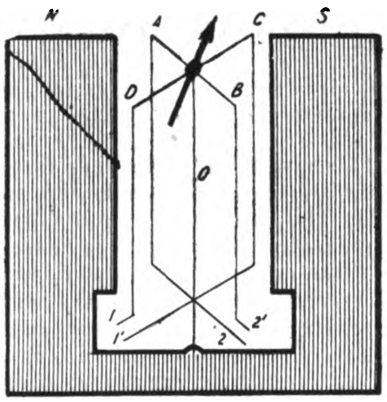


Figure 1

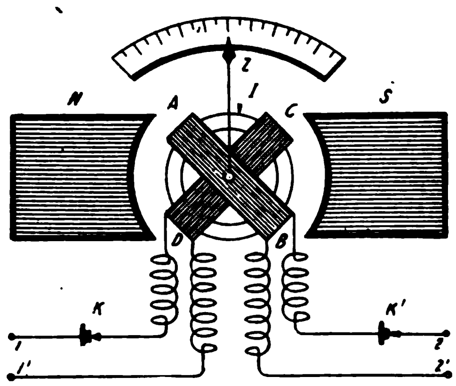


Figure 2

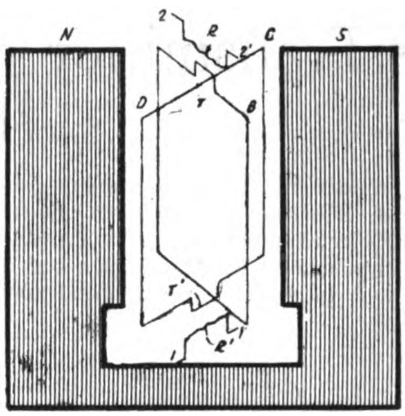


Figure 4

Figures 1 and 2 show the disposition of the meter coils. Figure 4 is a diagram of the thermo-couples

The oscillatory currents induced in the aerial conductors, before traversing the coils flow through the syntonized circuits comprising a detector which may be either of the crystal or of the electrolytic or ionized gas type, or of the magnetic, thermal, or thermo-electric type. They are transformed from oscillatory to rectified currents or to currents having the preponderance of current in one direction.

The coils may be arranged in circuits provided with thermo-couples operated by heaters in the oscillatory circuits, in which case the thermo-couples act as in Boys's micro-radiometer. The coils may be of thin wire like galvanometer coils or may be made with a thicker wire, like ammeter coils. When the rectified currents traverse the coils, magnetic forces are produced by the action of the magnetic field, which cause the movable system formed by the coils to be deflected and such deflection can be shown either by an index or a scale mirror.

The tangent of the angle of deflection depends upon the ratio of the values of the currents traversing the coils, these values being proportional to the currents in the aerial conductors of the receiving station. The deflection depends upon the direction from which the radiating waves arrive. A graduation made once for all shows exactly the direction from which the electric waves arrive, provided the quadrant from which they are transmitted is known.

Figure 1 and figure 2 of the accompanying drawing show diagrammatically the disposition of the galvanometer coils. Figure 3 is a diagrammatic view of the circuit connections of a modified form of the system. Figure 4 is a diagrammatic view illustrating the use of thermo-couples. Here NS is the magnet or electro magnet. AB and CD are the coils which are rigidly connected to each other and which are revoluble on the central axis O. An index Z is attached to the coils. A stationary soft iron cylinder I is disposed in the fields so as to reinforce the action of the magnetic field of the rotating coils.

The detectors or rectifiers of the electric waves are shown by K and K'. The terminals 1, 1' and 2, 2' connect the instrument with the directive aerials X and Y.

The constructive forms which the invention may assume in practice are numerous and they vary according to the type of the detector or rectifier of electric waves which are used. The following are the three preferred forms:

(1) In the circuit's movable coils AB and CD two thermo-couples are inserted. Two resistances of manganin or of any other suitable material are traversed by the oscillatory currents coming from the directive aerials. The thermo-couples produce in the coils AB and CD rectified currents which cause the coils to take up a definite position in the stationary magnetic field.

(2) When tubular detectors or rectifiers of the ionized

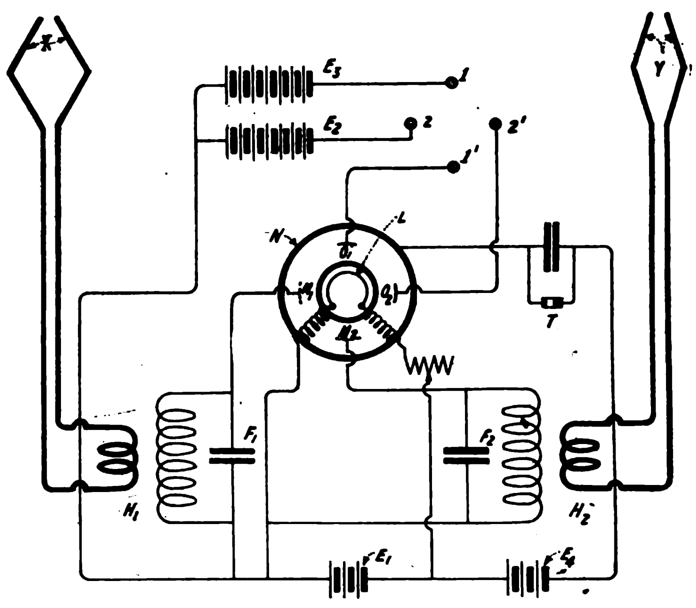


Figure 3.—A horizontal section of the tube and the circuit connections

gas type are used, one of the tubes may be provided for each directive aerial. In order to indicate with the greatest accuracy the direction from which the electric waves arrive, the particular form of tube for ionized gas shown in figure 3 can be used with good results. The figure shows a horizontal section of the tube and the circuit connections.

The incandescent filament L is placed in the central part of a glass tube having a spherical or cylindrical form, provided at the periphery with the cylindrical plate N for the reception of the telephonic signals. M^1 M^2 are metallic grids: O^1 O^2 are metallic plates connected respectively to the leads of 1' and 2'. The latter are connected to the galvanometer coils as shown in figure 2.

The position of the grids M^1 M^2 relatively to the plates O^1 O^2 and to the filament is not necessarily that shown in the drawing but may be changed to other positions. The battery E^1 is a source of energy for the filament L, the batteries E^2 and E^3 energize the space between the incandescent filament and the conducting plates O^1, O^2, E^4 transmit current across the ionized space between the filament and the cylindrical plate N to energize the circuit of the telephone T. F^1, F^2 are capacities inserted in the oscillatory receiving circuit of which H^1 and H^2 represent the oscillation transformers, that is to say, the primary coils of the transformers H^1 and H^2 are connected at xx-yy to the directive aerials.

(3) When a detector of the electrolytic type is used, a single vessel containing acidulated water or other suitable liquid may be employed wherein the electrodes for both or all the detectors are immersed.

In figure 4, there is shown diagrammatically the arrangement of the thermo-couples. In this figure NS is the magnet, AB and CD are the galvanometer coils, T and T' are the thermo-couples and R R' are thin strips of gold leaf or manganin which are connected with the directive aerials and act as heater elements.

A Transmitter Designed to Radiate Waves of Low Decrement

TO render the receiving apparatus of a radio system most effective, the impulses impressed upon the receiving circuit should occur at the rate of approximately 1000 impulses per second, which corresponds to the frequency or pitch of a tone of good audibility. To insure

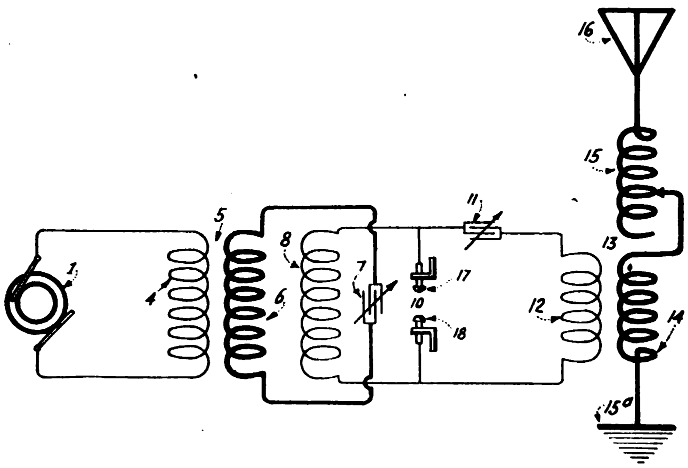


Figure 1.—Diagram of transmitter for generating slightly damped waves

uniformity in the production of the tone in the receiving circuit and also the production of a note having a constant pitch, these impulses should be produced at regular as well as frequent, intervals. Moreover, the loudness of the tone produced in the receiving circuit depends upon the amplitudes of the impinging wave trains. This last property is secured over long distances by generating wave trains at the sending station that are only slightly damped or possess a low decrement. It is apparent, therefore, that the wave trains originating in the sending station should be produced at regular intervals and with suitable frequency, as well as with high initial amplitudes, in order to radiate from the antenna a series of wave trains that may be projected over wide spaces and be instrumental in producing in the receiving apparatus audible notes of constant pitch or uniformity.

C. L. G. Fortescue claims that the transmitter shown in the accompanying drawings generates waves that are only slightly damped. At the same time, the wave trains projected into space may be produced at a high rate and uniform frequency in order to insure the production of a uniformly pitched and audible note in a distant receiving station.

In figure 1, a source 1 of alternating current is connected by conductors 2 and 3, to a primary winding 4 of a transformer 5. One secondary winding 6 of the transformer is connected in a closed circuit with an adjustable condenser 7. The windings 4 and 6 of the transformer are magnetically linked closely with each other. The capacity of the condenser 7 is so chosen that its effect in the circuit comprising the primary winding 4, will under certain circumstances, completely compensate for the inductive reactive drop in the circuit when subjected to the flow of alternating currents having the frequency of those generated by the source 1. In other words, the circuit comprising the primary winding 4 may operate, in certain instances, at unity power-factor since the condenser 7 will completely compensate for the inductive reactance created therein.

A secondary winding 8 of the transformer energizes the high frequency oscillating circuit 9, which comprises a spark gap 10, an adjustable condenser 11 and a primary winding 12, of an oscillation transformer 13. A secondary winding 14 of the oscillation transformer has one of its

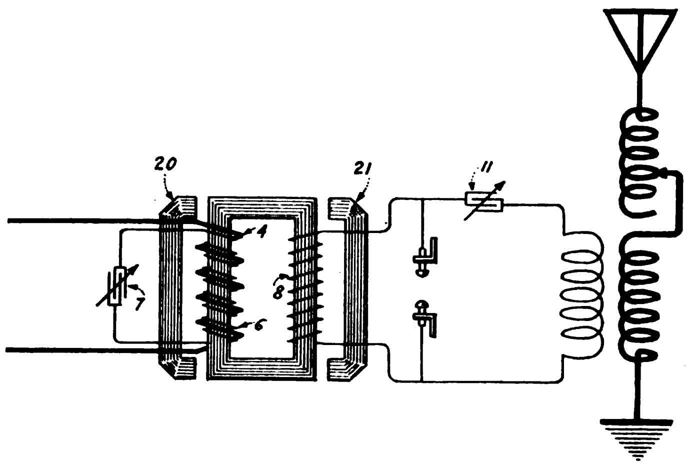


Figure 2.—The structure for obtaining the desired relations of the transformer windings

terminals grounded at 15 and the other connected, through an adjustable inductance 15, to the antenna or electrical wave radiator 16. The windings 8 and 4 of the transformer 5 are magnetically linked loosely with each other and, therefore, a leakage flux will obtain between the primary or inducing winding 4 and the secondary winding, under certain operating conditions.

Again, if proper quenching of the sparks generated by the oscillation producer 10 is effected, the oscillations in the circuit comprising the primary winding 12 will discontinue after a very short time interval. The secondary circuit, therefore, will continue to oscillate at its natural frequency and with its natural damping just as if the primary circuit did not exist.

The capacity of the condenser 11 is so chosen that the circuit comprising the secondary winding 8 and the primary winding 12 of the oscillation transformer is in resonance with the circuit comprising the primary winding 4 of the transformer 5, when the oscillation producer 10 is inactive. In other words, series resonance conditions are established between these two circuits, since the condenser 11 inserts a condensive reactance that resonates with the inductive reactance inserted by reason of the leakage flux obtaining between the windings 4 and 8.

The condenser 7, by reason of its association with the winding 6, compensates for the inductance obtaining in the circuit of the primary winding 4 only when the spark gap 10 is active. As a result, the maximum flux threading through the primary winding 4 occurs with the maximum voltage or the peak of the alternating current wave generated by the alternator 1, when the condenser 11 is rapidly charging and discharging through the gap 10.

When the voltage in the secondary winding 8 is sufficient to break down the spark gap 10, the condenser 11 will discharge through the gap, thereby generating high frequency oscillations in the oscillating circuit 9. Simultaneously therewith, the secondary winding 8 will be short circuited by the gap. At the same time the circuit comprising the primary winding 4 will operate at unity power factor by reason of the action of the condenser 7. The value of the flux generated by the primary 4 is, therefore, independent of the conditions obtaining in the high frequency oscillating circuit 9.

When these conditions exist, the voltage induced in the secondary winding 8 is likewise coincident in time with the magnetic flux generated by the primary winding 4, because the circuit comprising the short circuited secondary winding 8 is in resonance with the circuit comprising the primary winding 4. In other words, this combination of circuits is tuned to the frequency of the source of supply 1.

In figure 2, there is shown diagrammatically, a structure for obtaining the desired relations between the windings 4, 6 and 8 of the transformer 5 of figure 1. It will be noted that the primary winding 4 is disposed on the same core leg as the secondary winding 6. The windings 4 and 6 are, therefore, closely linked magnetically with each other. The secondary winding 8 is disposed on a second core leg. Magnetic shunts 20 and 21 provide means for increasing or varying the magnetic leakage between the primary winding 4 and the secondary winding 8. By properly positioning the magnetic shunts 20 and 21, series resonance may be established between the winding 4 and the winding 8 in combination with the condenser reactance element 11.

Methods of Signaling with Arc Transmitters

SIGNALING with arc transmitters has heretofore usually been effected by varying the wave length of the radiated wave. This has been done by short circuiting a portion of the inductance, but in high powered stations the current in the short circuit is large, which makes it a difficult problem. Leonard Fuller has recently shown another method in which there is provided an oscillatory circuit, figure 1, containing an inductance 9 and a capacity 12 and an energy consuming reactance which is controllable to vary the losses occurring therein. This circuit is shunted around the source of oscillations or arc 2.

When an arc is shunted by two dissimilar oscillatory circuits, it will oscillate upon one circuit or the other, but will not oscillate upon both at the same time. It will in fact oscillate upon the circuit most agreeable to arc conditions, to the total neglect of the other. By varying the reactance of the shunt circuit, this circuit is chosen or neglected by the oscillations, and consequently the radiating circuit is either neglected or chosen according to the manipulations of the key.

The energy consuming element comprises a core 14 formed of stiff iron laminations, which are chosen to provide a large hysteresis loss, especially at high frequencies. A coil 15, forming part of the shunt oscillatory circuit, is wound on a portion of the core. The current in the coil produces a flux in the core, which causes a loss of energy due to hysteresis. By reducing the hysteresis the losses are reduced, so that the oscillations will prefer the shunt circuit to the neglect of the radiating circuit. This loss may be reduced by subjecting the iron core to a M.M.F. produced by a direct current coil 16, which is wound on a portion of the core and arranged in circuit with the battery 17. A key 18 arranged in the battery circuit provides means for opening and closing such a circuit.

Choke coils 19 are preferably arranged between the battery and the coil 16 to prevent the high frequency current generated in the coil from passing into the battery. Other means to accomplish this result may also be used. The size of the coil and battery are preferably such that when the key is closed, the core is saturated, thereby reducing the hysteresis and hence the losses in the shunt circuit. Due to the losses, the core becomes

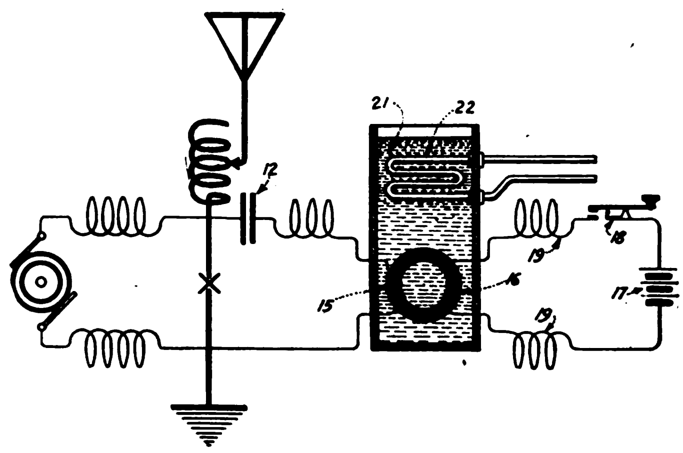
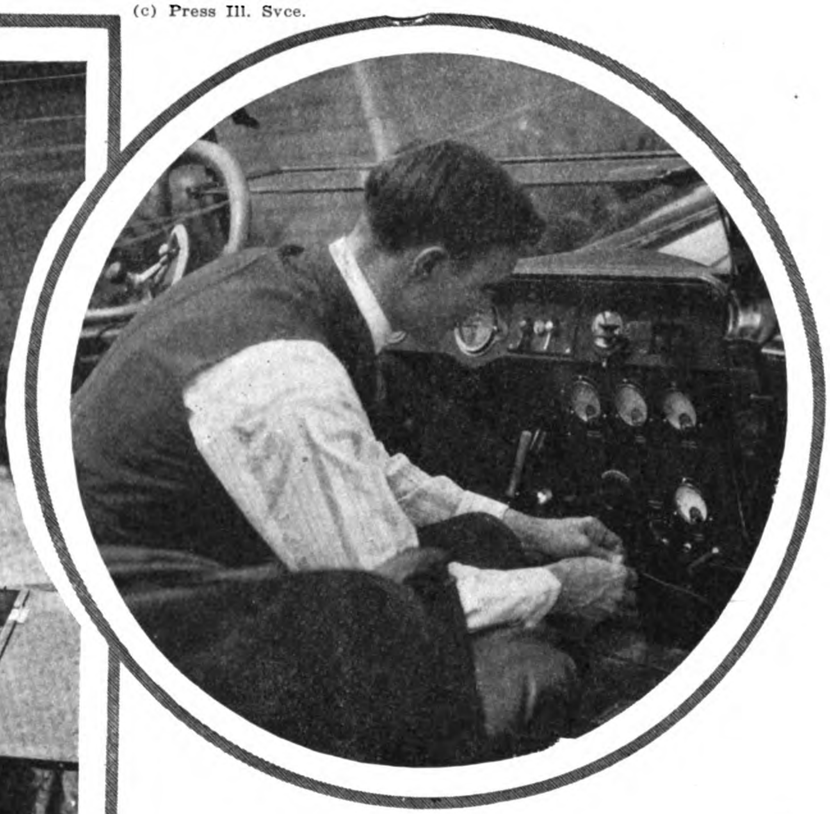


Figure 1.—An oscillating circuit containing an inductance, a capacity and a reactance shunted around the arc; used in Fuller's method of signaling with arc transmitters

heated and in order to dissipate the heat, the core is immersed in an oil bath 21 through which pipes 22 carrying cooling water pass.

Signaling is accomplished by opening and closing the key 18; closing the D.C. circuit serves to reduce the hysteresis and hence the losses in the shunt circuit, thereby causing the arc to oscillate upon that circuit to the neglect of the radiating circuit and opening the D.C. circuit, causing an increase in the losses in the shunt circuit and thereby causing the arc to oscillate in the radiating circuit.

(c) Press Ill. Svce.

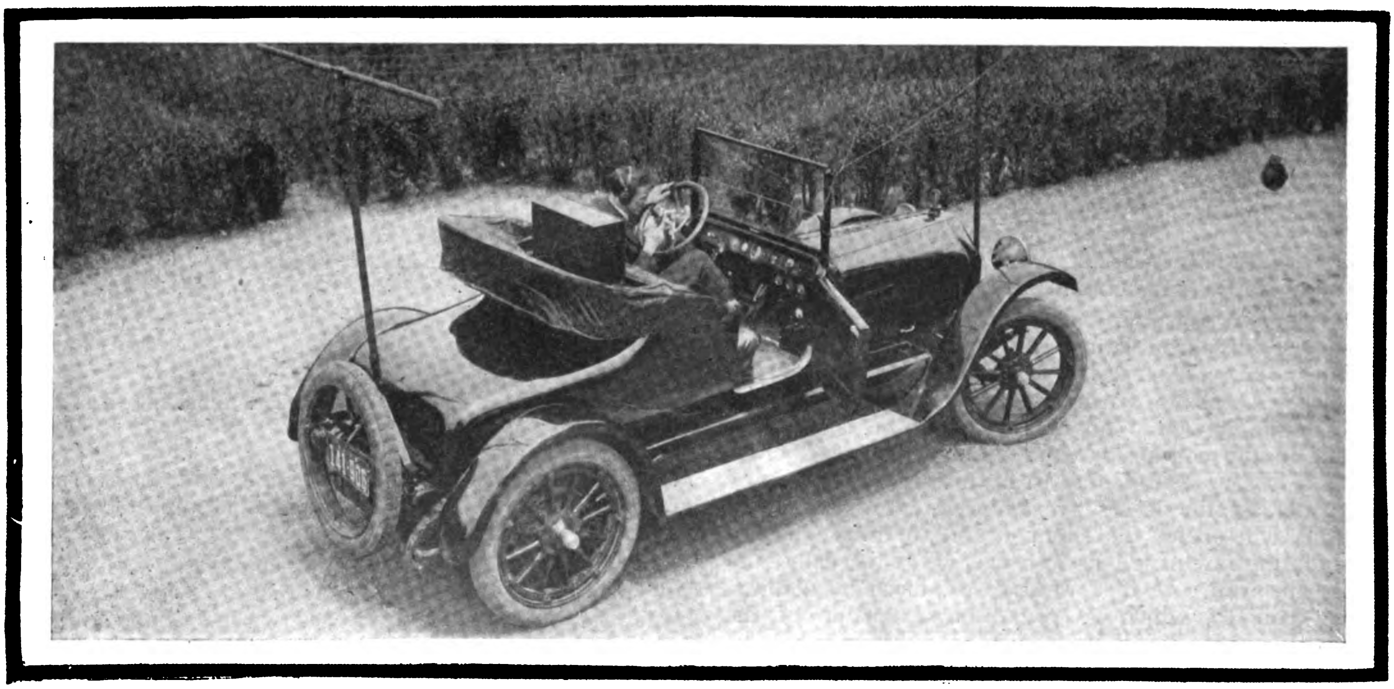


Wireless On Wheels

The radio telephone has been successfully used on airplanes and small craft, but the adaptation to the automobile is novel and presents a field for future possibilities

The radiophone equipment shown above is capable of keeping in telephone communication with another station for a distance of from 15 to 20 miles and with its emergency radio telegraph it can communicate as far as forty miles

The transmitting apparatus (on the left) is of the latest type, employing vacuum tubes as generators of radio energy, while the receiver is a highly developed device with enclosed regenerative circuits and amplifiers which enable communication to be maintained long after the signals become too weak to be heard without these new devices.



The antenna equipment is compact and may be slung under the running board on hooks provided for that purpose. In the photo it is shown above the running board as it cannot be seen very well when it is in the proper position under the running board

A Summer on the Great Lakes

The Second of a Series of Impressions of a Novice in Commercial Wireless Operating

By Julian K. Henney

II—Such Is Life

"WHAT a wonderful thing wireless is! I simply don't see how it works."

Every time some talkative passenger came to the radio room of the Juniata that summer, and started the usual line about how interesting and wonderful is wireless, I thought of that first night and the day following. And as I sat there on the stool that had been Jones' undoing, I thought too, how wonderful — and fearful — the new art of radio communication had been.

Snell won the first watch by the toss of a penny and I turned in. At two o'clock he awoke me to finish the night, or to stand by until relieved, should our friend come to.

When I turned out of the warm bunk and bundled up in more clothes, I noticed at once that the waters had calmed a bit, although the wind was still whistling in the rigging above us and the four huge stacks were booming away in an awesome manner. There was still quite a bit of roll and the chairs were trying their best not to get dizzy and fall under the table. As I climbed to the high stool, the pinnacle from which Jones had ignominiously fallen, I mentally prayed that I might be spared a similar fate.

I saw at once that it was no wonder that seasickness had overtaken the wireless man of the Seeandbee. That stool was about the worst thing imaginable that one could be perched upon in a gale. Like the old three-legged milking stool that used to grace every cow shed in farmland, it simply would not stand still. With every lurch of the ship—they came less frequently now, thank Heaven —I threw out my hand to keep from falling against the opposite wall; both feet went out in the same direction, too, on those occasions when I was able to get them untangled from the rungs of the blooming stool. The receivers clung to my ears tightly and only served to accentuate the dull roaring outside and the groan of the stacks above. That morning watch promised to be anything but delightful.

Signals soon came in, however, and they served to distract my attention from the swaying of my seat. They were the first I had heard since my amateur station had been closed because of the war emergency, so I was all eagerness to hear them again. First came a few buzzes in familiar tone. It was like hearing from an old friend, for the station sending was a D. & C. boat plying between Toledo and Mackinac, on which I had once served as operator. Next came a coarse resonant rumble from far away Calumet. That these signals should be received, clear down in Lake Erie, was a surprise to me, but when Cape Hatteras started coming in with his old high-pitched, earsplitting racket, I began to realize the effectiveness of the tall masts of the Seeandbee. Several other stations were picked up—one sending out submarine warnings, another talking in code—and then, just before Jones relieved me, I made the acquaintance of Snell's friend Dietsch of the Detroit Third. He called to say good morning and to ask if we had any business for him. I came back with a good strong "nothing doing" and a good morning, and turned around to see Jones staring. We had a little friendly confab and he apologized for robbing us of our sleep, before I turned in. It was five o'clock by my watch, and at eight we would be in port!

From the very start of that first day we began to realize how interesting wireless could be. We lugged our cargo of freight—the hand trunk of mine; the suitcase with a lifetime outfit in it; the mandolin; the straw hat and Snell's kodak—down three flights of stairs and across the gangplank. At the end of the plank a sleepy-eyed officer took our blue passes and cursed us heartily because we laughed at him. He looked as if he had put in a wild night of it, and when we smiled he hastened to explain that he had been up with a sick passenger. This of course amused us still more so instead of only smiling, we laughed outright. Thereupon the officer invited us to ride to a place much warmer than the Seeandbee on a stormy night. The reception committee appeared to be constructively, on the job. Our friend of the sardine sandwich and the ginger ale, looking as though he were the sick passenger, then came out and he joined the assistant purser in his malediction.

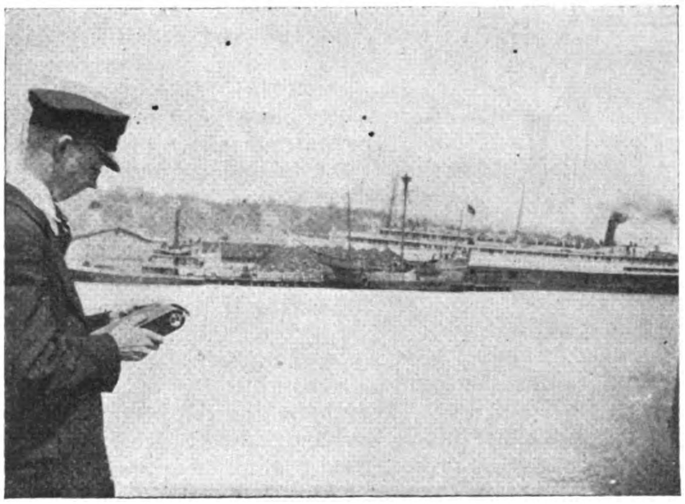
We figured that we could lug our stuff to the Juniata, get it stowed away, see that things were shipshape, and then hike to town for something to eat. We needed it; neither of us had had a thing to eat except the shredded wheat of the night before.

The newly painted funnel of the vessel that was to be our home for the summer, loomed up through the early morning mist and fog, astern of the Seeandbee, and the ship looked mighty good to us after the experiences of the night we had spent on the sidewheeler. Three masts and the brightly shining red copper wire of a new aerial beckoned to us across Buffalo's alleged river as we gazed upon the white and spotless decks and the green waterline of the Juniata. It was to be our home for a good many days after that, and there were to be times when we would give most anything to be able to get off for a few days and sleep in a real bed that did not shake and tremble all night long. But at the present time we were full of youthful enthusiasm, full of spirit that seemed indomitable; as full of curiosity as if we were to play with a new toy for the first time. The red smoke stack and the pure white steam rising from behind it invited us to hurry aboard and get acquainted.

As the sun began to penetrate the mist which is common to lake ports in the early morning, we walked across the bridge to where the Juniata was tied up alongside an old warehouse. My traveling bag was heavy—have I emphasized that fact before?—without anything in it, its weight was enough to stagger a man. I had stocked it for a three months' stay. Snell was burdened with three times as much stuff. We were somewhat warm when we arrived at the warehouse.

I wondered at the time what in the world Watson could have in his suitcase. Had he brought a private wireless outfit of his own or only a few hundred pounds of sugar for his personal use during the summer? I found out later I had overestimated the capacity of that heavy affair. It only held two suits of clothes, a uniform, a half dozen pairs of shoes, a library of seven or eight volumes, several portfolios of mandolin music, an innumerable number of films, all of the usual run of heavy clothing that mothers continually load on disgusted sons, and several reams of letter paper. In one small suitcase! There certainly was reason for Snell's belabored breathing on that muggy July morning.

So we lugged and lugged, and lugged some more. At about every third step, one of us would give out and stop for breath. Watson would change the kodak to the left hand, pick up the wardrobe with the right, and leave the mandolin on the ground. He would look disgusted



Evidence of the existence of the troublesome kodak that marred the early pleasures of two enthusiastic wireless operators

with the world in general, mop his face, and valiantly start off again. Then he would come out with the kodak on the ground. Finally, to expedite matters a little, I grabbed the kodak and led the pilgrimage through the hot sun that fairly roasted us as it beamed down and reflected sizzlingly from the dusty tracks along which we were walking.

At the entrance to the warehouse an old bewhiskered gentleman wearing a policeman's club demanded our passes. Here was a chance to exhibit prideful possession of new water-front passes. Now, there are passes and passes. Ours were issued at Cleveland and they were supposed to be good at any water-front of the United States. It said so plainly on the front of the little cards we handed the guard. Other embellishments consisted of our photographs, pasted on the face of the pass, with very interesting and useful information concerning the land of our nativity, our present whereabouts, our domestic state, and many other things. All of these intimate details appeared unimpressive to the guard.

As we flashed the cards into the old gentleman's view, it became evident that they were new ones on him. After the first squint, off came his spectacles, to be polished with the most aged and worn bandana I had ever seen. Then he caught sight of the pictures. He pulled his long white chin whiskers and tried to reconcile the photo with my moist and exasperated countenance; the sun grew warmer and warmer.

"Now see here young man," punctuating his remarks with swishing expectorations of Navy plug, "this here card's . . . no good to me. If'n you fellers expect. . . get in here. . . got to go to the office. . . get passes. Do you see? Passes is what you got to have. . . get in here. Yes sir, that's what you lads need if . . . want to get on the Juniata."

So we had to convince the old fossil that those pretty picture cards were passes. Our tempers were pretty far gone when he finally let us enter the warehouse, pointing out the hole in the door through which we could get to the steamer.

We hastened across the long building, winding our way among piles of flour that rose to the ceiling, stacks of bright copper ingots, bales of binder twine in sufficient quantity to tie up the universe, and huge packing cases in an innumerable number. Most of them looked fully as heavy as Snell's suitcase, and at least one—a case for a grand piano—faintly resembled my own outfit.

Arrived at the opening in the door he stopped to draw breath before going through to the river. Then we gathered up the luggage once more, for the last time, we firmly resolved. I took the mandolin and my traveling bag and Watson carried the rest of the paraphernalia. We pulled ourselves through the hole and saw—not the Juniata firmly tied up to the dock, but gracefully moving out in midstream on her way to the passenger docks. We were too late!

It was too much for overweighted nerves. Watchman, warehouse, Seeandbee, luck in general, individually and collectively, were made the recipients of the best of our American vocabulary. My grievances were expressed on general principles; Snell's because he knew it was a full half-mile from the warehouse slip to the Lackawanna pier where the Juniata would stop to take on passengers. This meant a half mile walk in the sun, back over those hot and dusty tracks—and a half mile more, after we had arrived at our starting place. I, of course, didn't know these details.

We sat down on a stevedore's truck and said various things about the weather and affiliated factors. Youth, however, is invincible; the funny side of it all soon became apparent. Laughter refreshed our minds. We knew that we were up against it, and it was best to be happy; to think of the good dinner we were soon to get.

It was then ten o'clock; by ten-thirty we had tramped back to the bridge over which we had just traversed; our passes had been viséd several times all over again. The walk was one to be remembered but not discussed.

You can easily see that we were about the happiest youngsters that ever boarded ship when we walked the gangplank of the Juniata that second day of July and started up the long and circuitous path that led to the radio room.

Our happiness was short lived, however. Scarcely had we crossed the plank when we were stopped by a man, tall and lean, complacently picking his teeth as though he had just had a full dinner. It was the captain. Introducing ourselves with our neat and well written letters from the Superintendent of the Marconi Company we asked the skipper if he had anything in particular for us to do beside getting ourselves acquainted with the radio equipment. Captain Jones was new at running ships with wireless attached to them, so he merely grunted, waved his hand and said he would see us again. He did . . . lots!

We disappeared up the companionway toward the radio cabin. Snell led the way, announcing that since he had been on board the Juniata for several months the previous summer, he was on to the curves of the ship. He disappeared with a rush up the steps, but those three narrow and steep flights, seemed like fourteen to me. By the time I had dragged my traveling bag and the kodak up to the aft saloon deck, I was nearly ready to fall over the rail.

But our troubles had barely started!

The equipment had been installed a few days before by the Marconi construction man, and it was our manifest duty to see that the stuff worked before the ship left port.

The first thing we noticed was the new paint. It was on everything, table, walls . . . apparatus, daubed on in generous fashion. It was not dry, and the plentiful supply on our coats required first attention. Snell was rather precipitous. He had sat down in the disconsolate looking chair that stared bravely through its new paints at us. Gracefully, and most confidently, he leaned back, all unconscious that he had wiped off half the white paint on his coat. Then he duplicated the result by putting his arms on the operating table in the same manner that we later found Bill—the second mate—eating. Friend Snell's disposition was not thereby improved.

I sat down, carefully, and with due respect for the fresh whiteness, hardly expecting to escape entirely. I pressed the key; the transmitter uttered a roar that brought me hard up against the wall—and more paint. But it was definitely established that the sender worked, and judging from the noise, we decided that it worked to perfection. But when we put on the receivers there was "nobody t' hum", as the Third Engineer might have remarked. We jiggled and juggled, changed all sorts of adjustments and traced wires, but still nothing but silence rewarded us. The navy station at Buffalo was in sight; so were several steamers, but not a scratch came into the receivers. Until a signal should be caught there was not the slightest excuse to leave for town and dinner. After two hours of alternate listening and adjusting we decided that something was wrong with the outfit.

"Maybe it's the phones," said Snell.

So I dumped the luggage out of my grip and dug up my head receivers. Watson tried them, held up his hand as if to say, "Sh, there's something doing." But it was a false alarm; in a few minutes his expression changed: by his face I knew the somebody had not as yet returned home.

It was then nearly noon, and still not a buzz had been heard. The trouble was clearly in the tuner, but one look into the maze of wires dismayed us. We turned to the connections, the explanations of which required dumping my stuff on the deck, in full view of the admiring members of the crew, so we could find a book containing circuit diagrams. This helped us to understand the puzzle and at twelve-thirty we were satisfied that everything was all right with the tuner circuit. Finally, we carted the whole works up to the top deck in an endeavor to get a good ground connection to the copper indicators. Still nothing doing.

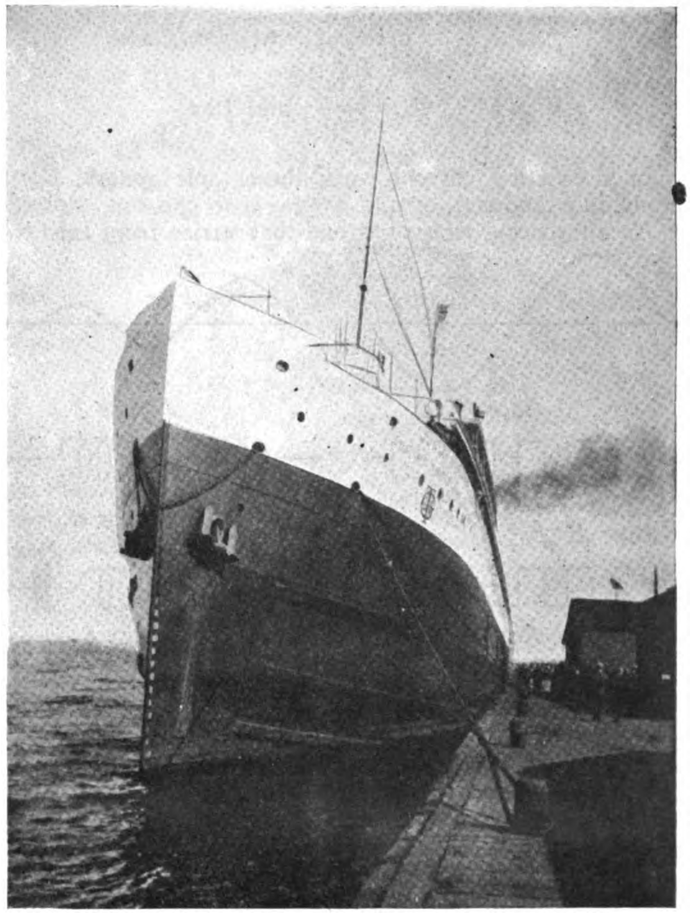
Fragmentary advice, muttered sections of virile vocabulary repeated in toto, spurred on by pangs of hunger and desperation, floated off the aft deck into the thick waters of Buffalo, but nary a splash of signals echoed in the receivers. About noon—that, is about one o'clock Buffalo time—the chef called us to the Officers' Mess and placed before us a couple of egg sandwiches. He was a wonderful chef. After devouring his offering we felt decidedly better and renewed our quest of the unknown with added zest.

At two o'clock, when we were still searching for trouble, several tugs puffed past towing the Tionesta—a sister ship of the Juniata—to the warehouse. As she was slowly maneuvered past us by the puffing tugs, I noticed the aerial wires came down to her deck in the same manner as our own, and as I thought of her equipment an idea came to mind. Why not exchange apparatus with the Tionesta? She was not due to sail for several days; the office would have plenty of time to get a new tuner to the vessel, and no one would be out. If worse came to worse, we would have a good outfit anyway and we could let the other operators worry.

As soon as the newly painted Tionesta was warped into her slip we hastened aboard. The construction man had taken the receivers with him, so we were compelled to disconnect the receiving cabinet and take it to our own ship to try it out. On the way back to the Juniata we had decided to merely exchange tuners and say nothing about it.

With the equipment tucked under our arms we ran for our steamer. It was then nearly three o'clock; we sailed at four. By a quarter after three everything was ready, wires connected again, receivers tested and batteries hooked up Snell sat in front of the outfit with a "Lord help us" expression on his face. Passengers were beginning to come aboard, and about everyone of them stopped at our cabin door on their way around the boat. The crew was below decks, much to our satisfaction. It was a tense moment. We would have to give up if the thing did not work at that late hour.

Fifteen minutes later the suspense ended. Strong signals were heard and we were at last free to sigh in relief and to take a look around us. It was then too late to go back to the Tionesta with the bum tuner, so we decided to carry them both until further orders.



The brightly shining copper wire of a new aerial on the vessel that was to be our home for the summer loomed up through the early morning mist and fog

At four we left for Cleveland on the first trip of the season, with a fair passenger list; at five we had a regular meal in the officers' mess, and at seven we sent our first message to the Marconi offices, announcing that we had "hooked" the Tionesta's tuner and that she had none at all. We fully expected to find two new operators at Cleveland waiting to take our jobs.

Without incident, the hours drew round to midnight when I came on duty fairly bristling with efficiency, after six hours of sleep. I looked about. The old box of a tuner lay in the corner of the cabin to which it had been relegated. The purloined one on the table registering every scratch of static and signal. Thoughtfully, I looked from one to the other, reflecting on the universal comment of passengers:

"What a wonderful thing wireless is. I simply don't see how it works!"

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

Resonance in the Audio Frequency Circuits of Amateur Radio Transmitters

By John J. Holahan

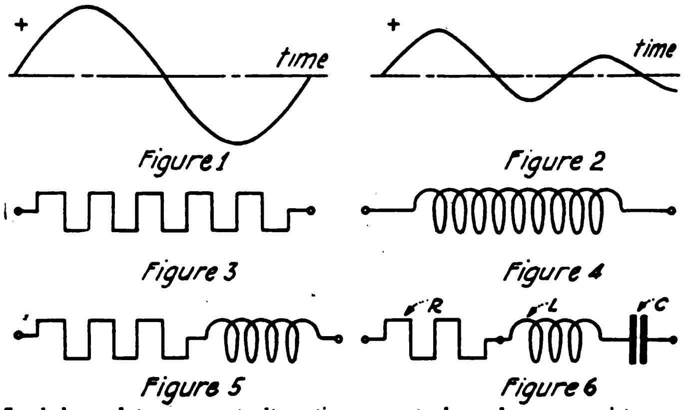
IN considering the effects of resonance in the audio frequency circuits of the radio transmitter, it is well to review briefly the theory of alternating currents. In direct current work the relations between electromotive force (volts), resistance (ohms), current (amperes) and power (watts), are given by the following formulae.

$$W = EI;\quad I = \frac{W}{E};\quad E = \frac{W}{I};\quad W = I^2 R;$$

$$E = IR;\quad R = \frac{E}{I};\ \text{and}\ I = \frac{E}{R}$$

In alternating current work these same general laws apply, in a modified form.

An alternating current is one that varies from zero to maximum to zero in one direction; then reverses, rises to maximum, then falls back to zero. This is called one complete cycle, and takes a certain period of time, which can be represented by the graph, figure 1. This is a sine wave such as is sought after in general commercial work. It also represents the wave form of sustained wave transmitters.



Symbols used to represent alternating current, damped waves, resistance, inductance, and their combinations in series

A damped wave is one that reverses in direction but changes in amplitude. It is represented by figure 2.

The period of an alternating current is the time it takes the current to pass through one set of positive and negative values. Frequency is expressed in cycles per second.

The period of the current is $f = \frac{1}{T}$, where T is the time of one cycle expressed in fractions of a second. Thus, the period of a 500 cycle current is 1/500 second.

The instantaneous value of an alternating current is the value of the current at any instant. The maximum value of such a current is the greatest instantaneous value during any cycle. The average value is equal to $I_a = \frac{2}{\pi} I\ max.$

The effective, or root mean square (RMS) value is the value usually spoken of in AC work, and is that indicated by AC ammeters and voltmeters. It is the square root of the mean of the squares of the instantaneous values of an AC current over a complete cycle.

The effective value $I_{eff} = \frac{I_{max}}{\sqrt{2}}$

As an illustration, if the effective primary voltage of a transformer is 110 volts, then the maximum value is $110 \times \sqrt{2} = 155.5$; the average value is $155.5 \times \frac{2}{\pi} =$ 99 volts. Effective values are used in this article.

All radio circuits contain resistance, inductance and capacity, connected up in various ways. Figure 3 indicates a simple resistance. In this case the current is represented by $I = E/R$.

Inductance is indicated by figure 4. It should be stated that any coil that has inductance has resistance also, but it is well to consider them separately, as they have different effects. The equivalent circuit is shown in figure 5. For this circuit the relations between E.M.F. current, resistance and inductance is given by

$$I = \frac{E}{\sqrt{R^2 + (\omega L)^2}} \qquad E = I\sqrt{R^2 + (\omega L)^2}$$

In the above $\omega = 2\pi f$, where f is the frequency in cycles per second. The factor ω is called the periodicity factor of the circuit. R is the resistance, E the voltage, I the current and L the inductance in henries. If this circuit could be made up to contain inductance only and no resistance, the relation would be,

$$I = \frac{E}{\omega L} \qquad E = I\omega L$$

The equivalent circuit for resistance, inductance, and capacity, in series is shown in figure 6.

In this case,

$$I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

$$\text{and } E = I\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

The term $\left(\omega L - \frac{1}{\omega C}\right)$ is called the reactance of the circuit. The term ωL is called the inductive reactance, and the term $\frac{1}{\omega C}$ is called the capacitive reactance. Inductive reactance is always positive, and capacitive reactance is always negative. Sometimes reactance is expressed by the letter X then,

$$I = \frac{E}{\sqrt{R^2 + X^2}} \qquad E = I\sqrt{R^2 + X^2}$$

The factor $\sqrt{R^2 + X^2}$ is called the impedance of the circuit. Resistance, reactance, and impedance are expressed in ohms.

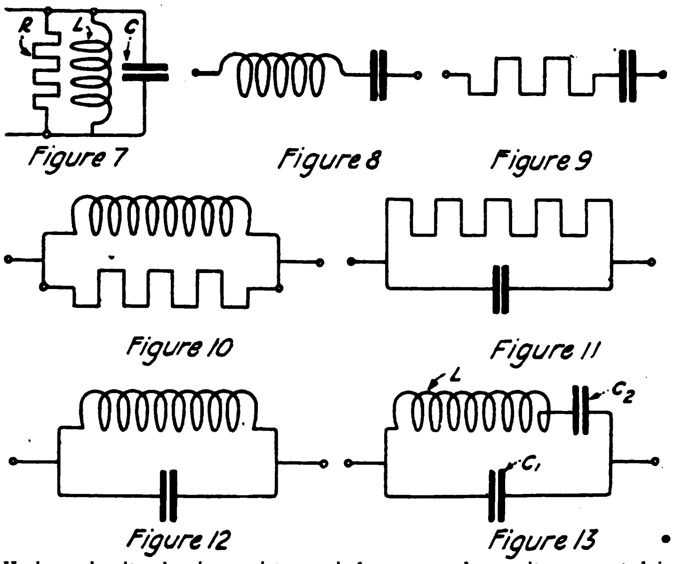
The reactance of a circuit may be positive or negative accordingly as ωL is greater or less than $\frac{1}{\omega C}$. When the reactance is positive ωL is greater than $\frac{1}{\omega C}$ and the current lags behind the E.M.F. in phase. When the reactance is negative $\frac{1}{\omega C}$ is greater than ωL and the current is ahead of the E.M.F. in phase.

The equivalent circuit for resistance, inductance, and capacity in parallel is shown in figure 7.

In this case,

$$I = E\sqrt{\left(\frac{1}{R}\right)^2 + \left(\omega C - \frac{1}{\omega L}\right)^2}$$

and



Various circuits showing resistance, inductance and capacity connected in series and parallel

$$E = \frac{I}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\omega C - \frac{1}{\omega L}\right)^2}}$$

For a circuit with capacity only,

$$I = E\,\omega C \text{ and } E = \frac{I}{\omega C}$$

An inductance and capacity in series are shown in figure 8. Then,

$$I = \frac{E}{\omega L - \frac{1}{\omega C}} \text{ and } E = I\left(\omega L - \frac{1}{\omega C}\right)$$

For a resistance and a capacity in series as in figure 9.

$$I = \frac{E}{\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}}$$

also

$$E = I\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$$

For a resistance and inductance, in parallel as in figure 10,

$$I = E\sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{\omega L}\right)^2}$$

also

$$E = \frac{I}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{\omega L}\right)^2}}$$

For a resistance and capacity, in parallel as in figure 11.

$$I = E\sqrt{(\omega C)^2 + \left(\frac{1}{R}\right)^2}$$

also

$$E = \frac{I}{\sqrt{(\omega C)^2 + \left(\frac{1}{R}\right)^2}}$$

For an inductance and capacity in parallel as in figure 12,

$$I = E\left(\omega C - \frac{1}{\omega L}\right)$$

also

$$E = \frac{I}{\omega C - \frac{1}{\omega L}}$$

Figure 13 indicates an inductance and capacity in series, shunted by a capacity in parallel. This is a "dummy" antenna of negligible resistance for which

$$X = \frac{\omega^2 L C - 1}{\omega C_2 + \omega C_1\,(1 - \omega^2 L C_2)}$$

also

$$I = \frac{E}{X} \text{ and } E = I X$$

RESONANCE

In a radio circuit, containing a resistance, an inductance and a capacity, in series, which is the usual radio circuit, we have seen that,

$$I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

Now if we select such values of L and C so that

$$\omega L = \frac{1}{\omega C}. \text{ Then } \omega L - \frac{1}{\omega C} = 0$$

and

$$I = \frac{E}{\sqrt{R^2 + 0^2}}$$

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

The current is then limited solely by the resistance.

To explain this more fully, let us take the case of a simple valve which is shown in cross section in figure 14-A. The frictional resistance of the opening represents the resistance of the circuit, i. e., ohms. The pressure on the water corresponds to the E.M.F. of the circuit, and the amount of water that will flow to amperes. Now, if ωL predominates as in figure 14-B, then the opening is smaller and the resistance is higher. If $\frac{1}{\omega C}$ predominates, then we have the condition of figure 14-C; the opening is small and the resistance is still high. But, if $\omega L = \frac{1}{\omega C}$ the openings in the body and spindle of the valve coincide and the amount of water that will then flow is determined solely by the pressure and the frictional resistance of the opening in the pipe.

CRITICAL FREQUENCY

This arises from the condition of resonance. If the resistance of the circuit is constant and we adjust L or C

so that $\omega L - \frac{1}{\omega C} = 0$

then, $\omega L = \frac{1}{\omega C}$ or $\omega^2 = \frac{1}{LC}$ or $\omega = \frac{1}{\sqrt{LC}}$

and since $\omega = 2\pi f$

then $f_c = \frac{1}{2\pi\sqrt{LC}}$

This is true for the usual radio circuit where the value of R is very small. The formula that takes in the value of the resistance R is

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$$

If R is small, then $\frac{R}{4L}$ reduces practically to zero and

the formula becomes $f = \frac{1}{2\pi\sqrt{LC}}$

It can be shown that for high efficiency in radio sets. that the natural frequency of the transformer secondary and the condènser should be the same as that of the generator. That is, the leakage reactance of the secondary should equal the capacitive reactance of the condenser. The leakage reactance of the secondary can be trànsferred back to the primary by dividing it by the square of the ratio of transformation. This primary reactance is made up of the leakage reactance of the transformer, the leakage reactance of the generator, and the reactance of the regulating reactance coil if any.

Take as an example, a 1. kw. 500-cycle transformer with a 220-volt primary and an 11,300-volt secondary shunted by 0.008 mfd. condenser; suppose the primary current is 10 amperes: the voltage on condenser,

$$V_{max} = 1000\sqrt{\frac{2 \times W}{\text{spark rate} \times \text{mfd.}}}$$

$$= 1000\sqrt{\frac{2 \times 1000}{1000 \times 0.008}} = 16{,}000 \text{ volts}$$

and $V_{eff} = \frac{V_{max}}{\sqrt{2}} = \frac{16{,}000}{1.4} = 11{,}300$

From the relation $\omega L_2 = \frac{1}{\omega C}$, L_2 should equal $\frac{1}{\omega^2 C}$ when L_2 = leakage reactance referred to the sec.

Operating 12 per cent off resonance for a good spark tone = 500 — (500 × .12) = 440 cycles

$$\frac{1}{\omega^2 C} = \frac{1 \times 10^6}{4\pi^2 \times 440^2 \times .008} = 16.5 \text{ henries}$$

Secondary leakage reactance = $2\pi \times 500 \times 16.5 = 52{,}800$ ohms.

When the gap is in action and the transformer secondary is practically on short circuit, the current in the

secondary $\frac{\text{Sec V}}{\omega L} = \frac{11{,}300}{51{,}800} = 0.218$ ampere.

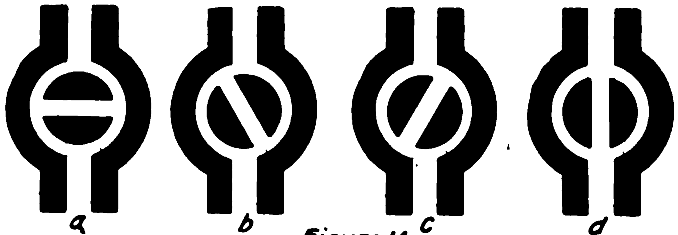


Figure 14

Cross section of a simple valve used to illustrate the relation of resistance, inductance and capacity

When the secondary is charging the condenser with the gap not discharging $I = \omega C E = 2\pi \times 500 \times 0.008 \times 10^{-6} \times 11{,}300 = 0.283$ ampere. For working conditions, take the average of these two or 0.25 ampere. This is an approximation.

The ratio of transformation for the conditions outlined above

$$= \frac{\text{Pri I}}{\text{Sec I}} = \frac{10 \text{ amp.}}{0.25 \text{ amp.}} = 40 —$$

Ratio squared = 40 × 40 = 1600 and the total primary

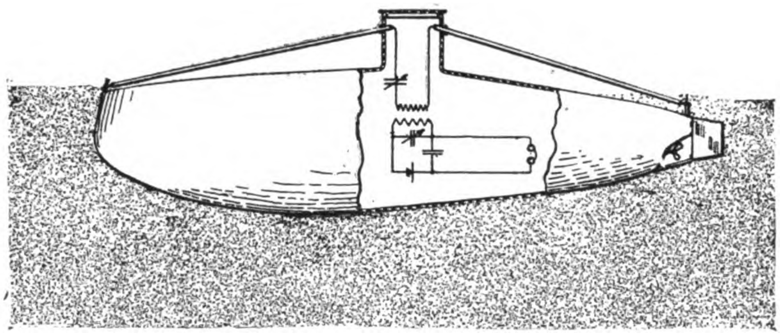
inductance = $\frac{16.5}{1{,}600} = 0.01$ henry. The total primary reactance must equal $2\pi \times 500 \times 0.01 = 31.4$ ohms.

This must be made up of the leakage reactance of the primary, the leakage reactance of the generator, and the reactance of the primary choke.

Methods of finding the leakage reactance of generators will be given in a paper on 500-cycle generator design.

Roger's Underground Aerials

THE Roger's wireless telegraph aerial for submarines is a closed circuit loop with a transmitting or receiving apparatus coupled at the middle as shown in the diagram figure 1. The antenna wires 11 are thoroughly insulated from the structure of the vessel except at the points 12 and 13 where a connection is made to the hull. An inductance connected in the middle of the antenna transfers the incoming signal to the detector circuit and the variable condenser 23 is employed as a tuning element. The same antenna is used for transmitting purposes, the primary of the oscillation transformer of the transmitting set being coupled inductively to the coil 16.



Method of installing the Roger's system aboard a submarine

Several forms of the Roger's underground aerial have been described in a recent U. S. patent. Figure 2 shows where the underground conductor extends horizontally or substantially parallel to the earth's surface. This aerial is enclosed with a metallic covering, casing or screen. 21 which may be a tube of lead pipe, iron or any other suitable material. The antenna is insulated from the metallic covering by means of the insulation 12; that is, although the antenna is buried in the earth it is completely insulated therefrom and from the metallic covering or casing.

The diagram of figure 2 shows a receiving apparatus inductively coupled to one end of the aerial, the other end (of the aerial) being ground to earth through the plate 25. A conventional type of transmitting apparatus, indicated to the right of the drawing, may also be coupled to the coil 24 for transmitting purposes.

In the modification shown in figure 3, the ground connection is replaced by a second antenna 20′ which extends in the opposite direction to the antenna 20. The signal instruments are located between the antenna and are coupled thereto by the usual inductive coupling. The signaling instruments are encased in a metallic chamber 26.

Figure 4 shows structure similar to figure 3 with the exception that the aerials lie on the surface of the ground. In figure 5, the antenna is elevated slightly above the surface of the earth being supported on struts or pins 28. The metallic covering in this case is not in direct contact with the earth. The covering may or may not be insulated from the earth.

Figure 6 shows two antennae of the Roger's type submerged beneath the water and figure 7 shows the employment of ground connection 30 at the outer end of the antennae.

The inventor remarks that careful tests and experiments have shown that by the employment of sectional metallic casing in intimate contact with the earth, but insulated from the radio conductor or antenna—the sections of the casing being insulated from each other and connected by couplings of insulating material—very much longer antennae may be employed than is possible with the continuous metallic casing. He also states that this construction reduces the interference of static.

Careful scrutiny of these diagrams leads us to believe that these underground aerials function like the closed circuit loops in the Weagant system, experiments on which were begun several years ago.

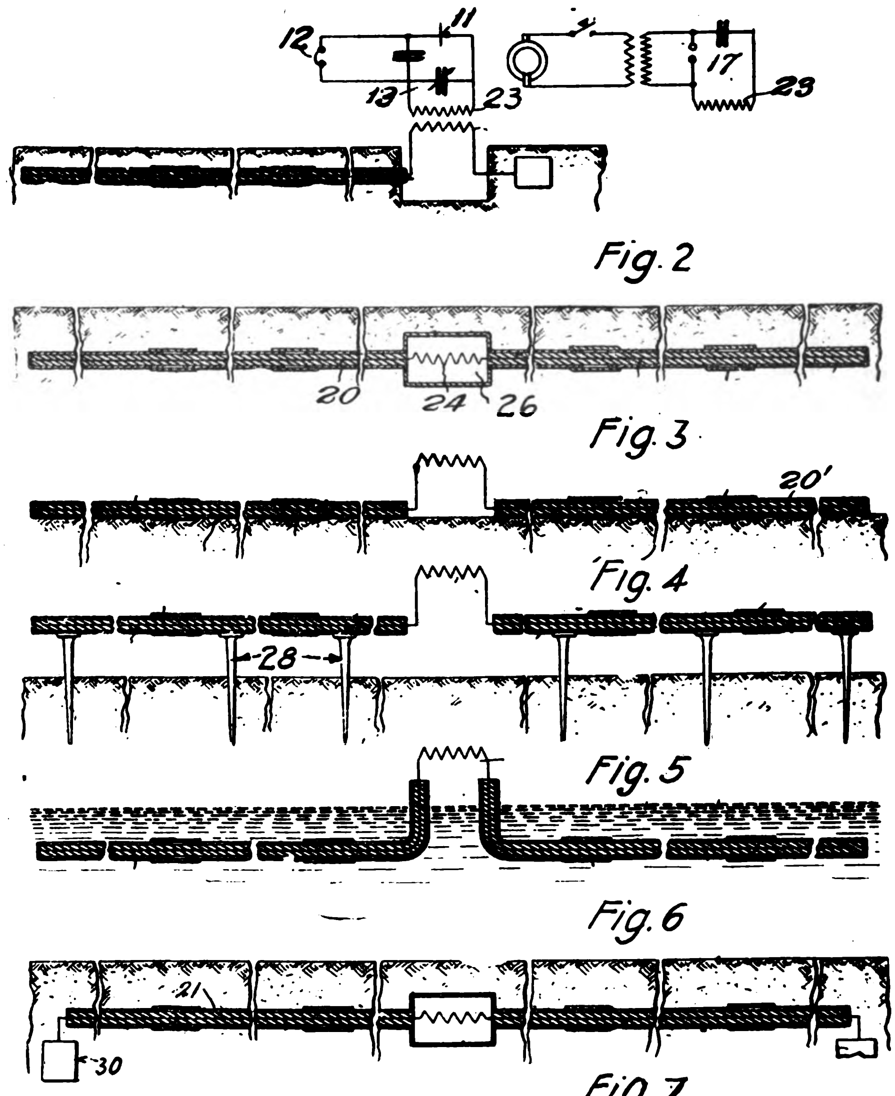


Diagram showing various arrangements of the aerials

Panel Transmitter

SEVERAL well designed transmitters have been described in this magazine but I have failed to see any that compared, in compactness, short leads and simplicity, with the transmit-

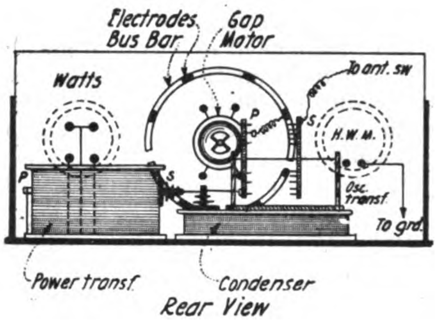


Figure 1.—Showing rear view of the panel transmitter

ter shown in the accompanying drawings. It is designed for those who desire a compact and efficient transmitter instead of a cumbersome and complicated one.

The panel is a marble slab 30″ x 18″ x 1½″. Bakelite or some such material, however, is better since it is hard to obtain marble free from metal veins which would cause serious losses. It is supported by a baseboard 30″ x 20″ x 1″ and is supported by brackets at each end. On the face of the panel is mounted a hot wire ammeter on the left, a Vernier type rotary gap in the center and a wattmeter on the right as shown.

The rotary gap has 12 stationary electrodes (only 8 are shown) in a 12″ circle. A light rotating arm 10″ long is mounted on the motor shaft and insulated therefrom. The 1/20 H.P., 6000 R.P.M. series wound motor is securely mounted on the rear of the panel, the shaft protruding through a ½″ hole. Any fan motor will answer the purpose. A small rheostat mounted on the operating

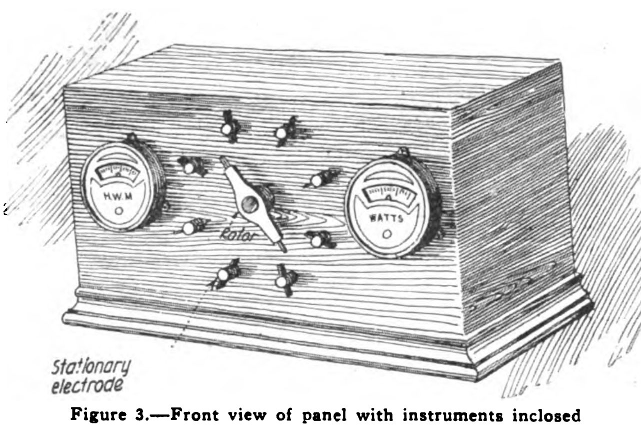


Figure 3.—Front view of panel with instruments inclosed

table, is hooked in series to vary its speed. The gap is quick to start and stop and produces a high musical note. It runs with less vibration than if a heavy disc was being propelled. It may be started and stopped by connecting to the antenna switch as shown in figure 4.

The stationary electrodes are connected in the rear by heavy bus-bar cut in two semi-circles, 6 electrodes on

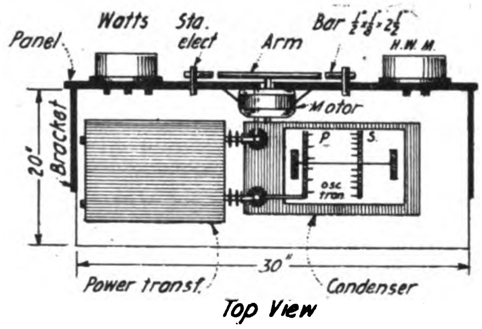


Figure 2.—Top view showing the position of the various instruments

each half as shown. A bar ½″ x ⅛″ is used for electrodes.

The transformer is a 1 kw. open core with a variable reactance coil mounted in a case, allowing close variation of power. However, any well designed transformer will do.

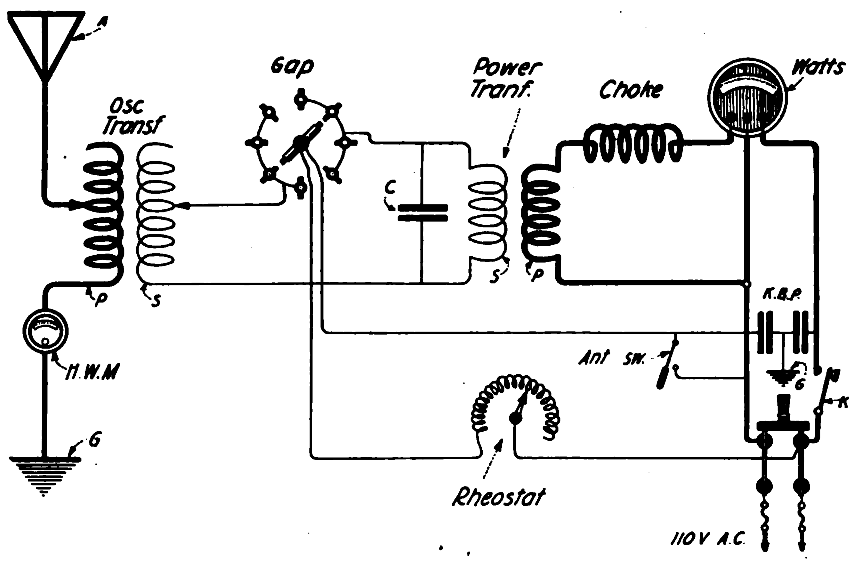


Figure 4.—Diagram of circuit used

The condenser is a glass plate, oil immersed type. Four banks of four plates each are connected in series parallel to reduce the strain on the plates. Its capacity should be about 0.008 mfd. for 200 meter wave. It is mounted so that the terminals will meet the transformer terminals which may be changed to make a short lead.

The oscillation transformer is placed on the condenser case as shown. Its base and uprights are hard wood with bakelite supports for the copper ribbon. The primary which may be stationary, has 5 turns of heavy ribbon. The secondary which slides on an insulating bar has 9 turns. In both cases the turns are spaced ¾″ apart. The pancake type has proven more efficient than the "bird-cage" type. The connector used to vary the inductance is soldered to heavy flexible ribbon or wire. It is provided with a set screw so it may be secured well after tuning. One is sufficient for each inductance. Fixed values are not advised because changes in various things will require constant changes of inductance.

All low tension wiring is lead covered and the lead grounded. It should be run at right angles to high tension leads and as far away as possible.

Condensers are shown as protective devices, but the writer would advise a high resistance carbon rod placed across the line and grounded in the middle as condensers break down easily.

A switch may be used to cut the H.W.M. out of the circuit, but switches in the high tension circuits are sure to cause trouble and losses of energy.

If a little care is taken in placing the various instruments very short leads will result. A short ground lead and longer antenna lead is preferable than the reverse. Use of a magnetically controlled antenna switch and a relay key, allows remote control.

Herbert M. Walleze—*U. S. N.*

The Marconi V. T.—A Three-Electrode Oscillation Detector of Approved Operating Characteristics

AMATEUR experimenters who have been accustomed to use the audion detector will greet with pleasure the announcement that the Marconi Company is now able to supply three electrode tubes for experimental purposes in any quantities. Several types of vacuum tube detectors were developed for specialized services during the war, but realizing that a good majority of the amateurs are not in position to purchase a family of vacuum valves, the Marconi Company has provided an all-around detector of uniform operating characteristics which may be said to represent an average of the good points of all vacuum tubes.

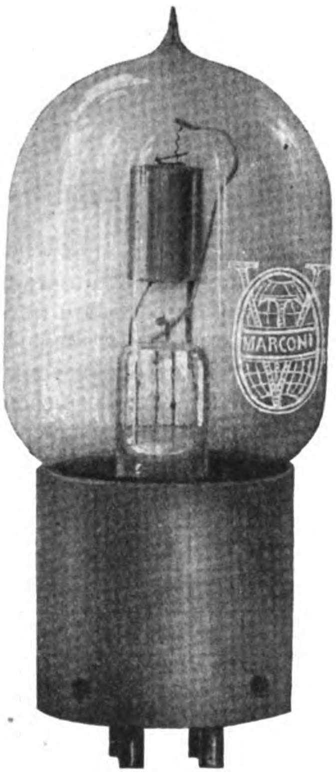


Figure 1.—The Marconi V.T. Oscillation detector

A point that will make special appeal to the experimenter is that the Marconi V. T.'s are standardized. This insures to all purchasers a uniform degree of sensitiveness and does away with one of the chief objections put forth by former buyers of vacuum tubes.

The Marconi V. T. is built to take the standard 4-contact base which makes all connections to the grid, filament and plate when the bulb is inserted. The tube has the usual grid, plate and filament. The filament operates off a four-volt storage battery without a rheostat. If a 6 volt storage battery is employed, a 10 ohm variable rheostat should be connected in the filament circuit. The filament current is approximately .7 ampere. The plate voltage for reception lies between 20 and 60 volts. In the amplification circuit shown in figure 3, the plate E.M.F. should be 80 volts.

The D. C. characteristics of the tube for various plate potentials up to 375 volts are shown in figure 4 and indicate uniformity. Figure 5 shows the curve of voltage amplification which compares favorably with other types of detector bulbs.

The preferred detection circuit in figure 2 shows the usual inductively coupled receiving tuner, the secondary coil of which is shunted by a variable condenser of say .0005 mfd. maximum capacity, although for the shorter range of wave lengths, this condenser may be dispensed with. The grid condenser may be fixed or variable. Its capacity should be approximately .0001 mfd. A grid leak of 2 million ohms is connected between the grid and filament in order to provide maximum ratification. The leak prevents the piling up of high negative potentials on the grid which otherwise would render the tube inoperative.

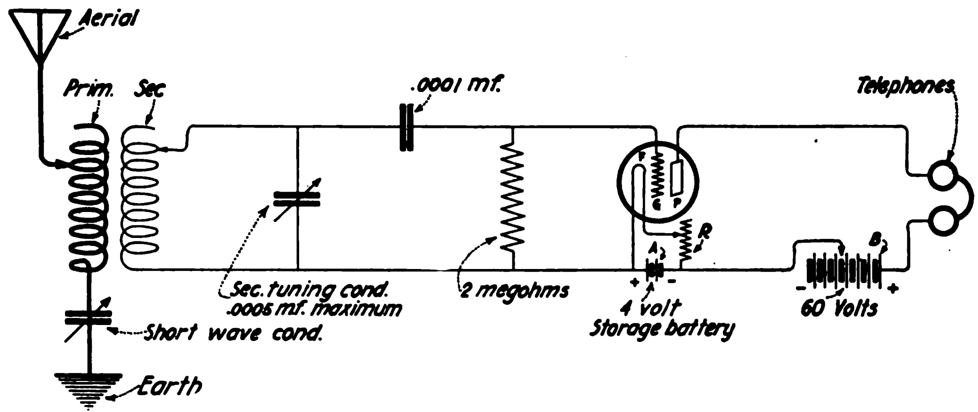


Figure 2.—The best detection circuit for the Marconi V.T.

Although these leaks can be made by drawing lead pencil lines between two binding posts on cardboard, the Marconi Company has provided standardized leaks of 2 million ohms mounted on a base ready for use. This saves the user a good deal of experimenting, for unless he possesses a bridge for making resistance measurements he would have some difficulty in securing the required resistance.

For amateur experimenters who desire to work their 200 meter sets over great distances, the circuit for the cascade amplifier in figure 3 has been provided. It is believed that once the experimenter has an opportunity to observe the amplification which this circuit makes possible, he will employ none other. It is to be noted that the plate circuit of the first tube is coupled to the grid circuit of the second tube throught the choke L3; and that the plate circuit of the second tube is coupled to the grid circuit of the third tube through a resistance R-1 of 2 million ohms. The leak resistances R have resistance of 2 million ohms each.

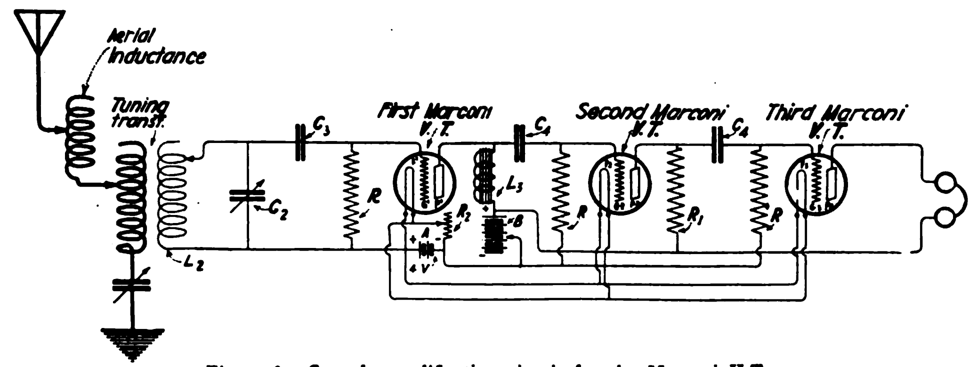


Figure 3.—Cascade amplification circuit for the Marconi V.T.

A particular feature of this circuit is the use of a single battery for the filaments and another battery for the plate circuits of all tubes. The current consumption of the three filaments in parallel is approximately 2.2 amperes. The plate battery—commonly known as the "B" battery—should, in this circuit, have a potential of 80 volts for maximum amplification. The choke L-3 has an inductance of approximately 20 henries. It can be made by winding 10,000 turns of No. 36 enamel wire on a core of silicon steel or iron wire 5/8" in diameter and 3" long. Condensers C-4 should have a capacity of .005 mfd. each.

by putting 60 volts on the plate circuit and then carefully adjusting the rheostat until loud signals are obtained for distant stations. Other values of plate voltage should then be tried and different filament temperatures keep-

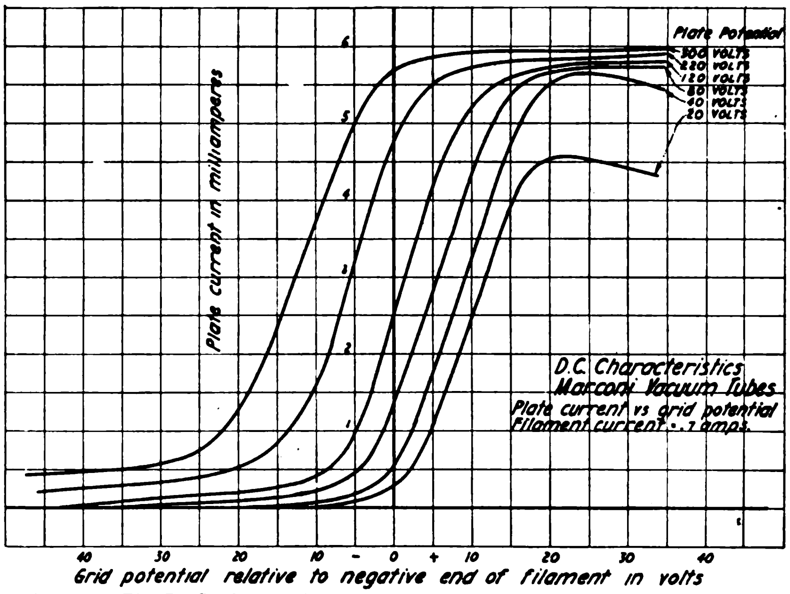


Figure 4.—The D. C. characteristics of the tube for various plate potentials indicate uniformity

There are certain precautions which the operator should take in the operation of this tube. It should be noted that its operating life is approximately 1500 hours and this means that if the amateur uses the tube four hours per day, its life will extend over a period of one year. By careful use of this tube, still longer life may be expected.

If the potential of the filament bat-

ing the filament current well within the limits.

The filament should not be burned at higher temperatures than are necessary for strong signals as lower temperatures will tend to prolong its life.

If a battery in excess of four volts is used for the filament, care should be taken to cut in all the resistance at the rheostat immediately after the valve is

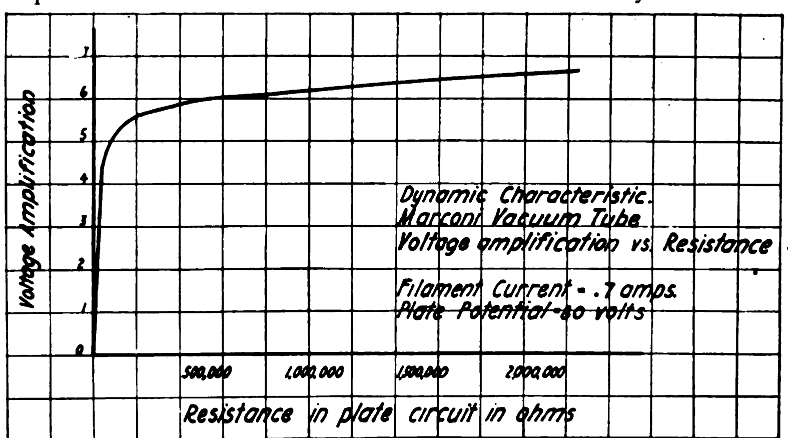


Figure 5.—The curve of voltage amplification

tery exceeds four volts, care should be taken not to exceed the stated filament current of .7 ampere.

The required filament temperature can be obtained without an ammeter

put out of service, for otherwise the storage battery may recuperate sufficiently, while standing idle, to burn out the filament the next time the filament circuit is closed.

THE HEART OF THE WIRELESS ON THE NC 'PLANES

Fleming Pat. No. 803684
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MARCONI V. T.

$7.00 each

Standardized Socket . . . $1.50 additional

Agreements recently effected have made vacuum tubes available for experimental use. The Marconi V. T. is the only vacuum tube, or audion, which may be sold to amateurs, laboratories, schools of instruction and experimenters.

A highly developed, all-around tube for use as a detector and amplifier in wireless communication. It has practically the same electrical constants as the tube used by the Allied armies and navies throughout the war in continuous wave transmission and reception.

The approximate operating life of the MARCONI V. T. is 1,500 hours.

Class I.—Designed for use as a detector; operates with plate potential of 20 to 60 volts.

Class II.—Designed for use as an amplifier; plate potentials from 60 to 110 volts may be applied.

Tubes in either class may be used for detection or amplification, but those of Class I are best as detectors, and Class II tubes are superior as amplifiers.

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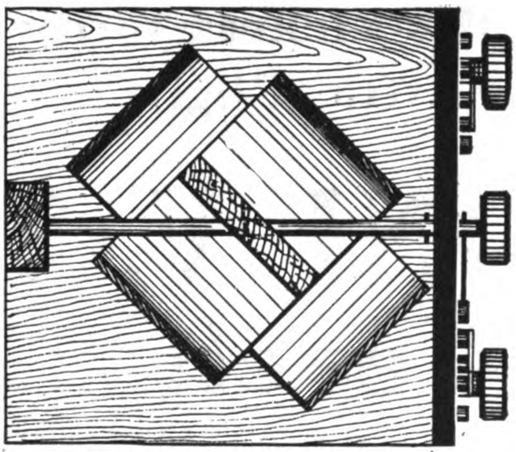
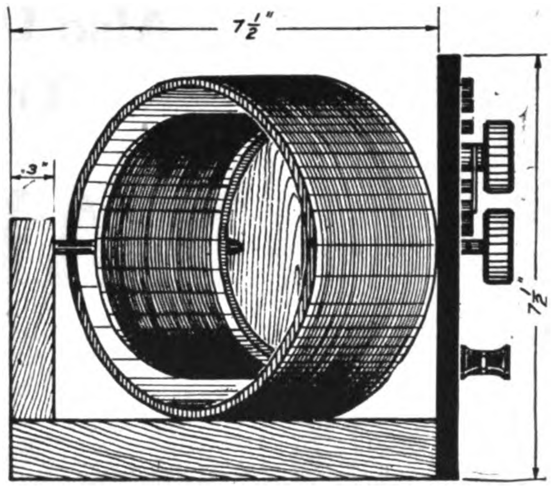
A Receiving Transformer for Arlington Time Signals

THE receiving transformer shown in the accompanying drawings is suitable for the reception of wave lengths up to 3,000 meters when used with the average amateur antenna. The unusual feature of this transformer is the method of mounting the primary and secondary coils. Each coil is mounted at a 45 degree angle with the shaft. This permits the coupling to be varied through a 180 degree scale, and allows room for the shaft to pass through without interfering with the windings.



Top plan view of the receiving transformer showing primary and secondary coils mounted at a 45 degree angle with relation to shaft



Side elevation and dimensions of construction

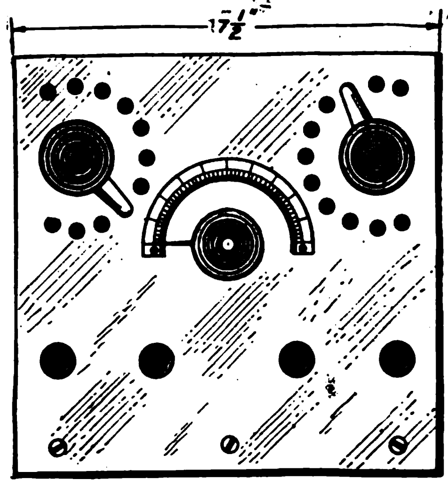
The primary inductances consists of 200 turns of No. 28 S.S.C. wire wound on a shellaced paper tube 6" outside diameter, 3¼" long, 3/16" thick. Eleven equally spaced taps are brought out and connected to one of the 11-point switches on the hard rubber panel. The tube is clamped to the base with a metal strip held down at each end with a wood screw. The inductance of this coil is approximately 6,000,000 centimeters.

The secondary inductance consists of 240 turns of No. 30 S.S.C. wire wound on a shellaced paper tube 4½" diameter, 3" long and 3/16" thick. Eleven equally spaced taps are brought from this coil to another 11-point switch, with extra flexible green silk covered telephone cord. These leads should pass through 11 holes drilled through the wood block which supports the tube, near the shaft, so as to reduce the strain on the connections. All connections must be soldered. The tube is mounted on the block before winding and held with 6 pins, three at each end. The inductance of this coil is approximately 6,000,000 centimeters, and when shunted by a capacity of .0005 mfd. will respond to a wave of 3,250 meters.

The shaft is of hard wood ¼" in diameter by 8½" long. It passes through the secondary coil support at a 45 degree angle and is held by a wooden pin glued in place. The knob is turned from ½" hard rubber and pinned to the shaft.

The base is of hard wood 1" thick. The panel is fastened to the base with 3 wood screws as shown. Four hard rubber binding posts are mounted on the panel, two for the secondary and two for the primary.

This scheme of coupling may be used with any size of tuner, and can easily be mounted on a panel or cabinet set with other apparatus. A va-



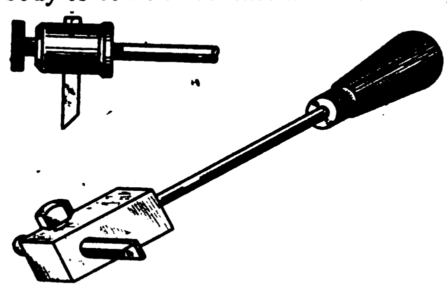
Panel board with switches and binding posts mounted

riometer connected in series with the primary will be useful when close tuning is desirable. The coupler can be used with an ordinary crystal detector, but is intended primarily for audion work.

Clyde J. Fitch—*Massachusetts.*

Soldering Copper for Delicate Work

FINE apparatus and instrument work involves a considerable amount of delicate soldering work which, like many other things, is best done with properly designed tools. The soldering copper shown in the accompanying sketch will help wonderfully in many of those particular and hard-to-get at jobs. A large binding post and a bit of brass rod will suffice when improvising for a short job but the usefulness of the more permanent type well warrants its construction. In either case the body should contain sufficient mass to store a considerable amount of heat. The right angle feature provides a comfortable working posture and does not obscure the work from view while soldering. It also permits the heating of the tool on a gas range without oxidizing the tip by allowing only the body to come in contact with the flame,



Improved soldering tool for delicate work

which means in other words, less filing and retinning. In work on fine wires, the tip will work nicely with extensions up to one inch.

C. H. BIRON—*Massachusetts.*

Contest Winners for August

The June WIRELESS AGE subject for discussion was: "What are the relative merits of the regenerative vacuum tube receiver and the cascade vacuum tube amplifier for radio reception at amateur wave length?"

First Prize—The Regenerative Receiver and the Cascade Amplifier for Amateurs

IN pre-war amateur stations, the cascade amplifier was usually regarded as an expensive luxury, because of the necessity of a separate battery for each bulb, and the multiplicity of other equipment required. In addition, it was difficult to adjust readily, and because of these defects it found only a limited application, being more of a novelty than a utility.

At the hands of modern research engineers, however, an improved type of vacuum tube was evolved, which does away with the critical adjustment required by the old type of tube and makes the cascade amplifier a practical device. Tubes similar to this are now being placed on the market for the amateur experimenter, and through their use, we may expect the cascade amplifier to become common in all of the more advanced amateur stations, taking the position formerly held by the regenerative receiver.

The most common regenerative circuits in use at the present time are of the following types: The variometer type, as used in a popular amateur receiver; the tickler coil regenerative, largely used by the U. S. Navy; the condenser regenerative; and the single coil, direct-connected type, used in the Simon airplane receiver. There is still another type which was described in the june WIRELESS AGE by Mr. M. W. Sterns. These are all fairly simple, requiring a minimum of apparatus, a single vacuum tube, and only one set of batteries. Since the upkeep cost of the batteries required for a cascade receiver is considerable, there is no doubt but that the regenerative set will always remain popular among amateurs of limited means. Another point in its favor is the simplicity of adjustment which is so essential when interference is bad, although, as I have already mentioned, the cascade amplifier in its perfected form is equally simple. The main points in favor of the regenerative receiver for amateur purposes, are: Low initial cost; greater simplicity of apparatus; and lower upkeep cost of batteries and tube renewals.

The cascade amplifier, on the other hand, is absolutely necessary for certain types of receiving work, as with the directional loop antennae, the use of which would be a long step forward in solving the interference problem. Also, the use of recently perfected static eliminators will make it possible to use a greater degree of amplification which should permit some remarkable receiving ranges.

The question of supplying battery current for a multi-stage amplifier is best met by using a medium-sized storage battery of perhaps 60 ampere hours, and having a rectifier or charging machine at the station. With an efficient rectifier such as the Tungar or a small motor generator, such a battery can be charged once a week at a cost of about fifteen cents, whereas battery stations usually ask a dollar or more. The initial investment required will soon be repaid by the money thus saved.

The successive tubes in the cascade amplifier are coupled together by three different methods, by resistances, by impedances, or by transformers, any of which can be constructed by the amateur, or purchased at a moderate cost, so that the chief outlay will be for the tubes and battery equipment. Summing up these considerations, we find a large initial cost, larger upkeep cost, wider application for new receiving devices, and increased receiving range, which would seem to indicate that the cascade amplifier will be a necessity in the truly modern amateur station.

Arno A. Kluge—*California*.

Second Prize—Regenerative vs. Cascade Amplifier

THE regenerative audion circuit is popular for several reasons. Its low cost is the special inducement which attracts the radio amateur. The operating results are very satisfactory, amplifications as high as one hundred times being recorded. Only one tube which acts as detector and amplifier is needed, and there is only one high voltage and one low voltage battery to regulate. The number of adjustments in the secondary circuit are few, only three or four variable condensers being necessary. The regenerative circuit is almost equally effective in receiving undamped waves, thus adding to the utility of the set.

The cascade amplifier is a very fine instrument for boosting weak signals to audible ones. The principal objection to its use is the prohibitive first cost—an audion detector and several amplifier units being required. The cascade amplifier using one plate and one filament battery is just beginning to be recognized by the experimenter, and if he possesses the funds to buy a set of this kind, he will put it all over the fellow with a single bulb set.

In some cases each amplifying unit has a separate high and low voltage battery unit, and these are so closely related that an expert is needed to operate them. The amplifier is a very effective instrument; but for the average amateur it is a little beyond his reach. The regenerative circuit gives remarkable results with careful handling, and being simpler than the cascade amplifier it continues to grow in favor with the progressive radio amateur who is impressed with practical results.

R. C. Hitchcock—*Connecticut*.

Third Prize—This Experimenter Prefers the Regenerative Receiver

IT is claimed by one of the editors of a contemporary radio publication that the vacuum tube cascade amplifier is far superior to the regenerative valve for amateur work. The editor bases his claims on the matter of reliability, claiming that the regenerative set will work one minute and won't work the next; that, in some cases, it works very satisfactorily when the amateur has no traffic to handle, but when it is most needed, the bulb cannot be made to oscillate for the love of money.

It seems to me that the set to which the gentleman referred is quite typical of some of the amateur home-made regenerative sets, but I can assure him that if he has ever operated a regenerative set using the proper circuit he has a 100 per cent. fool-proof set.

If the amateur will choose a circuit which secures good amplification a good bit below the oscillating point of the bulb and if he fits his aerial change-over switch with contacts to break the "B" battery circuit while transmitting, and not the "A" circuit, he will always "come-back" from transmitting and find the bulb adjusted to almost perfect amplification. If the *filament circuit* is broken when sending—not the high voltage circuit—the "A" battery invariably picks up a bit and he finds the set completely out of adjustment when he switches over to receive. The reason for breaking the B circuit and not the A battery is that the B battery's "picking up" does not affect the operation of the bulb as much as the A battery does.

Another point in favor of the regenerative set is the matter of low cost, as compared to that of a 3-step amplifier. I will admit that the amplifier is more suitable for reception over a longer range of wave lengths than is the regenerative set, without changing as many adjustments, but as the amateur wave is pretty closely defined between 200 and 425 meters, it is a comparatively simple matter to adjust the plate inductance, be it a variometer or a tapped coil.

I doubt whether a 3-step amplifier and a detecting valve are as "fool-proof" in operation as some may believe unless a modern circuit using one filament and one plate battery is employed.

Don't you think that it is a little early to predict the use of undamped oscillating sending sets for amateurs? It certainly cannot be expected until some kind manufacturer comes out with a nice little high voltage DC motor generator set at a price somewhat in reason.

I have been wondering quite a bit lately whether we may not predict transoceanic amateur communication before so very long. There certainly must be at least one amateur in England who could help us out at that end of the line—as soon as the Britishers come out of their "ban-ishment"—and I know there are several amateurs in New York City who can most assuredly offer the best that can be had in amateur apparatus. Figure it up, and you will see that the air-line distance from New York to some city in England is not so terribly much greater than is the distance some of the U. S. "hams" covered in the long past season of 1917. In addition look at the great expanse of water we have to work over—practically all the way across. I've been thinking long and hard of this thing and want to see some of the "boys" up in New York City try it out. I feel sure before many seasons pass that it will be done. If you think it worth while trying, and to get the matter stirred up, I can give the names of two amateurs in England whom I know would be eager and willing to co-operate with our American friends in making tests.

John M. Clayton—"5 *BV*."

Electrician's Pliers

A WESTERN inventor has brought out two types of plier wrenches that will fill a long-felt want in any mechanic's tool-kit. These wrenches are quick-acting, self-adjusting, always taking a firm grip on any object that may be clamped in the jaws. Their construction is simplicity itself.

The main feature claimed for the wrenches is that the jaws are always parallel when clamping objects of various sizes whether the jaws are closed or wide open. When clamping nuts, pipes or objects of various sizes, the grip of the handle is always the same.

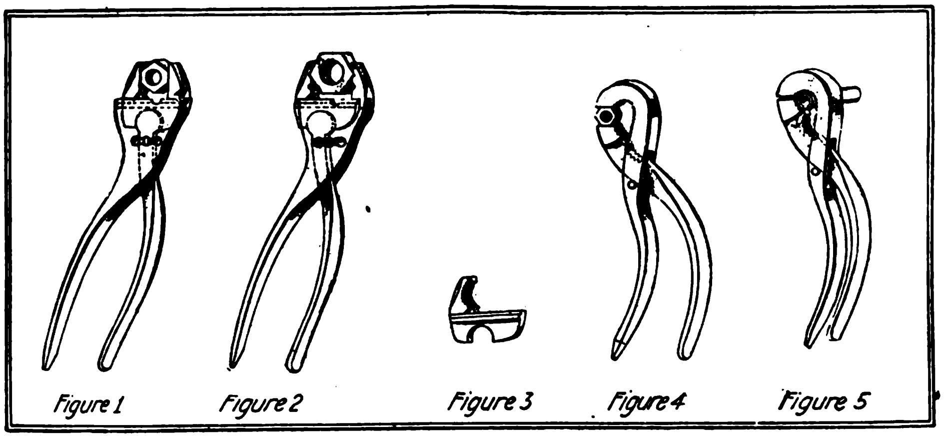
In figure 1, the jaws are clamping a medium size nut while in figure 2 they are holding a large size nut and the jaws are nearly entirely open. It will be observed that the handles are in about the same position irrespective of the jaw opening.

Drawing No. 3 shows a pipe jaw that is interchangeable with the regular jaw used for nuts. This attachment proves very valuable for loosening nuts that have had the corners rounded off. The pliers may also be used as a pipe wrench.

In sketch No. 4 a special form of pliers are shown gripping a medium size nut. It is to be noted that the jaws are parallel, and that the handles are far enough apart to give good leverage. This plier wrench has no adjustments. It is semi-automatic and self-adjusting to any size, such as nuts or pipes that may be clamped in the jaw.

In drawing No. 5 the jaws are nearly closed and are gripping a small size pipe. Note that the jaws are parallel the same as they are in figure 4 gripping a medium size nut. An eight-inch pair of pliers will take a three-quarter inch pipe. Moreover, it has a parallel jaw opening that will take in any flat object such as a nut. As these plier wrenches have hook jaws and end openings they will appeal particularly to steam fitters, electricians, automobile owners and mechanics in general.

A. C. Allen—*Illinois.*



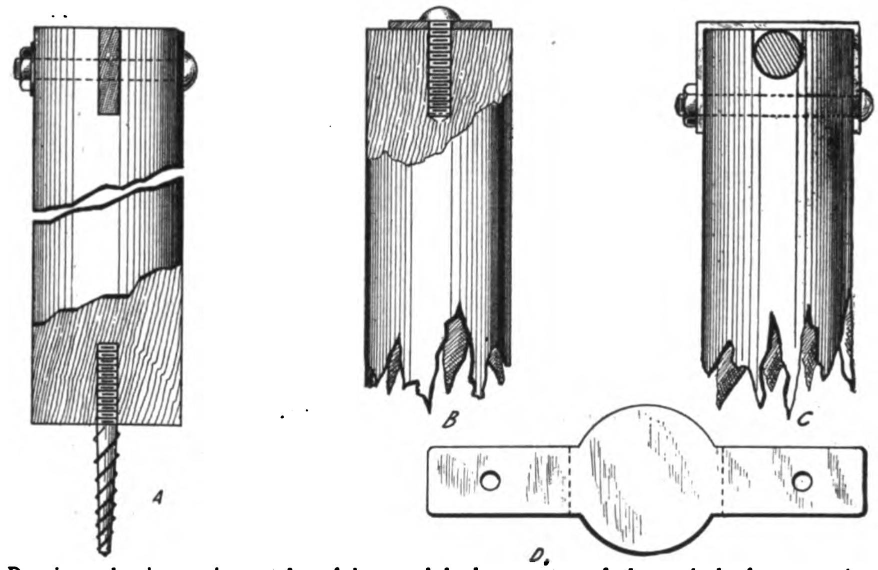
Improved mechanic's pliers suitable for extensive use

A Neat and Efficient Aerial Lead Support

IN carrying the aerial lead from the instruments to the point where it passes out of the operating room, it should be supported at intervals on neat insulated supports. Although several forms of electrose and porcelain pillars suitable for this purpose are on the market, a plain pillar of genuine hard rubber, bakelite, or even good hard fibre possesses all the desirable characteristics in the way of insulation, and further, it can be made to suit the exact requirements of the individual installation in which it is used.

The size of the rod used will vary according to the size of conductor to be carried, but ¾" diameter by 4" high will be found to possess the required mechanical strength and right proportion. There is nothing to be gained by using a much greater diameter rod than this and the expense mounts rapidly with increase in diameter; on the other hand, a smaller diameter is too weak mechanically, and gives the insulator an appearance of frailty. As depicted in the drawings, a wood screw of about No. 10 or No. 12 size and 1¾" long has its head sawed off and the smooth portion threaded with a 10-24 thread. The length of this machine thread will be about ¾". It is screwed into a hole drilled and tapped into the bottom of the pillar, leaving about 1" of wood screw thread protruding. If the conductor is flat strip or ribbon, and it is desired to support it on the pillars in an edgewise position, a slot can be sawed in the top of the rod for a depth equal to the width of strip and the same held in place by a machine screw passing through the rod and strip as at A. Where the strip is to be run flat upon the supports, it can be secured by a machine screw passing through the strip into a threaded hole in the top end of the rod, as at B.

If the conductor be of circular crosssection as in the case of wire or tubing, then the method shown at C can be used. This consists of forming a groove in the top end of the rod of such a depth that the conductor comes flush with the top of the rod when it lays in the groove. It is held in position by a cap made of a piece of sheet brass with two ears (see figure D), that extend down on either side of the rod and is clamped by a 6-32 screw passing through the same. If desired, a plain tie wire may be used in the place of the metal cap. However, this is not so good because all the sharp projections of the tie wire would be present. This should be avoided on a conductor carrying currents of high voltage and high frequency. Another and probably the simplest method that can be utilized, is to merely bore a hole through the rod to slip the conductor through, and after all the pillars are fastened in place the conductor is threaded through the holes in same. There are still other means of fastening, but they require the chasing of threads on a lathe which is not always available. When the pillars are mounted on brick walls a hole should be drilled in the wall with a star-drill and plugged with a soft wood plug to accommodate the woodscrew. If a lathe is handy, the pillars may be turned to a taper and a series of grooves may be cut on the surface of the rod. The only real requirement is that the ends be cut off square.



Drawings showing various styles of improved lead supports and the method of construction

J. A. WEAVER—*Maryland.*

The Monthly Service Bulletin of the

NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

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Radio Telegraphy vs. Telephony for Amateurs

MANY are looking forward to the time when amateur communications will be carried on by the wireless telephone instead of by the familiar wireless telegraphy. The writer is of the opinion that such a time will never be for the reasons that are given in this article.

Prior to the war the radio amateur station had reached a high state of efficiency. The entire country was threaded with the so-called "trunk lines" and the public was being well served in many localities. The short wave regenerative set was being perfected, and efficient 200 meter transmitters were a known quantity. Had not the war interfered a very high state of perfection would have been reached.

The war called many of us and gave us a taste of Government and commercial wireless operating. Many improvements were made. Vacuum valve circuits were brought down to perfection, the barrage receiver was invented, ground wires and loops came into use and static was substantially eliminated. The vacuum valve transmitter for wireless telephony has been improved to such an extent as to allow speech transmission for hundreds of miles.

The war is now over and the amateur is returning to his old line of work. Trunk lines will be carried to a point of perfection, the non-synchronous gap type of transmitter will be pushed to the limit, many amateurs will do serious work with the vacuum tube wireless telephone and some may cover distances of from 100 to 300 miles, but the end of the wireless amateur insofar as the radiophones is concerned is in sight. Large concerns have invested thousands of dollars in the wireless telephone and are going to make it take the place of the ordinary line phone. This will be possible through the use of recently perfected interference eliminators. The long lines between central stations will go down first. Their place will be taken by the high power radio telephone transmitter. Although a number of years may elapse the local lines will be the next and last to go down. Their place will be taken by short range radio telephone sets operating as before in conjunction with a central exchange.

It suffices to say that when wireless telephones become universal there will be no novelty connected with them and the amateur will look for fresher fields of experimenting which will not be the wireless telephone.

J. STANLEY BROWN.

Good Sense Dictates the Design and Mounting of a Radio Set

THE term "radio amateur" is synonymous with "experimenter." His motto is efficiency spelled with a big "E" and he forever strives to increase the range of his set with unceasing vigilance and tireless energy. In order to secure this increased efficiency, it frequently becomes necessary to rearrange and change the connections of the apparatus. Then too, in the event of the adoption of some new and up-to-date piece of apparatus corrections are also necessary.

When the instruments are mounted on a panel, they usually present a more "commercial" appearance, much desired by some amateurs. However, the progressive element are more desirous of results and are willing to sacrifice mere appearance for range. It is upon this element that progress in the art is dependent. Since it is the customary condition of the average amateur to be financially embarrassed, which means that his funds are inadequate to secure instruments which he knows will increase the efficiency of his transmitter, he will readily realize the economy of a practical and efficiently grouped arrangement of instruments. In case that he already has the instruments mounted neatly on a panel and sees that the arrangement is inefficient or an individual piece of apparatus has become defective, the cost of making the changes are increased and it is very likely that the appearance of the panel will suffer thereby.

So that if the amateur will content himself with a neat arrangement of his instruments with a view of securing maximum efficiency through shortening the connecting leads, etc., he will be amply rewarded by a corresponding increase in the effective range of his transmitter.

P. L. Welke—*Maryland.*

Suggestion for Prize Contest OCTOBER Wireless Age

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

What type of oscillation transformer is best suited mechanically and electrically for 200-meter transmission and what are the constructional details?

Hawkeye Radio Association

All radio men residing in Iowa should register their names and addresses together with all information concerning their experience, with Mr. J. W. Silcott of Brooklyn, Iowa. Reorganization of the Hawkeye Radio Association has been started by a few of the old members under a new plan with a larger scope of action. This plan is similar to that described in the February, 1919, issue of the Wireless Age.

The Association would be glad to hear of the plans of other middle west organizations. It is believed that certain details of the work of a state organization could be carried out better if all state organizations could be "leagued" together. In order to do this, there should be a similarity of scopes and aims.

The H.R.A. would like to hear discussions of the above plan.

Amateur Wireless Telephony

PRACTICALLY every live, up-to-date amateur has read and studied something of radio telephony. There have been innumerable articles and books on this subject describing the theory and practical uses of the wireless telephone. Some articles even tell how to make a small vacuum tube transmitter.

Amateurs will undoubtedly experiment a great deal along these lines and probably an efficient short distance set will eventually result. If correctly designed, a small transmitter using the ordinary audion bulb and having about 100 volts in the plate circuit is capable of transmitting the voice from three to four miles. By connecting another bulb in parallel and increasing the plate voltage, the range may be increased. A set of this kind may be easily constructed by the amateur, because many of them own audions. Although it is not meant to go into constructional details, it may be said here that it is fairly simple to construct a low amperage storage battery out of test tubes and lead strips, which, when charged by a home-made electrolytic rectifier is capable of delivering one hundred volts or more. It is, therefore, safe to say that many experimenters will construct sets of this kind for local work.

The range of communication, however, is limited. The only reason radio telephone transmitters of sufficient power to send 100 miles or over will not be used among amateurs, is their high cost. A set of this kind requires a high D.C. plate voltage, probably of at least 500 volts, and as alternating current is usually the only kind available some sort of rectifier must be used. Even then, a 500 volt A.C. source must be had. The only other way of getting high D.C. voltage is to use a motor generator.

The total cost and up-keep of such a set may be beyond the means of the average amateur. Of course, advanced experimenters may, and in all probability will, make and use sets of this kind but they are of small number.

In summary, it may be said that wireless telephony will, in the near future rival, if not take the place of wireless telegraphy in local work; that is, within a radius of about ten miles. For all other radio work, wireless telegraphy will hold its own. An efficient one kilowatt station will transmit reliably a distance of 300 miles and if a special short wave regenerative receiver is used at the receiving station, the range may be further increased. A radio telephone transmitter of this range would cost many times as much to construct and be much more expensive to operate.

RALPH FOSS—*Illinois.*

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 one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.
Positively no Questions Answered by Mail.

R. B. C., Los Angeles, Cal.:

The "hard" Marconi V.T. will meet your requirements. The "soft" bulbs are particularly suitable for detection purposes.

A book will shortly be issued by the Wireless Press that will give full details concerning the construction of an amateur wireless telephone set capable of working fifty miles. Low power vacuum tube transmitters, say of 10 watts output, do not require an induction coil to modulate the antenna currents. It will be sufficient to connect the microphone in series with the earth lead, shunting the microphone with three or four turns of copper wire wound on a mandrel 4" in diameter.

It is recommended that you purchase a small 500 volt generator to energize the plate circuit of your transmitter. One hundred dry cells will not give a potential of 250 volts.

Regarding the diagram in the Wireless Age: the middle tap leading to the tube filament need not be variable, but the taps leading to the grid and plate circuits should be variable.

In the second edition of "Vacuum Tubes in Wireless Communication" you will find up-to-date diagrams of tube transmitters, the construction of which is for the most part self explanatory.

* * *

C. S., Bishop, Cal.:

You should have no difficulty in selecting from the advertising columns of this magazine a receiving set that will meet your requirements. Several amateur manufacturers can supply you with a long wave set.

* * *

F. G. S., Graniteville, Mass.:

We do not know of any manufacturer that will supply you with a vacuum tube wireless telephone set. So far this apparatus has only been manufactured for the government. Any vacuum tube receiving set will record wireless telephone signals.

* * *

J. R. P. Jr., Parkersburg, West Va.:

You can reduce the power input of your transformer to 1/2 kw. by connecting a reactance coil in series with the primary. Wind up a choke of 4 layers of No. 10 wire on a core 2" square and bring out several taps at regular intervals. The core should be 14" long.

* * *

A. S. K., Great Lakes, Ill.:

Regarding the variometer described in the May issue: It is intended that the field frames have 30 turns each, and the rotating balls 32 turns each.

* * *

H. S. W., Dover, Ohio:

You will undoubtedly find it a difficult matter to eliminate the inductive interference from the high tension power line you mention. Some amateurs have achieved success by running a small aerial parallel to the power line and coupling it inductively to tuner secondary in such a way that the currents induced in the receiving circuits will be opposed.

* * *

H. G. F., Bensenville, Ill.:

The vacuum tube detector is by far more sensitive than silicon or any other crystalline detector. All of the textbooks issued by the Wireless Press, pertaining to radio, contain diagrams applicable to your needs.

* * *

A. B. L., Chicago, Ill.:
The secondary of a spark coil or a high voltage transformer often is suitable as an intervalve coupling in a cascade amplifier.

The impedance of the intervalve coupling should at least be equal to the internal impedance of the tube. If the impedance of the tube is known, a number of secondary transformer pies of equal impedance can be selected. The impedance of any choke may be measured by connecting it in series with a 500 cycle source. A voltmeter should be connected across the coil, and a milliammeter in series. The reading of both should be noted and the resulting data inserted in the formula $Z = \frac{E}{I}$, where Z = the impedance in ohms.

Some telephone receivers have sufficient impedance to be used as intervalve couplings. The impedance of one standard headset at 500 cycles is 22,000 ohms. Two such telephones in series will be sufficient for the average valve.

Two megohm resistances are used as intervalve couplings with the Marconi V.T. A booklet accompanies each valve showing the best circuits for reception.

* * *

D. R. J., Boston, Mass.:
The bi-directional, direction-finding set is practically as good as the uni-directional instrument. The latter is a little more difficult to adjust than the former, particularly when it comes to making the first calibration. A single frame aerial 4 or 5 feet square will do for long wave reception provided a cascade amplifier is employed. Signals have been received several thousand miles with coil aerial erected indoors and outdoors. They are entirely practical for amateur communications provided the receiving set is sufficiently sensitive for long distance working. A book will shortly be issued by the Wireless. Press giving complete data on such aerials.

* * *

K. R. Z., Schenectady, N. Y.:
Merchant vessels are gradually being returned to private ownership and as this is done, the naval operator is replaced by a civilian operator. There are plenty of opportunities for employment. It is, in fact, somewhat difficult to keep pace with the demand for qualified radio operators. Only those possessing first grade government license certificates are employed in the Marconi service and many appointments are made each week. The situation in so far as the operator is concerned was never better. Good salaries are being paid and permanent employment is assured to those who make good.

It requires about four months instruction to train a beginner to pass the government license examinations. Some men require a longer period of training.

* * *

B. L. A., Andover, Ohio.:
A "Vernier" variable condenser is of considerable value in vacuum tube receiving sets, particularly when receiving wireless telephone conversations. Extremely close tuning is necessary for the best results.

The only high power wireless telephone station at present in operation is that located at New Brunswick, N. J. The output of a 200 kw. radio frequency alternator is modulated by a magnetic amplifier which in turn is controlled by a bank of vacuum tubes and a microphone. We are not familiar with the exact schedule but the station is frequently heard talking at the wave lengths of 8,000 meters and 13,600 meters. The antenna current at New Brunswick for telegraphy is 450 amperes.