September, 1919 20 Cents

The WIRELESS AGE

Volume 6 Number 12

Wireless Achievements in the A. E. F.

By Lieut. Col. L. R. Krumm and Capt. Willis H. Taylor, Jr.

Across the Ocean on the NC-4.

Second Instalment, by Ensign Rodd

HATS OFF TO THE NAVY

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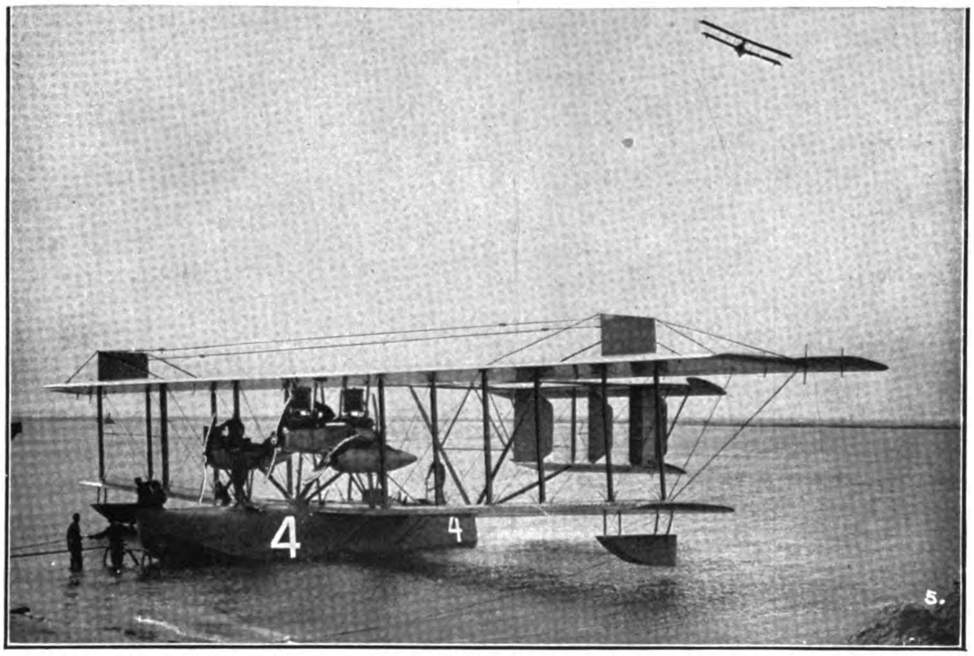
Extract from New York World, June 3, 1919.



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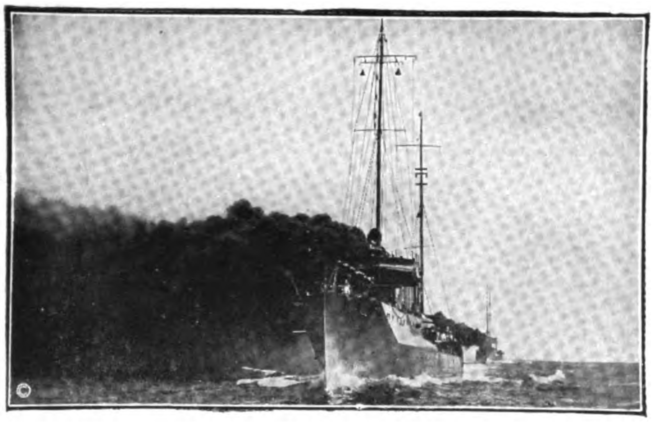

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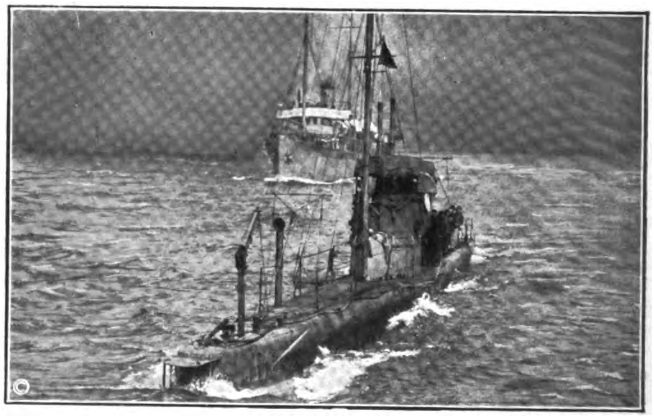

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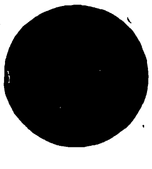

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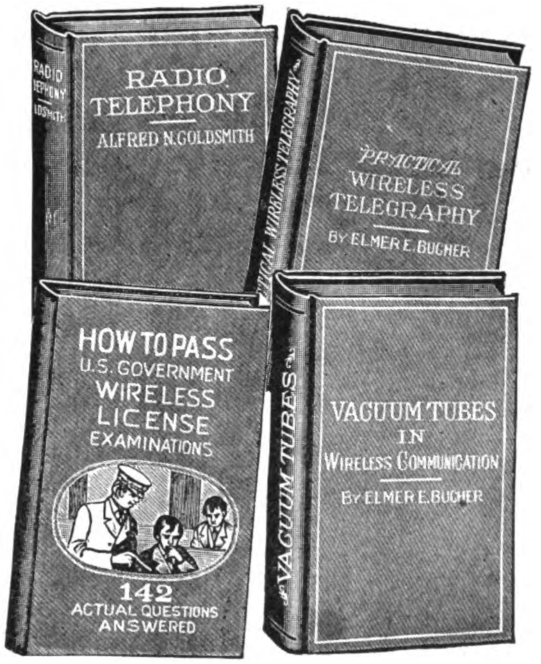

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The Wireless Age

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Published Monthly by WIRELESS PRESS INC. **233 Broadway, New York**

Edward J. Nally, Pres. **Charles J. Ross, Vice-Pres.**
David Sarnoff, Secy. **George S. De Sousa, Treas.**
J. D. Conmee, Business Manager

Yearly Subscriptions in U. S., $2.00
Outside U. S., $2.48; Single Copies, 20 cents
Entered as second class matter October 9, 1913, Post Office at New York, N. Y., under the Act of March 3, 1879

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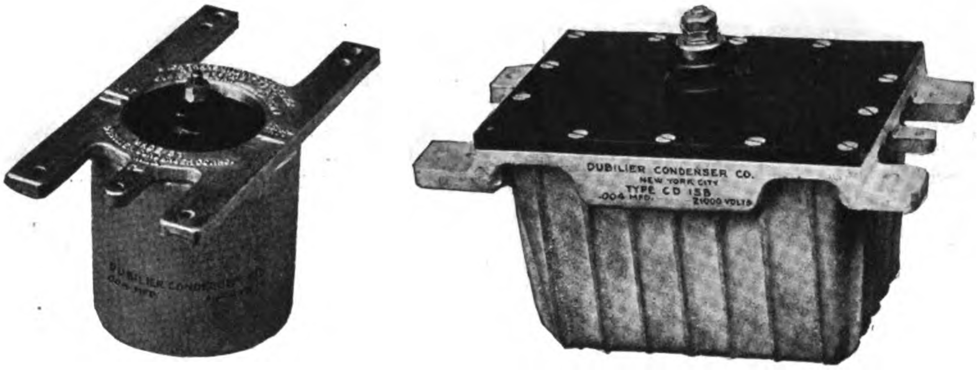

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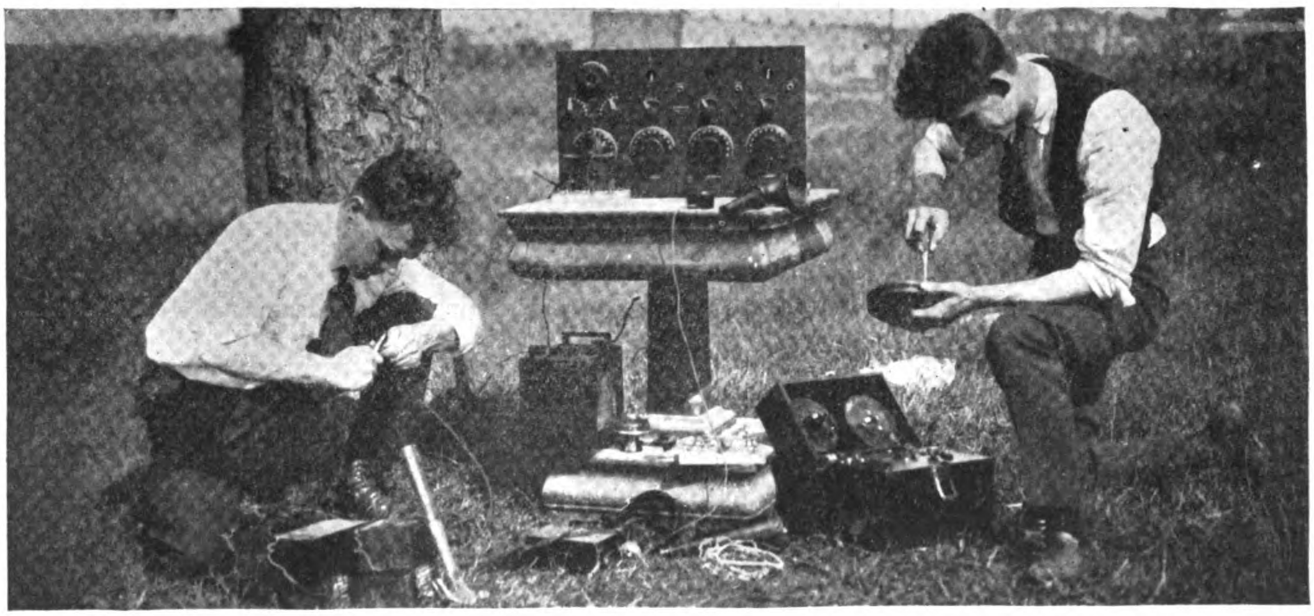
Wireless in the Wood

So considerable were the improvements made in the use of tree antenna for wireless communication during the war period that interest has been revived in amateur experiments along that line. Long distance transmission and receiving, duplex operating and radio-telephony has been accomplished

The receiving apparatus shown above is of the modern type; the picture shows the rear view with the Marconi V. T. bulbs being placed in position

On the left is a view of the method of rigging the lead-in wire



Walter Wehmann on the left and James Candido on the right are two of the number of tree-antenna-enthusiasts

Vol. 6. No. 12. September, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

New Method of Producing Electric Current for Use in Wireless

According to "Norges Handels og Sjofartstidende," Engineer Hermod Peterson has recently patented a device for the production of electrical current for radio-telegraphy. The electricity is received by an accumulator, which releases it at certain intervals. The system is sparkless, and the sounds are clearer than in the older inventions. The clearness of sound depends upon the regularity of the current, and with this system the current is released with a mathematical exactness. The device has further advantages in that it is cheaper, simpler, and more durable than those now in use.

If the claims made for this invention prove well founded it is thought that it will mark a distinct step in advance of what has so far been accomplished in this line, and hence its possibilities are creating considerable interest in the radio world.

Wireless to Aid Mail 'Planes

The Post Office Department has contracted for the erection of three high-power radio stations, the first of a chain of wireless communicating centres in various cities to be used primarily for the direction of mail-carrying airplanes handicapped by fog.

Stations will be established at Bellefonte, Pa., and Cleveland, Ohio, with a third at some point on Long Island or at Newark, N. J. Appropriations for them already are available. Others will be erected at Washington and Chicago as soon as Congress provides funds.

Each station will be equipped with steel towers 200 feet high and 300 feet apart and will have a range of approximately 400 miles to mail airplanes and approximately 700 miles between stations, the difference in range being due to the lesser sending ability of airplane wireless equipment.

Establishment of the radio stations will enable the Post Office Department to maintain communication between cities having air post delivery independent of telegraph and telephone services in the event of a disruption of service by storms or other causes.

Wireless and the Hidden World of Vibrations

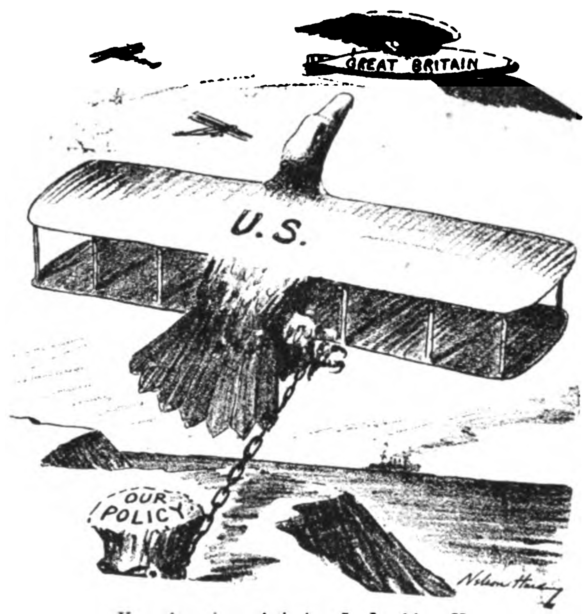
That communication with the dead may be made as commonplace a matter as is wireless communication with a person in Europe at the present time, was the remarkable statement made by Dr. Frederick Finch Strong, of the Krotona Institute at Hollywood.

Experiments have been made there, it was announced, demonstrating the methods which, when further extended, will accomplish this amazing result.

The Krotona experiments give rise to the hope that a technique, whereby new forces and kinds of matter may be revealed.

A sort of transformer process for the dull human senses is being worked out in the hope of proving by means of actual communication with the dead the theory held concerning the continuity of life after death.

One experiment which leads to the belief that any number of things may be camouflaged under a kind of color which makes it impossible for the eye to detect is with ultra-violet rays. Rare minerals, which respond to certain wave lengths, take up and transform them so that they become visible.



Yes, American Aviation Is Looking Up.
—Harding in the Brooklyn Eagle.

Playing Checkers by Wireless

A game of checkers by wireless has been played by two Delaware men, who flash their moves back and forth through the air between Wilmington and Greenville, Del. They are Fred R. Fooding of Wilmington, an official of the Delaware Bank and a licensed radio operator, and William Anderson of Greenville, a student at Delaware College.

The first game of the series lasted an hour and a half. At the end of the period each player had six men on the board. As each player flashed his move on the checkerboard to his opponent he made the move on the board in front of him, which was duplicated by his opponent.

This item is contained in current news, without any explanation, however, of how the ban on transmitting was overcome.

Marconi International Cable Code

IT is announced that the Marconi international cable code, being published in parts of the United States and Great Britain as rapidly as completed, will, for the first time in history, permit people of nine languages intelligibly to communicate with each other without need of translators. The languages to which the code is adaptable are English, French, Spanish, Portuguese, Italian, German, Dutch, Japanese and Russian. Since the code includes phrases of commerce, law and finance likely to be used, however technical, it will be very voluminous and will, for practical purposes, far surpass Esperanto or any other artificial language for international use. The code words will be the same, but, of course, there will be necessity for a book for each of the nine languages. It is said that hundreds of business experts and linguists have been engaged for three years in preparation of the code, and it has been called "the concentrated essence of a lifetime of code study and compilation."

Not only can an American business man, by consulting the English code book, send a code message to a Spanish merchant, which the latter can immediately transcribe by looking up its meaning in his Spanish code book, but the misunderstandings so common in the translation from one language to another will be obviated. The message will be concise and unequivocal to the Spanish as well as to the American. It would be hard to overestimate the advantage that such direct communication will be in facilitating international business.

Marconi took a gigantic step in annihilating distance and bringing nations together when he completed the commercial wireless. The international cable code provides one of the greatest facilities for making it effective. There are other changes, in the interest of better service, such as a condensed manner of sending figures and a letter combination code that permits the sending of two words for the usual cost of one.

Conquering Fog by Means of Wireless

GUGLIELMO MARCONI'S new invention for the purpose of protecting vessels during a fog was discussed recently at the annual meeting of the Marconi International Marine Communication Company, Ltd., in London. Godfrey Isaacs said:

"This new discovery provides a means whereby a ship in the densest fog may discern the approach of another ship, provided that that ship be also fitted with this apparatus, at the same time giving an approximate idea of the distance of the approaching ship. We are at present engaged in giving commercial shape to this new apparatus, and as soon as possible its value on board ship will be demonstrated. We have great hopes that by this means all risk of collision at sea during the thickest fogs will be eliminated, to which end, of course, every ship would have to carry the apparatus, for it stands to reason that if a great liner were fitted and a small tramp were not, the danger of collision and the loss of one or the other, or both, of the ships might result.

"Inasmuch as this new device should provide means of disposing of that which is so great a danger in misty and foggy weather, it is not unlikely, we think, that every ship which goes to sea will be eventually fitted with this new installation, and we shall all be spared the harrowing accounts of the terrible losses which from time to time it has been so distressing to read in the daily press resulting from some terrible collision at sea."

Wireless Between U. S. and Germany Resumed

WIRELESS communication with Germany has been resumed in a limited way by the American government. Business communications between American houses and their agents in Germany are accepted in New York at 44 Whitehall Building, and other points where the navy has district communication officers for transmittal to the trans-Atlantic wireless stations at the Navy Department here and at Otter Cliffs, Me., where they are dispatched to the receiving station at Nauen, Germany. Similar communications are dispatched from Nauen to the United States stations. Press dispatches to the extent of 500 words from this country and a similar number of words from Germany are also accepted daily.

British Government Pays $2,950,000 to Marconi Co.

AN AWARD of £590,000 ($2,950,000) damages was given to Marconi's Wireless Telegraph Co., Ltd., in a suit for breach of contract brought against the British government. The contract was in connection with the construction of the Imperial Wireless System.

The Marconi Company claimed it was entitled to £7,180,000, basing their claim on a provision in the contract that it was to receive royalties amounting to 10 per cent on the gross receipts from the stations for the entire period of the contract, which was to have run for twenty-eight years. The government claimed the damages payable to the company amounted to £50,000.

Wireless on All Ships Over 150 Feet Long

THAT all passenger ships more than 150 feet in length entering or leaving any port or harbor in the United States shall be equipped with wireless is provided in a bill introduced in the House at Washington by Representative Britten, of Illinois.

It is provided also that all United States Coast Guard stations shall be equipped with wireless.

Increased Earnings of English Marconi Co. for 1918

MARCONI'S Wireless Telegraph Co., Ltd., reports for 1918 a profit of $1,989,500 against $1,919,000 in 1917. Dividends on the ordinary shares were increased from 20 to 25 per cent and on the preference shares from 17 to 22 per cent. General reserve was increased by $750,000 to $7,250,000. Shares of associated companies are shown in the balance sheet at a cost price of $6,825,000, compared with a present par value of $11,730,000.

Energy Transmitted on Wireless Waves.

WIRELESS telegraphy and wireless telephony, now commonplaces, suggest the possibility of transmitting energy by wireless waves. A Roumanian engineer, M. Constantinesco, has been experimenting in England with a method that seems novel.

He uses a tube filled with water or some such liquid in which vibrations of the nature of sound waves are produced at one end and the energy is reconstructed at the other end in a mechanical form. The details of the apparatus are kept secret, but Constantinesco's researches have been financed by the British government, and it has already been applied in the mechanism that stops the discharge of bullets from the rapid firing gun of an airplane each time that the blade of the propeller passes before the muzzle.

Wedded by Wireless While Flying in Airplanes

MISS EMILY SCHAEFFER of Sea Gate, L. I., and Lt. George Burgess of Brooklyn, were the principals in a wedding ceremony that featured the second of the two Police Field Days held at Sheepshead Bay. They flew in a plane piloted by the groom who is an aviator attached to the Mineola forces. In the second plane the Rev. Alexander Wouters of the Edgewood Dutch Reformed Church, the first real "sky pilot," flew, with Lt. Eugene Barksdale, the best man as pilot. A long streamer of bunting indicated the bride's plane.

Dr. Wouters conducted the service with the aid of a wireless telephone. The bride and groom were fitted with telephones too. Gov. Smith and Mayor Hylan had receivers, and there were thirty-two receivers for that many of the bridal party in the grand stand.

Besides that, there was a megaphone-like do-dad in front of the centre of the grand stand from which the voices of the contracting parties and of the minister issued. More than 100 persons, who were crowded round, probably heard the voices from this instrument.

Mrs. Burgess, who is 26 years old, the same age as her husband, now a radio instructor at Mineola, tells a thrilling tale of how she met Lieut. Burgess.

"I met my husband, Lieut. Burgess, about six years ago when I was canoeing with a girl friend. He was then the assistant manager of the radio station of the Marconi Wireless Telegraph Company at Sea Gate. The canoe suddenly pitched, as canoes do, and my friend was thrown into the water. The lieutenant saw the accident from the shore and came to our aid in a boat. He rescued my friend and of course we thanked him and our acquaintance began.

"I am interested in the radio code and understand it. When we talked over our wedding, it was suggested that we get married in an airplane by radiophone to demonstrate its wonderful possibilities."

Big Danish Wireless Station

OFFICIAL announcement in Washington that Denmark is making plans to open wireless communication between Copenhagen and the United States, has been made by the Danish Legation. This statement has been made public:

"Information to the effect that regular wireless connection has been established between Denmark and Great Britain has just been received by the Danish Legation here. Plans are now being worked out by the Danish Ministry of Traffic for erecting a great trans-Atlantic radio station near Copenhagen which will put Denmark in direct wireless communication with the United States.

"Danish newspapers complain that their telegrams for some time have been greatly delayed because of the crowded cables. The Danish papers express the hope that the still important plan for a great trans-Atlantic station will soon be realized. The Danish press is anxious to get into direct communication with America so as to be able to obtain news from over here at first hand and at reasonable rates.

"The Danish wireless station at Lyngby is at times able to hear the American station at Arlington talk to Rome, but is not powerful enough to send messages over the Atlantic. The plans now under consideration by the Danish government call for the erection of a trans-Atlantic wireless station."

Postal Wireless Service Throughout British Empire

POSTAL wireless service, to extend throughout the British Empire, has been provided for by the House of Commons in voting 170,000 pounds for the project. The first stations will be opened between England and Egypt. The service may begin by the end of the year.

Eiffel Tower Revives Ancient Custom

AFTER the peace treaty had been signed by Germany's representatives in the Hall of Mirrors at Versailles the Eiffel Tower wireless station sent broadcast the massage "Fermez les portes" ("Shut the doors"). The phrase, as many will understand, was suggested by the fact that when peace was declared in ancient Rome the doors or gate of the Temple of Janus were closed.

Lieut. Durrant of the R-34 Describes Wireless Equipment

LIEUT. REX F. DURRANT, wireless operator of the R-34, speaking of the radio apparatus used during the trans-Atlantic flight, said:

"We had the wireless direction finder on board, known as the maximum method. We had a range of 300 miles. We got very good bearings on Cape Race. All the Canadian wireless compass stations helped us a great deal in our navigation.

"We had a main transmission set using continuous wave with a range of 1,200 miles and a wireless telephone with a 100-mile radius. We also had an auxiliary continuous wave set and an emergency spark set. All these sets functioned perfectly during the voyage.

"We were never out of wireless touch up to the time we passed Newfoundland. We were in direct constant communication with Clifden, Ireland. We were in touch with the British Air Ministry every two hours. We held the Air Ministry wireless station on top of the Hotel Cecil in London half way across the Atlantic. In mid-ocean we were in direct communication with Clifden, Canada, and the Azores at the same time. We carried 400 feet of trailing aerial, for use on all the sets except the direction finder, which was worked by coils.

"The small spark set was excellent. Cape Race read it at 300 miles, although it had only one-tenth of an electric horse power.

"As a result of my experience on the voyage I am designing a larger coil for the direction finder set on these ships. Also, as a result of my experience it has been proved beyond doubt that continuous waves will be the future means of wireless transmission."

Marconi Wireless Rig on Yacht

THE yachts in the Long Island Star class in the annual race to Captain's Island and return included a Star boat with the new Marconi rig, so called because the method of arranging stays makes it resemble the mast of a wireless station. It is the first time that the righ has been put on a boat of this class, and the innovation was watched with the greatest of interest by all yachtsmen.

Donald Cowl is the Corinthian who is trying out the innovation. The yacht that he has altered was formerly the original Little Dipper, the property of G. A. Corry.

Distinguished Service Medal awarded in the name of the President by Gen. Pershing to Lieut. Col. Krumm for "exceptionally meritorious and distinguished services," due to "masterful ability and exact scientific knowledge"

Lieut. Colonel Louis R. Krumm

The famous French decoration, the Legion of Honor, conferred upon Lieut. Col. Krumm and establishing him among the few American officers who have been admitted as Chevaliers to the century-old order founded by Napoleon

The Authors of Wireless in the A. E. F.

Colonel Krumm is best known to wireless men as Chief Radio Inspector, Bureau of Navigation, Department of Commerce, a position which he has held since 1912. He has degrees of mechanical and electrical engineering from Ohio State University and for seven years served as an electrical engineer, Signal Corps. He was commissioned a reserve Captain in this branch of the service in May, 1917, and within three months was promoted to Major, sailing for France, Sept. 27, 1917. His elevation to the rank of Lieutenant Colonel preceded the Armistice by two weeks, recognition of efficient direction of the Radio Division during the entire term of his service in the A. E. F.

Captain Willis H. Taylor, Jr.

Captain Taylor, a graduate mechanical engineer of Stevens, received his reserve officer's commission as 1st Lieutenant, Signal Corps, two months after war was declared. For six months he was assigned to recruiting for the radio branch, going overseas in December, 1917. Four months later he became assistant chief of the Radio Division, A. E. F., and thirteen months after his enlistment was promoted to the rank of Captain. General Pershing mentioned him in a citation for "exceptional and meritorious services" as the officer responsible for the co-ordination of the work of the other Sections in the A. E. F. and maintenance of liaison with the Radio Division at Washington

Wireless in the A. E. F.

First Authentic Account of the Organization of the Radio Division of the Signal Corps and an Inside View of the Great Obstacles which Americans Had to Overcome

By Lieut. Col. L. R. Krumm

Officer in Charge Radio Division, Signal Corps, American Expeditionary Force

and Capt. Willis H. Taylor, Jr.

Co-ordination Officer, Radio, Division, Signal Corps, A. E. F.

IT HAS been a commonplace saying in all articles relating achievements of the Great World War that it was a contest of science and skill.

In no branch of an army's activities is this better exemplified than in the utilization of the wireless method of communication. Thus the prepartion of articles recounting the work of the U. S. Army Signal Corps and its use of radio telegraphy and telephony for military purposes has presented the problem of selection from superabundance, leaving the authors confronted by the difficulty of picking out from the mass of material available those things which will best reflect the magnitude of the task and its accomplishment. In this and the succeeding articles of the series there will be set down without embellishment those historical and technical facts which appear to be of most interest. not alone to the radio profession but also to the general public.

The Authors in the headquarters of the Radio Division at Tours, France

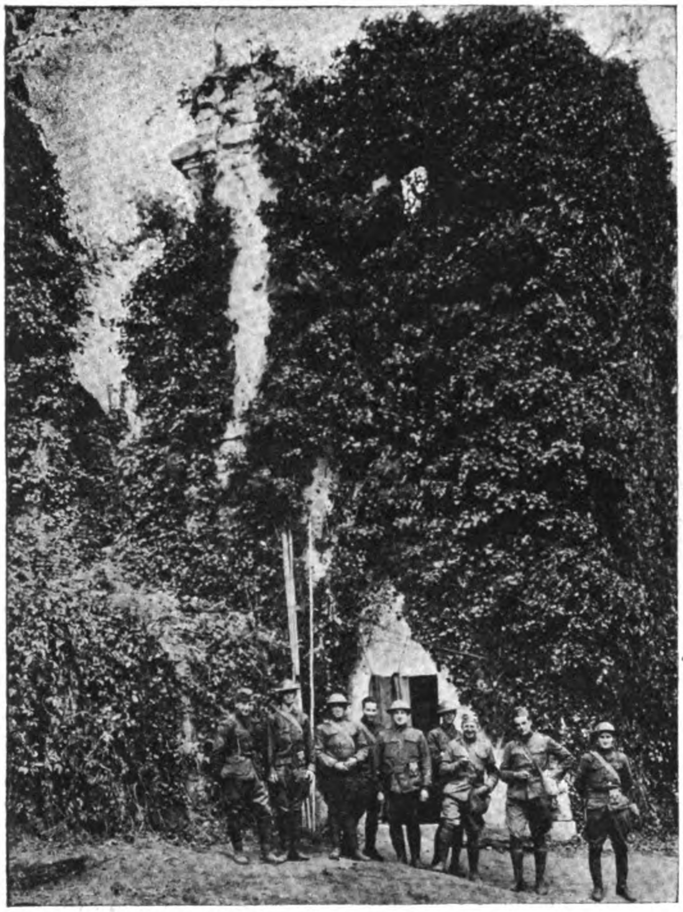
The absolute unpreparedness of the American Army for a war of the magnitude of this one is a matter of universal knowledge; nowhere was it better indicated than in the radio equipment and personnel available to the Signal Corps when this country entered the war. Only two types of military radio equipment had been developed and put in use; these were the ¼ kw. 500 cycle quenched spark pack set, adapted to be transported on mules and provided with a hand driven generator, and a 2 kw. 500 cycle quenched spark automobile set. Both were fairly good equipments of their types, quite satisfactory for warfare such as might be encountered on the Mexican border. Unfortunately neither of these sets was suitable for use in the European war, so that it may be said that the U. S. Army, at the time of the declaration of war against Germany, had no suitable radio equipment for its signalling troops. This was demonstrated. Some of these sets were sent to France, but were never used for transmission during operations. Practically all the radio equipment used by the American Expeditionary Forces was of French manufacture, for the development and production of equivalent material in the United States on a quantity basis was not accomplished until about the time the armistice was signed.

It is interesting to note that after the armistice, an effort was made to utilize one of the pre-war 2 kw. spark tractor sets at Spa, Belgium, to provide communication for the American section of the Armistice Commission which had its headquarters at that point, but its use caused such interference with the undamped wave sets of the stations of the other allied armies as to make the American army decidedly unpopular from a radio standpoint. The station had to be replaced by an undamped wave set, the sharper turning of which permitted the simultaneous operation of the different sets in that vicinity. Spark sets having more than 100 watts transformer input were decidedly *de trop* with the Allied Armies in France, and the extensive use of vacuum tube undamped wave transmitters—even with the very front line troops—was decidedly contrary to the previous practices or principles of our Signal Corps. In a later article a detailed description of these sets will be given; at this time it will be sufficient to say that the suitability of this type of equipment to meet the trying conditions of war communication was most thoroughly demonstrated.

The many special functions of the radio personnel will also be described later, for it should be observed here that the diversity of employment was developed to a point which it is probable that few officers of the Army before the war had thought of, much less provided for.

Brigadier General Edgar Russel, Chief Signal Officer, American Expeditionary Forces, who arrived in France in June, 1917, had seen long service and distinguished himself as an officer in the Signal Corps, having served in Mexico and the Philippine Islands. He was well aware of the inadequacy of our Army's radio personnel and equipment and realized that it would not be easy to overcome the deficiencies. The problem of personnel was similar to that of all other branches of the service. Men could be given their initial and fundamental training in the United States contemporaneously with the training of the other services. But equipment in enormous quantities and especially constructed for war uses had to be provided from the beginning, and radio equipment of this character was not available in the United States. There were experienced American manufacturers to be called upon, but their capacity was limited and the large requirements of the Navy demanded added output. It soon became evident to General Russel that his supply must come from one of our Allies. Soon after his arrival he arranged with the French authorities to obtain from them the necessary radio and T. P. S. (ground telegraph) equipment for our troops until such time as these could be supplied from the United States. His foresight in this direction will be further emphasized in the story of supply.

The French Army made greater use of undamped wave sets than any of the armies. The probable reasons for this may be of interest. Prior to the war it was a well-known fact commercially that the German spark sets were superior to the French spark sets. At the beginning of the war, so French officers told us, the German Army's radio equipment and communication was considerably superior. The French, realizing the necessity for better equipment, wisely appreciated the possibilities of vacuum tubes for transmitting and receiving; then decided, therefore, that the use of spark sets would be restricted to those types suitable for front line work, where simplicity is the controlling factor. For all other wireless communication they adopted undamped wave sets which used the same type of three-element tube for both transmitting and receiving, thus greatly simplifying their supply problem.



The very old and the ultra-modern joined hands in wartime when a divisional wireless station was installed by American men of the Signal Corps in this ancient chateau, erected about 500 A. D.

Now as to the importance of wireless. Radio telegraphy, it must be remembered, is essentially the emergency communication method of the Army. In trench warfare where positions were permanent and troops did not change their lines—in some cases for years—wire communication was preferred and desired: very complicated wire systems were installed and maintained even under conditions of greatest difficulty. But even in these positions, radio stations were provided to take up the burden of maintaining communication in time of heavy shelling, when the wires were broken and could not be repaired. In mobile warfare, on the other hand, radio immediately demonstrated its superiority over all other means of communication and those officers best qualified to judge are convinced of its even greater utilization in future wars.

Radio operations take on the general character of the other activities of an army in that, in a general way, they can be divided into offensive and defensive classes. The use of this classification in regard to communication may seem strange, but it can be easily explained. Offensive radio may be considered as its use in establishing and maintaining communication during battles or other operations in the same manner as the telephone and telegraph or visual signals are used. The superiority of radio at such times is at once evident, for any method of communication requiring wires is too difficult to erect and is entirely too vulnerable to injury in the deluge of artillery projectiles hurled in modern battles.

The one fault in wireless communication which has not been practically overcome to date, although the problem is now under consideration in many laboratories, is that it cannot easily be made a selective or secret means of communication. The fact that all radio work can be heard by the enemy brings us to the so-called defensive radio. If the enemy can overhear your radio stations, he is equally handicapped by the fact that you can hear his, and therein lies your opportunity to profit by the old adage that "forewarned is forearmed."

In the mobile warfare that brought us the victory, ground telegraphy proved to be practically worthless and will probably be displaced in future wars by small wireless sets using loop antennae.

Wireless equipment for tanks was one of the problems that long defied solution. A set was finally developed that makes possible communication with the post of command and co-operating airplanes.

As might be expected, military communications are never transmitted in plain language. Code is always used. Cipher has been discarded because it requires too much time to encipher a message for transmission and because it can be accurately deciphered by mathematical methods.

Phrase code was used principally, and was frequently changed. In spite of all precautions, however, one of the main sources, if not the main source, of intelligence regarding the enemy's projected operations lay in the interception of messages by the Radio Section (Intelligence) of the Signal Corps. These Radio Sections (Intelligence) were the defensive radio organizations of the army. Whereas each combat division numbered among its troops a Field Signal Battalion included in which was one company of 75 men, assisted by certain men of the outpost company and some from the infantry signaling detachment, which was expected to maintain the radio communication within the division, the Radio (Intelligence) Section was not attached to any unit smaller than an Army and was expected to cover our entire front and operate wherever needed. In addition to the duty of intercepting messages from ground and airplane radio stations of the enemy, these men were charged with the responsibility of locating them by direction finding or goniometric stations, noting the channels of communication and every characteristic that might tell us how many and what troops were opposing us, and their probable plans for our future destruction. How the plotting of the location of stations and channels of communication clearly indicated the enemy's organizations is a fascinating subject; the methods used will be explained in a future article, as well as the counter efforts of the enemy to confuse our radio intelligence operators.

Included in the duties of the Radio Section was the operation of the so-called Listening Stations. These stations were intended to intercept all messages from the enemy's T. P. S. (ground telegraph) stations and all grounded telephone or telegraph lines. Grounded lines were never intentionally used by any army in the latter part of the war, but no electric circuit could be maintained in a proper state of insulation and balance which would prevent our listening stations intercepting the messages carried thereon if it was anywhere near us, as was the case during the position or trench warfare stage.

Low frequency amplifiers were connected to long leads running to grounds placed as near the enemy lines as possible. The stations were necessarily installed in dugouts within a few hundred feet of the front line trenches and the experiences of the men who were assigned to operate and maintain these stations were among the most heroic of the war. As the effectiveness of these stations depended upon the nearness of their grounds to the enemy's wire lines, our men when carrying these ground wires over into the enemy's territory, performed some of the most daring deeds of the war. One of the subsequent articles of this series will tell how these expeditions were carried out; how one of our men actually went over into the enemy's trenches and connected to important lines of telephone communication, enabling us to intercept Hun conversation for several days before it was discovered.

This ground telegraphy—developed by the French during the war and known to them as the T. P. S. (Telegraphie par Sol)—was made practically possible by the development of amplifiers utilizing three-electrode vacuum tubes. The transmitter consists essentially of a 50-watt induction coil, the primary circuit controlled by a telegraph sending key in series with the storage batteries carried as the source of power. The secondary of the

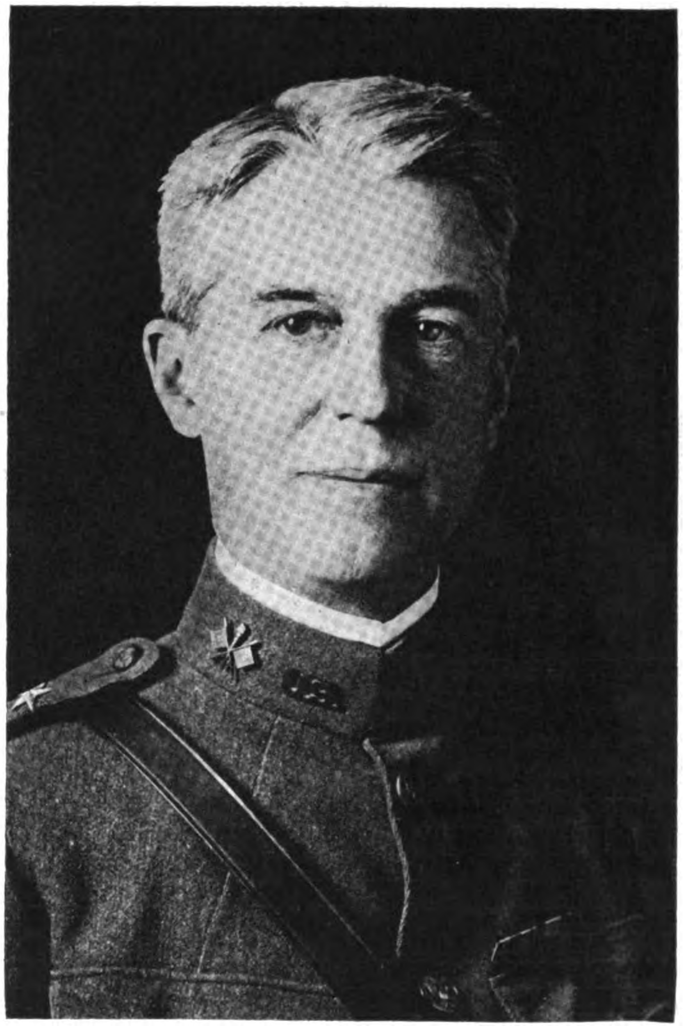
One of the main sources of intelligence regarding the enemy's projected operations lay in the interception of messages by the defensive radio organizations of the U. S. Army.

So-called listening stations were installed in dugouts within a few hundred feet of the front line trenches; the experiences of the men who were assigned to this duty were among the most heroic of the war.

induction coil is grounded through wires carried to grounds about 100 yards apart. Transmission is effected by the lines of flow of current between grounds which are intercepted by the receiving station. Audio frequency amplifiers, such as were used in the listening stations, were used for receiving, the receiving amplifier being also connected to ground plates separated by distances of 100 yards or more. It is a very crude means of communication, because of its efficiency being so dependent on local conditions; its use therefore, was necessarily limited, but in trench warfare of fixed positions it served very well in many places of favorable terrain.

In the mobile warfare that brought us the victory it proved to be practically worthless and ground telegraphy will probably be displaced in future wars by small but efficient portable radio sets using loop antennae. In open warfare T. P. S. stations soon lost track of their relative positions and consequently lost their communication when endeavoring to establish a station in a new position. One of the greatest defects in this means of communication was found in the necessity for the long ground leads which were difficult to maintain, and the requirement for ground circuits of the receiver to be in such relative position as to intercept a maximum of potential and current. The system was never reliable for more than 2,000 yards, and then only under the most favorable conditions. Where a river or other low resistance path for electricity intervened between the transmitting and receiving station the distance was reduced proportionately. But for several years T. P. S. was the main reliance of the French, and for a time of our own troops for front trench line emergency communication. In an attack at Seicheprey our troops in repelling the attack used this means of communication, whereas the Boche carried over with him a portable radio set of the spark type and also a telephone line which was extended with the advance. His reasons for carrying the radio seemed rational, and judging from the telephone circuit, he evidently expected to occupy the position permanently. The fact that both means of communication fell into our hands before the fight ended indicated a miscalculation on his part.

The enemy also used ground telegraphy in the front trenches which made the establishment of our listening stations essential, so that these could fulfill their intelligence-gathering function for this means of communication exactly as did the radio intercept stations in gathering the enemy's messages from the air.



Brigadier General Edgar Russel, Chief Signal Officer, A. E. F., who early in the war realized the inadequacy of our army's equipment of apparatus and personnel; his foresight contributed largely to the eventual success of the American signalmen

Ground telegraphy (T. P. S.) messages were coded of course, but no code or rules or regulations have ever been devised which will prevent indiscreet conversation over the telephone. German efficiency experts evidently failed to devise any means to prevent these leaks and German conversations were constantly overheard. This required that all of our men employed in listening stations should understand German readily, as well as have the ability to record telegraphic code. As a matter of fact ground telegraphy sending is necessarily slow; interception of the code was found to be much easier than the determination whether a faint gutteral voice from the enemy's line was demanding more ammunition or more men. At first we endeavored to get German-speaking radio operators, but the supply was limited; so we selected men who understood the German language and taught them code at the same time when we were coaching them in the use of the equipment and the German military phrases they might expect to overhear.

Another, and possibly the most important function of these listening stations, was the so-called "policing" of our own telephone lines. We knew that alert German ears were also pressed to receivers of their listening stations and could overhear indiscreet language on our lines. Code names were provided for all places, units and common subjects of conversation over our lines, but in the press of action—and, sometimes, even in the quietest hours—our officers failed to realize the danger of using plain English and neglected to obey the orders and instructions forbidding its use. Our listening stations were constantly on the alert for these indiscretions and many a high ranking officer was embarrassed by having a verbatim report of his careless words handed him a few minutes after he had completed a telephone conversation.

A radio intelligence detachment was housed in this old barracks when the Boche became suspicious and put over a few shells; the soldier is standing in one of the resultant holes

As has been stated, a perfectly balanced insulated metallic telephone circuit cannot be overheard, so that the condition of the line was also revealed by these stations and immediate steps would then be taken to repair the circuit in question.

We learned how the enemy appreciated the potentialities of our listening stations when our troops captured some German trenches in the latter part of the war. Their telephones were sealed up and captured orders indicated that these phones were only to be used in the greatest emergency; the officer breaking the seal was required by these orders to send in a written report as to the necessity for its use. In some parts of the line, as far back as two miles from the front, German telephones were found to be sealed up, indicating a respect for our listening stations exceeding our own, for we did not expect them to be over that distance.

All of the various fields of military radio activity so far outlined were practically a sealed book to the American Army before its entrance into the war and the gigantic undertaking of training and equipping the personnel for this work represents one of the greatest achievements of our army. Lt. Col. Krumm sailed for France in September, 1917, with as little real knowledge of the task before him as many of his readers. Samples of some of the French radio and T. P. S. equipment had been shown to different officers here under injunctions to observe the greatest secrecy, although many of them embodied no new ideas.

No real information of how the equipment was used or the scope of the work was forthcoming, especially in regard to the radio intelligence work. This phase of communication was always kept from general discussion in our own army, even after we had been in the war for a long time. It was considered that the less the enemy knew of our activities, the less preventative measures he would take against them. Few, if any, officers or soldiers who were not directly concerned in the intelligence work were aware of the fact that much of the information that guided their operations had been obtained by the Radio Section. The only other sources of information comparable with it were the prisoners captured from the enemy. By the same token, the less our men knew of our work the less they could tell should they fall into the hands of the Germans. If the location of a listening station became known its effectiveness was immediately destroyed by the counter measures taken against it, so that many a doughboy noted the strange equipment in a dugout in his sector without knowing its purpose.

The Germans are generally given credit for first discovering the possibilities of these ground listening stations and the precautions they took at the outset to keep the men assigned to this duty from coming in contact with other soldiers and discussing their work, are interesting. They were given extra pay, their meals were brought to them and they were pampered in every way and they were evidently the most exclusive branch of service in the German army. Once the work became known to the Allies, though, this exceptional treatment was discontinued and these "cellar detectives" were treated like the rest of their army.

In the early Spring of 1917, a French delegation headed by Dr. Abraham, the well known scientist was sent over to the United States to demonstrate the wireless and T. P. S. equipment used by the French Army, but the information was treated more as of scientific interest than as vital for general distribution among those who would later be called upon to use it in the field or to guide them in the manufacture of similar equipment in this country. Specimens of the apparatus in use by the French Army were furnished, which were to be used to guide the development and production in this country of equivalent material so that the U. S. Army could later be entirely independent of European supply. The fact that this desirable and, if the war had continued, possibly essential condition was not attained has already been told. The French Government had promised, meanwhile, to provide all the necessary radio equipment for the American troops until such time as production could commence in the United States, and this they were able to do until the drive of the Germans in March, 1918, when the rapid advance toward Paris resulted in a loss to the French of enormous reserve supplies of radio equipment. They were brought face to face with the urgent necessity of re-equiping their own men without considering ours. Added to that, it was these dark days of the war that brought on the influx of American troops at the rate of ten thousand a day—figures entirely beyond the calculations of the French when they agreed to furnish us the necessary radio equipment. Our own material had not been satisfactorily developed or produced in quantities in the United States and we were unable to look there for relief. Of those who watched the progress of the battles around Chateau Thierry, none were more harassed by anxiety than the officers who were concerned in the problem of obtaining radio equipment for our troops.

With the turning back of the Huns on their tracks toward Germany and the removal of the threat to Paris, where most of the radio factories of France are located, the French Army authorities regained confidence and the supply of wireless equipment was resumed. The British were never able to furnish us any amount of apparatus and it was inadvisable to use different types, which would complicate the supply and maintenance of equipment as well as the training of the personnel.

Tours of duty with both the French and British Armies had indicated to Lt. Col. Krumm that the French equipment was equal to the British and more suited to the methods of the American Army, so that no concern was felt as long as it was possible for the French Army to provide us with radio material. Nor was there any doubt as to the ability of our men to handle the apparatus; the standard of operators of this country is as high as that of any of the Allies, and events proved our faith in our men to be well founded.

It might be well at this point to acknowledge the debt this country owes the amateur radio operator for the work he did in the Army. In his position as Chief Radio Inspector, Bureau of Navigation, before the war, Colonel Krumm had looked upon the amateur radio man somewhat as an omnipresent American evil, like mosquitos. But it was these amateurs who were among the first to respond as volunteers for the Signal Corps, and his respect for them increased immediately and it has never since abated. Subsequently, their excellent work in the field under the most discouraging circumstances, under the most trying and uncomfortable conditions, has earned them a place in history. Too generous appreciation cannot be recorded of those who fostered and cultivated this invaluable source of supply of American radio operators, probably without ever realizing just how well they had planted the seed. Allied officers often spoke of this phase of our personnel supply and regretted the interest in radio matters had never existed in amateurs of their countries, as it had in ours.

The value of real enthusiasm for his work—an outstanding characteristic of most amateurs—was particularly shown in the radio intercept stations. The ideal operator for this work is one who never for one instant ceased to hunt for enemy stations with his receiver. He must record a jumble of mixed letter groups which to him mean nothing. A mistake of one letter in a three letter group will probably throw the decoders entirely off the true meaning of the message. He must record the wave length used and get all the prefixes so that the stations communicating can be determined. But above all he must instinctively note every personal characteristic of the senders "fist," or transmitting methods. Many a German organization has been traced all along the front by some peculiarity of a radio operator attached to it, who did not realize the necessity of absolute uniformity in sending. To detect these things the intercepting operator must never let down the intensity of his interest. The enthusiasm of the amateur for his work was one of his biggest assets.

When we entered the war the U. S. Army had in use only two types of wireless equipment; neither of these sets could be used in France.

Officers of the line did not take radio seriously. One whose unit had been isolated in the Argonne sent back this wireless message: "All communication cut off. How shall I keep in touch with you?"

The various fields of usefulness found for wireless were practically a sealed book to the American Army; the gigantic undertaking of training and equipping the personnel for this work represents one of the nation's greatest achievements.

Unfortunately for the Army, a very large proportion of the commercial and amateur operators joined the Navy at an early date, so that the supply of expert men available was soon exhausted, and the many additional men required had to be trained. This branch of our activities holds many points of interest and will be covered more fully at another time.

Officers of our Allies often indicated their belief that our men were notably successful because they were fresh in the work, but they expected when we had been in the war as long as they had, that we would also lose our enthusiasm and effectiveness. This no doubt was true to some extent, and it applied in a minor way to all branches of the service, but on the whole the American Army can look back on the work of its radio personnel with genuine and particular satisfaction.

When a man has had three or four years of operating under constant shell fire all the glamour of war disappears and the daily communication duty becomes a grind. This view was illustrated one day when Colonel Krumm visited one of the French artillery receiving stations to which range corrections from airplanes were wirelessed. As the visitor was regretting that his limited knowledge of French prevented him from questioning the operator, the latter in good English informed the American officer that he knew him in New York. The operator then explained that he was a New York boy of French parentage and had joined the French Army three years before, resigning his position as a Marconi operator on a ship sailing out of his home port. Commercial operating had never been like his present job, he readily admitted, and added that he was "fed up" with the war thing. This was in the Champagne country during the disheartening days of the Fall of 1917. Our men never experienced the depressing effect of the discouraging battles as did the Allied operators—so it is fair to assume that the Allied officers were right in their estimate of American effectiveness.

This listening station in the Vosges is typical of those maintained so secretly by American wireless men that doughboys in the same sector never learned the purpose of the strange equipment

Captain Taylor joined the A. E. F. in December, 1917, about the same time as the first detachment of about seventy expert operators arrived. The Radio Section (Intelligence) of the Radio Division was then organized. The accompanying chart shows the scope of this organization and the duties of the Radio divisions on the day the armistice was signed. On December 8th, 1917, the first radio intelligence stations, intercept and gonio, were established in a French sector. It was considered advisable to operate some intelligence stations in the French position so our men, both operators and decoders, would have an opportunity to work under actual fighting conditions. The radio intercept and goniometric stations were there-

CHIEF SIGNAL OFFICER AMERICAN E. F.

RADIO DIVISION
Lieut. Col. L. R. Krumm
OFFICER IN CHARGE

CO-ORDINATION SECTION
Captain Willis H. Taylor, Jr.

Function:
Co-ordinates work of other sections as follows:
Maintains liaison with Division of Research and Inspection and Radio Div. at Washington.
Checks all requisitions to Supplies Division.
Supervises and co-ordinates radio requirements of Tank Corps, Artillery, Sound Ranging and other arms of service.
Supervises development of such equipment as radio tractors, trailers and other radio auxiliaries as necessity arises.
Formulates radio bulletins covering field instructions for the operation and maintenance of radio equipment and auxiliaries.

AIR SERVICE SECTION
Major F. N. Shumaker.

Function:
Installation and maintenance of radio equipment on airplanes.

Supervision of operations of independent squadrons.

Prepares originals and checks Air Service requisitions for radio equipment to be checked by Co-Ordination Section.

Indicates Air Service personnel needs to Correspondence and Personnel Section.

Maintains liaison with the Air Service and in general co-ördinates the work of that service and furnishes information as to the needs of the Air Service.

Prepares technical instructions for guidance Air Service Radio Personnel.

OPERATIONS. TECHNICAL SUPERVISION OF RADIO OPERATIONS IN THE FIELD

ASSISTANT CHIEF SIGNAL OFFICER

G. H. Q. Radio Section Signal Corps—3 officers and 75 men. Operation of long wave intercept stations at G. H. Q. Information collected for Radio Intelligence Sec. G. S. G-2.

TRAINING SECTION
Captain Harlowe Hardinge, Hq. 2nd A. I. C.

Function:
Supervises the training of the radio personnel of the army other than the Signal Corps for which the Signal Corps is required. This includes Air Service, Tank Corps and Artillery personnel.
The training of the Air Service personnel covers squadron radio officers, pilots, observers, radio mechanics and operators and the special personnel of the bombing squadrons involving direction-finding and navigating radio equipment.
All the above work is covered at several fields in France and England.
Training of the Tank Corps signalling personnel, the most important part of which is radio training. This is carried on at the main tank center.
Various officers are sent from this section to different artillery training areas as requested for the establishment of radio schools and the training of artillery radio personnel.
Indicates to the Cor. & Pers. Sec. the number and qualifications of the Air Service personnel which has completed training and which is available for assignment to active duty.
Submits necessary requisitions for equipment and Air Service facilities to accomplish the above training.

CORRESPONDENCE AND PERSONNEL SECTION
Lieut. Ray Rice

Function:
Compiles monthly, weekly and other reports.

Supervises office, personnel correspondence and files.

Radio Division, Signal Corps and Air Service personnel, records and matters.

Requests necessary orders covering movements of Signal Corps and Air Service radio personnel and maintains the necessary records covering personnel.

OFFICER IN CHARGE, RADIO SECTION BASE
Major Robert Loghry

Function:
The work of this Base is accomplished by utilizing the authorized organization of the Army Radio Section with such extra personnel attached thereto as is necessary. These duties include the operation of the intelligence system of the different armies as required by assigning radio detachments to each army under the command of necessary officers.
The assignment of call letters and wave lengths to the different armies.
Technical co-ördination of the radio operations of the different armies.
Maintenance of a store room where radio equipment is overhauled and repaired.
Submits all reports, technical request and requisitions to the Chief Signal officer through the A. C. S. O., G. H. Q.
Supervision and co-ordination of the radio work of the independent Air Service force.
Trains replacement personnel for the radio detachments, maintenance of a school and operation of practice stations.
Has available field instructors capable of teaching troops the use of radio and T. P. S. equipment.
Supervision of field tests of radio equipment under development.

CHIEF SIGNAL OFFICER OF AN ARMY

RADIO SECTION DETACHMENT
Function:
Operation of the radio intelligence stations of an army consisting of control, intercept, gonio and listening stations.
Supervisory work of the radio activities in the army as desired by the Chief Signal Officer of each army.

CHIEF SIGNAL OFFICER OF AN ARMY

RADIO SECTION DETACHMENT
Function:
Operation of the radio intelligence stations of an army consisting of control, intercept, gonio and listening stations.
Supervisory work of the radio activities in the army as desired by the Chief Signal Officer of each army.

fore established to the west of Verdun in territory held by the French and covered by their own radio intelligence system. Our stations were understood to be practice installations and every assistance was given us by the French to become acquainted with the practical phases of the work. Thus we were pleased and flattered when, within a short time, we received a request from them to furnish copies of all the messages and goniometric readings recorded; subsequently we had reason to know that they were exceedingly grateful for our assistance.

With the entrance of our troops into the line came the real test of our radio communication. The training or practice which we carried on under conditions which appeared to be exactly those of actual warfare seemed advantageous; but how fallacious this idea was quickly developed in the operations. The first troops to go into the line had been given several months' training; the

A camouflaged gonio, or wireless compass station of a type operated by the Radio Section (Intelligence) Signal Corps, in France

officers had been afforded an opportunity to visit sectors held by the French and English troops and had been in the atmosphere of war for several months before actually participating in it. Later, when our soldiers were arriving at the rate of two divisions a week and were sent into action almost immediately, many of the signaling troops were unfamiliar with the radio equipment and had only a sketchy knowledge of their proper function in the communication system. Troops which went into the line with the British Army, after training with French sets, were provided with British radio equipments. Because of the delay in producing equipment in the United States few of the radio personnel sent over to the A. E. F. were properly trained or prepared to take up their work, in fact, their first knowledge of duties and the equipment which they would use was gained after their arrival in France. This made radio training one of the hardest problems. Yet in spite of the many handicaps nearly all acquitted themselves with credit and the difficulties overcome by the different radio companies of the Signal Corps will make interesting reading.

Considering the short period of training given our signalmen the results were magnificent; possibly the principal factor in restricting the usefulness of our radio was the ignorance of many American officers as to its limitations and possibilities. The reluctance of our officers to code message was the greatest single handicap. Operators were absolutely forbidden to transmit anything "in the clear" and all messages were required to be handed them in code. So difficult was the enforcing of this requirement that the probable future practice in handling these messages will be to have them coded by the Signal Corps personnel. The failure by line officers to take radio seriously is illustrated by an episode. said to have occurred in the Argonne. An officer commanding a unit which had become isolated sent back the following radio message: "All communication cut off. How shall I keep in touch with you."

Earlier in the article one class of radio operations was referred to as embracing offensive activities, to indicate the use of the wireless telephone and telegraph as a means of communication between the different units and branches of service of an army. This not only includes stations at different infantry battalion and regimental headquarters, brigade, division, corps and army headquarters, and similar units, but also the special radio services of the air service, the tank corps, artillery sound ranging by the engineer corps, and the meteorological service. All have highly specialized requirements, especially the air service.

At the beginning of the war the air service was part of the Signal Corps, which is the communication branch of the army. At that time the wireless communications of the air service were supervised by its own radio division as part of the Signal Corps. Later, when the air service was separated from the Signal Corps and established as a separate service, its radio organization was continued. It was found advisable, however, to centralize the supervision of the radio of the air service in the Signal Corps, and about a month before the signing of the armistice this work was taken over by the radio division of the Signal Corps, so that all radio operations of the army properly came under the supervision of the Chief Signal Officer, A. E. F. Radio equipment for the airplanes engaged in war operations must be governed by the peculiar requirements and limitations of the flying craft, but the major portion of their work is with ground stations. Radio communications between planes in flight and from the ground to the planes was never reliably accomplished, in fact, in the war operations of the air service in France. Radio telephonic communication between airplanes—the goal of the air service of every army and the essential requirement if squadrons or larger bodies of planes are to act as a unit—is a subject which was given preferred attention in the United States. Various articles have been written indicating results achieved in the development of radio equipment for communication between and to airplanes from the ground. The sets developed in this country were received shortly before the armistice; they were being tested out and personnel was being trained when hostilities ended. But the radio telephone was never used by our air service in actual combat.

In the so-called artillery reglage work where the airplane observer supplies batteries and groups of artillery with information indicating the accuracy of their shell fire and the correction necessary to obtain the greatest results, our airplanes were probably as effective as those of any other nation. In this wireless work they used the French spark sets, a very simple and light equipment, utilizing a wind-driven generator mounted on the fuselage with the rotary gap on the generator shaft. A trailing single wire antenna was used.

Airplanes were also used for reconnaissance, supplying information by radio to unit commanders regarding the activities of the enemy, and also in many cases the position of our own line. It must be remembered that in mobile warfare, calling for rapid advances such as marked the last part of the war, many of the units were located in woods or other positions which the commanders themselves were unable to recognize. Airplanes thus became the most accurate source of information as to the location of the advancing lines.

Tank radio was also one of the most interesting and difficult questions which confronted American research experts. No wireless equipment had been devised which would operate from a moving tank. In the British Army the tanks merely acted as transports for the set; it was the practice to drop the set from the signaling tank, establishing it in some protected and suitable place as near the front as possible. The French had experimented with a set using a trailing antenna, but it was found to be unsatisfactory and as far as known never was used in action.

A large antenna cannot be used on a moving tank; it must be small, easily erected and removed. An undamped wave tank set was developed in the A. E. F., so constructed that the radiated wave length was entirely independent of any change in the antenna, which was of the umbrella type consisting of a short pole projecting a few feet above the tank with ribs that could be spread as desired. A sample equipment had been sent back to the United States before the armistice, but had not been put in production and supplied us in time for use. The possibilities of this set cannot be over-estimated, as the mobility of the tanks makes a reliable means of communication absolutely necessary; with an efficient wireless installation they could not only have communicated with their post of command, but with the airplanes working in conjunction with them.

Artillery receiving stations work with reglage airplanes controlling their batteries. Sound-ranging receiving stations were provided to note the radio activities of enemy airplanes, the prelude to their artillery activities. The wireless method was also used in communicating meteorological data, of the utmost importance in the regulation of artillery fire and airplane operations. Weather and meteorological information was sent out approximately every four hours. Spark equipment using approximately the same wave length and spark characteristics as the airplane stations were used for this purpose.

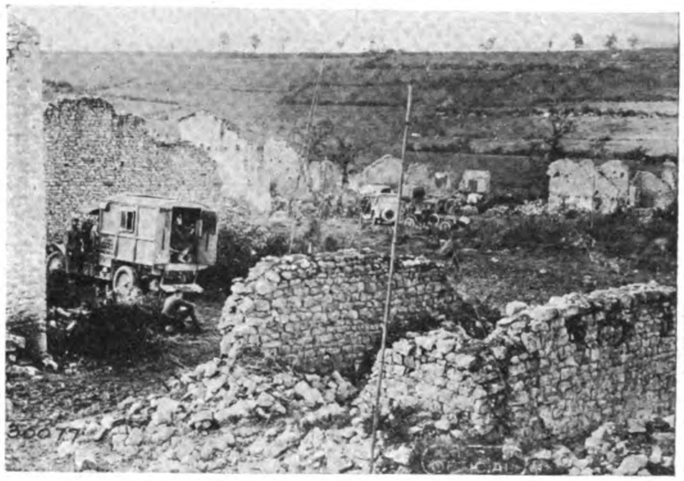
The personnel necessary for all these special radio activities required highly specialized training and this was accomplished as well as time and facilities allowed at many points in France and England. A large school was established at the Air Service training center at Tours, where observation officers were trained in the use of their radio equipment and radio operators and mechanics were developed in large numbers. Captain Harlowe Hardinge, a trained engineer, who had been one of New York's most enthusiastic amateurs before the war, was in charge of the radio school at Tours and the excellent results attained there are largely due to his ability. Other training centers were established for instruction in artillery fire control by wireless, tank radio, and in England a school was to be conducted for the instruction of personnel for the operation of direction-finding equipment, wireless apparatus which enables bombing planes to attain their objective at night and return to their home field.

The debt this country owes to the amateur radio operator in the Army is acknowledged in this article.

These civilians were the first to respond as volunteers and their excellent work in the field under the most discouraging circumstances has earned them a place in history.

Allied officers often spoke of this source of personnel supply and regretted the lack of interest in amateur work in their countries.

The supply of radio apparatus had its special problems. This was an undertaking which necessitated the most careful compilation of advance requirements, so that the ever increasing and overwhelming numbers of American troops might be promptly supplied with the proper radio equipment which would enable them to take their place in the line without delay. To this end all of the production facilities of the French operated in conjunction with the excellent general supply system of the Signal Corps. It should be appreciated that the French were practically unprepared to manufacture radio equipment in quantities sufficient to meet the needs of the French Army, yet the problem was enormously complicated by the wholly unexpected arrival of an immense American Army in an incredibly short period. Considerable readjustment of their manufacturing plans was required to meet this demand. General Ferrie, Chief of the French Military Radio Telegraphic Service, and his staff will always be remembered in this connection for their untiring efforts and co-operation in this difficult task.



Divisional Fiat tractor radio station in operation within ruins to avoid detection

While it was the policy of the Signal Corps not to manufacture any radio telegraphic or telephonic apparatus in France, the equipment purchased had to undergo rigid inspection before acceptance from the French Government. This work required men familiar with all phases of manufacture. Well equipped laboratories were established to provide for this important function, and to conduct the research work necessary in the development and solution of immediate problems. Here, too, was centralized that necessary research which served as the basis of intelligent constructive suggestions forwarded to the United States. In this work the Signal Corps was extremely fortunate to have Major E. H. Armstrong as an advisor on all technical matters. To him may be credited many achievements in connection with the constantly arising difficulties with apparatus and its maintenance, to say nothing of the radio development carried on by him in his laboratory.

The reader has now been given an outline of the great field of endeavor covered by radio men in the A. E. F. That these various activities required specialized methods and equipment is evident to laymen as well as those actively engaged in the art. The succeeding articles of this series will cover each subject in more detail, describe some of the French apparatus used and record some of the many experiences that befell our radio men in the A. E. F. while accomplishing results which should ever remain a source of pride to the whole American people.

(To be continued.)

Lowenstein's Quenched Gap

VARIOUS forms of quenched gap have been proposed heretofore, but they have one disadvantage. If any of the component gap elements have to be removed for repair or replacement, it cannot be effected without disturbing other gap elements in the series, and practically taking apart and reassembling the complete gap structure. Such a procedure involves loss of considerable time and it also involves expert work which may not be convenient.

This and other defects inherent in quenched gaps are obviated in the improved construction devised by F. Lowenstein, in which the component gap elements, which are broadly of the tubular type, are so assembled and mounted that any spark gap element or unit is individually removable and replacable practically in an instant, without disturbing any other unit of the complete gap, and without the exercise of any special skill on the part of an operator. The number of spark gap elements in the series may be readily varied at will to adjust the total spark length in response to working requirements.

on the outer and inner shells respectively. This form of joint between the insulating rings and the shells or electrodes insures that the spark gap space is sealed substantially air tight, which is desirable. The seal is permanent even when the electrodes become heated and expand; for in the event of such expansion the electrodes press against the ring surfaces 18 and 19 which are similarly located as regards resistance offered to the radial thrust of the shell expansion, and the tightness of the joints therefore maintained.

Another advantage secured by this construction is that the clamping pressure of terminal rings 14 and collars 21 is exerted in a direction parallel to the gap surfaces, so that the width of the gap is independent of the clamping pressure. Where gap electrodes are held by clamping means exerting pressure transversely of the gap surfaces, the width of the gap and hence the performance of the sending system, varies with the degree of clamping pressure.

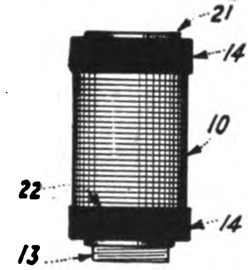


Figure 1

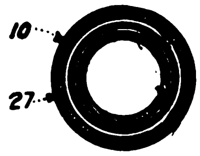
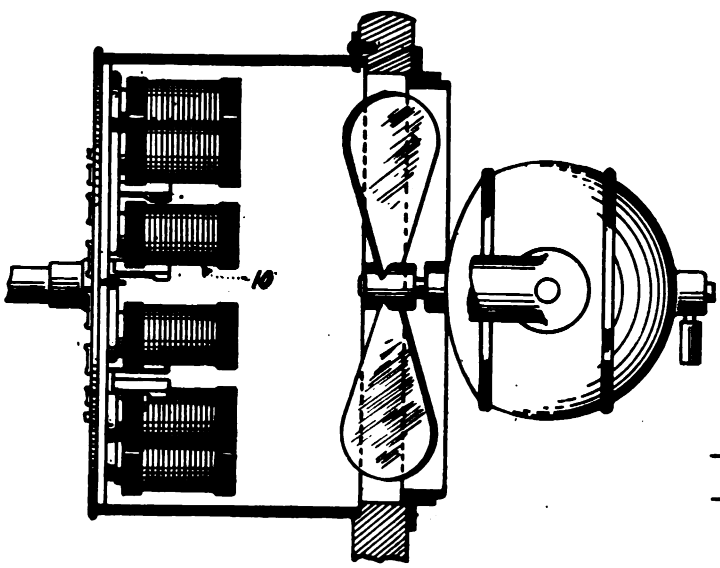


Figure 3



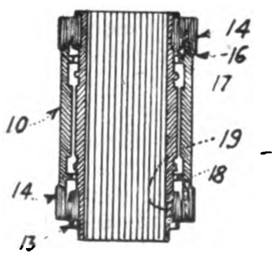


Figure 2

Figure 4

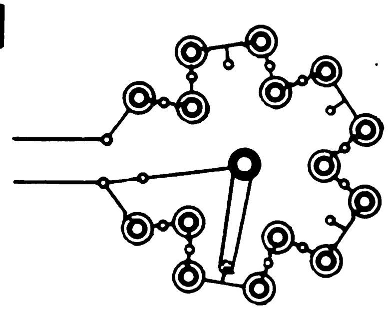


Figure 5

Various parts and the complete assembly of the quenched spark gap with cooling fan in place

Referring to figures 1, 2 and 3, the spark gap device comprises an outer cylindrical shell 10, within which is an inner shell 11 which in this instance projects unequal distances beyond the ends of the outer shell, the projecting portions being threaded as at 12 and 13. These shells or electrodes are made of copper and are spaced apart and insulated from each other by insulating rings 14, each of which is slotted or channeled along one side to accommodate an end of the outer shell or sleeve. Each insulating ring is thus divided into two connected parts, 16 and 17, whose parallel inner faces 18 and 19 engage the convex surfaces of the outer and inner shells, respectively. The parts 17 of the insulating rings extend between and space apart the shells to form the spark gap. The outer faces 20 may be slightly sloped or beveled as shown. The insulating rings may be locked in place by threaded collars 21 which are adapted to be turned down on threaded portions 12 and 13 of the inner shell into locking abutment with the rings. When the rings are in proper position they abut against shoulders 22 and 23

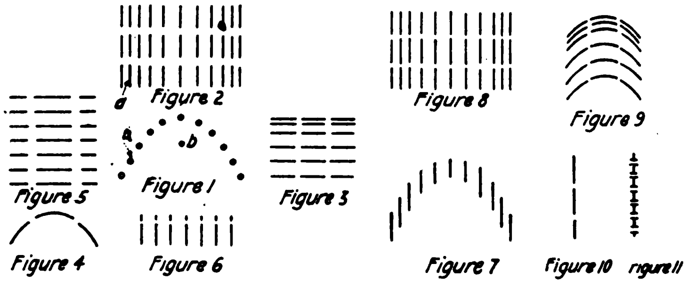
As shown, the central or intermediate portions 24 of the electrodes are formed in such a way that the annular spark gap spaced is narrower at this locality than toward the ends; and it is at this locality that the sparks actually pass between the electrodes. Annular circumferential ribs 10^a and 11^a formed on the electrodes 10 and 11, respectively, project into the wider portions of the gap space and are in staggered arrangement. These ribs act as baffles to prevent particles of metal from being "spattered" or otherwise transferred from the spark to the insulating surfaces at the ends of the gap, thus preventing deposit of metal on the surfaces and consequent destruction of their insulating properties.

The outer or convex surface 27 of the outer electrode shell and the inner or concave surface 28 of the inner shell are longitudinally grooved or fluted to provide a large radiation surface for rapidly dissipating the heat from the spark. In practice, when the spark gap is in operation, both these surfaces are cooled by a fan. Figure 4 shows the mounting of the gap and cooling fan. Figure 5 indicates the circuit for cutting in and out the gaps.

Marconi and Franklin's Directive Radio System

PARABOLIC reflectors to confine the radiated wave in a wireless system within a limited area have been devised by G. Marconi and C. S. Franklin. It is understood that these reflectors work extremely well and have been applied in a practical way for transmission at very short wave lengths.

The reflector is constructed of two or more sets of



Detailed drawings of the newly devised parabolic reflectors

rods—which term includes strips and wires—arranged on a parabolic surface around the transmitting or receiving aerial as a focus, each rod being tuned to the aerial and the rods of the different sets being preferably in line with each other. By this means, the efficiency and effect of the reflector are very largely increased. For example, by making the reflector of three sets of rods arranged on a parabolic surface and having a focal distance of one-quarter wave length, the range may be increased from 400 per cent to 500 per cent as against 80 per cent obtained with the simple reflectors before known.

The construction in detail follows: On a parabolic surface surrounding a transmitter or receiver and in the correct direction having regard to the polarization of the transmitted waves, is arranged a number of long wires which are divided up into elements each in tune with the transmitter. The length of each element is preferably about half a wave length, but may be made either greater or less than this by inserting in it either a condenser or an inductance. The adjacent ends of these elements may be insulated from each other or joined by inductance coils or condensers, the controlling factor being correct tuning with the aerial. That means that each element when in its working position in the reflector is in tune with the aerial.

In practice, it has been found that some of the elements may be removed slightly from the true parabolic surface provided that those elements of the reflector which are nearer the focus than they would be if on the parabolic surface are tuned to a rather longer wave, and those elements which are farther, to a rather shorter wave. For very short waves, no earth connections are required or desirable, but for longer waves, it is an advantage to earth the aerial and the lower elements of the reflector.

Very good results can be obtained by arranging the elements on a cylindrical parabolic surface, but better results can be obtained by arranging them on a true paraboloid, particularly when using a reflector having a focal length equal to three-quarter wave length or more. In the drawings, figure 1 is a plan, figure 2 a rear view and figure 3 a side view of a reflector constructed in accordance with this invention.

Figures 7, 8 and 9 are plan view, rear view and side view respectively, of a third form of reflector.

Figures 10 and 11 are diagrammatic detail views each illustrating a single set of rods or wire reflector elements of which the reflectors may be built up.

The reflector illustrated in figures 1, 2 and 3 has three sets of parallel rods (a) arranged on a cylindrical parabolic surface with an aerial or antenna (b) at the focus. This arrangement is for concentrating vertically polarized waves in the horizontal direction.

In the arrangement shown in figures 4, 5 and 6, the individual reflector members are placed in parallel planes which are spaced apart vertically instead of being spaced horizontally as in figures 1, 2 and 3. The object of this arrangement is to concentrate horizontally polarized waves in the horizontal direction. In the arrangement of figures 7, 8 and 9, the reflector has three sets of parallel rods arranged on a true parabolic instead of a cylindrical parabola; this will concentrate both vertically and horizontally polarized waves in the horizontal direction.

These figures illustrate reflectors made with three sets of parallel rods or, stated otherwise, reflectors made up of a number of wires each divided into three elements, each element being in tune with the transmitted or received wave. As illustrated, each of these elements should be nearly half a wave length long; alternately each of these wires may be divided up into a larger number of elements connected together by condensers.

Figure 10 shows one wire divided into three elements each in tune with the desired wave. Figure 11 shows one wire divided into a number of shorter elements connected together by condensers. The capacity of each condenser must be such that if joined in circuit with the inductance of the wire joining it to the next condenser, it would form a circuit in tune with the desired wave.

Reducing the Dielectric Stress of Condensers

IT is a well known fact that high potential condensers, such as for example, the Leyden jar, are usually subject to break-down near the edges of the conducting armatures. The dielectric stress centers at these edges, although at other points between the plates, the stress may be nearly uniform. This concentration of pressure is evidenced by minute discharges or "brush" that pass from the coating to the dielectric. This playing of the brush over the surface of the dielectric causes local heating in the latter, due to its poor conductivity.

David T. May has devised a method whereby the localization of this stress is materially minimized. In figure 1 is shown a condenser of the Leyden jar type having inner and outer conducting plates. Extending from the edges of these conducting plates 8 and 8′ are two metallic caps, 9 and 9′ which are suitably attached to the dielectric but are electrically separated from the conducting plates by air gaps, 10, 10′, 11 and 11′, the latter pair being the

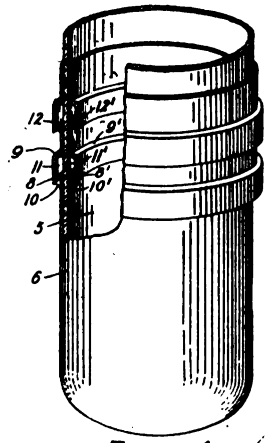


FIGURE 1

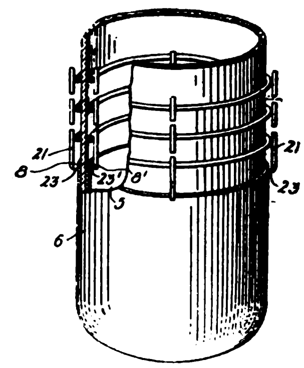


FIGURE 2

Condensers of the Leyden jar type

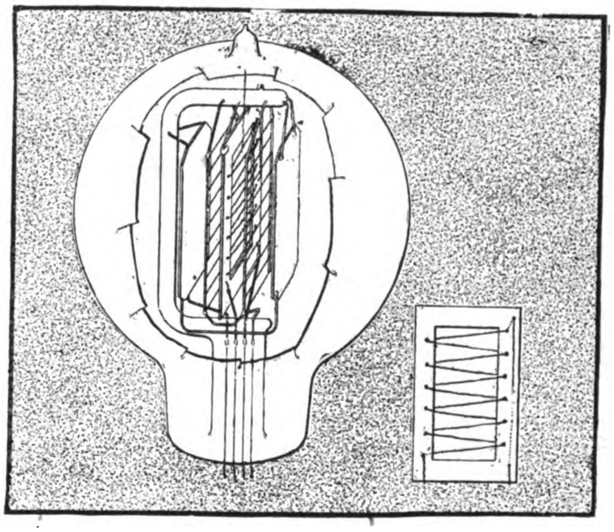
greater. When a condenser equipped with these caps is connected to a source of high potential, it is found that the brush no longer plays over the surface of the dielectric, but that sparks pass across the gaps 10 and 10′. In this way the stress at the edges of the plates 5 and 6 is considerably relieved and the interposition of the air gaps 10 and 10′ in the path of the current cuts it down to a point where the brush is not produced to an injurious extent at the edges 12 and 12′ of the caps. If it is desired, a plurality of caps may be employed, each one being separated from the preceding one by air gaps of suitable dimensions. It is preferable that the gaps 10 and 10′ should be smaller than the gaps 11 and 11′ because sparking across the shorter pair of gaps will be to those portions of the metallic caps from which the heat may be radiated away most readily without injuring the dielectric.

In figure 2 is shown a modification where metallic rings are sprung against the walls of the jar instead of the metallic caps. Each of these rings carry several wire pieces which form air gaps with the metallic conducting plates of the condenser. Harmless sparking will occur across the gaps 23, 23′ upon charging the condenser to a high potential and the injurious brush is thereby eliminated.

Warping of Filaments Prevented

TROUBLE has been experienced in the past in connection with the employment of filaments in vacuum tubes due to the fact that the cathode filament when heated becomes elongated and unless some means is adopted for overcoming it, a warping of the filament will occur. Inasmuch as the energy output of a thermionic device of this sort is dependent among other things, upon the distance between the cathode filament and the other electrode members, it follows that any warping of the filament toward or away from the grid member for example, will cause an alteration in the constants of the tube. It has in the past been proposed where filaments of loop form has been used, to remedy this defect by providing a spring support for the apex, thus placing the filament under a certain amount of tension and taking up an expansion of the loop in such a way as to keep the loop in its initial plane. Such tension on the filament has been found, however, to be undesirable in some instances, as tending to decrease the life of the filament.

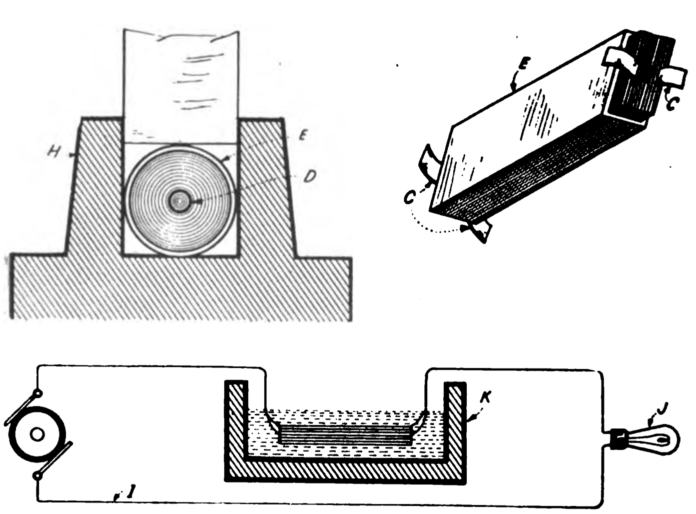
Alexander McLean Nicolson has devised a method of maintaining the filament in its initial plane, which consists in entwining or threading the filament on a supporting member so that it will be held by the said support at several points distributed along its length. While this arrangement does not, of course, prevent the linear expansion of the filament, it minimizes the effect of such expansion in that it prevents the cumulative warping effect and confines the warping to several relatively short sections, the result being that the total effective lateral displacement of the filament due to warping is kept within reasonable bounds.



Nicolson construction of the filament on a supporting member

Eliminating Moisture from Paper Condensers

AN improved method of overcoming difficulties encountered in the impregnation and the elimination of moisture from paper condensers has been devised by William C. Brinton. Ordinarily it is desirable to dry the paper used in paper condensers thoroughly in order that the moisture may be excluded, and this drying process oftentimes materially weakens the paper mechanically. After drying the paper and forming the condenser, it is necessary to impregnate the whole, quite some moisture being absorbed during the process of assembly due to handling.



Showing construction of paper condensers to eliminate moisture

In the method devised by Mr. Brinton, the difficulties are overcome by arranging the dielectric or conducting material (the paper preferably not having been preliminarily dried) winding the strip on a mandrel cylindrical in shape, withdrawing the mandrel, inserting the condenser into a tubular casing of drawn steel, and without intermittent treatment, subjecting the whole to pressure to convert the cylindrical condenser into a condenser of oblong shape and of considerably reduced volume. The condenser is then immersed in a body of dielectric impregnating liquid, such as wax or olive oil, preferably heated, and simultanteously an electric alternating current is passed through the condenser. This results in the conversion of the moisture into steam at a high pressure, the escape of the steam, and the replacement of the displaced water by impregnating dielectric liquid.

A Summer on the Great Lakes

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

By Julian K. Henney

III—Life on the Deep Blue Water

AFTER leaving Buffalo the Juniata followed the shore line of Lake Erie to Cleveland, arriving there the next morning. The clear sky, the blue water, and the fresh air made a fervent appeal to all of us, for we had been caged up on board the steamer all day long.

A few minutes after we left, the City of Detroit III slipped out of her berth on her way to Detroit, and at eight o'clock the Seeandbee started back to Cleveland. We had company on Lake Erie that night, but the wireless signals were indecipherable through the static. Shortly before arriving in Cleveland we tried to get into communication with WCX there, but atmospheric electricity was roaring in with all the sharpness and continuity of a tropical thunder shower. Then, and often during the summer, Watson and I thought of inventing a static preventer, but at each attempt we decided that it was slightly beyond the scope of our technical knowledge. Instead we devised methods of keeping the sparks from jumping into the receivers, and making blue flames all around the galena detector crystal. We hadn't fancied the carborundum supplied with the tuner which we had hooked from the Tionesta, so we had substituted galena from a small supply which I happened to have along. Needless to say, the crashes of "X'S" knocked the galena all over the place, and it was quite impossible to work Cleveland.

At six o'clock, we were startled by the ear-splitting scream of the Cleveland fog horn howling outside our porthole. That is some blast! I firmly believe that if all the unholy, unearthly and fiendishly disconcerting noises in the world were concentrated in one the Cleveland siren would have it beat. I much prefer to risk the perils of the fog unaided.

A few minutes later the black shape of the Western States crept past us in the early morning fog, making her way to the splendid new Ninth Street Pier; the Juniata poked her nose through the murkiness toward the deserted old coal docks where our passengers were scheduled to land. We tied up beside a coal barge and several camouflaged Shipping Board boats.

As we left, an hour and a half later, one of the camouflaged affairs appeared over the port bow with disconcerting suddenness. The sensation was an eerie one; in fact, often during the summer I watched those painted ships approach, never knowing whether the vessel was going sideways, forward—or straight up. In foggy weather it was almost impossible to see them at all.

In Buffalo we watched high-speed riveters put on the plates; in Cleveland we saw many of the new ships being loaded to their depth of eighteen feet; in Detroit we heard their radio equipments being tested, and in all of the northern ports we came across them at odd intervals. The continuous string of numbers which zigged off their wireless aerials by the hour was enough to drive a man crazy; they sent a message in plain United States, and I often wondered if the operators thought, dreamed, and ate numbers.

At noon of the second day we passed Colchester Light at the entrance to the Detroit river. The sun had chased away the last of the murky atmosphere, and the warmth felt good after the damp fog of the early morning.

Noon was one of the turning points of the day. It meant a change of watch for nearly everyone—and for half the crew it was a Godsend. In cold weather neither the decks, the pilot house, or the radio cabin were pleasant places, and a nice warm meal and bunk looked pretty good. To those of us who were compelled to climb out into rain or sleet, or the dampness of Lake Superior fog, the watch changing meant something. Midnight was also an important time of day, for at this hour the night tricks changed and the first mate starts his "six on" while the Second Officer and the Old Man slept. There was always a lunch in the mess rooms, warm coffee in the galley and, occasionally, some fruit.

That first noon hour on board the Juniata was indeed an important event. As usual, I was hungry. Sitting on a hard chair with the receivers over one's ears is not supposed to be a hunger provoking job, but Snell and I were always ready to eat when the time came. Answering the questions of all the women on board and half the men, sending an occasional message, constituted our principal duties. The queries were monotonously alike. "What is that wire for? I thought this was wireless," or, "That long rope hanging over the back end with the whirligig on it—is that your aerial?" Or a lady passenger would use up a half-dozen blanks writing a message to the kids, and then nearly faint when you suggested the rates—all of these occurrences somehow were hunger-provoking. And that first day was no exception.

Snell and I ate in the First Officer's Mess, along with the two mates, three engineers and the Purser's Assistant. The mess room was located about a dozen steps from the radio cabin and, with no occasion for delay, I was the first to enter the small room. As I sat down I felt that this was to be the supreme test. I awaited the appearance of the waiter with some apprehension and considerable anxiety. Snell and I had decided that we might as well inaugurate the season by asserting our authority from the start. We knew that it would be easier to have our own way from the first, than to wait until we got acquainted. The subjugation of the porters had taken place the night before; we had made them make up our bunks and bring us icewater. Now the campaign on the messroom waiter had to be accomplished without further delay. The performance started with a rush. There was no one in the room to see any possible failure and this rather emboldened me. As the waiter appeared from the galley, a clean towel over his arm, and a handful of shining implements in his hand, he queried: "Soup?"

"*Well* yes!" said I, with considerable rising emphasis on the latter part of "well." The effect was astonishing.

"Yes suh—yes suh—right away suh!" and Baltimore, the negro, rushed away to the galley with the greatest speed ever attained by any waiter. In a jiffy he was back with a bowl of steaming soup. He placed this in front of me with a most abject look and he kept offering crackers and celery, wiping the implements over and over again, and bowing and scraping so that I feared I would not get the soup down before I choked with suppressed mirth.

That soup was the hottest stuff I had ever tasted. Whether the heat was caused by the galley stove or by the militant seasoning of pepper was more than I was able to ascertain at once. By the time I had succeeded in swallowing several spoonfuls the Second Officer had come in. Bill was a huge fellow, fully six feet tall and wide in proportion; he towered over all the other members of the crew. He was the most feared man on board, and when there was any enforcing of the rules to be carried out, they let Bill do it. His brand of profanity was the choicest and his command of it was liberally attested to by the deckaroons, or common deckhands. When Bill came in and sat down he was puffing like an engine. I supposed he was peeved about something; but I soon discovered that Bill always puffed. Bill had the asthma. He also had a capacity for soup. Before he was ready to demonstrate this the rest of the officers had come in. Conversation began.

Bill pointed to the coffee, "I see they've been scraping the galley floor again," he observed.

The coffee did look a little muddy, and I thought I detected the odor of potato peelings and coal ashes.

But taste or looks did not bother Bill. He gulped the mixture at a swallow and called for more. Then he tackled the soup. Two spoonfuls were down before he looked up, reproachfully, at the Chief.

That officer returned a look of sympathy and understanding. "They tapped the well last night," he shot back.

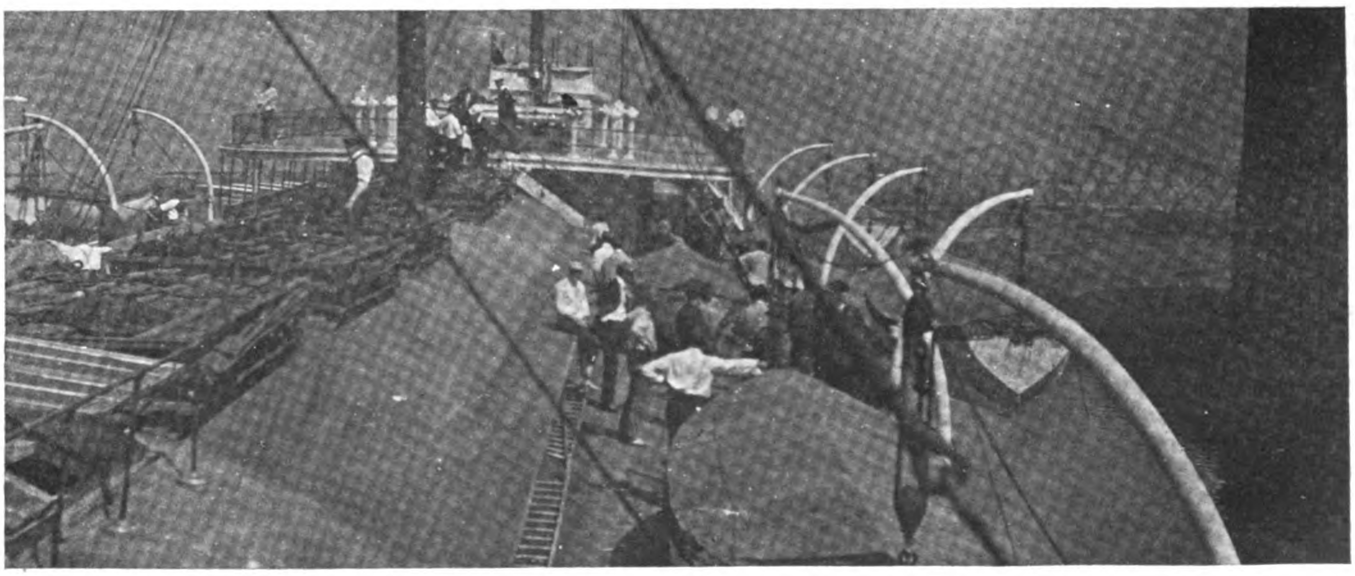
I had already noticed a rim of dark round objects at the edge of the soup. I had thought these pepper; now I wondered if they might be mud. I began to lose interest in the soup. But not Bill; he was gulping it down with all speed. Thoughts of the well—the bottom of the ship—and of the seepage or bilge water which it contained, did not disturb him. By the time Baltimore had brought me the remainder of my dinner, Bill was ready for more soup. It went with the same rapidity and lack of imagination.

Throughout the remainder of the meal the Chief found something wrong with everything, and never hesitated a second about springing any crude joke he happened to think of that might aid to describe the eats. His remarks were liberally punctuated by profane expletives. Finally, the First Officer put a stop to the rumpus.

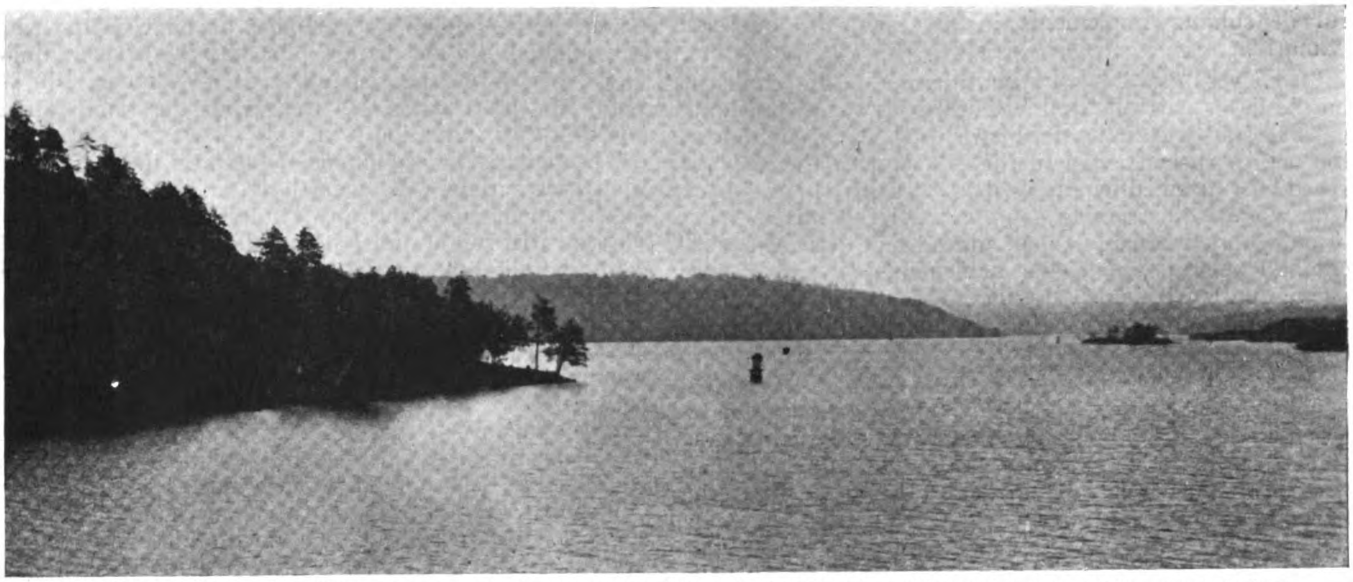
For several weeks the same performance was repeated at each noon and evening meal. The same kind of food was brought in and the same conversation took place between the Chief and Bill, in all of which the other officers and myself took little part. Later in the season the owner of the line happened to eat with us. After this we had the passenger bill of fare and each man was required to write out and sign what he wanted. This was an occasion for considerable mirth with Bill and the Chief. Neither wanted the other to know what he had ordered, but both were anxious to find out what the others had eaten. The new system livened things up a little and put us on a better basis as regards the rest of the crew.

When traffic was heavy the Purser ate with us. Occasionally, too, he ate with us after a night in the buffet, or when some woman passenger he didn't care for succeeded in getting a seat at the Captain's table. At such times the conversation was still more sordid. The Chief and Bill both knew that Mac's stomach was weak, and his digestion was easily upset so the conversation would start with the usual allusion to the galley floor, to horse meat and to bilge water, when Mac began to lose interest in the food the Chief would remark that the gravy tasted like tobacco. Immediately, the Second Engineer would note acquiesence and point to the galley slave toiling away in the corner of the second officers' mess, a big burly chap whose jaws worked constantly beneath cheeks eternally full of Honest Scrap. Purser Mac at this point of the game would look at Paul with such an appeal in his eyes that Paul would gravely reprimand the engineers and the rest of us who were enjoying the affair.

But to get back to my narrative. After dinner I was off duty and had six hours to use sleeping or loafing, as I chose. I found this a good opportunity to watch the beautiful scenery of the Detroit River. Cottages along the banks were flitting past in a never ending stream; many vessels passed us, and each saluted with the cus-



On the boat deck were the life rafts and bunks for the colored pantrymen; the upper deck was called the "flicker," but no one knew just why



When off duty I had good opportunities to watch the scenery; I alternated my sightseeing with wandering expeditions about the boat

tomary three long and one short blast, signifying that they were glad we were back on the Lakes again after lying idle for the winter. I alternated my sightseeing with wandering expeditions about the boat and soon became acquainted with the Juniata. She was a real vessel —much different from others I had been accustomed to sail on.

Forward on our deck—the salon deck—were the music room and library, both generously furnished with soft chairs and cozy corners where one might read or watch the scenic panorama. In the splendid weather we were having, however, most of the passengers were out on deck, lined up in the lee of the wind in steamer robes and chairs, or parading up and down the promenade deck. Aft of the music room, through a long corridor lined on both sides with parlors, were the social hall and stairs that led to the lower, or berth, deck. The social hall, decorated with well executed mural paintings was followed by the long dining room with its many tables and wide windows that let in all of the light.

The dining room was a beautiful place in the morning. The long rays of the sun came pouring in the port windows and were reflected from the polished floor and from the mirrors at the ends of the room. The mahogany of the chairs, their soft red plush bottoms, the white linen and shining service were something to remember, and I thought that morning that eight dollars a day was not too much to pay for these pleasant surroundings. At night the tables and chairs were unhooked from the floor and piled along the sides, clearing the center of the room for the dancers, called by the inviting music of the ship's orchestra. Fizzy drinks then appeared and the place took on the appearance of a metropolitan cabaret.

Aft of the dining room was the monstrous galley in which over five hundred meals were prepared each day. I did not explore this place at first, for it was teeming with blacks. Later I made it a haven when the weather was cold. All night long the fires were kept brightly burning, and a pot of coffee was always sizzling away on the back of the stove. Here I made the acquaintance of people I would have never seen otherwise, for they were coal passers and firemen, men who are not allowed the freedom of the upper decks. Every night these fellows came up from below to get a swig of hot coffee as the coal dust ran from their faces in streams. It was only occasionally that they could be persuaded to talk, for I was considered an officer and the men from the hold were timid about speaking to anyone so near the Old Man.

On the next deck—the boat deck—was little except the life rafts and boats, bunks for the colored pantry men, and a few choice parlors up forward. Aft were skylights over the galley, the engine room and the buffet, as well as many red ventilator funnels. The upper deck was called the "flicker" but no one knew just why.

Above the forward boat deck was still another deck, called the sun deck, where friends of the Captain and officers of the boat might sun themselves in nice weather. This deck communicated with the bridge and the pilot house, and it was usually by this route that I took messages and weather reports to the skipper. In the portion to which "our deliberate brethern" were relegated was a room devoted to social activities. Here were the fights, the banjo entertainments, and the crap games. A smooth table had been placed in the center of the room over which hung a lamp, casting a dim light over the players faces as they crowded about the dice, most of the light being directed to the table top where the lucky "bones" fell. At any time of the day or night when the men were not at work in the galley, the "come seben, come 'leben" could be heard as well as the arguments and blows that sometimes resulted from a throw of the lucky cubes.

At the extreme after part of the boat deck—back of the stack—was open space where the men often stretched out on the deck and slept in the sun. Many times I have stolen up the stairs quietly and found a half dozen blacks peacefully snoozing away, some with their backs against the hot ventilators, some on top the skylight where all the odors from the galley and engine room escaped, and some flat on the deck, half covered with cinders from the stack. They seemed to sleep with one eye open; one could never make any noise up there but what the whole bunch would jump to their feet in mortal fear that they had overslept and that the boss of them all, Tom Williams, had come after them.

Tom had been in the employ of the company at least as long as the Juniata had been in service, probably longer, and had come to that state of mind where he thought he owned the ship. His manner of storming and swearing at the blacks was enough to strike fear into anyone's heart, but his never ending tirade soon palled on me.

Friction between the upper men and those who lived and worked below decks was constant. I fully expected to see a full fledged battle on the flicker before the season was over, for the men of both parties were aching for a chance to get at the others. For this reason Tom kept his men up on top and away from the lower

(*Continued on page* 28)

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

PART II

(*Continued from August* WIRELESS AGE)

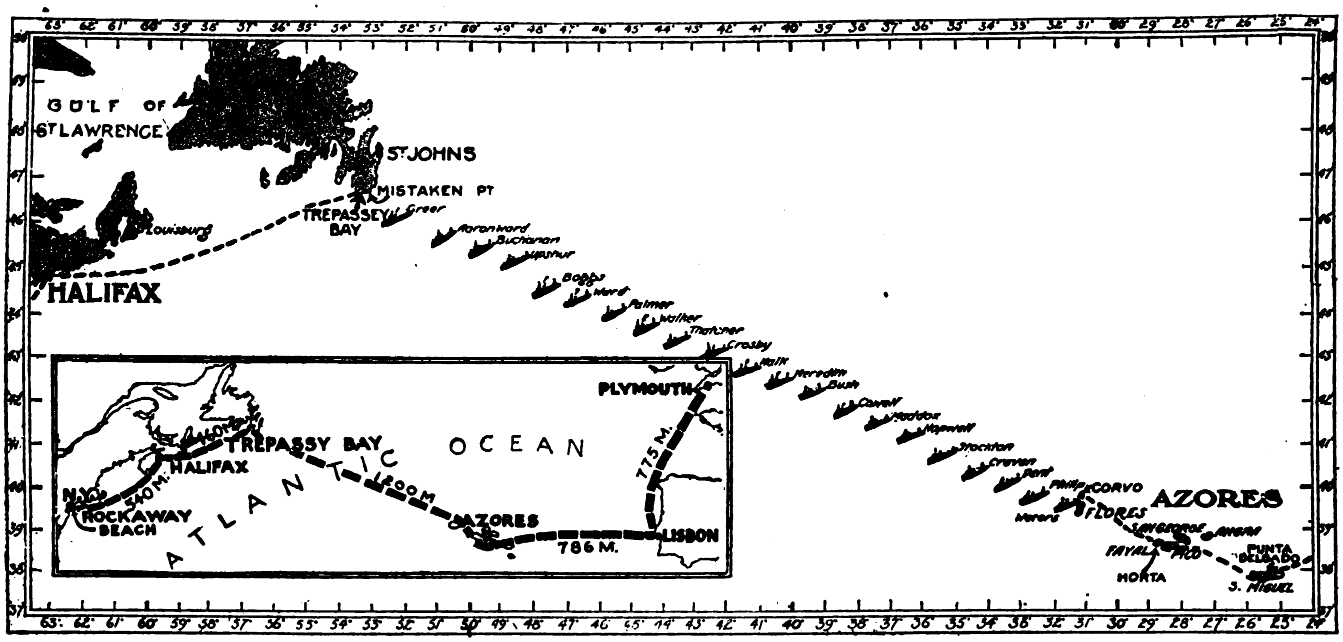
SEVERAL minutes elapsed before I had any true realization that we were actually on our way overseas. Then the steady thrumming of the motors and a sight of the gradually fading shore line served to awaken in me a quiet sort of exultation in the fact that with good luck this enterprise might go down to posterity as an event in history.

More practical things, however, almost immediately engaged my attention. In the first transmission of wireless signals, using the skidfin antenna, I noted that the lead-time, one of which I recall came from the "Maumee" in the following fragmentary form:

"Maumee will not be able to move for three days comma that heavy. . . ."

Afterward I heard that she had broken down while plying back and forth through heavy seas to refuel the destroyers which were waiting for us. At the time the message was received she was in the vicinity of the Azores.

Within a half hour all three planes had passed station



This map shows the location of the destroyers in the lane flung across the sea for the safety of the naval aircraft; the Author's wireless communications with these vessels and the shore stations is a feature of the article

out to this aerial leaked slightly, undoubtedly due to the fact that considerable water had been shipped in the take-off. These first communications were with the NC-1, and when we had been in the air for about three-quarters of an hour I let out the trailing wire antenna, from which all radio messages were thereafter sent and received until we neared the Azores on the following day.

The flag plane, the NC-3, soon after inquired for our position, asking if we were just astern of her; I sent a reply requesting that she turn on her running lights.

About a half hour later, while I was communicating with Cape Race station and with the other two planes, we passed over the second destroyer, and then twenty minutes later, I heard the wireless signals from the NC-3 requesting destroyer No. 3 to cease firing star shells, as they had sighted her. Compass signals were then given and these were heard all the way to destroyer No. 10, more than 350 miles distant.

There were all sorts of interesting wireless communications registering in my head phones along about this No. 4 and Cape Race reported by wireless, "signals good," which message was clearly received. Boston—then a thousand miles distant—came in, and I clearly heard her call the Acushnet.

My next communication to the destroyers informed them that we were about to inspect the motors on the NC-4, and proposed to use the Aldis lamp for this purpose. This lamp was intended for signaling, but as a matter of fact, it was an ideal light for examining the motor, although the idea had not struck us until this time. Incidentally, I might mention here, that perhaps the most inspiring sight through the entire trip was that of the four Liberty motors, each spitting six tongues of blue flames from either side. This roaring, flashing fire symbolized a wonderful mechanical achievement, for the flames bore direct testimony to the fact that the entire forty-eight cylinders were hitting perfectly.

In contrast to the flashing of the power explosions from the motors and the vicious blue shafts that belched from their sides, was the placid disc of the moon rising slowly from the surface of the sea. Cold ladders of light led out across the black waters below us, seeming to be harbingers of a guiding hand of Fate which would lead us safely to our island objective.

Any further philosophical thoughts which I might have entertained on the subject were interrupted when I happened on the tune of 1,200 meters and heard the station at Brest being called by one who signed himself NEC. I then copied the following message:

"S/S GEORGE WASHINGTON ne-1 Ck. 126. Confran. Position eight PM GMT May sixteenth. Lat. 47-05; Long. 23-00. Expect arrive Brest seven PM. GMT Sunday May eighteenth period. Please furnish five hundred tons fresh water comma eight hundred tons coal and stevedores upon arrival period carrying capacity three hundred fifty first class passengers six thousand three hundred thirty-five troops and one hundred forty stretcher cases subject to material reduction if president and party . . . Swedish minister to United States and wife on board. Please reserve Paris train accommodations . . .. (interference from UB2 calling CQ) . . . afternoon period Major General Squier and aide on board. Please reserve Paris train accommodations for . . . . eighty sacks navy mail."

A broadcast from destroyer No. 5, directly below us, interfered with the remainder of the message.

The George Washington was then 1,175 nautical miles or 1,325 statute miles away; I am certain that this distance was never before covered by wireless to an airplane in flight from a ship at sea.

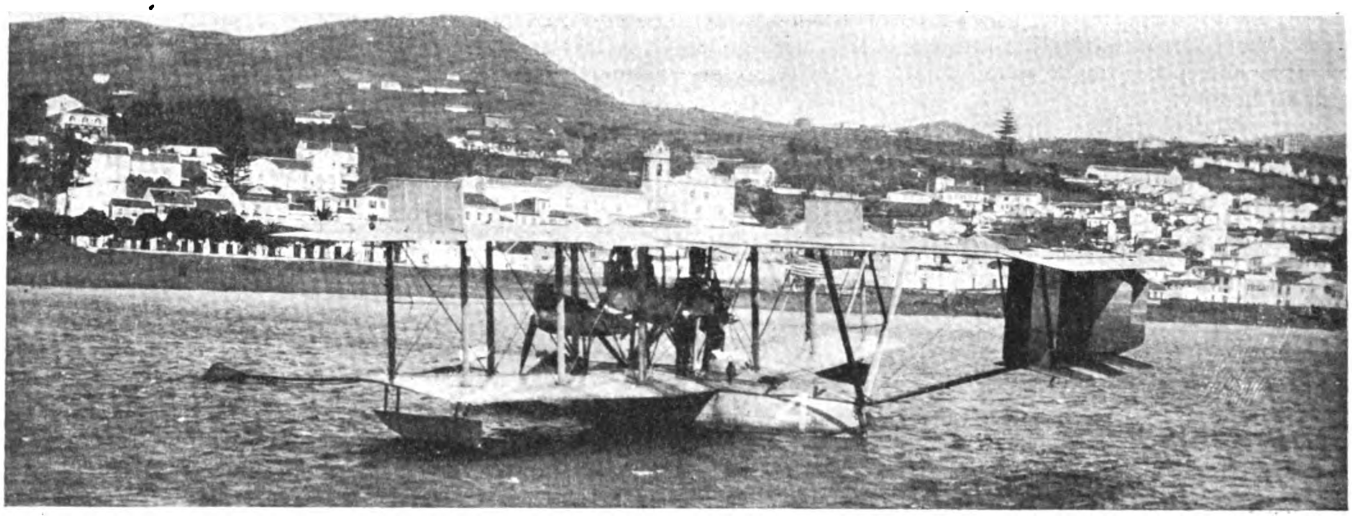
Nothing of special consequence happened for about a half hour, then the station at Cape Race asked me to send a short story of the flight thus far, the distance which we had covered, and anything of special interest. A request was also appended for a report of the NC-3. I was not authorized to transmit messages of this charatcer so I merely replied that everything was going along O. K.

A few minutes after this message had been sent, the steamship Abercorn asked if she could help us in any way; and the next episode worthy of record was when destroyer No. 7 sent me compass signals which were audible 30 miles distant. I had regularly been reporting each time when we passed a destroyer, sending these messages clear to the Cape Race station at Newfoundland. Evidently they were being received, for the operator at Cape Race answered promptly each time.

We flew over destroyer No. 8 at 3:29 (Greenwich Meridian Time), and about twenty minutes later I sent out a 22 word message to my mother in Cleveland, Ohio, by wireless to Cape Race station. We were 425 miles away from the Newfoundland station at that time, and the operator at Cape Race marveled that I was able to hear his signals, when I told him that his signals were still good. He could not understand how it was possible to hear him through all the noise made by all four Liberty motors pegging away at full speed.

Lieutenant Harry Sadenwater, the operator on the NC-1, had kept in almost constant communication with me up to this point. We exchanged friendly messages between our work with the destroyers and felt highly elated at not being "called" by a shore station. It reminded us of the early days in wireless when chit-chat exchange between operators was tolerated to a great extent.

At 4:06 I asked destroyer No. 9 for a weather report and received his reply within four minutes. This illustrates the efficiency of our communication. I cannot say whether it was due to the electrical or mechanical design of our transmitter, or whether it should be credited to the excellent work of the operators on the destroyers; in any event, it seemed just as easy to call a destroyer 300 miles away and get a quick reply as it was to communicate with one which was directly under us as we passed by in our flight.



The seaplane NC-4 at rest on the waters in the harbor of Horta, after completing the history-making flight across the Atlantic

At 5:30 the naval men at Cape Race inquired as to the time when we had passed destroyer No. 10. I informed them that I had not picked up that vessel's broadcast, so did not know: the Cape Race operator responded with a lengthy message, asking that he be kept advised as to our position. He added the final comment: "Signals great."

A half-hour later I heard at one time six destroyers sending out their compass signals, these vessels were respectively numbers 12, 13, 14, 15, 16 and 17. No. 16, the Hopewell, more than 200 miles distant came in exceptionally loud.

Soon afterward we passed over destroyer No. 13, which information I imparted to Cape Race. Immediately afterward I heard, clear as a bell, a 14-word message sent to the Aroostook, stating that the signals from the plane were "great."

The NC-1 then inquired whether I had heard any wireless communications of the NC-3. I listened and found that the flag-plane was communicating with destroyer No. 13, and at the conclusion of these communications I heard her ask destroyer No. 16 for a weather report.

It was about 7 o'clock when I heard the station at Bar Harbor very faintly. The messages were being communicated to two of the naval vessels, probably off the coast of Maine, Bar Harbor being almost 1,100 miles away.

A half-hour later I sent the position of the NC-4 to Cape Race, but I did not hear this station answer. This was not surprising for the last communication I had sent had spanned a distance of 650 nautical miles.

I became a bit sleepy at this time and sought the open hatchway for a few breaths of fresh air. Chief Machinist Mate "Smoke" Rhodes had slept peacefully all night covered with life preservers, the only visible part of his anatomy being two feet set at a spread eagle angle. As the cobwebs were cleared from my brain by the rush of air, I began to speculate on the reasons why there was no noticeable change in temperature, for I had fully expected it to become warm as we approahced the Azores. Then I recalled how at Rockaway I had counted on writing some letters during the long flight. I had often done this before, and in the rush of things preceding our departure I had made a mental reservation that I would catch up with several weeks correspondence; but nothing had been done on the flight; I never had a spare minute, it seemed.

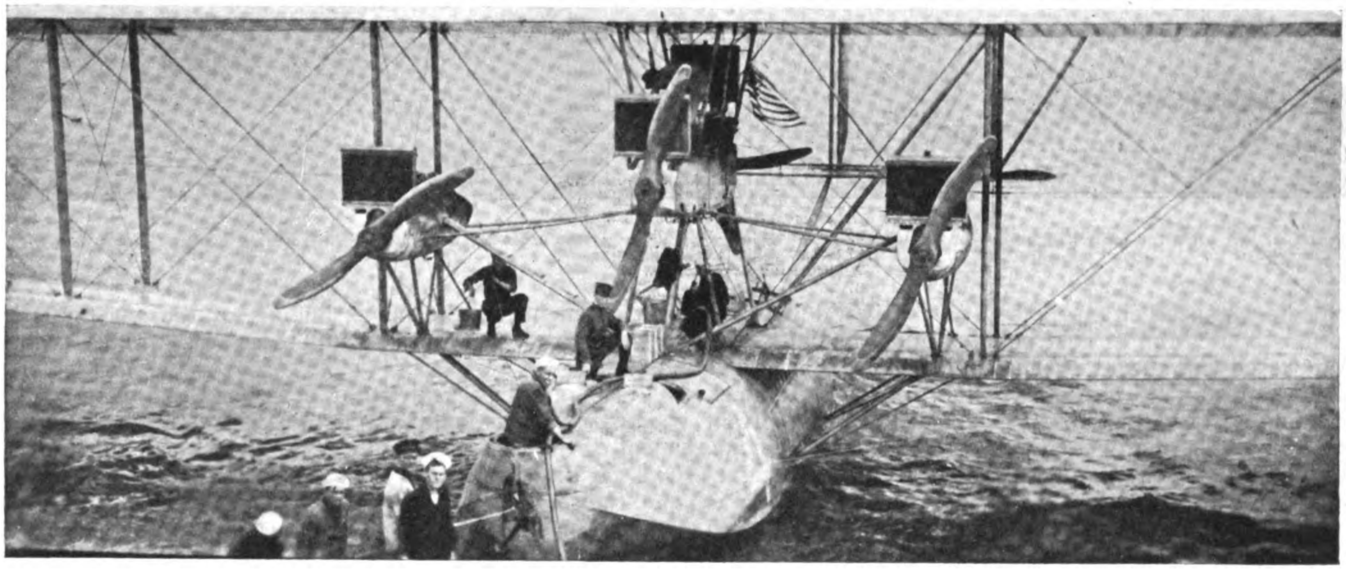
When I returned to the instruments I picked up Lieutenant Sadenwater of the NC-3 and remarked that the thought of sleep had never occurred to me. He replied that perhaps, too, I had not thought of food, adding that he had a sandwich in his hand at the moment. He was right; I had given no thought to the supplies we had taken aboard at Trepassey. "Smoke" was awake by this time and I scribbled off a note asking him to go back and get a sandwich. When it came, I seemed to have no taste for anything but the buttered bread. I got away with this, but passed up the coffee, for the Thermos bottle in which it was contained, was faulty and the contents were cold.

We crossed the steamer lane soon afterward and there was considerable interference on the 600 meter wave length. I heard the NC-3 calling destroyer No. 17 and by the strength of his signals I figured that the craft was a good distance ahead; the NC-1 then came in loud, and I noted that this vessel was just one station behind.

The hour between 8 and 9 was a busy one. The steamship Imperoyal wished us good luck and stated that she was bound from New York to Spain with gasoline. A few minutes later I heard two vessels calling Cape Race; one sent a message and the other reported to some station that he had met two planes and had a good time communicating with them. I found it was possible to hear two destroyers at once with the amplifier entirely disconnected from the receiver, antenna and counterpoise. A remarkable record was made, too, in this hour, when the NC-1 asked the destroyer No. 16 for a weather report and received a reply in one minute.

Destroyer No. 17 notified me at 9.31 that the NC-3 had just called with a rush message but that the operator could barely hear it. This was the last heard of the NC-3. Fifteen minutes later we struck a heavy fog and from then on I adjusted to the 1,500 meter wave length so as to get all the compass bearings possible.

The hour from 10 to 11 brought some anxiety. At 10:30 I established communication with destroyer 19 and asked if he heard our motors, explaining that we were flying between the fog and the clouds. The reply came back that the destroyer had not sighted us, but that the operator on board thought we were off her port bow. I was just about to ask for compass signals when the navigator came aft and requested me to inquire about the fog conditions close to the water in the vicinity of destroyers 19 and 20. I received an immediate reply from 19, stating that the fog was very thick near the water; destroyer 20 then wirelessed the information to me that it was misty in her vicinity. The operator on this vessel asked whether we were flying high or low and I told him: "high, but we want to come down if it is clear at the surface."



The epochal flight had just ended when this photograph was taken, but to the Author this seemed relatively unimportant; he was far more concerned with securing the soothing solace of a cigarette

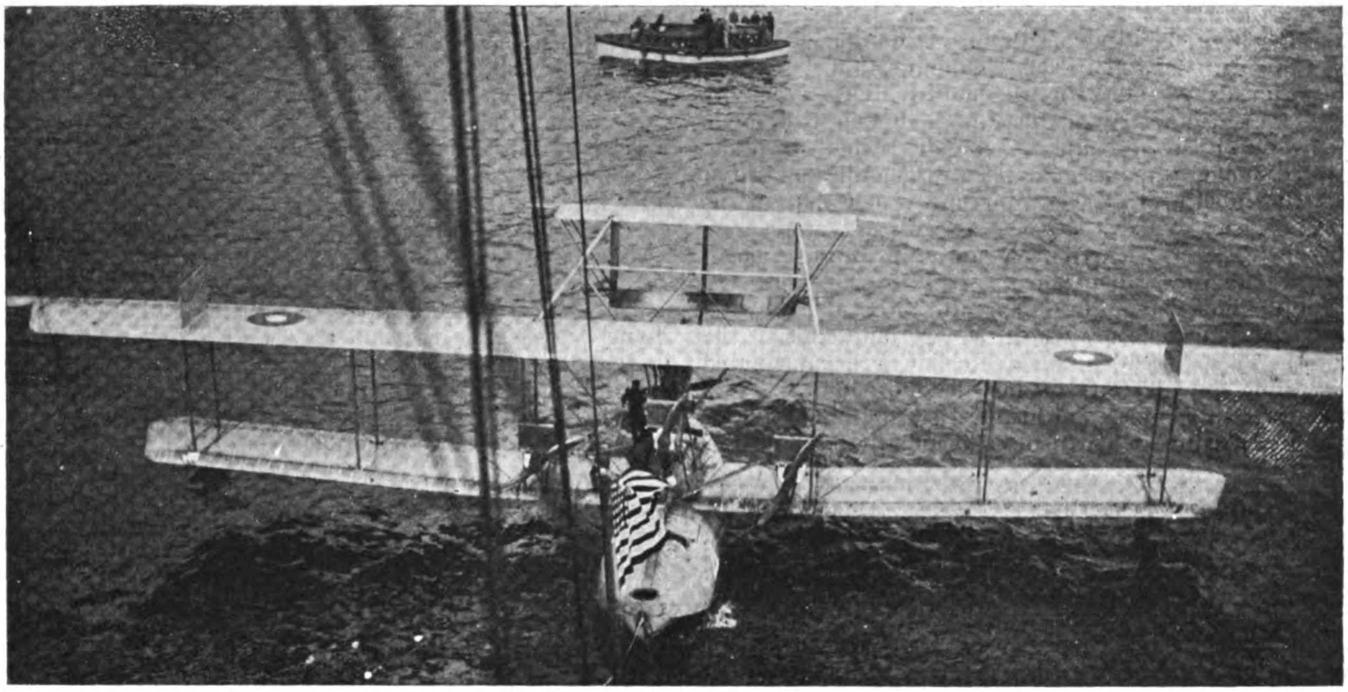
At 11:13 destroyer No. 21 replied to my inquiry that the visibility at the surface was 10 miles and that the wind was blowing at the rate of 20 miles an hour.

Then, at 11:30, we sighted Flores—the most welcome sight that had ever greeted our anxious eyes.

We came down near the surface so I reeled in the trailing wire aerial and in subsequent communications used the skid-fin antenna. We were concerned about the NC-1 and the NC-3. I inquired of destroyer No. 23 whether the other planes had been heard. A reply stated that the NC-1 had passed two hours earlier and that a message had been intercepted stating that the NC-3 was off her course between destroyers 17 and 18. The information immediately followed that the NC-3 had just been heard, asking for bearings.

Forty minutes later we picked up land again, sighting rocks that were so close on our bow that the craft had to be raised instantly to avoid striking them. As we came down to the surface of the water, I worked with the Cruiser Columbia lying in the Bay of Horta.

Hardly had we brought the craft to a standstill when the captain's gig of this vessel came to meet us. The doctor on the Columbia evidently expected to find us all



The NC-4, just after the craft had been brought to a standstill on the conclusion of the cross-ocean flight to the Azores, a dramatic moment in the annals of aviation

in, for he was perched on the bow and loaded down with Thermos bottles full of beef bouillon and stimulants.

We were by no means exhausted, but the hot beverages looked good and no member of the crew refused them. Welcome as this attention was, however, the important thing to me was the opportunity at last to get a smoke. All night I had been tantalized by the fragrance of cigarette smoke wafted through the passageways of the plane. Commander Read had permitted smoking in the forward compartments of the plane, but aft of the gas tanks it was considered dangerous and there was nothing doing for me.

As I looked back at it now it seemed relatively unimportant that our landing at Horta meant the accomplishment of the first successful air flight across the ocean. I was far more concerned with the relaxation of restrictions and the soothing solace of a cigarette.

(*To be Continued.*)

A Summer on the Great Lakes

(*Continued from page* 24)

decks but there was little to prevent the firemen from coming up on top after the blacks. If ever a time comes when the two gangs of men decide to have it out—and such a time must surely come—there won't be any Juniata left. Of the total crew of a hundred and thirty, at least sixty were black, so one could expect a pretty good battle—and an even one too.

Below us was the berth deck, so called because most of the staterooms were here. Here, too, was the barbershop, more bunks for the engineers, barber, bellhops and some of the colored fellows who could not be accommodated on top; also the "fantail." This was the extreme after end of the ship where the huge coils of rope—the breast and stern lines—a steam capstan for making fast the line, and a shower bath for the crew were conveniently located. The shower consisted of a hose placed in the center of the space and hooked to the ceiling or deck above, so that it could be moved about by the recipient of the water. As the fantail was decidedly open to the public, shower baths were prohibited during the day time and when near port. Only when the ship was on the "high seas" could the affair be used; even then I doubt if it was ever used, for the officers had a shower of their own, less public by far; and the crew—well I am not sure that they thought an occasional shower necessary.

One man always went swimming in the third engineers trousers when we docked at Mackinac, but the rest of the crew must have been cleansed by liquid fire and suggestion rather than by the use of water. So the fantail was used not for a bathhouse, but for the customary shipboard poker and crap games. Here the members of the crew made and lost their money, several hundred dollars often changing hands in a single day. The rail and the capstans were filled with shouting followers of the game who tossed their quarters and halves into the ring with the utmost abandon. Only when the steamer docked did the dice game stop, and then only because the players were afraid of police, or because they needed their money for refreshments.

Still another deck was below the berth deck, this one being used for most of the freight which could not be stored in the hold. Here was the passenger gangway with the offices of the Purser and Steward on opposite sides of the stairs leading to the upper decks and the social hall. The engine room was also on this deck, although the engines proper were still further down, and there usually was a pile of coal which was carried on deck and not placed in the bunkers. This was used in cases of emergency when the coal below was gone or on fire and could not be used. On this deck was stored the copper and zinc ingots which usually comprised part of our freight. The flour and dry goods cases and such stuff were swung into the hold by steam winches which kept up their terrible squeak for a day and a night while we were in Buffalo and Duluth.

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

A Simple Buzzer Transmitter for Amateur Use

THE buzzer type transmitting set will no doubt find wide application in the experimental field due to the ease of construction and low cost. The instructions here given, were purposely made very general in order to encourage the experimenter to follow his own initiative in varying certain dimensions. Since the cost of these experiments will be very slight and will require little else than time and patience, the amateur will no doubt welcome these general instructions rather than the more explicit instructions given in the usual constructional article.

Buzzer transmitters have been made in a variety of sizes for various uses, powers and voltages. In a subsequent article photographs and descriptions of the standard transmitters furnished to the Navy and Signal Corps will be given. The purpose of this article is to describe a 75 watt outfit suitable for operation on 110 volts D.C. Figure 1 shows the elementary wiring diagram. The iron core choke which operates the buzzer contacts, for use on 110 volts should have a core of No. 22 soft Norway iron core wire about 1" in diameter and about 4½" long. The winding space is about 4" long and ¾" deep making the diameter of coil over the winding about 2½". The space is wound full of No. 22 B&S D.C.C. magnet wire.

The vibrating spring of the buzzer, figure 4, is made of 1/32" spring steel or cold rolled steel, preferably the former, 1" wide and 5½" long. On the rear of the spring is fastened an armature of soft iron 1" in diameter and ¼" thick. On the front of the spring is mounted a piece of copper of the same size as the armature to which is soldered a piece of 1/16" sterling silver which acts as the vibrating contact. The stationary contact is formed as shown in figure 2, and is also fitted with a piece of sterling silver 1/16" thick and 1" in diameter. Figure 3 shows a simple way of supporting the stationary contact, figure 2. It is made of 1/16" sheet brass 1" wide and is bent as shown.

The condenser is easily constructed of mica or glass plates. The dielectric must only withstand a break-down test of about 500 volts. For 200 meters, the capacity should be about 0.013 mfd. Any standard text book will show the experimenter how to calculate the dimensions of this condenser. It can be purchased quite cheaply because the voltage is very low.

On account of the low voltage generated in this set, practically any kind of an oscillation transformer can be used. A suitabe transformer has about 15 turns of No. 12 B&S bare copper wire, wound on a form about 11 or 12 inches in diameter. One or two turns placed on the inside act as the primary. The primary need not be moved with respect to the secondary as the oscillations in the primary are quenched so rapidly as to give almost *impact excitation*. For all wave lengths between, say 150 meters and 300 meters, it is necessary only to add more or less turns in the secondary while the primary and coupling remain constant.

The contacts are the most expensive part of the outfit; in order to get a good job done in sweating the silver to the copper, it is advisable to have the work carried out by a jeweler. The contacts need to be large for the reason that currents in the neighborhood of 40 amperes flow in the oscillating circuit so it is necessary that the contacts be faced off absolutely parallel in order not to pit the silver, but to make use of the entire contact surface.

The theory of operation is as follows: Referring to figure 1, when the key is depressed current flows through the iron core inductance, thence through the contacts which are normally closed and back to the line; this energizes the iron core choke and it attracts the iron armature and abruptly opens the circuit at the contacts. The energy stored in the choke—equal to $\frac{1}{2} LI^2$—now flows through the closed oscillatory circuit which bridges the open gap and charges the condenser. The energy stored in the condenser—$\frac{1}{2} CE^2 = \frac{1}{2} LI^2$—discharges across the now closing gap and produces damped oscillations which are quickly damped out in the primary circuit. The secondary circuit then oscillates

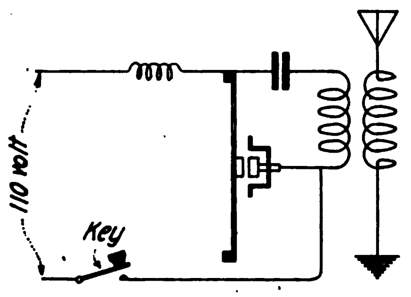


Figure 1

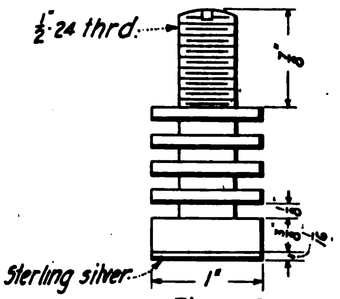


Figure 2

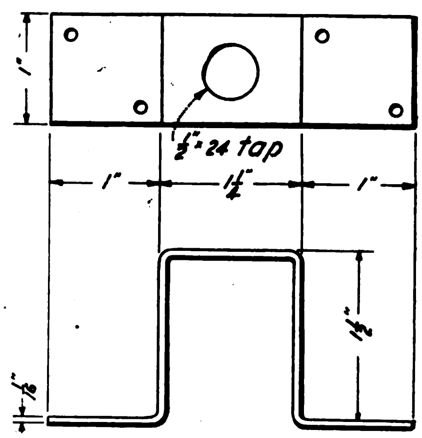


Figure 3

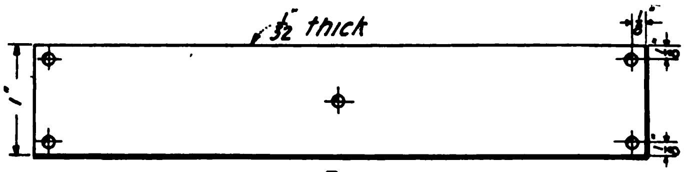


Figure 4

Constructional details and dimensions of the buzzer transmitting set

at its own natural period. The action of course, is repeated indefinitely as long as the key is depressed.

As mentioned before, the primary oscillations are quenched out so rapidly as to give substantial impact excitation. Let us now consider the reason for this rapid quenching. There are many factors which contribute to quenching. They are enumerated as follows:

1. The cooling effects of the massive metal plates.
2. The magnetic blow-out due to the magnet coil mounted behind the contacts.

The mechanical quenching due to the contacts actually closing or opening the circuit.

4. The re-transference of energy from the secondary back to the primary due to the close coupling.

The set is adjusted as follows: Depress the key and screw up on the stationary contact until a smooth note is obtained and an ammeter in the primary source of power reads about 0.75 amperes. Next adjust the number of turns in the secondary circuit until the wave length is the correct value as indicated on a wave meter. On a small antenna a radiation of about 1 ampere may be expected and a distance of about 20 miles can easily be covered. This outfit will produce a very smooth but low note and is practically noiseless in operation. If a commutator form of "chopper" is inserted in the ground circuit any note desired can be produced at the will of the operator by simply varying the speed of the motor driving the chopper.

Some items to experiment with are the variation of air gap between the choke coil and vibrator; making the choke coil core movable and noting its effect on the note without the chopper; and last but not least the re-design of the coil and the adaptation of the set to alternating currents.

M. W. STERNS—*New York.*

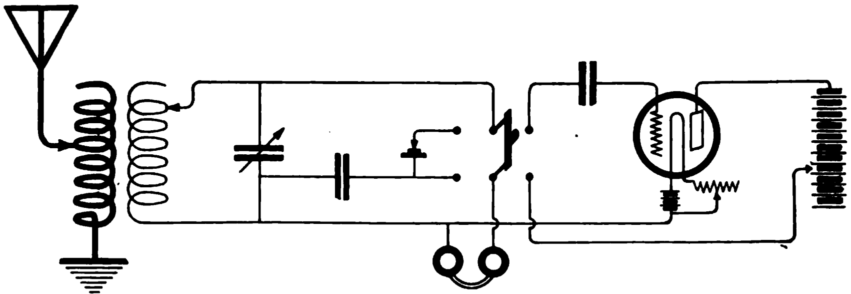
List of Long Wave Stations

Call	Location	Type	Wave-length
BUC	Taranto	Arc	3,500
			4,166
BWP	Punta Delgada, Azores	Arc	2,000
BWW	Gibraltar	Arc.	2,750
		Spark	4,600
BUCQ	Jassy, Roumania	Spark	6,000
BXY	Hong Kong, China	Arc	5,000
BYC	Horsea, England	Arc	4,500
BZI	Jacobs, Durkin, S. Africa	Arc	2,700
BZK	Bathurst, Sierra Leone,	Arc	3,600
	W. Africa	Spark	2,000
BZL	Demarara, Br. Guiana	Arc	4,200
		Spark	1,279
BZM	Mt. Pearl, N. F.	Arc	4,200
		Spark	1,525
BZO	Ascension Islands	Spark	4,600
BZQ	Christiana, Jamaica	Arc	4,200
		Spark	1,280
BZR	Bermuda	Arc	4,200
		Spark	1,525
BZV	Port Nolloth, Hong Kong	Arc	2,000
		Spark	3,263
BYZ	Renella, Malta, Med. Sea	Arc	4,600
		Spark	4,600
FFH	Bezierte, Tunis, N. Africa	Arc	6,000
FKQ	Martinique	Spark	1,000
FL	Eiffel Tower	Arc	10,000
GB	Glace Bay, N. F.	Spark	7,500
ICI	Coltano, Italy	Spark	6,500
IDO	Rome, Italy	Arc	11,000
LCM	Stavanger, Norway	Timed	12,000
		Spark	9,500
LP	Berlin, Germany	Spark	5,500
MFT	Clifden, Ireland	Spark	6,000
MUU	Carnarvon, Wales	Arc	14,000
MPD	Poldhu, Ireland	Spark	2,800
NAA	Arlington, Va.	Arc	6,000
		Spark	2,500
NAD	Boston, Mass.	Arc	5,000
NAM	Norfolk, Va.	Arc	5,250
NAO	Charleston, S. C.	Arc	4,750
NAR	Key West, Fla.	Arc	6,500

Call	Location	Type	Wave-length
NAU	San Juan, P. R.	Arc	5,000
NAW	Guantanamo Bay, Cuba	Arc	4,500
NAY	Pt. Isabell, Texas	Arc	8,500
NBA	Darien, C. Z.	Arc	7,000
NDD	Sayville, L. I., N. Y.	Generator	9,800
			11,600
NFF	New Brunswick, N. J.	Generator	13,600
NPG	San Francisco, Cal.	Arc	8,600
			4,800
NPL	San Diego, Cal.	Arc	13,300
			9,800
NPM	Pearl Harbor, Hawaii	Arc	11,000
NPN	Guam, M. I.	Arc	5,000
NPO	Cavite, P. I.	Arc	12,000
NPU	Tutuila, Samoa	Arc	6,000
			3,000
NSS	Annapolis, Md.	Arc	16,900
NWW	Tuckerton, N. J.	Arc	9,200
OUI	Eilvese, Germany	Generator	15,000
PMX	Java, Dutch, E. I.	Arc	6,100
POZ	Nauen, Germany	Generator	12,600
SQC	Cairo, Egypt	Arc	5,800
SUC	Suda	Arc	5,860
			3,870
UA	Nantes, France	Arc	11,000
			9,000
VCU	Barrington	Spark	1,525
			3,500
VJZ	Rabaul (Pacific)	Spark	2,900
VKT	Nauru (Pacific)	Spark	2,200
VMG	Apia, Samoa	Spark	2,000
VPW	Singapore, Malay Peninsula	Arc	3,400
WSO	Marion, Mass.	Timed	2,000
		Spark	2,000
XDA	Mexico City, Mexico	Spark	4,000
YN	Lyons, France	Arc	15,500
	Aden	Arc	4,441
	Amethyst	Arc	4,200
	Corfu	Arc	6,000
	Milo	Arc	4,160
	Toulon	Arc	6,000

Change-Over Switch for Use of Audion or Crystal Detector

THE accompanying circuit shows a very simple and efficient method of using either a crystal or a valve with the receiving tuner. One movement of a switch is all that is necessary to change the tuner and telephones from one detector to the other. The switch may be either the regulation double pole, double throw type, or of the pole changing pattern, which has two levers connected by an insulating strap carrying the handle. Of the two contacts at the rear of this switch, one is connected to each lever, and each lever slides over two of the four front contacts. This latter type of switch may be easily constructed of six ordinary switch-points and the scrap to be found in any radio man's laboratory. It may be placed directly on the front of the receiving cabinet in a space a little over an inch square.



Circuit using either a crystal or valve with the receiving tuner

This circuit was designed and thoroughly tested out by Mr. George A. Wolf, one of the radio operators at New York Police Headquarters, and so far as known is the simplest and most efficient method of accomplishing the change-over from the valve to the crystal detector. It will be noted from the diagram that placing the switch on the left contacts gives the standard crystal detector circuit; when placed on the right contacts, the standard audion circuit results, and on either position, very few "hanging-on" pieces of apparatus appear.

In many instances an operator desires to save valve material for delicate work, and to use a crystal detector for ordinary receiving. A panel set equipped with both types of detectors and this circuit makes an ideal receiving outfit, and may be as readily constructed as a single detector type. The use of the pole-changing type of switch is advised, because of its neat appearance and the small space required.

For receiving undamped waves a wire may be led from the aerial lead, direct to the plate, as in the circuit developed by Mr. Chambers a few years ago. When this is connected, undamped waves up to the wave length of the tuner may be received. this lead may be inside the case of the receiving set, and arranged to be connected, at will, to the plate circuit by a single small switch which would be as near to the plate lead as possible.

Amplifying valves may be connected to this valve in the usual manner; and other detectors, or a potentiometer may be used on the crystal side. While it is possible that such additions may cause a slight change in the dead-end effect, it is hardly probable that this would be detrimental to the efficient operation of the circuit.

CHAS. E. PEARCE—*New York.*

Variable Tuning Inductance

THE variometer, besides being cheaply and easily constructed is a very useful instrument for the amateur wireless station, as it allows a gradual variation of the wave length in receiving circuits. This is important since close tuning is a necessity for efficient work in long distance reception. The energy losses due to the resistance of the winding of a large variometer are appreciable when used at small values of inductance, but it is a good instrument to use in series with a loading coil, for tuning between the taps of the coil.

The accompanying drawing shows a method of incorporating the variometer and the loading coil in one instrument making a compact and easily operated tuning inductance, and giving a gradual variation of inductance from practically zero up to any value desired. The coil in figure 1 consists of No. 28 S.S.C. wire wound on a 5" tube. It is arranged in 3" sections as shown, a tap being taken at each section and connected to a multi-point switch. Since this wire winds 60 turns per inch, there will be 180 turns per section. The two bottom sections are ¾" long, each consisting of 45 turns. The rotor coil also has two ¾" sections of 45 turns each. Leads are brought from this coil with extra flexible cord, and connected in series with the outside winding. One of these leads connects to one of the binding posts. The other binding post is connected to the shaft of the multi-point switch. The tube on which the rotor coil is wound is 4¼" in diameter by 2" long which allows enough clearance if the thickness of the outside tube is not over ⅛". The drawing shows clearly the method of mounting the rotor coil. Since every experimenter will use the material at hand no minor details are covered.

The inductance is varied by means of the multi-point switch and by rotating the inside coil. When this coil is tuned so its magnetic field opposes the field of the outside coil, the inductance is minimum; when tuned so its magnetic field assists the field of the outside coil, the inductance is maximum.

The length of the outside tube and the number of 3" sections wound on it depends upon the wave length of the signals it is desired to receive.

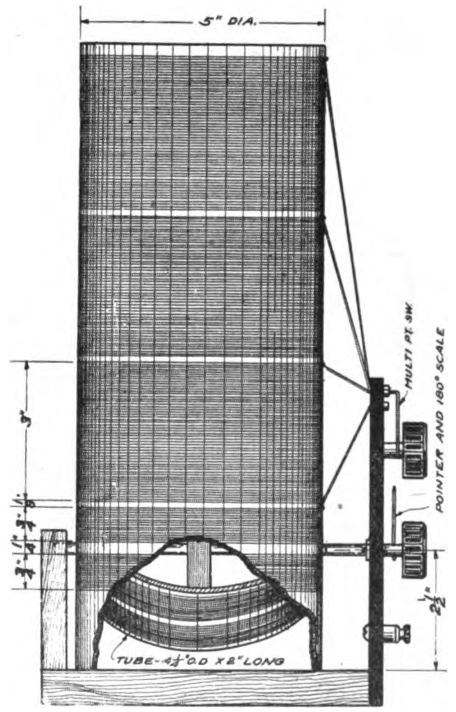


Figure 1—The variometer and loading coil combined in one instrument to form an easily operated tuning inductance

If this coil is used with the regenerative vacuum valve circuits for the reception of undamped waves, the control handles should be at least 12" from the coil, otherwise the presence of the operator's hand near the coil affects the signals. When the inductance is adjusted to the signals, removal of the hand from the control handles will eliminate the signals if the control handles are less than 12" from the coil. Any movement near the instrument will change the tone of the signals. This is due of course, to the capacity of the operator's hand, which changes the natural frequency of the circuit.

C. J. FITCH—*Massachusetts.*

First Prize—Long Wave Receiver

By C. R. Leutz

FIGURE 1 shows the layout of a receiver which has a range from about 2,000 to 20,000 meters when used with the average amateur antenna. I claim for this receiver that it is particularly selective and at the same time simple in construction. Selectivity on long wave lengths, now that there are so many high power stations working on this side of the Atlantic, is particularly desirable if one wishes to receive the trans-Atlantic and trans-Pacific stations at all times.

Figure 2 is a theoretical wiring diagram and together with figure 1, the conclusion is reached that amateurs generally have not only failed to find a really good method for affecting reception on the long waves, but that a great many of them apparently do not thoroughly understand the requirements for this sort of work. There is an impression among amateurs, and this is quite general, that better signals are obtained when direct coupling between antenna and closed circuits is used. This opinion is persisted in no doubt due to the fact that louder signals may be obtained from the high power stations which are near by. Direct coupling gives directly to the antenna circuit and capacitively couple the plate circuit in this way to the grid circuit. Still many others use odd and various combinations of the above three methods with what pretends perhaps to be a proper and logical method. It is apparent that under circumstances such as these, the control of the coupling between wing and grid circuits is usually uncertain and in some cases no real control at all is available. Perhaps it might be pointed out that in order to obtain oscillations from a three element vacuum tube, it is necessary to couple the plate circuit with

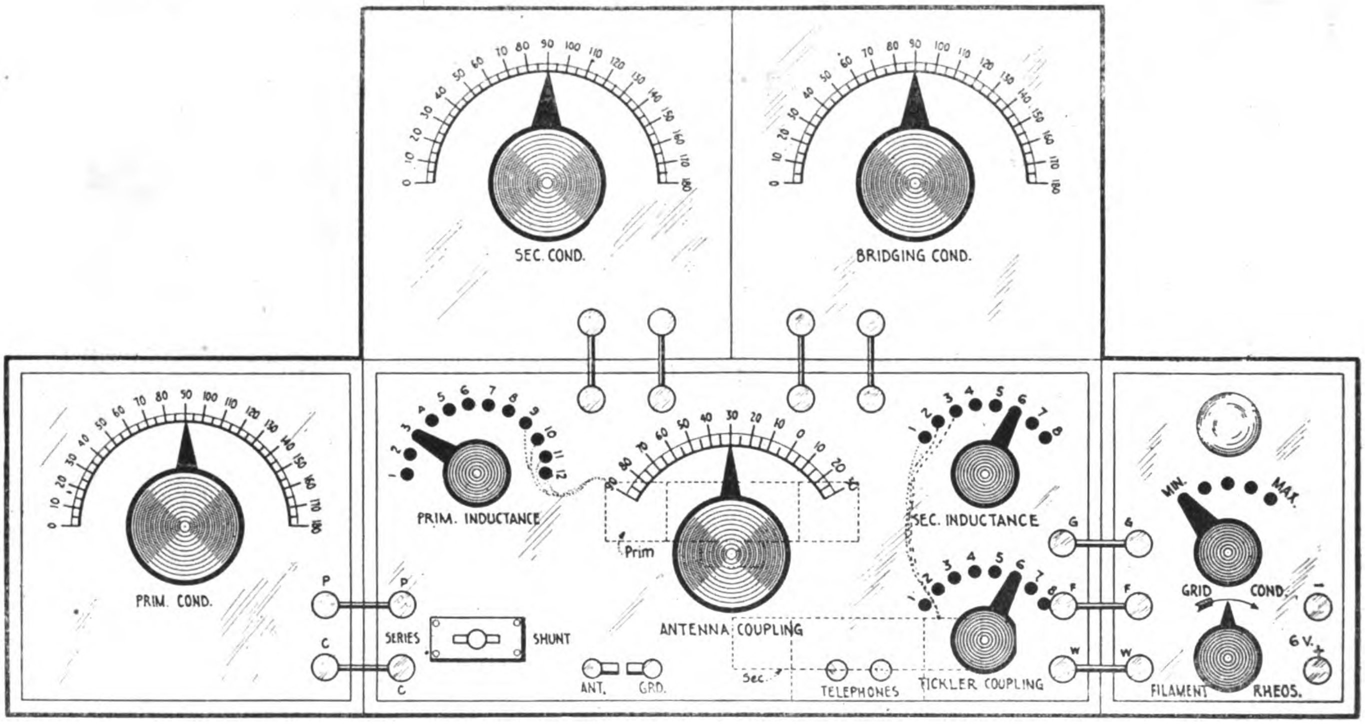


Figure 1—Main panel of the long wave receiving set showing position of instruments

will give the reader a very good idea of what is required in the way of apparatus. This apparatus in addition to the coupler cabinet, consists of a primary condenser, a variable condenser, a bridging condenser, and the audion panel. These three variable condensers should have approximately a maximum capacity of .001 mf. Larger condensers, of course, may be used as well as smaller, but the wavelength range will be increased or decreased accordingly.

It has been considered unnecessary to show the construction of the switches, condensers, audion panel, etc., inasmuch as these subjects have been covered in previous articles in THE WIRELESS AGE and are subjects more or less familiar to all amateurs.

From articles which appear in print from time to time and from questions which various amateurs have asked, rise to losses which are serious when incoming signals are weak.

Although various articles which have been printed from time to time in THE WIRELESS AGE, and all recent text books giving data on vacuum tubes and vacuum tube circuits, have very clearly pointed out the methods of securing regenerative and oscillatory action in a vacuum tube receiver, there still seems to be considerable confusion in the mind of the amateur as to how this may be accomplished. Some seem to be satisfied with the placement of the telephone receivers in common to grid and plate circuits, the two circuits being coupled by virtue of the capacity in the telephone cord and in the magnet windings. Others resort to capacitive coupling between the plate of the detector tube and the antenna circuit and thence to the secondary or grid circuit. Still others connect the plate of the detector the grid circuit. This may be done inductively or capacitively, or the plate circuit may be tuned to the same frequency as the grid circuit, in which case that small amount of coupling provided by the connections to the filament and the filament itself which are common to both plate and grid circuits give sufficient coupling to set up oscillations when the two circuits are in resonance. This, of course, is inductive or conductive coupling. It is quite apparent that any combination of inductive and capacitive coupling with wing tuning in addition, will provide oscillations, but for all practical purposes, the simplest method which will give a generation of oscillations and at the same time afford perfect control over a wide range of wavelengths, is the most desirable method.

Any claim to novelty which the receiver here shown may possess lies

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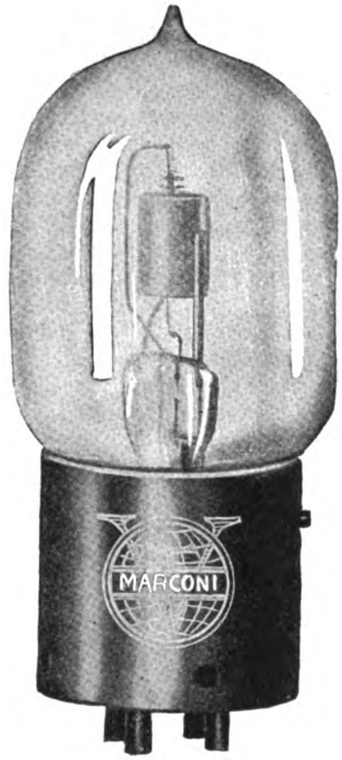

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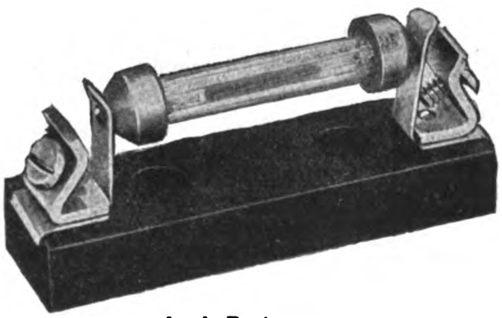

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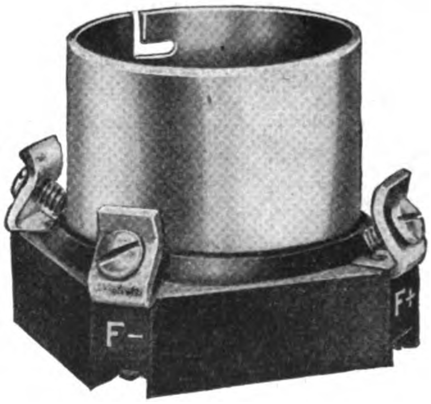

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principally in the type of coil used, the method of securing inductive coupling between wing and grid circuits, and in the mechanical arrangement of the antenna circuit and closed circuit inductance. The wing-grid coupling in this case is obtained by making a portion of the closed circuit inductance common to both wing and grid circuit. The amount of this common inductance is determined by the position of the "tickler" switch. Final adjustment for effective coupling between the two circuits is had by use of the bridging condenser which is shunted across the telephone receivers, but the primary of the amplifier determines if an amplifier is used. The control of oscillations thus provided is all that can be desired. This method has been chosen due to the fact that only two coils are required; that control of oscillations is equal to the control provided by any other method; and because the range over which oscillations may be secured is perhaps very much greater than any other method conveniently available. The use of a third coil in the plate circuit, the third coil being coupled to the secondary inductance, also provides a very good means of securing oscillations, and has been used in the later models of the Navy receiver. but unless considerable care is exercised, the electrical constants in this third coil are quite likely to be such that the third coil or tickler coil has a fundamental wave-length within the range of wave-length it is desired to receive. in which case the energy losses in the third coil at or near this wave-length will be so great that no oscillations are possible.

The coils are wound as follows:

Secondary coil: Winding form, 2½", outside diameter, 1¼" wide. Wind on 6 turns of .01" paper, shellac together, next, starting about 3/16" from edge wind on a layer of 32 turns of No. 20-38 Litzendraht, 22 S. C. C. or 22 D. S. C. This is then to be covered by one layer of 10 mil paper, the wire carried back to that side where the winding was originally started, and a second layer placed on, etc., etc., until 33 layers or a total of 1,056 turns have been wound on. Two or three layers of paper are then wound on top of the last layer of wire, shellaced, and the entire coil taped with cotton tape about ½" or ¾" wide. During the process of winding, taps should be taken out as follows: For secondary inductance switch, tap at 4 layers, 7 layers, 10 layers, 14 layers, 18 layers, 23 layers, 28 layers, and 33 layers. For tickler coupling taps should be taken out as follows: 15 turns, first layer, second layer, third layer, fourth layer, fifth layer, sixth layer, and seventh layer. All the secondary taps should be led to secondary switches in order, and all tickler taps to the tickler switches in the order that they are taken out; that is, the taps from the fourth, seventh, tenth layers, etc., in the case of the secondary, should be led to switch contacts 1, 2, 3, etc., and taps taken out at 15 turns, one layer, two layers, etc., should be led to switch contact numbers 1, 2, 3, etc.

The above method gives a coil which has been bank wound by layers. This method of winding decreases materially the distributed capacity of the coil and this distributed capacity is still further lessened by the introduction of a good grade of paper between layers. A coil manufactured in this way is a great deal freer from dielectric losses than a coil which is not bank wound and which does not have separation between layers, and it is the writer's opinion that the effort required for construction will be well repaid by the difference between the results obtained on a coil of this type and anything which can be purchased.

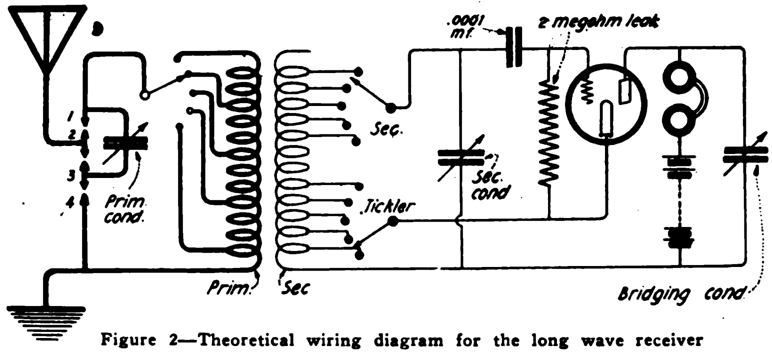

Figure 2—Theoretical wiring diagram for the long wave receiver

The primary coil is wound in the same manner on a form 3" outside diameter and 1¼" wide, 32 turns per layer, and 27 layers, taps being taken out at the end of the 3rd, 5th, 7th, 9th, 11th, 13th, 15th, 17th, 19th, 21st, 24th, and 27th layers, these taps leading to the respective switch contacts of the primary switch.

After the coils have been wound and taped, they should be baked in the oven for a period of one or two hours at a temperature not exceeding 200° F. at which time they should be removed and varnished immediately with a good grade of insulating varnish, or, if this is not available, with shellac made by mixing flake shellac with 95% alcohol. After varnishing, they

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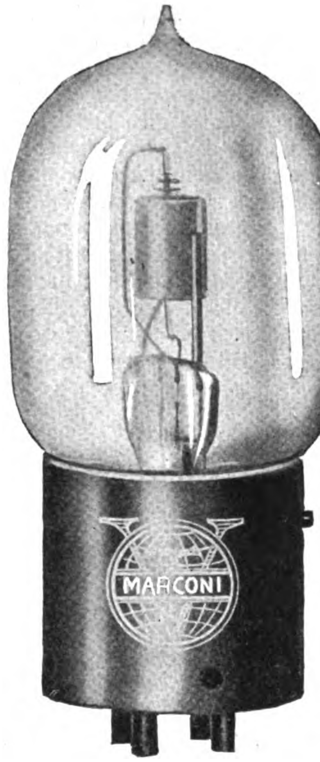

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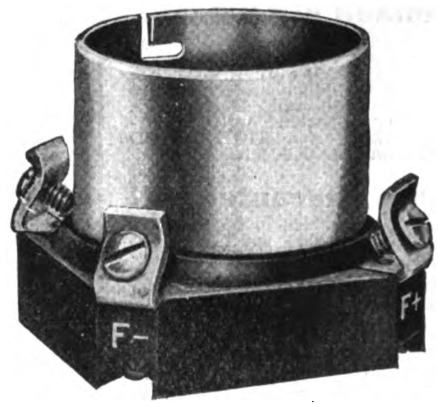

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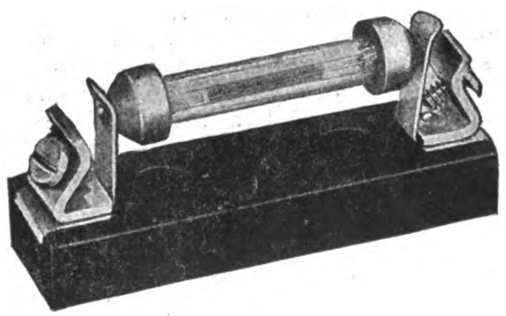

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should again be baked for a period of two hours or so at the same temperature, until the varnish is thoroughly dry and hardened.

This treatment insures a moisture-free and moisture-proof coil. The coils are then ready for use in the coupling device which is shown in detail in figure 3 where dimensions of the individual parts are also given. At maximum coupling, or 90° on the coupling scale, the two coils will lie in planes which are at right angles but the plane of the one coil does not cut the center of the other coil. If this were the case, the coupling between the two coils would be zero, but if off center, and both of them still in a vertical position, the primary coil may be so placed as should the distance as shown in figure 1 prove incorrect with the particular coils which might be made up for this receiver any failure on the part of the device to provide zero coupling when the coils are in parallel planes, may be overcome by tilting the coils slightly one way or the other.

For best appearance, the length of the coupler case might be made to equal the width of two variable condensers and the height of the case to equal the width of one variable condenser. A small audion panel may then be made to match, but if desired, it would be possible to make a large panel to include the coupler, the three variable condensers, and the audion panel, although it is suggested

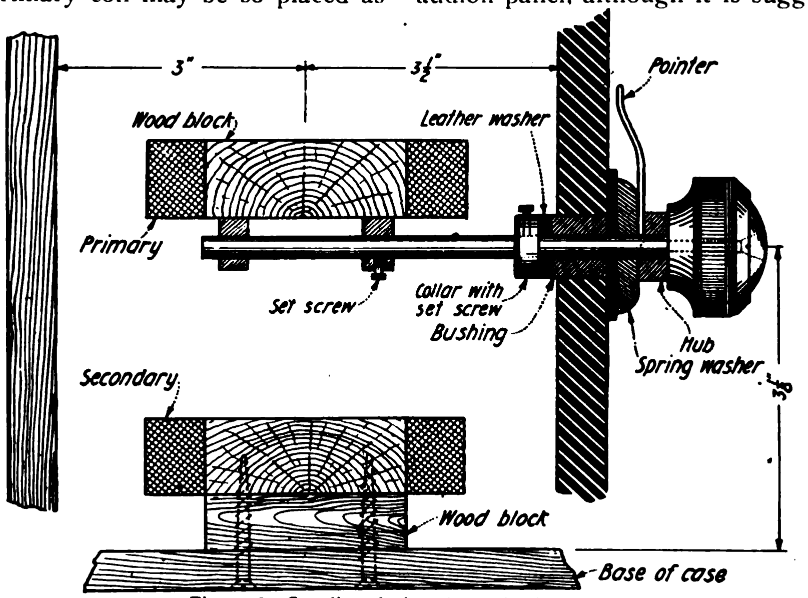

Figure 3—Coupling device shown in detail

to give the proper co-efficient of coupling for wavelengths within the range of this receiver, as is approximately the case in figure 1. At the maximum position or thereabouts on the scale (zero degrees) the coils are in parallel planes but do not have a common axis. The more nearly common their axes the greater the coupling between the coils when their planes are in parallel. but as their axes are separated the coupling decreases and reaches a minimum at that point where, if the coils were of the same size and same construction, the axes are separated a distance equal to the mean radius of the coils. The proper distance to be chosen between the axes of the primary and secondary coils when their planes are parallel (pointer at zero degrees) will have to be determined by experiment if it is desired to have zero coupling when the pointer stands at zero. The negative portion of the scale is provided in order that any electrostatic coupling between condensers or any electro-magnetic coupling arising from wiring, may be neutralized. This negative coupling will also take care of any miscalculation in the placing of the coils. That is. that from the point of view of utility, most amateurs will find it better to follow the method outlined. In the lower left hand corner of the main panel in figure 1, a telephone type of switch is shown. This is a double pole double throw switch and is used for throwing the primary condenser either in series or in shunt.

In operating this receiver, the following procedure may be observed. An arbitrary value of secondary inductance and capacity is selected and the tickler coupling increased from left to right until oscillations start. The beginning of oscillations will be indicated by a dull thud in the telephone receivers. If the tickler switch is carried still further to the right sometimes a howling or squealing will result, indicating that the coupling between wing and grid circuits is too great. Switch should then be retarded until this howling just ceases. Another indication of oscillations may be had by touching the finger to the grid terminal of the receiver. If a click is heard both when the finger touches and when the finger leaves the terminal, the circuit is oscillating. Any failure of oscillations to start may be due to an incorrect value of bridging condenser, antenna coupling, tickler coupling, filament current or plate potential, assuming, of course, that the receiver is properly wired.

Once oscillating, the coupling is set rather close, and the primary circuit adjusted by the use of primary inductance and primary condenser until the primary circuit is in resonance with the secondary. This resonance point will be indicated by the fact that static and signals approach and pass through a maximum, but if there is no static or no signal, a click should be heard as the primary condenser carries the circuit through the resonance point, the strength of this click depending upon the degree of coupling between the two circuits, or, if the coupling is very close, two clicks may be heard, the first indicating that the secondary circuit has ceased oscillating due to the effective resistance introduced by bringing the antenna circuit into resonance, and the second click indicating that the secondary circuit has re-commenced oscillations after the effective resistance of the primary circuit has been removed. Generally speaking, comparatively low values of coupling between the two circuits give the best signals (close coupling increases the resistance of both circuits) and, of course, greater freedom from static or interference. By moving from tap to tap of the secondary inductance and by adjusting the tickler coupling and bridging condenser so that oscillations are at all times being set up, and by, at the same time, keeping the antenna circuit somewhere near the resonance point, it is possible to cover the entire range of the receiver and thus pick up and log for future reference, the various stations which may be operating.

Once a station is heard, primary, secondary, and coupling are carefully adjusted and finally, the tickler coupling or bridging condenser is decreased until a maximum signal is heard. It may then be well to further decrease the antenna secondary coupling, to retune antenna and secondary circuits and to make a final adjustment of the bridging condenser.

The above procedure has been outlined as applying to undamped wave stations. Damped wave signals may also be heard with the circuits in an oscillatory state, but the note of the spark signal will be changed due to beats occurring between the damped oscillations of the spark signal and the undamped oscillation generated in the receiver itself. If it is desired to receive spark stations on their natural spark tone, it is only necessary to reduce the tickler coupling or bridging condenser value to that point where oscillation of the circuit just ceases, at which time the natural spark tone will be evident.

Second Prize—Long Wave Receiver

By L. M. Clausing

EASE of manipulation as well as high efficiency should be given consideration in the construction of a long wave receiver. Efficiency is quite often attained by the amateur, but ease of manipulation is usually sacrificed, often by the choice of a circuit using a multiplicity of condensers and loading coils. I recall that my first set required at least three loading coils and five variable condensers, all of which were scattered over a large table to avoid undesirable couplings. To some experimenters, the space factor may not be of importance but large loading coils and condensers provided with long handles to get away from the great sensitivity to capacity changes resulting from the proximity of the operator's body are not convenient for practical work and usually require a very critical adjustment.

Another consideration of great importance to most amateurs is the cost of construction and maintenance. When amplifiers are used, one "A" and one "B" battery should suffice for all bulbs. The potential of the grid in each bulb should be such that the greatest efficiency is secured without burning the filament at an excessive brilliancy.

A form of feed-back which does not require a change of adjustment for small changes in wavelength is also desirable, and when small feed-back adjustments are necessary they should not appreciably affect the secondary tuning.

In the circuit which follows, the grid condenser has been eliminated and the grid given the proper potential with respect to the filament by the use of the potentiometer P. The adjustment required for tuning to long wavelengths are accomplished by a

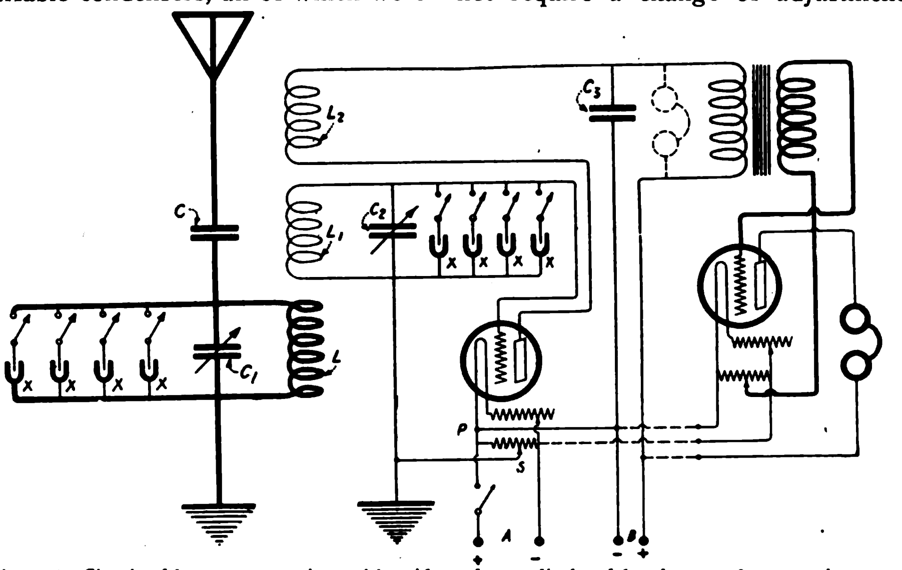

Figure 1—Circuit of long wave receiver with grid condenser displaced by the use of a potentiometer

variation of primary capacity C_1 and secondary capacity C_2. C is a fixed condenser of .00008 mf. P is a potentiometer with a total resistance of 100 ohms. The inductances L, L_1 and L_2 are of the new "honeycomb" type. They are small in size and the distributed capacity of the windings is sufficiently low for all practical purposes. Each of these coils has an inductance of 35 millihenries.

The condensers C_1 and C_2 have rotary plates so shaped that the capacity varies more nearly directly in proportion with the scale variation. Each condenser has a capacity range from .00002 to .0007 mf. The metal case of this condenser acts as an electrostatic shield and should be grounded as shown in the circuit diagram. C_3 is a fixed condenser with a capacity of .002 mf. and may be made with mica as a dielectric. Fixed condensers marked X have a capacity of .0005 mf. These also may have a mica dielectric.

The use of an amplifier is optional, but it is desirable in many cases where trans-Atlantic signals are to be received on a small antenna. With a two step amplifier, at my station, signals have been copied from the Nauen station in Germany *without aerial and ground connection*.

In operation, the receiver is wired exactly as shown. To operate, the filament is lighted, slider "S" moved near the negative end of the resistance P, inductance L_2 placed at a distance of 2" from L_1, L placed 3" from L_1, and the condenser C_1 varied over its entire range. If no resonance clicks are heard in the telephone receivers during this operation, reverse the leads connected to the terminals of L_2. Clicks will now be heard if all the instruments are connected as they should be. Such clicks indicate the presence of oscillations in the closed circuit and occur at the point where the primary is in tune with the secondary circuit. If there are two clicks widely separated, reduce the coupling between L and L_1 until just one click is heard. Also loosen the coupling between L_1 and L_2 to the point where it is just possible to maintain oscillations. When the proper adjustment for S is obtained, the distance between L_1 and L_2 may be as much as 6" to 8". For weak signals this last mentioned adjustment is best and needs only to be changed slightly for the entire range of wavelength.

The set is now ready for reception. To locate a station it is only necessary to vary C_2 and follow it up as indicated by the click from C_1. If the couplings between all three inductances are always fairly loose the settings for a station of any given wavelength will always be the same.

The fixed condensers, X, X, etc., may give place to variable condensers having a maximum capacity of .0025. In this case, adjustment for wavelengths below 7,000 meters will be somewhat critical.

Third Prize—A Long Wave Amateur Receiving Set

MANY amateurs have the impression that during the summer months receiving is difficult if not impossible due to the static which is so troublesome at this time of the year. This is to a certain extent true, but not nearly so much so as is generally believed. In fact it is very seldom that the static gets so bad that the high whistling tone of the undamped wave stations cannot be heard, and quite a thrill is experienced when they are first tuned in as the sound is unlike any ever heard before.

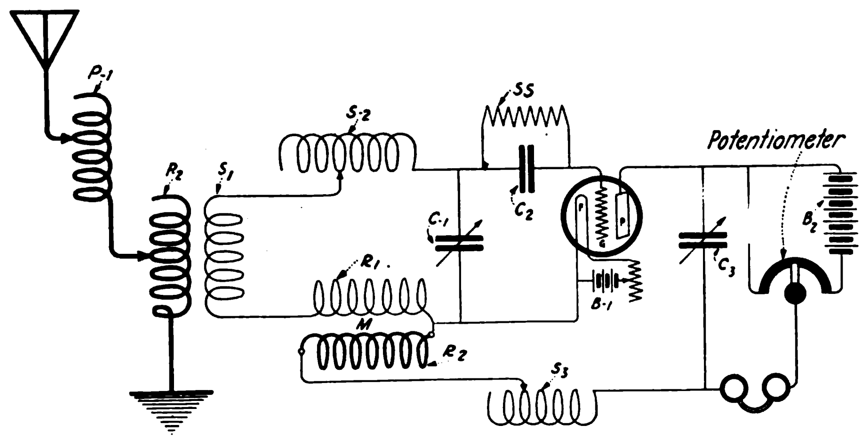

Figure 1—Showing wiring connections

Although an aerial span of two hundred feet or more is desirable for long wave work, it is not necessary. In fact the author finds little difference in the readability of signals on a 400 foot aerial and one sixty feet long.

With reference to the apparatus itself the connections as shown in either figure 1 or figure 2 may be used, figure 1 being somewhat better. The coil P-1 is the primary loading coil and may be wound with number 28 wire. The winding should be about 30 inches long on a tube about 5 inches in diameter. The primary coil P-2 should be wound with the same size wire as coil P-1 and should be 12" long and 6" in diameter. It should be closely variable, the slider being about

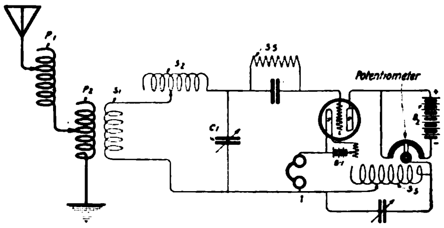

Figure 2—Modified circuit

the simplest method. The secondary S-1 should be about 12" long and about 5" in diameter, and should have 16 or 18 taps. This coil should be mounted so as to telescope into P-2. Secondary loading coil S-2 may also be wound on a tube 5" in diameter with No. 34 wire and should be 36" in length. S-3 is identical with S-2. The primary R-1 and the secondary R-2 of the regenerative coupler M should be made so as to telescope like a loose-coupler. No set size need be used for this coupler and any old loose coupler may be used if it is not convenient to construct one. A good size for one is: Primary 6" diameter by 6" long wound with No. 28 wire, no taps. Secondary 5" diameter by 6" long wound with No. 28 wire, no taps.

The long coils should be tapped every two inches or so. Loops may be run through the walls of the tubes and then brought out to switches in a convenient place. This makes it unnecessary to break the wire from start to finish.

It is a rather difficult matter to wind the longer coils entirely by hand but if the builder will use a little ingenuity an arrangement can be worked out which will materially lessen his difficulties. Using a winder made from an old scroll saw the author once wound a coil 20" long and 5" in diameter in fifteen minutes. If access can be had to a lathe the coils may be wound in a short time.

In practice the three coils P-1, S-2 and S-3 may be of the same dimensions and No. 30 S. C. C. wire used throughout. Only one section of each coil need be tapped as the other sections of the coil may be cut either in or out and the tuning done with the tapped section. This is clearly indicated in figure 3. For any variation up to one full section set the switch B on point C and tune with switch A. For variation up to 2 coils and over one, set switch B on point D and tune with the switch A, etc., etc. Such an arrangement saves quite a lot of time and labor and is just as satisfactory as having the whole coil tapped.

No very definite sizes and dimensions are given above for the apparatus described. The builder will be able to meet the requirements from materials which he has at hand.

The variable condensers C-1 and C-3 may be either the large or small types well known to all amateurs. A large one is better for C-3. The condenser C-2 may be made of mica coated on each side about 2" by 4". A small variable condenser may be substituted. No bridging condenser is needed across the receivers although one may be used if desired.

A potentiometer is shown for the "B" battery regulation, but a switching arrangement may be used. Another feature of these connections is the grid leak "SS." This may be made of a piece of fibre about 1" long and ½" wide with a binding post at each end. It is connected in shunt to the grid condenser and a pencil line drawn between the posts. If the static or incoming signal is so strong that it paralyzes the bulb the "plugging" can be prevented by running a pencil between the posts until it stops. A line ⅛" in width is about right.

The circuits are adjusted for oscillations by using very close coupling

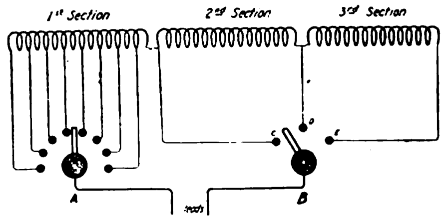

Figure 3—Method of tapping the coils

at M, and adjusting S-3 and C-3 until a click is heard both when the finger touches and leaves the grid binding post. This double click is an indication that the circuits are oscillating. The primary circuit is now brought into resonance with the closed circuits. By keeping these circuits more or less in resonance, and varying their wavelength, any undamped wave-stations which may happen to be sending will be heard. The undamped wave stations are in operation at practically all hours of the day, and consequently may be heard at practically any time one may care to listen.

A modification of the circuit described above is shown in figure 2, where no regenerative transformer is used, and where the coupling between the wing and grid circuits is provided by the capacity of the telephone cords.

JAS. B. HOLSTON—*Nashville, Ills.*

The Monthly Service Bulletin of the

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Vacuum Tubes in the Army

THE radio experimenter who has not been in touch with the work of the Signal Corps during the war will be interested to learn of the progress made in the construction of the vacuum tube during the past two years. Prior to the closing of the amateur stations this device was used by the more advanced experimenters, but only for the receiving purposes, and at its best it still had certain defects.

Skilled engineers from several of the largest electrical companies have improved the vacuum tube from the make-shift device of two years ago, to one of the most useful and efficient instruments known to radio communication. The standard tube applied to the Signal Corps for receiving purposes has a number of features which are a distinct advance over any tubes the amateur has had access to, and in addition a transmitting tube of considerable power has been developed, and in such quantities that it should be obtainable at reasonable cost.

The standard receiving tube operates on the usual 4-volt filament battery and 40-volt plate battery, but it has operating characteristics much better suited for its use by inexperienced operators. No critical adjustments of either the filament current or the plate voltage are required, the tube being designed so that it is operative over a 20 per cent. variation in these values. Thus, the filament rheostat and plate potentiometer are eliminated, which is indeed a marked improvement. Again, the same tube will function equally well as a detector, amplifier, or oscillator, making it unnecessary to select different types of tubes for each specific purpose.

As an amplifier, the amplification constant ranges from 12 to 25 and two such tubes connected in cascade will give amplifications in the neighborhood of 500. It has been found, however, that a cascade circuit of more than three steps again introduce the unstable conditions of the earlier tubes, and to overcome this, resort was had to an ingenious device. The signals were amplified at radio frequencies for three steps, then a detector tube was introduced, and from its output circuit, the signals were again amplified three times, at audio frequencies. Using this combination of seven tubes, it is possible to obtain an increase in signal strength up to the current saturation of the tube. For such an amplifier 60 volts are required in the plate circuit, and 4 volts, 7.7 amperes for the filament.

Experiments were also carried on with the object of producing tubes that would require a minimum battery equipment. The engineers finally succeeded in designing some that require 0.2 ampere at 2 volts for the filament, and other tubes which operate efficiently with from 4 to 6 volts in the plate circuit. What a boon these tubes would be to the average amateur who is troubled with the question of adequate current supply?

The transmitting tube which was adopted as standard for our army in the field, was more difficult to design than the receiving type, but it shows the results of careful engineering. It requires 7 volts for the filament, and 250 to 350 volts for the plate circuit. It has an output of from 3 to 5 watts high frequency power. It found a wide application on the small airplane transmitters, and was also used as an amplifier tube in the receiving circuit where a greater power output was required.

Transmitting tubes of much higher powers have been designed for experimental purposes, one of which had an output of 30 watts high frequency current, and required a plate voltage of 800. Another had an output of 100 watts, with a plate voltage of 1,500, but it is unlikely that such tubes will ever find a wide application in the amateur field, owing to the difficulties attending the production of the high voltage current.

Much credit is due to the engineering experts who have achieved such remarkable success in this work of developing the vacuum tube.

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.

O. E. S. Stanwood, Wash.

See answer to E. J. W. in this issue.

In the June issue of THE WIRELESS AGE, page 29, second column, the fifth line from the bottom, the word "each" should be omitted so that the line will read "a tap placed at 55 turns." Turn fifty of section 1 and beginning of section 2 are connected and form tap 1. Tap 2 is at 55 turns on section 2 or 105 turns total. Tap 3 is at end of winding. The 3/8-inch space is left to reduce distributed capacity on the lower wave lengths.

Figure 6, page 29, June WIRELESS AGE, have the numbers 5 and 7 erronously transposed in the winding diagram.

* * *

E. J. W., Roxbury, Mass.

See reply to O. E. S. in this issue.

The coil you wish to use is wound with Litzendraht and No. 18 D. C. C. wire on a tube 3 inch outside diameter. A four banked winding is used as shown in figure 6, page 29, of the June issue. A section of fifty turns is wound on the spool and a space of 3/8 inch is left after which another section of 240 turns is wound on with the tap placed at 55 turns.

In the next to the last paragraph, page 29, the word "each" before the number of turns, should have been omitted.

* * *

P. A. H., Pawtucket, R. I.

The diagram shown on page 41 of the July WIRELESS AGE is incorrect in that the wire running from the 20,000 ohm resistance to the double pole double throw switch should not be shown as connecting to the ground lead..

* * *

M. W., Troy, N. Y.

Satisfactory results for calculations such as yours may best be obtained by the use of Nagaoka's formula (see August, 1915, issue), rather than Cohen's. You seem to have failed to convert your dimensions into centimeters in all cases. The inductance of a coil 4 inches in diameter by 1 inch in length wound with a single layer of 30 turns is approximately 125,000 centimeters.

From dimensions given in figures on page 27 of the May issue, you will yourself be able to calculate the various inductances which go to make up the receiver there described. In the case of the ball, it may be considered as a cylindrical winding 2 1/4 inches long and having a mean diameter of 3 15/16 inches, the spacing in the center being disregarded. Each pair of field frames may be treated in like manner. Your results will be sufficiently accurate for all practical purposes. If you use No. 32 wire throughout the secondary circuit of your receiver, its effiicency will be considerably decreased since resistance rises rapidly at the higher frequencies. Otherwise the receiver should operate in a very satisfactory manner.

* * *

W. G., New York City.

See article to appear in October issue on "A Two Stage Amplifier Cabinet."

H. H., Atlantic City, N. J.

Cells of the "A" and "B" for the vacuum tube detector you mention should be in series.

Castor oil may be used in a condenser to increase the capacity of the condenser, the specific inductive capacity of castor oil being between 4.5 and 5 times that of air. Other oils, such as lubricating oils of various qualities, may be used. A particular good grade of oil which may be used in the case of transmitting condensers, is "Nujol," which may be purchased at any drug store.

The newspaper clipping which you enclose, refers to a loop aerial, but a coil such as you have mentioned, that is No. 18 copper wire wound on a frame 1 ft. square and 7 feet in length, would not make a good one. It would be better by far to make a frame 7 feet square and 6 or 8 inches in width.

An article will be published in this magazine in the near future on loop construction and the use of the loop for transmission and reception.

* * *

H. W. N., Victoria, B. C.

A fairly complete list of high power arc and spark stations with their wavelengths, is being published in this issue.

* * *

R. W. P., Detroit.

As Mr. Dean gave no dimensions for the condenser test tubes which he described in the November, 1916, issue of Wireless Age, it is impossible for us to say exactly what the capacity of the condenser would be. You will be safe, however, in figuring that it is somewhere in the neighborhood of .0003 mf.

* * *

M. B. DeL., Annapolis, Md.

The limits of amplification using three electrode vacuum tubes, vary with the type of coupling used between the tubes and the precautions taken to prevent extraneous and undesirable back-coupling, be it either electrostatic or electromagnetic, between the first tube or tubes in the circuit and later tubes. After a certain amount of voltage amplification has taken place, electrostatic or electromagnetic fields are set up due either to the concentrated windings of the coupling transformer or to the wiring, and sooner or later these stray fields will link the fields having to do with the wiring, or transformer of the first tube and oscillations will result. These oscillations are uncontrollable under these conditions and consequently the amplifier is no longer useful. With proper methods of shielding the various stages of the amplifier from these undesirable fields amplifications of the order of 100,000,000 times have been effected. With the ordinary methods of coupling tubes and where no effort is made to guard against magnetic and electrostatic fields existing in them, the order of amplification reaches a limit somewhere around 1,500 times.

The action taking place in an arc transmitter after the striking of the arc and up to the time when steady oscillations begin, results in a hissing, sputtering and bubbling noise in the telephone receivers at a station which is in tune with the arc transmitter. This hissing, sputtering and bubbling is due to the very rapidly changing conditions present in the arc chamber when the arc is struck. The arc will not act at all steadily until that time when the exactly proper atmosphere has been attained in the arc chamber. The nature of this atmosphere depends upon the temperature and upon the amount of alcohol which has passed into the vaporizing chamber from the supply reservoir. During this period of adjustment the arc is at all times endeavoring to supply oscillations, but due to lack of proper temperature, or as above stated, the proper mixture in the chamber, the oscillations are choked out, etc., until finally the temperature having reached the normal operating valve and the proper mixture having been attained, steady oscillations commence.

The modulator member of a two-tube radio telephone outfit acts simply as an amplifier of voice currents passed into the microphone. These voice currents, after having been amplified, are superimposed upon the radio frequency oscillations of the oscillating member of the outfit.

* * *

R. Y., Toronto, Ont.

While a vacuum tube is oscillating there is not necessarily any sound in the telephone receivers, but if while oscillating, a finger is touched to the grid terminal of the receiver and removed again, a click will be heard in the telephone receivers both when the finger touches the terminal and when it is removed, but if the receiver is coupled to an antenna, the characteristic note of spark signals or static will be changed to a hissing, scratchy note. Inasmuch as there is usually more or less static of one character or another, this serves as a fairly reliable indication.

The loose coupler which you describe has a calculated primary inductance of about 45,000,000 centimeters and a calculated secondary inductance of about 75,000,000 centimeters, which being the case, you should be able to receive wavelengths up to 15,000 or 16,000 meters provided your secondary was shunted by a maximum capacity of .001 mf. and provided your antenna was of sufficient size, or a loading inductance was used to make up for what the antenna might lack.

The hook-up which you enclose is not considered the best hook-up for undamped wave reception, due to the fact that the control of the oscillations generated by the vacuum tube is not what it should be. You will find articles in the September issue which will give you preferred schemes of connections, with which you should be able to receive any of the Trans-Atlantic stations on an 85-foot antenna.

It is difficult to say which vacuum tubes are the most sensitive inasmuch as they vary considerably in sensitivity. You will probably find your tubular audion to be as good as any.

* * *

K. E., Seattle, Wash.

If you have in mind the construction of a receiver such as described by Mr. Jones in the June issue, it will not be as satisfactory to wind the inductance in five layers, and not advisable in any case unless the wire is wound on in banks. We suggest that you refer to articles being printed in the September issue, covering construction of long wave receivers, if you desire to build a receiver which is more compact than the one above mentioned.

The comparative values of inductance in the primary and secondary circuits will depend entirely upon the antenna used; that is, its size. For the average 200-meter amateur antenna, the inductance values in these two circuits will run about the same, excepting where a shunt condenser is used in the primary circuit under which condition the primary inductance would not need to be as large as the secondary inductance.

There is no limit to the maximum wavelength which you can tune up to with a 100 foot antenna such as you describe.

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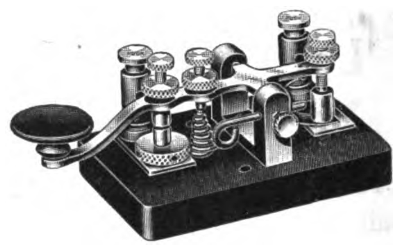

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