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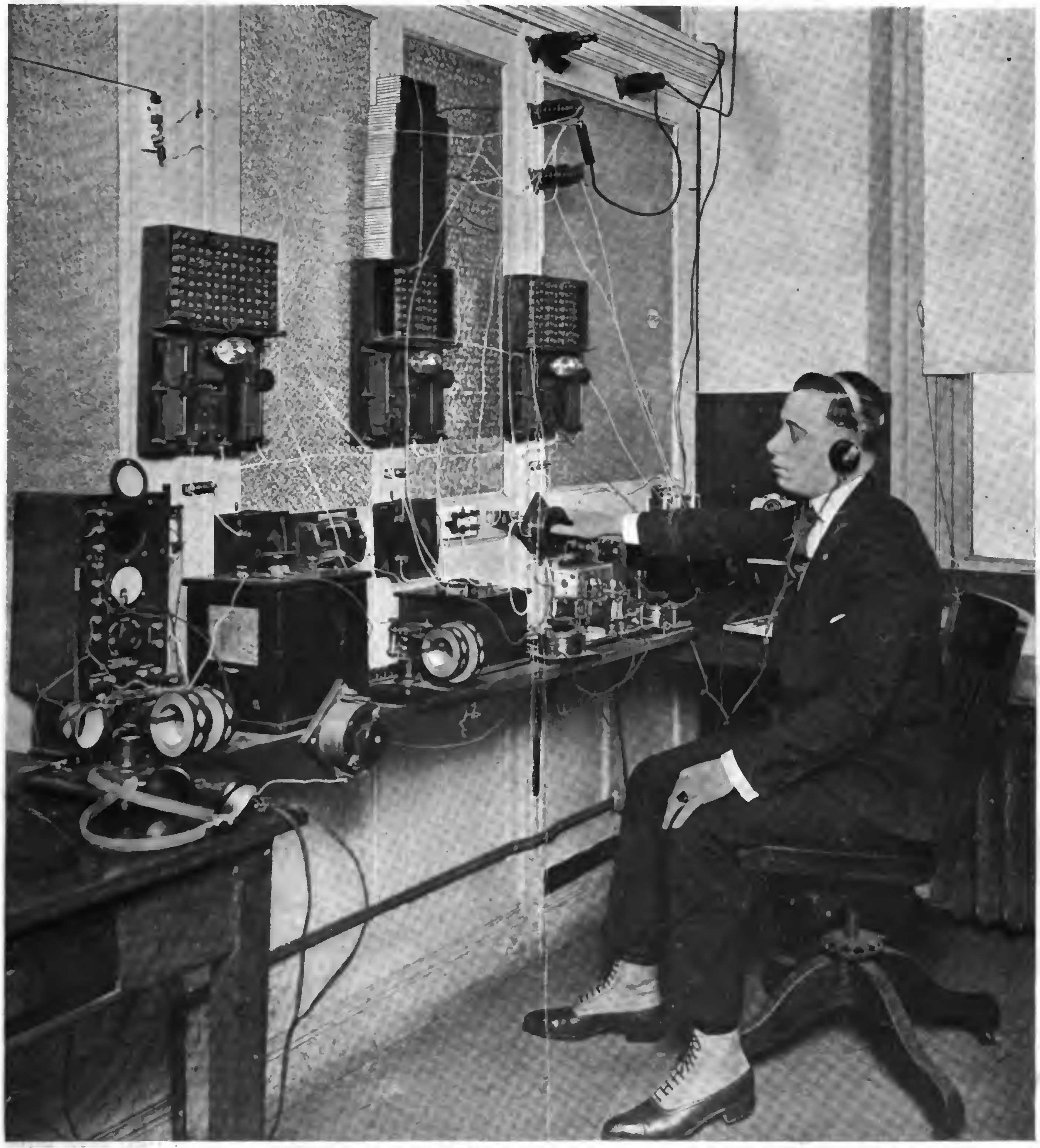
The WIRELESS AGE

Volume 7 Number 4



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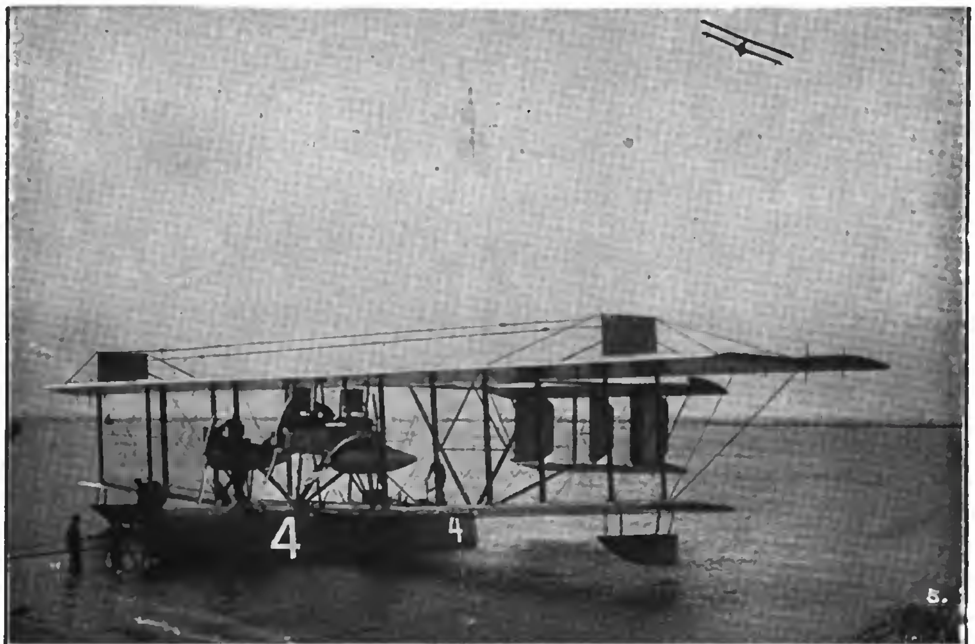

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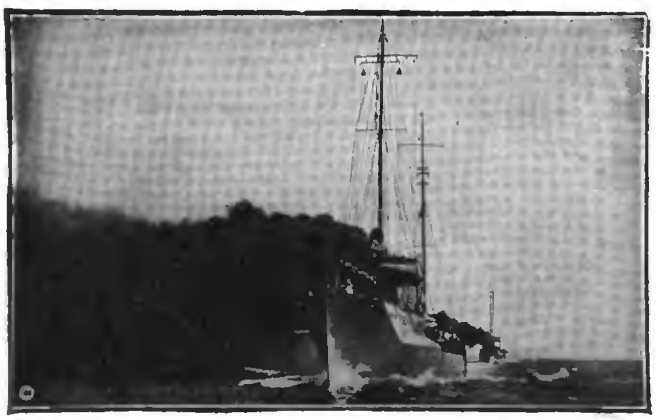

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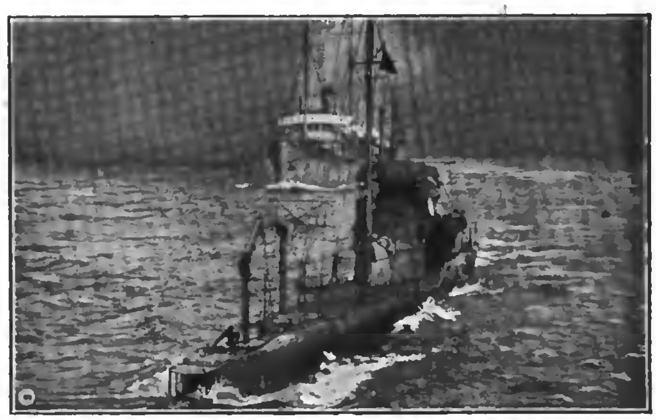

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The Wireless Age

Edited by J. ANDREW WHITE

Vol. 7 | Contents for January, 1920 | No. 4

Index of Equipment

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On this page, in the next or subsequent issues, will be announced additional designs with their type numbers, etc., as well as other developments of interest to the art.

WIRELESS IMPROVEMENT COMPANY, Inc.
Radio Engineers, Manufacturers and Distributors,
47 West Street, New York, U. S. A.

If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 1)

Vol. 7. No. 4. JANUARY, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

Honors for E. F. W. Alexanderson

ERNST F. W. ALEXANDERSON consulting engineer of the General Electric Company, whose inventions have made possible the plan of the Radio Corporation of America to connect the nations of the world by wireless has just been doubly honored as the result of his remarkable achievements.

The Institute of Radio Engineers, an international organization, elected him vice-president and awarded him a handsome gold medal, "in recognition of distinguished service in radio communication in 1919."

Dr. Alexanderson has gained a world-wide fame in the inventive and radio fields. Of his many inventions more than one hundred are protected by patents in the United States and other countries. Foremost of these is his high frequency alternator, which makes possible the sending of one hundred words a minute by wireless, as compared with twenty under other conditions.

Dr. Alexanderson was born in Sweden, and is the son of Prof. A. M. Alexanderson. He was educated in institutions abroad and came to America in 1901, accepting employment with the C. & C. Electric Company of New Jersey. A year later he entered the drafting department of the General Electric Company. Two years later, in 1904, he was transferred to the engineering department of the company. His ability and many inventions soon won him promotion as consulting engineer in charge of radio work.

Radio Corporation of America Plans Commercial Wireless

OUTLINES of a plan which it is expected will eventually link the principal nations of the world into a comprehensive chain of commercial wireless communication were made known following the election of officers and directors of the Radio Corporation of America, the new corporation formed to acquire the Marconi interests in the United States with the support of the General Electric Company of Schenectady.

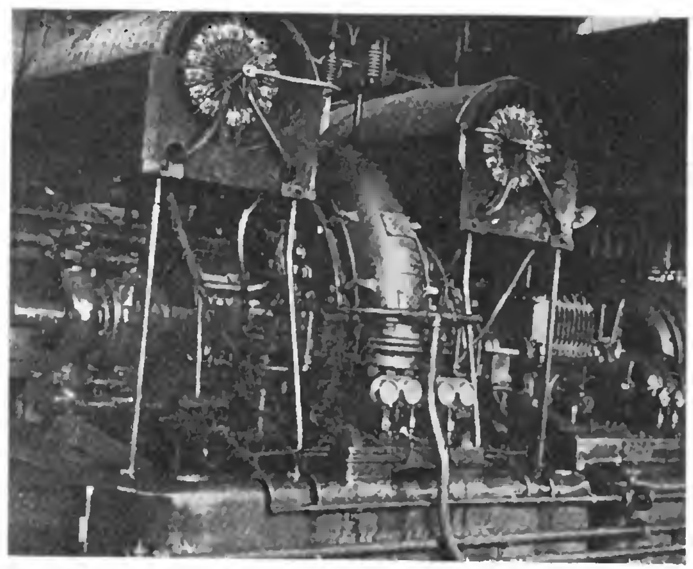
Edward J. Nally, who has devoted his life to communication service and who for a number of years has been vice-president and general manager of the Marconi Wireless Telegraph Company of America, has been elected president of the Radio Corporation.

Confirming the belief that the organization of the Radio Corporation will mean an immediate expansion of wireless development, the following statement, outlining the aims of the new company and planning the establishment of a world-wide commercial wireless service has been made by Mr. Nally:

"The principal aim and purpose of the Radio Corporation of America will be the establishment and maintenance of trans-oceanic and long distance overland communication.

"The Radio Corporation has been greatly strengthened through its connection with the General Electric Company by reason of which it will have available for its use the valuable wireless apparatus recently developed by the General Electric Company, the principal device being already widely known as the Alexanderson high-frequency alternator.

"Through agreements made with the Marconi's Wireless Telegraph Company, Ltd., of England, new powers and privileges are granted the Radio Corporation, extending its scope of activity and providing, among other things, for the formation of a South American company



The New Brunswick high power station of the Radio Corporation of America, operated by the Navy during the war period, is well equipped to enable wireless to compete with the cables in trans-oceanic communication. The photo shows the giant 200-kw. high frequency alternator with dynamo at the right and the transformers on top

to be managed by it. The Radio Corporation will own the majority of stock in various companies which will construct stations in South America for communication with the United States and England, and in due course with other countries.

"It is confidently expected that this will be the forerunner of similar plans for the further extension of trans-oceanic wireless. Thus, the Radio Corporation of America, under traffic arrangements with the British company and others will be enabled, as soon as its stations are returned by the government, to start traffic with the British Isles, Norway, France and Japan in addition to the South American project already referred to.

"Under new conditions of financial strength, and in possession of the engineering resources of the General Electric Company, with a departmental staff of exceptional experience and ability, the company expects to attain the great objective for which it has always aimed, namely, a world-wide system of commercial wireless communication.

"In accordance with what is understood to be the wishes of the United States Government, effective means have been taken to see to it that the actual control of the Radio Corporation shall at all times remain in the hands of loyal American citizens or corporations."

Radio stations, which the corporation is waiting for the Government to relinquish control, are the transmitting station at New Brunswick and the receiving station at Belmar, N. J., which will be used for the British service; Marion, Mass., and Chatham, Cape Cod, sending and receiving for Scandinavian service, and Tuckerton, N. J., for sending and receiving from France. Hawaii, Japan and China operations will be conducted from Balinas and Marshal, near San Francisco.

Wireless a Boon to Americans at Constantinople

EVERY afternoon the wireless apparatus on the American cruiser Galveston, which has been lying in the Golden Horn at Constantinople for many weeks, catches from six to eight foolscap sheets full of news as it crosses the Atlantic for the United States, and every evening the day's crop is handed out to Americans and others thirsty for tidings of the outside world.

In the absence of a real local American newspaper the United States Naval Radio forms practically the only source of quick information. Sailor men do all the work and the more ambitious on the staff have started a cartoon supplement to the regular edition.

English Marconi Co. Increases Capital

FOLLOWING the sale of its holdings in the American company to the General Electric Company, Marconi's Wireless Telegraph Company, Ltd., London, has announced an increase in its capital. The official notice says: "At an extraordinary general meeting of the company a resolution was passed authorizing the increase of the company's capital by £1,500,000. On November 28, 1919, the confirmatory meeting was held.

"At these meetings the chairman informed you of the important and extensive developments of the company's business and the necessity for the substantial increase of the company's capital in order to provide for the commitments already entered into and to be ready to carry out the offer, if and when called upon to do so, which the company has made to the Government to construct and organize a thorough and efficient wireless telegraph service between all distant parts of the empire and the mother country.

"In these circumstances and for the reason which has already been given at the extraordinary general meeting, it was regarded as inexpedient to distribute a cash bonus to the shareholders, but a promise was made that this should be compensated for by the terms of the issue of the new capital.

"The directors have pleasure in informing you that in fulfilment of this promise they have decided to issue the whole of the increased capital to shareholders only at £2 per share premium. This will entitle every shareholder, whether he holds preference to ordinary shares, to secure one new share at the price of £3 for every share he may hold on December 4, 1919, when the register closed."

Lightships to Have Wireless

AS a measure of protection for the sturdy seamen who man the chain of lightships marking harbor entrances and shoal spots, the length of the two coastlines, the Lighthouse Board at Washington is considering installing wireless apparatus aboard each ship and it is probable that the plan will be put through in the immediate future.

The necessity for bringing these ships into radio communication with the land was brought home forcibly to the government two winters ago when Cross Rip Lightship was torn from her moorings in Nantucket Sound during a terrific storm and was swept to her doom carrying 10 men to watery graves. The tragedy has taken its place with the gruesome list of sea mysteries, for the ship was without means of communication to tell of her plight or to ask assistance.

To guard against a repetition of this disaster, the department is desirous of restoring wireless on each of the 67 lightships stationed far out to sea, keeping lonely vigils that shipping may be protected. During the war they were so equipped as to make possible the dispatch of warning of possible enemy raids on the coast. Last July the apparatus on all vessels was removed, excepting Nantucket and Cross Rip Lightships, which are stationed in exposed positions, and it was deemed advisable to have these two light vessels retain their outfits.

Gen. Squier's Report Praises American Radio Men

WHEN it came to war-time electrical inventions, especially those in the field of radio communication, American experts accomplished brilliant work and more than held their own with experts of the allies and the enemy powers, according to the annual report of Major General George O. Squier, chief signal officer of the Army.

"Invention in telegraphic and telephonic science reached its apparent climax in the perfection by American officers of the airplane telephone apparatus, whereby an aviator can communicate vocally with the earth or with other planes," Gen. Squier said.

The report, which throws light on many unrevealed incidents in the electrical side of the war, mentions that possibility of the enemy cutting all cable lines caused much concern in the early months of the war, and led to work being pushed on auxiliary radio stations, especially on the construction at Bordeaux of what was intended to be the longest-range station in the world. Discovery of the fact that it was possible to "tap" a cable without detection increased the anxiety of the government to complete the air communication lines.

The report records the unsuccessful search made in 1917 of the Atlantic coast for the secret enemy cable which, apparently authentic information said, had been laid by German submarines.

Wireless to Help Traffic Across Sahara Desert

THE army air service of France has been assigned the task of conquering the Sahara desert. The camel, conqueror of the desert wastes, must now defend his title and his right to monopoly in desert realms against the intrusion of the aeronaut, the French government announces.

The government hopes to establish postal, express and freight aerial routes through the whole length and breadth of the desert.

France's immediate object in the aerial conquest of the Sahara is to uplift the inhabitants of the border regions of the French colonial possessions of Algeria, Tunis and Morocco and of the French colonies along the western coast of Africa.

Major Vuelleman and Lieutenant Dagneux, the French aviators who recently flew to Constantinople, have been commissioned to work out the details of the project. They hope to be ready to establish regular flights early next spring.

The first lines will start from Algeria and will pass by the Oran peninsula to Timbuktu, the famous trading post in the southwestern part of the Sahara.

The flight will be divided into five stages. The first step will be about 600 miles, the second 400 miles, the third 250 miles, the fourth 500 miles and the last one a little over 600 miles.

In order to make the line permanent and in order to aid lines to be established in the future, the government will install sufficient wireless stations throughout the western Sahara to enable airplanes to keep in constant communication with at least one station.

Gasoline and oil stations will also be installed at each of the wireless posts. An automobile rescue service will be established which will enable rescue parties to search for airplanes the moment any are lost track of by the chain of wireless stations.

Sufficient police force to protect the aviators and passengers from savage tribes and from wild animals when planes are forced to descend in the wilderness will also be organized by the government. The government counts largely upon gaining the co-operation of friendly and partly civilized tribes in making the vast region safe for the aviators, and in keeping the country policed.

Immediately following the establishment of the initial line the government hopes to replace all of the camel caravan lines and to make the latter entirely unnecessary.

Negro Operator in Overseas Service

PERRY VAN DERZEE, Topeka, will sail for overseas service as a wireless operator, according to word received in Topeka by his father.

Perry Van Derzee is thought to be the only negro wireless operator holding a United States Government radio license. He is a graduate of three wireless schools.

Wireless Operator Loses Life in Storm

THE French steamer Madonna arriving here from Naples reported the loss of Chief Wireless Operator Bergis, who disappeared at the height of a storm during the trip. He left the bridge at 9 o'clock one morning to go to breakfast and is believed to have been washed overboard.

New Device Rings Bell to Call Wireless Operator

A REMARKABLE development of wireless was demonstrated recently at the Marconi headquarters at Chelmsford, England. An emergency calling device has been invented which enables a ship in distress to ring alarm bells on other ships within wireless range.

Up to now it has been necessary for every vessel carrying wireless to have an operator always "listening in." The new invention means that the wireless plant will need no more attention than an ordinary telephone.

A ship will "ring up" and the operator will then take the message. There will be no need for him to remain glued to his instrument all day.

British Wireless Station in Bermuda

THE British Government is to open a wireless station in Hamilton, Bermuda, for commercial business with Canada, the West Indies and the United States.

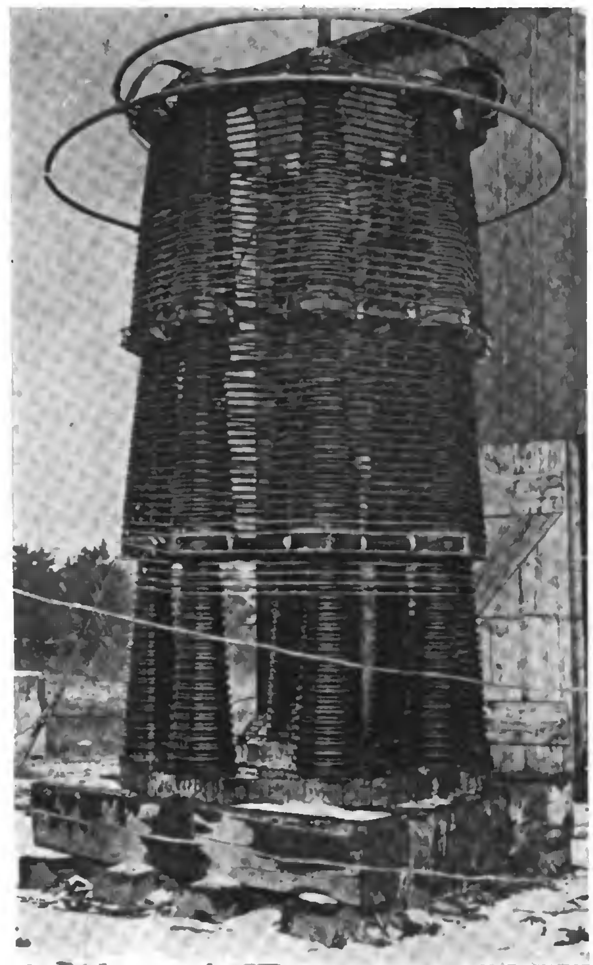
The colony will get one penny on each shilling of local business. The rate to Halifax will be one shilling a word.

French Adopt Wireless on Railroads

RAILWAY accidents have been so frequent and disastrous recently that French engineers after experimenting with new methods have installed a new system of railway signaling based on the principles of wireless telegraphy. The old system has always been considered good, but such speed has been attained by locomotives that it is now inefficient.

Another U. S. Radio Compass Station Erected

THE U. S. Naval Radio Compass Station at Surfside, Nantucket Island, latitude 41 deg. 14 min. 42 sec. North, longitude 70 deg. 05 min. 56 sec. West, call letters NBS, was placed in commission January 9, 1920, to furnish radio compass bearings to passing vessels.



Giant tuning coil at the New Brunswick high power station

Wireless Between Mexico and Chili Possible

THE possibility of establishing wireless communication between Mexico and Chili has been demonstrated in the most casual manner through the intercepting by the wireless station of the University of Santiago de Chili of more than 2,000 words sent from the Mexican station at Chapultepec.

The operator at the receiving station experienced not the slightest difficulty in the transcription of the message. This occurrence has been widely commented upon, as much in Mexican as in Chilean official circles, and it is hoped that within a short time it will be possible to establish a regular service between the two countries. In the last few days various messages have been exchanged with utmost clarity from Chapultepec to the University of Santiago de Chili.

Wireless in Foreign Trade

Its Valuable Influence in Promotion of International Commerce—Importance of The Radio Corporation of America. The New Company Which Combines the Marconi Activities With the Wireless Interests of The General Electric Company

THE post-bellum problems relating to commerce which are of special interest and pertinency to American business are those connected with the means whereby the international exchange of commodities which are produced or consumed by the United States may be enlarged and expanded. The war put upon the United States the responsibility of supplying foreign countries with amounts of American products in volume and value far beyond any previously conceived possibility or capacity. It did this, too, under the stress of most unfavorable conditions of transportation, of labor resources and of other necessary factors of commerce and industry.

It was a revelation to our own people of an unsuspected capacity for trade with the outside world, opened a vista of possibilities for commercial development such as had never been anticipated, and mirrored opportunities which American enterprise is eager to improve. Hence the wide discussion of the problems, methods, means and instrumentalities of foreign commerce in publications devoted to trade, finance or economics. Many of the questions involved have been argued and discussed from every conceivable angle, while others of equal importance have received very little consideration. Of this latter class none has greater influence upon success in establishing and maintaining foreign commerce than that connected with the means of communication between buyer and seller, principal and representative, in countries having international relations in commerce.

Trade Follows Communication

An old and familiar commercial adage tells us that "trade follows the flag." In a sense that is true, and it expresses a fact that is strongly emphasized in the efforts to build up an American merchant marine. But of much wider application is the equally correct statement that trade follows means of communication.

The main differences between foreign and domestic trade are those of time and distance, but chiefly time. "It takes two to make a bargain," and the bargain, to be satisfactory, should be explicit as to many details. "If you would come to a firm agreement with a man, meet him face to face," is a piece of advice not often physically followed in the transactions of international commerce. But it has been made intellectually possible by the magic touch of constructive science. The Marconigram is the effective medium which puts Tokio face to face with New York, or Buenos Ayres with Washington. And the same medium, capable of indefinite enlargement, is rapidly extending its sphere so that its expansion will keep pace with the broadening advance of America's foreign commerce. "World-wide Wireless" is already an accomplished fact, and its ramifications are rapidly being extended to cover the widest range of commercial need.

Why Wireless?

The importance of means of communication as a factor in the promotion of foreign commerce is so obvious that it needs no elaboration, but their quality and character are matters of considerable importance. The main requisites are that it shall be quick, reliable and as inexpensive as possible. Speed is the vital point in telegraphic communication on commercial affairs. "Do it now" stands first among the commandments of business diligence. Upon the basis of speed the Marconigram stands first among the factors of international communication, with less physical and mechanical impediments to rapid transmission than any other. Its accuracy is no less emphatic than its speed. The great improvements made to extend the range and amplify the resonance of the transmitting and receiving mechanisms of wireless telegraphy make radiograms the most reliable of all the methods of long-distance communication. The cost of wireless communication is considerably less than that of any other international service, and this makes it possible and profitable to use it much more liberally than any other systems the tolls of which are so onerous as to be prohibitive except in emergencies.

In wireless telegraphy, therefore, lies the hope of future satisfaction in the work of communication between the home and foreign fields of commerce. Wireless, as the efficient connecting link between port and port, the American manufacturer and the foreign consumer, the foreign representative and the home concern, broadens the outlook, makes straight the ways of communication and speeds up the transactions of international commerce.

Prompt Dispatch of Marconigrams

With the great revival and eager competitions of international commerce which have followed the World War there has come a demand for telegraph service which is unprecedentedly large. To the cable lines the demand has so taxed the capacity of the existing plants that they are in a state of chronic congestion, involving many delays in transmission that greatly reduce the value of the service. The demands on the Wireless have similarly increased, but the capacity of radio service is elastic where that of the cable is circumscribed, and it can be speeded up in the volume of work of which it is capable in a way to keep pace with every call upon it.

This elasticity of capacity is a strong factor in the influence which wireless telegraphy exerts, and which it will continue to exercise, over the expansion and welfare of American commerce with the nations of the world. Extensions of service as they may require enlargements of plant, can be effected with infinitely less expense than is involved in the laying of new lines of transoceanic cable. The potentialities of progress in wireless are practically unlimited to those who own and control the patented improvements that have made expansion possible. So that however great the need of extended facilities for transmission of messages overseas, the wireless service can be enlarged to meet it.

The Radio Corporation of America

The Marconi Wireless Telegraph Company of America, which built up for this country the wireless enterprise which gave to the United States its commercial wireless connection with Europe and the other continents, has recently been acquired by a new corporation, the Radio Corporation of America. That corporation acquired, in addition to the stations and wireless installations of the American Marconi Company, the manufacturing branch of business with its valuable American patents, the Marconi Institute for the training of radio men and all the property of that company, also all of the wireless interests of the General Electric Company, making it the most complete and best equipped radio organization in the world.

An American organization in every particular, the Radio Corporation of America is entirely independent of any other corporation, although it has traffic agreements with the British Marconi Company, the French Marconi Company, and the Governments of Norway and Japan. It has thus excellent facilities which make it the controller of a wireless service that is world-wide. It has stations on the Atlantic and Pacific Coasts of this country, and at Honolulu and Japan, for communications, via its Pacific Station, to the Hawaiian Islands, and the Far East.

Wireless to South America

In addition to its installation in United States territory the Radio Corporation is organizing a new company to be called the Radio Corporation of South America, to cover South America with wireless installations which will give to the United States a direct means of wireless communication with South America. There can be no more valuable contribution to the great endeavor of American business to build up wider and better trade relations with the Southern Continent than will be offered by the enlarged and intimate connection to be afforded by this chain of wireless stations.

For the present the Radio Company of America is circumscribed in its opportunities and plans for service by the fact that its stations, taken over by the Government as a war measure, are not yet released to the company; but when that is done, which is expected to be soon, the corporation will be enabled to push to completion the plans and policies it has evolved for the widest possible extension of radio-electric service in aid of American commerce.

Wireless News Service as Factor

Among the branches of useful service which indirectly, but none the less effectively, exerts a valuable influence in the promotion of American commerce, are the facilities the wireless offers for the dispatch of news, by means of which the newspapers of the various countries are and will be supplied with day-by-day information as to the various important happenings of each. Such interchange of information concerning the doings, the movements, the aspirations and achievements of various countries promotes an international knowledge which promotes friendly relations. With knowledge comes understanding, and the ability to see the point of view of the foreign business men.

Radio telegraphy, still in the infancy of its expansion, has reached an effectiveness of utility that is reflected in a constant increase in the demand for it. It was a great factor in the work of the war and new inventions to increase its efficiency resulted from the researches and inventions of many engineers whose discoveries are now included in the output of the Radio Corporation of America, for which the great works of the General Electric Company manufacture exclusively all of its radio equipment and devices.

Possibilities of Expansion

The radio telegraph covers a much wider field than is possible to ordinary telegraphy. It links the steamship to the shore so that the shipowner and all interested in the vessel may be kept in constant and almost immediate communication with all on board. The character of the terrain between stations makes little difference in the installation of radio service: Desert, mountain, water, all are traversed by its messages. In other words the physical difficulties and the expense of maintenance of way, which figure so much in the upkeep of the ordinary telegraph lines, are entirely absent from that of the radio. It would be as easy to communicate with Kamchatka or Timbuctoo as with Chicago or Havana if business should justify the construction of a radio station of sufficient range at these remote places.

It is the adaptability of wireless telegraphy which gives it so much present influence and assures it a much larger share in the future promotion of international trade relations. As the demands of commerce grow, chains of wireless stations will put all the nations and every principal post and mart in each of them, in close and intimate touch with each other. We will know each other better when all civilized people are thus drawn together.

The filling of each other's commercial needs will be much more promptly and efficiently done when the touch of a button will bring buyer and seller together to expedite mutual exchanges of export and import. The sense of aloofness from foreigners and insular prejudices will disappear when the radio service has brought all lands together in commercial accord.

It is already the case that a very large part of the commercial world is already reached by radio service, that the larger vessels of all the modern mercantile fleets are made less isolated and immeasurably more secure through wireless installations.

The subject of wireless telegraphy, its achievements, its aims, and its plans, is one of widely diversified interest. Its success and further extension is important, from an American point of view, because of the things it has wrought, and the work it is doing, to aid in the development of this country's share in international commerce.

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, A. E. F.

and Capt. Willis H. Taylor, Jr.

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

Part III

IT can reasonably be said that every move the enemy made after January, 1918, was observed and followed by American radio intercept, radio goniometric (compass stations) or ground listening stations. Intelligence of the greatest value concerning the enemy's plans and disposition of his troops was deduced from these intercepts and observations.

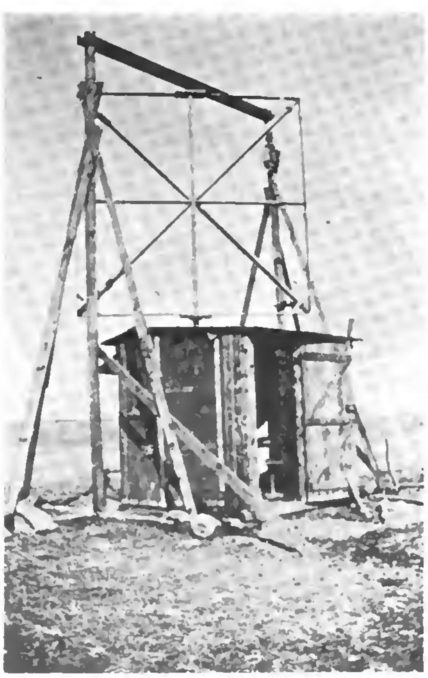
This source of information, so cleverly developed by the French and British, was utilized and improved to such an extent that toward the close of hostilities it was one of the most trustworthy aids to the operations of the American army. Information was obtained by these means which could not have been secured in any other manner. and the stations also continually served to check information received from other sources.

It was through information furnished by the radio goniometric stations that we had the ability to locate accurately every German radio station in the St. Mihiel salient on the days preceding the attack of September 12, 1918. The operation of the German stations furnished the only proof that the enemy had not withdrawn from the salient, and this proof—even in the face of overwhelming evidence to the contrary—prevented an eleventh hour change in the plans for the attack and a possible change in results.

The operation of the radio intercept and radio goniometric stations and T. P. S. (ground telegraph) and wire telephone listening stations and the forwarding of all data to the Intelligence Section of the General Staff, A. E. F., was performed by the Radio Section (Intelligence) of the Radio Division, Signal Corps. In the words of the Intelligence Officer of the First American Army, "upon the efficiency of the Radio Section depended, in large part, the success of the Intelligence Section of the General Staff."

Unceasing vigilance was required of the officers and men of the Radio Section, together with the ability to meet the myriad ever-changing conditions. Too much credit cannot be given to the enlisted personnel. The trying conditions under which they labored, and the important results achieved by them were bywords to all who had knowledge of this service.

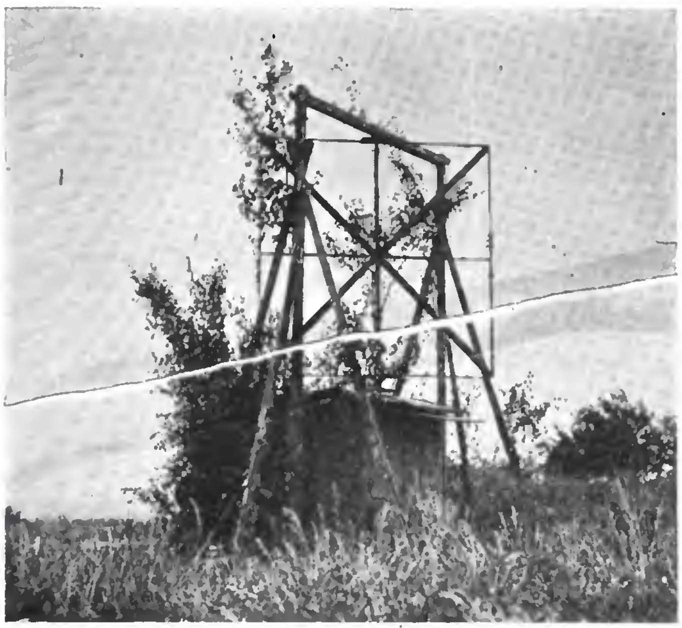
The Radio Section operated stations of six separate and distinct kinds, as follows: radio intercept stations which copied messages, generally in code, transmitted from German ground-radio stations; control stations which supervised the work of American radio stations and reported and stopped the use by our own forces of "clear" (uncoded) English and prevented other dangerous practices that might have served a useful purpose to the enemy; goniometric or radio compass stations which secured bearings on enemy radio stations, the



Radio goniometric station at Froidos in the Verdun sector

Radio intercept station at Ansauville in the Toul sector

Radio goniometric station at Landrecourt in the Verdun sector transmittal of this data, enabling the Intelligence Section (General Staff) to accurately locate the stations geographically; airplane intercept stations which copied messages transmitted from enemy planes to the enemy ground radio station; airplane goniometric stations which located enemy observation and radio fire control airplanes and sent the bearings immediately to the Air Service, which in turn sent our pursuit planes to destroy or drive



Camouflaged radio goniometric station on the Toul front

the enemy planes behind their lines; listening stations, which copied telephone and T. P. S. (ground telegraph) messages, thereby securing valuable information from enemy communications and at the same time policing our own telephone lines to see that dangerous conversation was not held over accidentally grounded circuits. The work of listening stations will be more fully described in another article of this series.

Before passing to the description of the apparatus used in the various types of stations and to outline the organization of the Radio Section (Intelligence), the following incidents may be of especial interest. They represent only a few of the many scoops that were made in addition to the daily confirmation of the enemy battle order, which may be briefly explained as the identification of the German units then in the trenches before us. Frequently the relief of a certain German unit was discovered before it had left the communication trenches.

On March 11, 1918, an entirely new code was put into service by the Germans. This was considered of great importance and indicated that the long-expected German attack would soon take place. All available officers and men of the Intelligence Section (General Staff) were assigned to its solution. On March 13, 1918, a message in an old solved code was intercepted by one of our radio intercept stations of the Radio Section (Intelligence). It was from a German radio station which had received a message in the new code and stated that the addressee was unable to read the message but asked that it be repeated in the old code. From the call letters given in this message it was possible to find the original message in the new code and the repetition in the old code, both having been copied. Comparison of the two gave a number of solutions which were at once communicated to the British and French intelligence sections. With this as a start, rapid solution was assured, so that before the Germans themselves were really familiar with their own new code it was being decoded by all of the Allies. The importance of the solution of this new German code can hardly be overestimated.

When it is considered that the message copied appeared to the radio intercept station operator simply as a series of letters without meaning, which is the hardest type of message to copy, and that in order to be sure of getting the valuable messages it was necessary to copy several hundred useless ones each day over long periods of time, also that the copying was done under difficult conditions and through interference which would have confused all but the best operators, then it will be possible to appreciate the fine work done by the men of the Radio Section. In this one instance a few minutes of inattention, a single mistake in call letters or the missing of a few groups of the code in one of the messages would have made the other useless. The American operators were the only ones who copied all three messages with sufficient accuracy to be useful, thereby enabling us to lay claim to the credit of performing this vital service for the Allies on the western front.

On the afternoon of April 24, 1918, a German message was intercepted from the St. Mihiel sector, announcing that an enemy attack had been postponed on account of bad weather. At 1.25 p. m. and again at 1.32 p. m on April 25, messages were again received ordering the German artillery batteries to remain at absolute attention and announcing that the barrage signal would be "BLUE." Our troops were notified and the necessary steps were taken to successfully combat the enemy raid which took place that night.

At 9.05 p. m. on April 28 a German message ordering an attack in the Toul sector at 1.00 a. m. was intercepted and telegraphed to the Intelligence Section (General

Radio division officer inspecting a camouflaged goniometric station on the Toul front

Staff) decoding office, where it was decoded and our troops were warned thirty minutes before the attack. Without a well organized system for copying and transmitting these messages this information would have been received too late to have been useful. It should be noted that in this case, as in others, the radio intercept station operators had no knowledge of the important nature of the message.

Again on June 14, 1918, a German message was intercepted stating that the French were preparing an attack and giving instructions for meeting it. The French Army Staff was notified. We were later informed by the French that they had planned an attack at the designated point and that our information that the Germans were prepared for it enabled the French to take the necessary precautions.

The radio goniometric stations (radio compass stations), like the intercept stations, performed excellent work; in spite of daily changes in the call letters of enemy stations they located accurately nearly all the enemy radio stations. The care and accuracy shown by the operator enabled the Intelligence Section (General Staff) to follow the movements of the German stations with precision and certainty. These movements often disclosed the intentions of the enemy.

The first radio intercept and goniometric station at General Headquarters, A. E. F., at Chaumont

One case in particular is very interesting. Just before the American attack on the St. Mihiel salient there were many indications that the enemy had withdrawn and the advisability of advancing the infantry without artillery preparation was seriously considered. The final decision to make the attack as originally planned was based upon the observations made by radio goniometric stations that enemy radio stations were still active in their old locations.

The airplane radio intercept stations also gave an excellent account of themselves by reporting the location of enemy radio fire control airplanes working with the German artillery, enabling the various American Air Service Squadrons to interfere with many well planned hostile "shoots," as a local radio controlled artillery action was termed.

The first American radio intercept station was established at Souilly in December, 1917, at the Headquarters of the Second French Army, which was defending the Verdun sector. Due to the inexperience of the men it was difficult, at first, to obtain satisfactory results, but after a few weeks they became so proficient that the Intelligence Section of the Second French Army requested copies of all messages intercepted by this station. On New Year's Day, 1918, another intercept station was established at Souilly, one station serving to copy short-wave German stations and the other long-wave German stations. These stations were soon moved, one to Landrecourt and the other to Froidos, both towns being a short distance back of Verdun.

After the First Division had taken over a portion of the front northwest of Toul, intercept stations were established at Ansauville, eight kilometers from the battle front. After a few months of bombardment and gas in this location the stations were moved to Menil-la-Tour and then to Toul, where better wire connections to General Headquarters A. E. F. could be secured. In the meantime the radio intercept stations at Froidos and Landrecourt were moved back to Souilly, First Army Headquarters, where they remained until the advance of the First Army on the Argonne front made it necessary to move them forward.

Most of the radio intercept operators had their share of thrills. For two weeks the Germans were endeavoring to destroy an ammunition dump located about a quarter mile from the intercept station at Landrecourt and about six miles from the lines, requiring the Germans to use a heavy calibre gun to reach it. A number of these huge shells landed in close proximity to our stations, throwing shell fragments and stones into the station huts. The operators stuck to their posts during these bombardments, although no protection whatever was afforded them. The dump was finally hit and exploded, its force breaking the oiled cloth windows of the radio station hut and upsetting a storage battery on the head of the operator. This man thereupon showed his courage by calmly replacing the heavy battery and continuing to copy.

Following the formation of the Second American Army in October, 1918, the Radio Section Base was established at Toul, with detachments operating in both the First and Second Armies. The First Army detachment moved its headquarters and intercept stations to what was known as "Radio Hill," near Essey, while the Second Army detachment established stations and quarters in dugouts formerly occupied by the enemy, on the crest of an eminence six kilometers from the line and overlooking the entire front of the Second Army. When the First American army pushed ahead in the Argonne, the intercept stations at Souilly were moved forward and installed on the top of the citadel at Verdun. This location afforded a perfect target for the enemy artillery. Gas alarms were an everday occurrence, antennæ were cut down and the stations were showered with shrapnel.

The equipment in the radio intercept station comprised standard French radio intelligence apparatus, together with some specially designed Marconi receivers which gave excellent results. The French equipment was known by the following names:

Fort Landrecourt forming portion of Verdun defense as seen from radio intelligence station at Landrecourt

Receiver Type No. 2.
Receiver Type No. 3.
Receiver Type A-1.
Amplifier Type 3-ter.
Amplifier Type L-3.
Amplifier Type R-2 bis.
Amplifier Type R-3 ter.
Wave Meter Type No. 2.

Receivers, Types No. 2 and No. 3, each consisted of a primary and secondary circuit made up of a variable

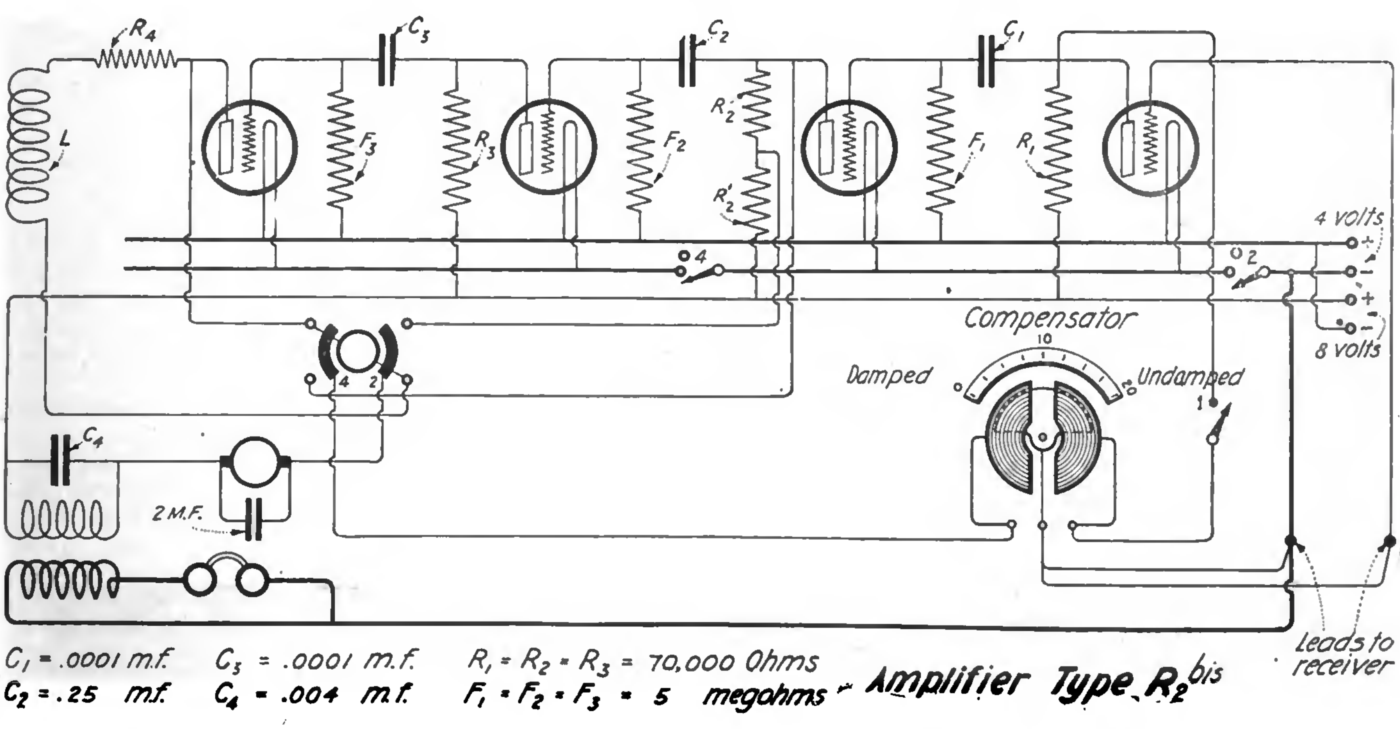
Radio goniometric stations on Toul front provided with small loops of American design

capacity and a variable inductance as shown in the circuit diagrams. The secondary of the Receiver Type No. 2 is arranged so that the coupling between the primary and secondary circuit may be varied by pulling out a movable section of the receiver box upon which the secondary inductance is mounted. A four-point switch on the panel makes it possible to connect the secondary circuit directly into the antenna for stand-by listening or to inductively couple it with the primary circuit for tuning purposes. Multi-point switches are provided for primary and secondary inductances by means of which the desired num-

The Receiver Type No. 3 is similar in both electrical and mechanical construction to Receiver Type No. 2 with the exception that the coupling between the primary and the secondary inductances is varied by rotating a portion of the secondary inductance within the primary inductance. Receiver Type No. 2 is designed to be utilized on wave lengths from 150 meters to 6,000 meters and Receiver Type No. 3 from 300 meters to 15,000 meters.

Both the Receiver Type A-1 and the Amplifier Type 3-ter have been described in a previous article.

The Amplifier Type L-3 was used principally for re-



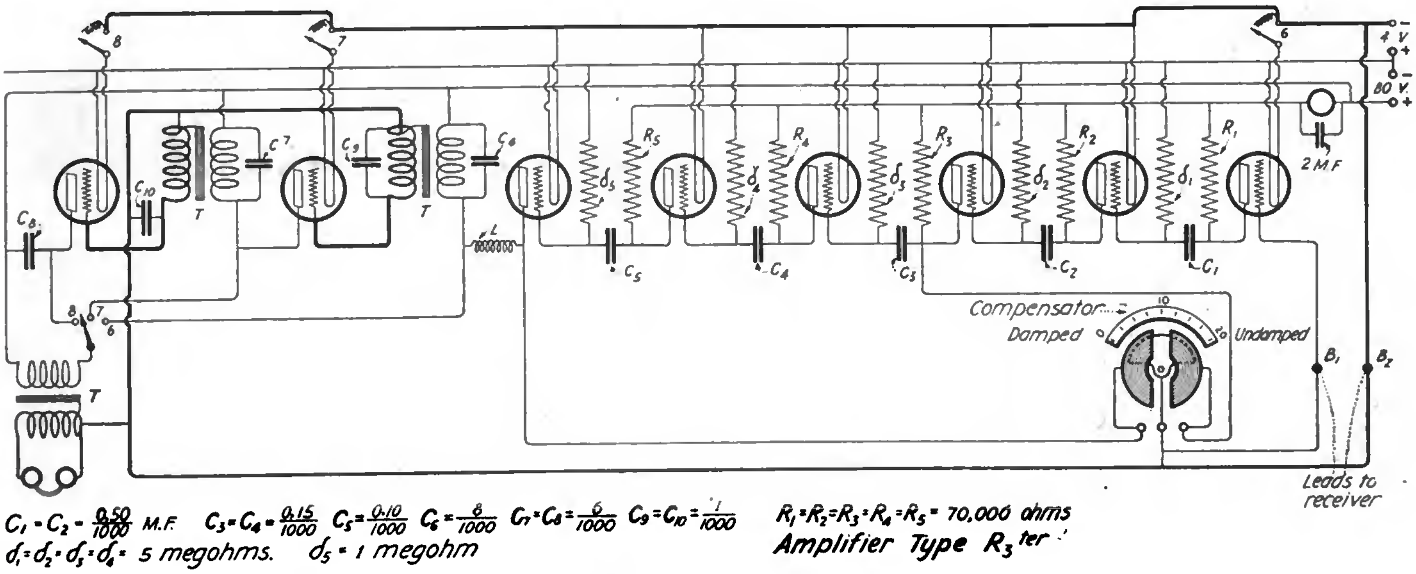
Circuit diagram of Amplifier Type R-2 bis

ber of turns may be used in both the primary and secondary inductances respectively. Numerous auxiliary switches are provided on both multi-point switches to disconnect the unused portions of primary and secondary inductances in order to avoid the absorption of energy by setting up oscillation in such unused portions or dead ends. By means of two switches, fixed condensers may be connected in shunt with the variable condensers of the primary and secondary circuit.

ceiving on loops; a description of this instrument will be given hereafter in connection with the radio goniometric station equipment.

Amplifier Type R-2 bis comprises four standard French vacuum tubes, as shown in the accompanying circuit diagram, coupled by means of high non-inductive resistances. All four tubes may be used in series, or the last two tubes may be cut out of the circuit. With four tubes it works best on wave lengths above 800 meters.

while with only two tubes in operation it may be used to receive efficiently wave lengths as low as 400 meters. The Amplifier R-2 bis was designed particularly for the reception of weak signals. The accompanying simplified circuit diagram will aid in an understanding of the complete diagram; all of the vacuum tubes being connected in the same way. In this diagram it will be seen that the grid is connected by means of a resistance to the quency amplifying effect may be very great. This defect is avoided by connecting several vacuum tubes in series, the first vacuum tubes then acting as high frequency amplifiers for weak signals and the last one almost solely as a detector. It will therefore be observed that this amplifier is particularly adapted for receiving weak signals. It also aided considerably in eliminating strong static.



Circuit diagram of amplifier Type R-3 ter

positive lead of the 4-volt filament battery. The grid potential between the points C1 and C2 charges the grid condenser which in turn imparts its charge to the grid in the usual manner, giving rise to variations in the filament plate current. The plate is connected through the resistance R to the positive lead of the 80 volt plate filament circuit B battery. The potential drop through the resistance R therefore takes place in accordance with variations of the plate current and therefore high frequency amplified oscillations are available. There is also a simultaneous detecting action carried on and the proportion of the two effects depends upon the strength of the signals received. The high frequency amplifying effect will be preponderant for weak signals, while the detecting effect is the greater on strong signals. The result is that for the circuit arrangement described a single vacuum tube so connected will work well on strong signals as evidenced by the telephone, but it will not work well on weak signals, although the high fre-

The amplifier R-2 bis is arranged to receive either damped or undamped waves. It is provided with what the French term a "compensator," which in our parlance is familiarly known as a "capacity feed back" or "regenerative coupling." Briefly, the purpose of this "compensator" is to maintain the production of high frequency local oscillations on the self-heterodyne principle, when receiving undamped waves. When four tubes are used it couples the plate of the fourth tube back in the grid of the first tube, while it couples the plate of the second tube in the grid of the first tube when only two tubes are used. The compensator's pointer should be to the right when receiving undamped waves and to the left when receiving damped waves.

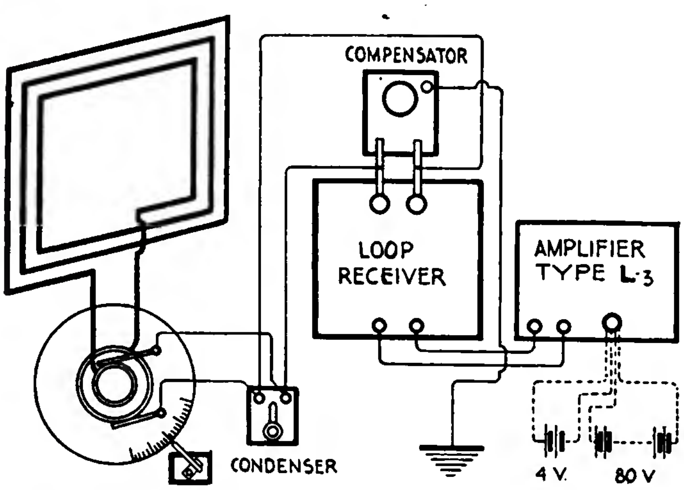
The Amplifier Type R-3 ter is very similar electrically to Amplifier Type R-2 bis, as will be observed from the accompanying diagram, but it has six steps of high-frequency amplification and two steps of low frequency amplification. This makes a total of eight standard French

Operator copying short wave length radio intercepts in Toul sector

Locating German field station in a radiogoniometric station on the Toul front

Copying coded German messages in a long wave length radio intercept station on the Toul sector vacuum tubes used in its construction. As in the Amplifier Type R-2 bis, the last vacuum tube of the high frequency amplifier serves as a detector. The two last vacuum tubes serve only as low frequency amplifiers of the amplified and rectified audible frequency signal impulses.

This amplifier may be used to receive signals on wave lengths varying from 2,000 meters to 20,000 meters for either damped or undamped waves. Further explanation of the function of the so-called compensator will be omitted, as it has been explained in connection with the Amplifier R-2 bis. Attention is directed, however, to the fact that when undamped waves are to be received the



Circuit diagram of a radiogoniometric station

plate of the sixth vacuum tube is coupled back to the grid of the first tube.

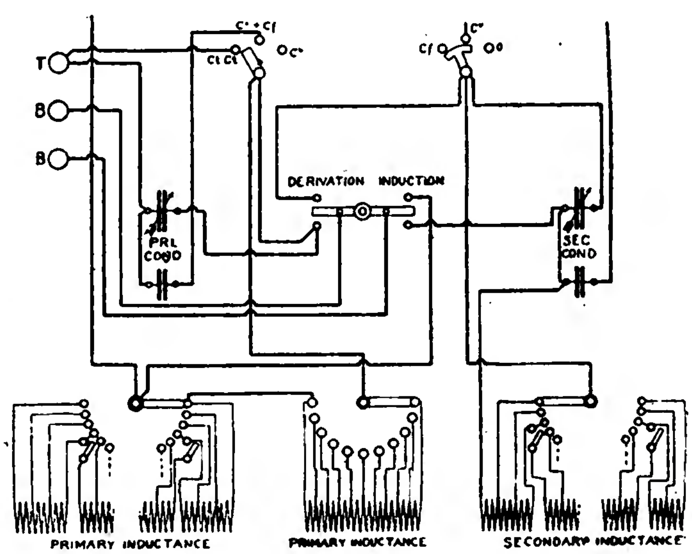
Provision is also made in Amplifier Type R-3 ter to utilize a variable number of vacuum tubes. A switch is provided whereby six, seven or eight lamps may be utilized, which means that no low-frequency amplification may be provided or that one or two steps may be used in accordance with the desires of the operator.

The most generally used wavemeter for calibration purposes in radio intercept stations was that known as Wave-Meter Type No. 2, and it was adapted to be used for a wave length range of 150 meters to 1700 meters. A few of the novel features of this wave-meter will be observed in the accompanying circuit diagram. The calibrated circuit comprises two inductances, the first in three sections and a variable condenser with a pointer moving over an arc graduated in wave lengths. Three scales of wave length are engraved on the arc, corresponding to the cases when one, two or three sections of the first inductance are connected into the calibrated circuit. The buzzer circuit is closely coupled with the first inductance of the calibrated circuit, serving to set up oscillations in it. By means of a double switch the coupling coil of the buzzer circuit may be cut out and the buzzer be made to serve as a "tikker," periodically breaking and closing the calibrated circuit, for the detection of undamped waves. The detector circuit has two coils wound on the same spool placed inside the first inductance of the calibrated circuit. A double, three-way switch makes it possible, first, to connect the two coils in series opposing for measurements of emitted waves (position Em); secondly, to connect in one coil alone for the reception of short waves (position PO); third, to connect the two coils in series, aiding for the reception of long waves (position GO). An auxiliary coil which can be connected into the antenna circuit more or less closely with the calibrated circuit is made up of two coils, the second of which is used for increasing the coupling for the longest waves.

The service performed by the radio goniometric stations was closely allied with that of the radio intercept stations, inasmuch as the determination of the point of origin of a German message which had been copied by our radio intercept stations aided the Intelligence Section of the General Staff in the preparation of their charts of German radio activity and helped to locate the concentration of German troops in different sections of the line.

The work done by our radio goniometric stations was greatly facilitated by the adoption of a small revolving frame to replace the somewhat cumbersome French frame. The smaller frame was found to be much easier to rotate, especially while working in a heavy wind. The operators were enabled in this way to obtain more bearings, with improved accuracy, while the intensity of the signals remained about the same.

In addition to our radio intercept stations radio goniometric stations were established at Froidos and Landrecout during January, 1918, and in March a station was installed at Ansauville in the Toul sector. The Ansauville goniometric station being located in a very dangerous position, it was later moved back to Menil-la-Tour. This station while at Ansauville and Menil-la-Tour was the first radio goniometric station operated by Americans in an "All American Sector." During an attack on the Toul front on May 27, 1918, it was operated by two men for the 24 hours of a day and took 650 bearings, thus establishing a record that was never subsequently beaten or even equaled. To understand what this figure means, one should have had actual experience in operating a gonio. In order to take one bearing it is necessary to tune in the calling station by manipulating the adjusting knobs of the loop receiver with one hand, while rotating the revolving frame with the other to find the two points of silence, in the meantime noting the call letters, tune and points of silence, then figuring the mean



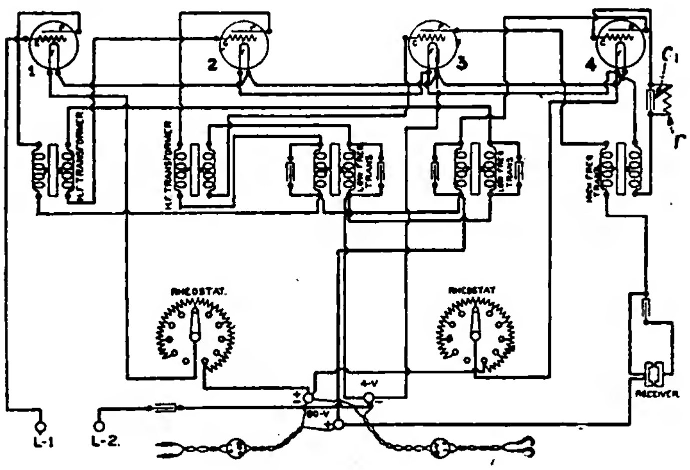
Circuit diagram of Receiver Type No. 2

of these. The wave-length and intensity of signals have to be determined, and whether a message or a call was sent, and in addition a record made of all this data. Two Radio Section men did this at an average of one every two minutes for eight hours!

The first radio goniometric station in the Toul sector having proven so successful, three of these stations were established in July, 1918, along the front taken over by the American Army in the Toul sector. The stations were located at Royaumeix, Cornieville and Saizerais.

Also in July, 1918, three radio goniometric stations were taken over from the French Eighth Army and operated by personnel comprising both French and American soldiers. These stations were located at Tomblaine, Luneville and Brouville.

In anticipation of open warfare, the American 2 kw. automobile tractor radio sets were converted into mobile radio goniometric stations and equipped with Radio Set Type E-3 bis. The first of these tractors proved so useful



Circuit diagram of Amplifier Type L-3

that two more tractors were rebuilt as described. In the St. Mihiel drive they proved of great value. One was stationed at Cornieville, one at Royaumeix, and one at Saizerais. The readings of all stations were transmitted by radio and, as the attack progressed, the Cornieville tractor advanced and took a more forward position at Hattonville. The tractors were afterward sent to the Verdun sector, where they continued their excellent work.

In the latter part of September, 1918, the goniometric stations of the French at Voncourt and Wombey, in the Verdun sector, were taken over from the French. These stations gave good results under American control until the St. Mihiel drive left them stranded, as the operators expressed it—in the "Service of Supplies."

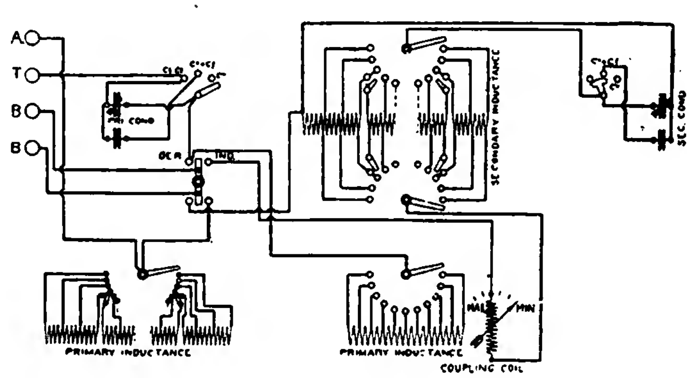
The three radio goniometric tractors moved from the Toul sector to the Verdun sector were stationed at Ville-sur-Taube, Avecourt and Verdun. In co-operation with three French radio goniometric tractors they covered the advancing front extending from the western edge of the Argonne to the right of the First American Army east of Verdun. They were later supplemented by a permanent station at Verdun. Reports from the "gonio tractors" were transmitted by radio to the P. C. T., located at First Army Headquarters, and to the Headquarters of the Second American Army on our right and to the Headquarters of the Fourth French Army on our left. The rapidity of the advance kept the tractors continually on the move, and oftentimes they worked as far as 75 kilometers from their base in the shell-torn and gas drenched territory just back of the fighting line.

The equipment used in both the permanent and tractor radio-goniometric stations was standard French radio equipment for the most part and was identified as follows: Goniometric station, complete, comprised a loop receiver—Type No. 2 or No. 3 Loop Compensator, and Amplifier Type L-3. A portable wooden hut was supplied to house the instruments and provide shelter for the operators.

The apparatus of the goniometric station was connected up in accordance with the accompanying schematic diagram. The hut and equipment served as a semi-permanent station for the reception of radio signals having wave lengths between 250 and 1400 meters, and for simultaneously determining the direction from which they were sent. Two such stations working in conjunction served to locate approximately the sending stations by means of simple triangulation. The loop, which is about ten feet square, is mounted above the roof on the end of a heavy wooden shaft, and can be rotated by means of a hand wheel attached to the shaft inside the hut. The lighter and smaller loops previously described were much easier to rotate.

The loop consisted of three turns of wire and the signals were received in the loop and loop receiver circuit, which was in turn connected to the amplifier that detected the signals. A German transmitting station having been picked up, the loop was rotated until a position was found in which the signals became inaudible; approaching this position alternately from opposite directions, an average position of minimum audibility was found, which gave approximately the direction from which the waves were coming; when the signal was faintest the plane of the loop was known to be perpendicular to the direction from which the signal was coming. If at first no position of complete silence was obtained, the loop compensator was used and successive adjustments of the compensator and plane of the loop were made until complete silence was obtained. An oriented pointer and a dial on the loop shaft indicated the geographic bearings for all positions of the loop.

The Loop Receivers Types No. 2 and 3 comprised only variable condensers, together with either one or two fixed condensers; in the circuit diagram herewith they are illustrated in conjunction with the loop compensator. The loop compensator was used to correct the inequality of the capacities of the two leads to the loop with respect to the ground. The loop compensator is simply an air condenser with three sets of plates, two fixed and one movable. The fixed plates are connected respectively to the two-loop leads through the loop receiver while the movable plate is grounded. It is therefore possible, by rotating the grounded plates, to equalize the capacities of the leads of the loop to a certain extent. This adjust-

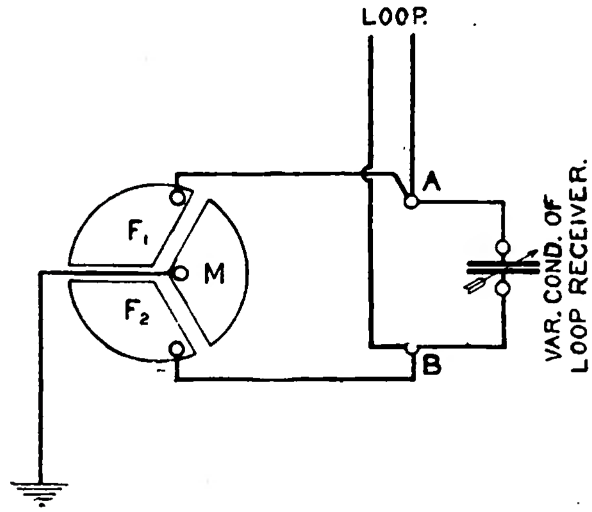


Circuit diagram of Receiver Type No. 3

ment is good for any wave-length, but it is extremely critical with reference to the position of the operator and any masses of metal and other similar effects.

The Amplifier Type L-3 was designed for receiving signals on wave lengths ranging from 200 to 1,000 meters. It makes use of four standard French vacuum tubes, as will be seen from the accompanying circuit diagram. The first three tubes act as high frequency amplifiers. The fourth tube, in which the grid is connected to the positive lead of the filament by means of a conductor, in which is placed a condenser C shunted by a high resistance R, acts as a detector. The low frequency detected current is again amplified by the second and third tubes.

The first "high frequency" part of the apparatus forms an amplifier with a transformer having thin sheet iron cores. High frequency currents flow through the transformer marked HF. The amplified currents flow through the condensers, shuting the windings of the low frequency transformers, whose impedance is very high for high frequencies, but which permits the flow of the continuous component of the filament-plate current. For currents of audible frequency the capacity of the condensers is greater than the reactance of the transformers. The low-frequency currents therefore flow through the



Circuit diagram showing use of loop compensator in radiogoniometric stations

transformer windings and are amplified by the second and third tubes as in an ordinary low-frequency amplifier.

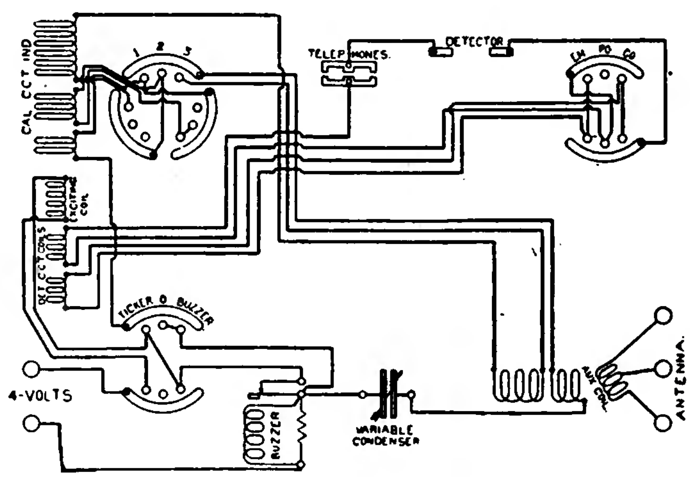
The number of messages sent in "clear" English—uncoded—and other violations of the radio regulations of the A. E. F., demonstrated the need for stations which specialized in copying messages transmitted by American field stations. Two control intercept stations of this character were established at Toul in July, 1918. One station copied damped wave-signals and the other station copied undamped wave-signals. When the First Army Headquarters moved to Souilly, two undamped wave-control stations were put into operation to supervise the work of American operators in that sector; by promptly reporting messages sent in "clear" they on several occasions succeeded in suppressing this dangerous form of radio communication.

At the time that the chain of radio goniometric stations were established along the Toul front airplane radio intercept stations were installed at Royaumeix and Tomblaine. From Royaumeix a special telephone line to Toul was used to send "alerts" to the Air Service, and similar direct connections were provided from Tomblaine to French Air Service pursuit squadrons. The radio goniometric stations generally took bearings only on German field radio stations, but when an enemy airplane was picked up by the special airplane radio intercept station all radio goniometric stations were notified and bearings were immediately taken to determine the position of the Hun plane. This work was unusually successful, and many hostile airplanes, directing their artillery by radio, were interrupted in their mission by the appearance of American pursuit planes which were enabled to fly directly to the approximate location of the German plane. The record of enemy airplane flights, the signals sent, and the portion of the front over which the German planes operated, was of great assistance to the Intelligence Section (General Staff) in compiling their charts of hostile airplane activity.

In the Verdun sector a combined airplane radio intercept and airplane radio goniometric station was able to locate many hostile airplanes, and by means of a special telegraph wire it was possible to immediately give notification of an enemy radio fire control airplane calling its battery. The Intelligence Section (General Staff) was usually able to identify the German artillery battery about to fire and notify the proper counter battery commander. Our artillery was often able to counteract the German artillery fire, sometimes even before it had really started its intense fire.

A press and general radio intercept station was established early in the fall of 1917 at American General Headquarters in Chaumont. This station copied all European press messages and communiques, as well as nearly all commercial and official business transacted between the Central Powers and neutral countries Inasmuch as Nauen (POZ) carried on much suspicious high speed transmission with Spain—ascertained by copying the corrections transmitted by hand of the high-speed message text—plans had been made to install high speed reception apparatus at this station, but the armistice intervened.

This article would not be complete without recording the service rendered by Major Robert Loghry. He was untiring in his efforts and was largely responsible for the excellent results obtained by the Radio Section. Nor would this article be complete unless acknowledgment was made to the French Army for the results obtained by our Radio Section. By furnishing equipment and radio stations and especially by the personal assistance given by the French army radio intelligence officers, the American Radio Section was able to reach a state of high operating efficiency in a short time which otherwise would have been impossible.



Circuit diagram of wave meters—Types Nos. 2 and 3

The fourth instalment of "Wireless in the A. E. F." will appear in an early issue of the Wireless Age.

Frequency Transformation

IN an invention of Ernst F. W. Alexanderson a method of transforming an alternating current of a given frequency and of utilizing the current thus transformed for radio signaling purposes is described.

Numerous systems have been heretofore proposed for transforming an alternating current of fundamental frequency into an alternating current of a frequency harmonic to the fundamental frequency. In some of these systems means have been provided for distorting the wave of the current of fundamental frequency from the sine wave form in such a way that certain harmonics are made prominent and these harmonics have been segregated in circuits which are particularly harmonic or harmonics which are to be utilized.

In prior systems of the type in question it has been customary to tune the circuit of the fundamental frequency by means of a condenser in series with the source of supply and the iron core inductance which has been employed for distorting the wave form. Such a circuit has a tendency to become unstable and in order to operate the same in a practical way it must be adjusted so that a substantially constant load is supplied from the source of energy whether current is being supplied to the utilization system or not. One of the objects of this invention is to overcome this difficulty by providing a system which does not tend to become unstable and in which the energy drawn from the source of supply will be a minimum

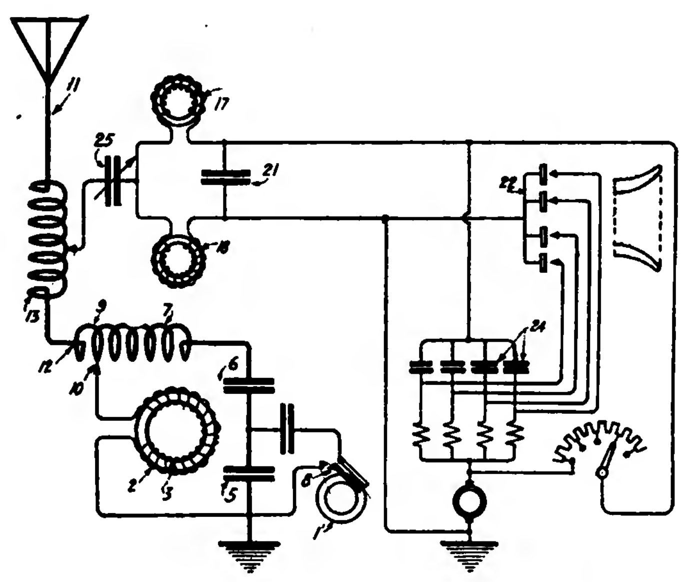


Figure 1—Circuit of the Alexanderson method of transforming the frequency of alternating currents for radio signaling

when no current of harmonic frequency is being supplied to the utilization system.

In carrying out this object, a capacity of such value as to compensate for the inductions on the circuit at no-load is provided. As a result, when no energy is being withdrawn from the system the only current flowing therein will be a circulating current between the capacity and inductance and the only energy required for maintaining this current will be that required to supply the energy losses of the circuit.

As indicated in the drawing, a source of energy, which in the present case is an alternating current generator, supplies current to the winding of the iron core 3. A condenser in series with the alternator compensates for the internal inductance of the alternator. Condenser 5 in shunt to the alternator is of such value as to compensate for the inductance of the winding 2. The condenser 6, which is in series with the alternator, is of such value as to compensate for the inductance 7, which is also in series with the alternator. With the system thus far described it will be apparent that the capacity 5 will draw a lagging current from the alternator and the inductance 2 will draw an equal lagging current, so that when no current is supplied to the radiating system the actual energy which the alternator is required to supply will be merely the energy required to make up the losses in the circuit. In utilizing this circuit arrangement for supplying current of harmonic frequency to a radiating system the terminal 8 of the alternator is grounded and the point 10 between inductances 7 and 9 is connected to the antenna 11. The effect of connecting the radiating system in this way is the same as shunting the inductance 2 by a resistance and hence the alternator 1 will be required to supply additional energy for maintaining current in the radiating system. For various reasons it is undesirable when current of a harmonic frequency is supplied to the antenna that current of the fundamental frequency should also flow in the antenna. In order to prevent this the inductance 9 is arranged in inductive relation to the inductance 7 and so proportioned that the point 12 at the end of this inductance is of substantially the same potential with respect to the fundamental frequency as the earth connection. In other words, there is a potential of fundamental frequency impressed upon the harmonic frequency circuit which is equal and opposite to that impressed upon the inductance 2 from the source 1. This being the case there is no tendency for current of the fundamental frequency to flow in the antenna. The antenna circuit is tuned by means of the usual variable inductance to the harmonic frequency which it is desired to utilize. With the arrangement here shown any desired odd harmonic of the fundamental frequency may be caused to flow in the antenna. If it were desired to utilize an even harmonic, it would be necessary to employ a source of direct current for saturating the core 3. The inductance 7 offers a high impedance to current of the harmonic frequency and hence but little current of harmonic frequency will flow in the fundamental frequency circuit. The condenser 5 will offer a low impedance to current of the harmonic frequency and most of the harmonic frequency current which does flow through inductance 7 will pass through condenser 5 instead of flowing through the alternator.

In order to control the amplitude of the antenna current to produce signals a shunt circuit may be provided to the antenna and the impedance of this circuit varied in accordance with the signals which are to be produced. In the present case a system has been illustrated whereby the antenna current may be varied to produce telephonic signals. The shunt circuit mentioned is connected to any suitable point in the loading inductance 13 and comprises a magnetic amplifier or controller. In the present instance the specific form of amplifier used consists of two iron cores with windings thereon, these two windings being connected in parallel with each other in the shunt circuit. Current for producing a normal saturation of the cores may be derived from a direct current generator which is connected in series with the windings, as indicated. A resistance may be inserted in this circuit in order to adjust the saturation current desired for the most efficient operation. The condenser 21 is of such value as to offer a comparatively low impedance to the high frequency current but effectually prevents short circuiting of the controlling current through the windings. A steady current from the generator is also caused to flow through the multiple microphone 22. The field winding of the alternator 1 is divided up into four separate parts and the current which flows through the microphone is led through these separate parts of the field winding so that the field winding acts as a steadying inductance for the current through the microphone. When the microphone is acted upon by sound waves a variable potential is produced across its terminals and this variable potential is applied to the windings 17 and 18, in order to vary the saturation in their cores and thus vary the impedance of the shunt circuit. This variable potential is applied through the condensers 24, which prevent the short circuiting of the steadying microphone current. Condenser 25 in the shunt circuit is so adjusted that the circuit becomes resonant when the antenna current is a minimum.

Duplex Wireless System

IT is well known that in wireless telegraphy and telephony the magnitude of the transmitted current is enormously greater than the received current, their ratio sometimes being of the order of one million to one. This enormous ratio renders inapplicable to wireless systems duplex methods which have been successfully employed in wire telegraph and telephone systems.

It is further well known that static or atmospheric interference not only constitutes a serious menace to the successful commercial operation of wireless systems, but also that its elimination presents a very difficult problem. This difficulty inheres in the fact that the natural or characteristic oscillations, set up in a receiving system by a static disturbance, are of substantially the frequency to most strongly affect the receiving device, and that, therefore, static interference cannot be turned out by a change of wavelength, as can persistent interference from a foreign sending station. As regards the elimination of static interference, this invention, the work of John Mills and John R. Carson, does not attempt to reduce or eliminate the radio-frequency natural oscillations, but by interposing detectors between a receiving device and the seat of said radio frequency oscillations, resultant low frequency oscillations are developed which by a combination of circuits are balanced out with respect to the receiving device. In the several embodiments of the invention in duplex systems, it is contemplated that the system be resonantly responsive to two frequencies, one of which is that of the signals to be received, and the other is that at which signals are transmitted.

The invention may best be understood by reference to the accompanying drawing.

Referring to Figure 1, 1 is an antenna for the radiation and reception of energy, said antenna containing the primary of an oscillation transformer 30, which couples said antenna with the transmitting apparatus, conventionally represented by a high frequency generator 29. The antenna system has a plurality of branches in parallel, it being grounded through three parallel branch circuits, 2, 3 and 4. The branch circuit 4, which may be termed the transmission branch circuit, is tuned to resonance at the transmission frequency, and said branch circuit therefore offers a very low impedance to currents of said frequency. Branch circuit 4 contains a tuning inductance 13, a tuning condenser 14, and an anti-resonant set 8 which is tuned to anti-resonance at the reception frequency. The branch circuit 2, which may be termed the reception branch circuit, contains a tuning condenser 10, a coupling coil 9, and a set 5 which is adjusted for anti-resonance at the transmission frequency. By means of the tuning condenser and coupling coil, the circuit consisting of the antenna in series with the branch

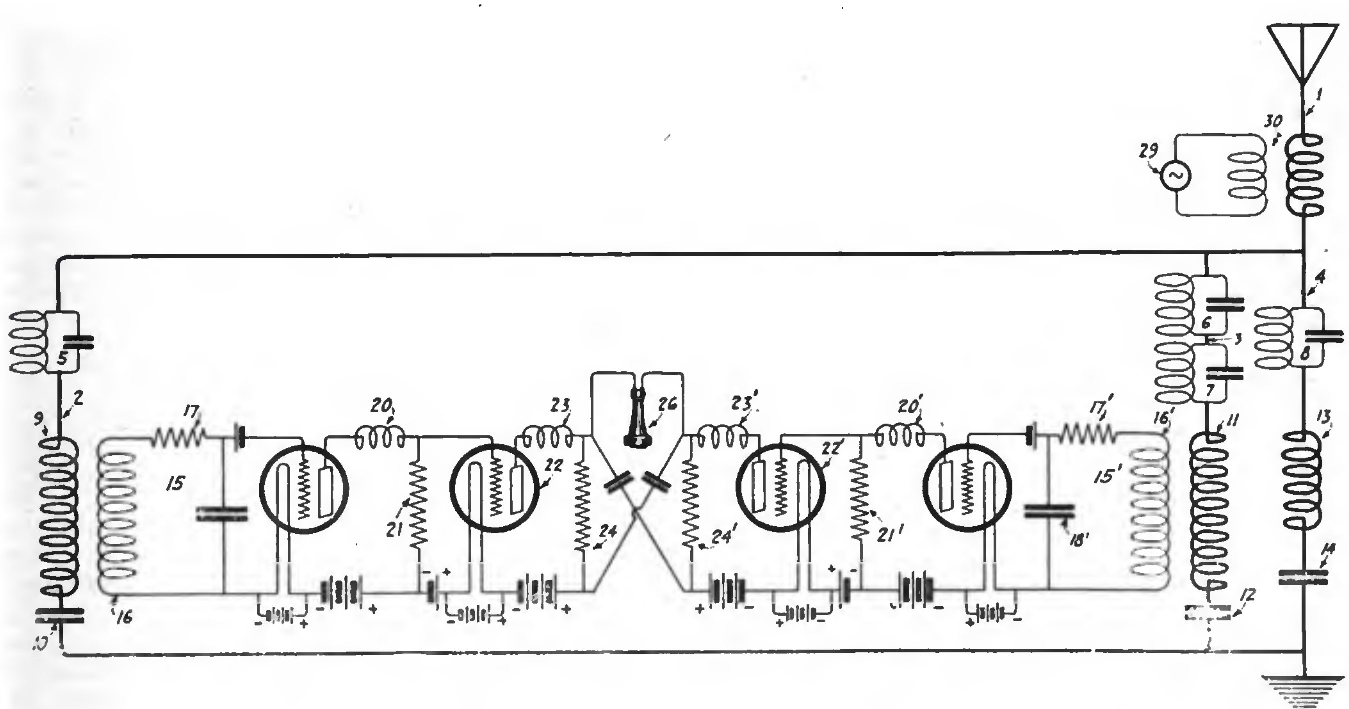


Figure 1—Circuit of the duplex wireless system which develops low frequency oscillations that are balanced out

circuit 2 is tuned to resonance at the frequency of reception. It will thus be understood that circuit 2 offers a very high impedance to the transmission currents and is adjusted for maximum response to the signals to be received. Branch circuit 3, which may be termed the auxiliary branch circuit, contains a coupling coil 11, a tuning condenser 12, and two sets 6 and 7, the first of which is anti-resonant to the reception frequency and the second is anti-resonant to the transmission frequency. The branch circuit, 3, therefore, offers a very high impedance both to current of transmission and current of reception wavelength. It is evident that the organization thus far described has a plurality of degrees of freedom and that as a whole it is resonantly responsive to two frequencies, one of which is the frequency of transmission and the other the frequency of reception. It is further evident that the circuit consisting of the antenna in series with branch 4 as well as branch 4 itself is resonant at the transmission frequency. It follows from the principles of electrodynamics that there is a third frequency at which branch 3 is most responsive, since the system as a whole has three degrees of freedom.

A receiving device, conventionally represented by a telephone receiver 26, is connected in a symmetrical manner both to branch 2 and branch 3 through amplifiers (preferably of the vacuum tube type), detectors (also preferably of the vacuum tube type), and the loosely coupled oscillation circuits. The oscillation circuit 15 contains a coupling coil 16, a condenser and a resistance element 17, and is tuned to the frequency of reception. The circuit 15′ correspondingly contains the elements 16′, 18′ and 17′, and is tuned to the frequency to which the branch 3 is responsive; 20, 23, 20′, 23′ represent high inductance impedance elements, while 21, 24, 21′, 24′ represent non-inductive resistance elements.

The operation of the organization shown in the figure will now be explained. Considering first the phenomena of transmission, it has been already stated that branch 4 offers a very low impedance to the transmission currents, while branches 2 and 3 are substantially anti-resonant at the transmission frequency; it therefore follows that practically all the transmission current flows through the branch 4, and only a very small fraction thereof through branches 2 and 3. However, owing to the enormous ratio of the transmitted and received currents, the fraction of the transmission current flowing through the branch 2, if only one part in one hundred thousand of the total transmission current, will still be much greater than the current excited by electromagnetic waves from the communicating station. It will be seen then that in spite of its high impedance to the transmitted current the oscillation circuit 15 may be excited more strongly by the said transmission current than by the relatively very small reception current to which 15 is tuned to respond. Except for the branch 3 and its associated apparatus, it may well be that in spite of careful design and sharp anti-resonance, the currents set up in the receiver 26 by the transmission current will be prohibitively large. One of the functions of branch 3 and its associated apparatus is, however, to substantially eliminate the transmission interference in a manner now to be explained. Since branches 2 and 3 both contain elements or sets which are anti-resonant at the transmission frequency, they offer substantially the same impedance to the transmission currents. Therefore approximately equal fractions of the transmission current flow through branches 2 and 3 respectively, and the effects of the current in circuits 15 and 15′ are, therefore, excited by equal induction from branches 2 and 3, respectively, and the effects of the current in circuits 15 and 15′ after translation and amplification oppose and may be made to substantially neutralize with respect to the receiver 26. When this condition is attained, it is evident that no current corresponding to the transmission current flows through the receiver 26, and therefore, the organization satisfies the fundamental condition for duplex operation, namely, freedom from transmission interference.

As regards now the phenomena attending the reception of signals from the communicating station it is evident that, by virtue of the anti-resonance of branches 1 and 3 to the reception frequency, the system is essentially the same as though branches 1 and 3 were removed, leaving the antenna grounded through the circuit consisting of the antenna in series with branch 2 and the oscillation circuit 15, which are separately tuned to the reception frequency. Therefore circuit 15 oscillates strongly in response to the received signals, while circuit 15′ oscillates very feebly. The current, corresponding to the received signals and flowing through the receiver 26, is essentially independent of the presence of branch 3 and its associated apparatus as well as of branch 4, and hence the arrangement shown is such as to satisfy the condition of efficient reception of signals.

The operation of the circuit shown in the figure in reducing static interference is as follows: When the receiving system as a whole is excited in its characteristic or natural modes of damaged oscillations, the predominant oscillation excited by the static disturbance in circuit 15 is practically determined as regards periodicity and damping by the electrical constants of the circuit, that is, by the values of its inductance, capacity and resistance elements. Similarly, the corresponding oscillation of circuit 15′ is determined by the electrical constants of the circuit. The predominant oscillations occurring in circuits 15 and 15′ will be of different frequencies, since these circuits are tuned to different frequencies; but such oscillations may be made to have the same damping factors by assigning suitable values to the inductance and resistance elements of these circuits. If the two damping factors are proportioned for equality, the voltages impressed on resistances 24 and 24′ will be of similar form and practically independent of the frequency of the natural oscillations, owing to the translating action of the detectors 19 and 19′ and the high inductive impedance of the inductance elements 20, 23, 20′, 23′. If the voltages impressed on resistances 24 and 24′ are equal and similar, the resultant current in the receiver 26 is zero. These voltages may be made equal in a number of ways, such as by proportioning the relative amplifying powers of the amplifiers 22 and 22′, or the relative values of the inductances 9 and 11. As regards static elimination the embodiment of the invention shown in the figure contemplates having the receiving device operatively connected to two parallel antenna branches, the receiving device being so connected to these parallel branches that the high frequency natural oscillations, after translation by detectors or after translation and amplification, oppose and substantially neutralize with respect to the receiving device.

It should be observed that in order that static interference shall be substantially eliminated it is essential that the oscillation circuits 15 and 15′ shall have practically the same time factors in order that the natural oscillations executed by the two circuits shall have the same damping. To this end it is necessary that

$$\frac{R}{L} = \frac{R'}{L'}$$

when R and L are the resistance and inductance respectively of circuit 15 and R′ and L′ the resistance and inductance respectively of circuit 15′.

Method of Signaling With an Arc

A METHOD of signaling for use in conjunction with an arc wherein the arc is extinguished and re-ignited, has been developed by Roland G. Marx and Leonard F. Fuller. The method described in their invention requires the handling of relatively small currents. With reference to the drawings, Figure 1 shows the scheme of connection and Figure 2 is a diagrammatic representation of the potential curve across the arc. In Figure 2 the potential curve 2 taken across the arc is a very irregular curve having sharp peaks 3, with-

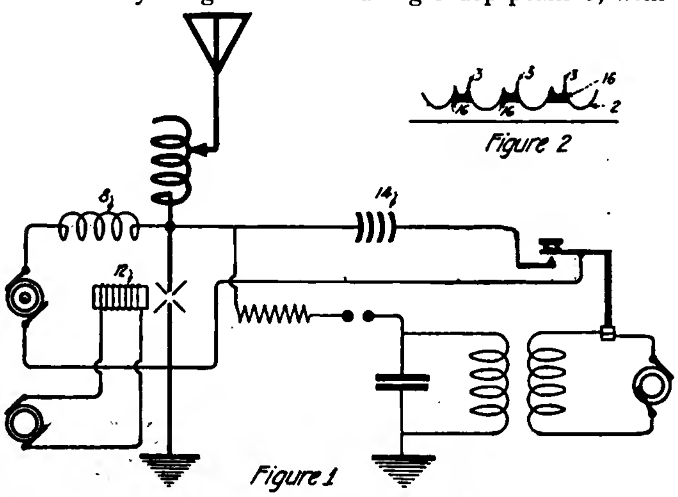


Figure 1—Circuit used in the arc method of signaling. Figure 2—Potential curve across the arc

out which the arc cannot oscillate, and means are provided for robbing the potential curve of these peaks. When the curve is so robbed of its peaks the arc is extinguished and radiant energy is not emitted from the antenna circuit. Signaling is accomplished by alternately extinguishing and relighting the arc at telegraphic speed.

The transmission system comprises an arc oscillation generator which is grounded on one side, preferably the negative, and connected on the other side to the antenna through a variable inductance or loading coil. Direct current is supplied to the arc oscillation generator by a generator and a choke coil 8 is arranged in the lead connected to the antenna side of the arc. The arc is subjected to a strong transverse magnetic field produced by the magnet coil 12, which may be separately excited by a generator.

The potential wave produced by the arc has a very jagged form, developing sharp peaks, and the wave may be robbed of these peaks at the arc or in the loading coil. This jagged wave form is impressed upon the first few turns of the antenna loading coil. In Figure 1 is shown the means for robbing the wave form of its peaks.

Connected across the arc is a circuit containing an electrolytic lightning arrester 14, which acts as a potential valve, and a signaling key. The lightning arrester is made up of two or more aluminum cells, connected in series, each cell consisting of two aluminum plates on which has been formed, by chemical or electro-chemical processes, a film of hydroxid of aluminum, the plates being immersed in a suitable electrolyte. When the jagged wave form is impressed on the arrester, the film opens, as it were, and a current limited only by the internal resistance of the cells, which is low, flows through the arrester. The part of the potential curve eliminated by the cells is indicated by the shaded portions 16 of the potential curve. When the signaling key is closed the wave form is robbed of its potential peaks which discharge through the aluminum lightning arrester and the arc is extinguished.

Ordinarily, when the key circuit is again opened, the arc will not re-ignite and means should be provided for re-igniting the arc immediately, so that the key may be operated at telegraphic speed. One form of means which may be employed for re-igniting the arc is shown herein, this form being so arranged that the arc is ignited as the lightning arrester circuit is opened. Connected across the arc is a spark circuit containing a spark gap, the secondary of the transformer and a capacity shunting the secondary. A stopping resistance is arranged between the spark gap and the antenna side of the arc to prevent direct current sufficient to maintain an arc across the spark gap from following the radio frequency current across the spark gap and passing through the secondary. The primary of the transformer is in series with an alternating current generator and a switch in the primary circuit is attached to the key by an insulating rod. When the lightning arrester circuit is opened, the circuit through the primary is closed, producing a high potential in the spark circuit and producing a spark across the spark gap which sets up radio frequency surges that ignite the arc.

Antenna Construction

ALTHOUGH it is very usual, in radio telegraphy, to place large inductances at the base of the antenna, and although several inventors have suggested placing inductance coils at the top of the antenna, inductance coils have never yet been distributed along the same line in order to increase the wavelength of the wire. Marius C. A. LaTour finds that it is possible to distribute inductance coils in this way along the antenna wire even under conditions compatible with the mechanical overloading that these coils will impose upon the wire. With this end in view, these coils may be arranged in the neighborhood of transverse struts. But, on the other hand, they may be constructed in such a way as to be extremely light. The drawings show one of the constructional forms of LaTour's invention. Figure 1 shows a portion of an antenna in the wires of which several coils have been distributed. These coils will preferably be constructed with magnetic circuits of iron or any other magnetic material. Figure 2 gives an example of a method of constructing these coils. They may consist merely of sheet iron discs cemented onto the antenna wire, but are otherwise insulated from one another by means of a coating of varnish or any other suitable insulating mate-

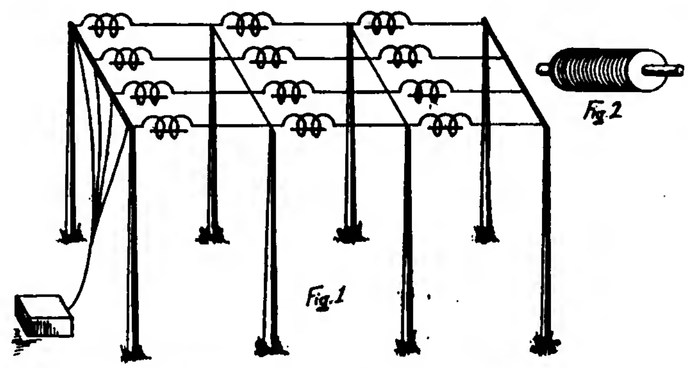


Figure 1—Antenna with inductance coils in place. Figure 2—Construction of the coils

rial. In general, that quality of iron will be employed which gives the lowest losses by hysteresis and by Foucault currents.

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

V. T. Detector and Four Stage Amplifier Resistance Coupled

By Charles R. Leutz

DURING the coming amateur radio season the best records will be made through the medium of efficient receivers and reliable V. T. amplifiers.

Many good receivers have been described and the writer feels that the amateurs will welcome information dealing with an amplifier suitable for use in connection with any receiver.

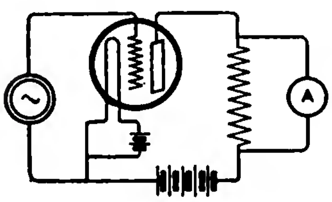


Figure 1

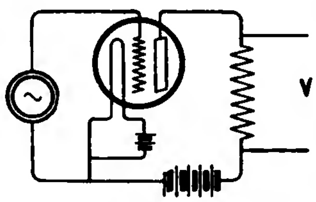


Figure 2

Circuits used to give the proper values of V. T's.

Those amateurs who have experimented with transformer coupled amplifiers find that great difficulties are encountered due to "singing," when more than two stages are used. This "singing" is due to generation of audio frequency oscillations at frequencies depending upon the inductance and capacities associated with the circuit. When using resistance coupling instead of transformer coupling this "singing" is not so great, and although the amplification factor of a single transformer coupled amplifier is greater than that of a single resistance coupled amplifier, the resulting overall amplification factor—using maximum number of tubes without "singing"—is considerably greater with a properly constructed resistance coupled amplifier.

Figure 3—Complete amplifier and detector panel set

A few words in regard to the fundamental action of a resistance coupled amplifier may be in place. With reference to Figure 1, suppose that an alternating E. M. F. is impressed between the grid and filament of a V. T., and that A is an absorbing circuit; the resistance R is varied over wide limits, keeping the plate potential constant. If readings were taken they would show that the maximum energy in the absorbing circuit would exist when the resistance of the absorbing circuit equaled the internal resistance of the V.T. This maximum output would vary with plate potential, because the internal resistance of the V.T. varies with plate potential.

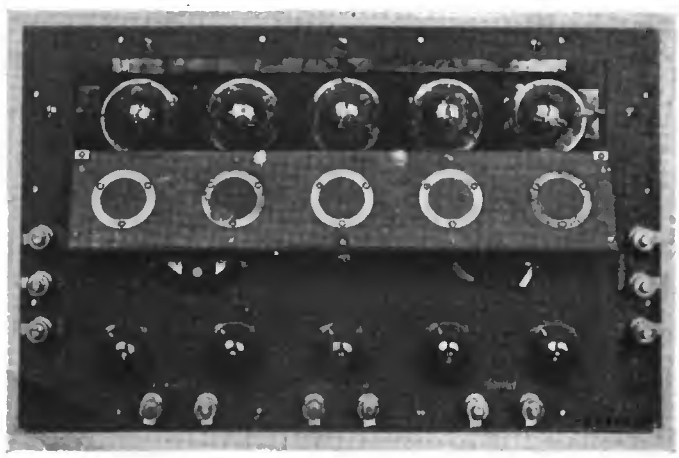


Figure 4—Showing the window panel with copper gauze windows opened to permit removal of V. T's.

However, as the audion is a potentially operated device, we want the maximum voltage across R instead of the maximum current in the absorbing circuit in all steps but the last, and the last step the nearer the impedance of the telephone is to the impedance of the V. T., the greater the efficiency.

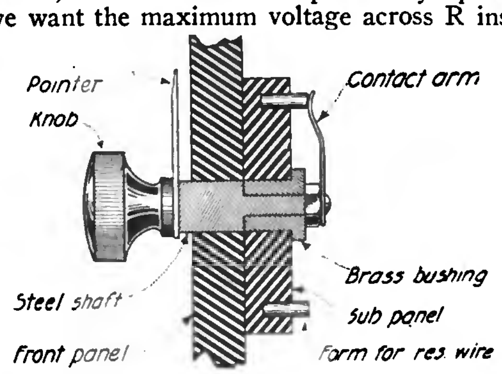


Figure 5—Showing the construction of the filament rheostat

With reference to figure 2, by varying R we find that for each differently constructed V.T. and for a given plate voltage, there is a definite resistance which will give the maximum voltage across that resistance. These experiments have been worked out and the proper values are given for Marconi V.T.'s in the following data:

Figure 3 shows a completed amplifier and detector. A window panel is at the top to allow replacement of burned out V.T.'s. This panel is shown open in Figure 4. In the window panel are copper gauze windows, so that the brilliancy of the filaments may be noted with the door shut. To prevent coupling (capacity) from the head telephones to the first V.T. through the operator's body, all the parts of the amplifier are enclosed in the case, which is copper lined. The telephone leads are covered with a flexible copper sheathing and the sheathing connected to the copper lining of the amplifier case.

A switch is provided to cut in as many stages of amplification as is necessary, at the same time automatically lighting the filaments of the V.T.'s, which are used. The construction of this switch is clearly shown in the photograph. The dimensions can be chosen by the amateur, as in the case of the completed amplifier. This particular instrument was about eighteen by twelve by nine inches.

A direct current meter is connected in the filament circuit, so that the V.T.'s may be adjusted to their proper filament temperature.

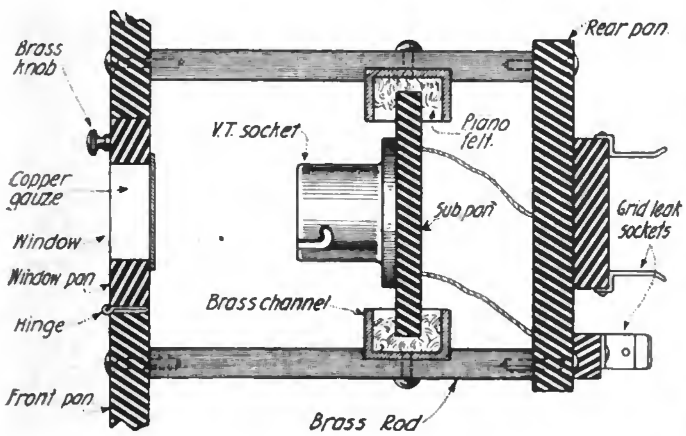


Figure 6—Section showing V. T. holder and shock proof construction

Binding posts are provided and each post has a lug underneath it so that if a permanent installation is desired the wires may be conveniently soldered.

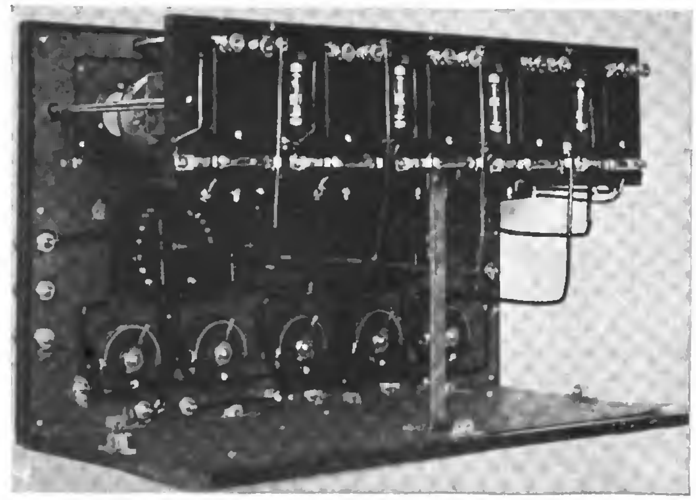


Figure 7—Showing the grid leaks in vertical and horizontal positions

A filament rheostat is provided for each V.T. The construction of this rheostat is shown in figure 5.

The complete rheostats may be purchased at a reasonable price from the Adams-Morgan Co.

In some vacuum tubes the grid and plate internal connections are not perfect electrically and it becomes necessary to provide a shock proof mounting to guard against noise being produced by vibration of the instrument. A successful design was worked out as shown in figure 6.

At the time of this design, moulded V.T. sockets and grid leak holders were not available, but can now be purchased of the Radio Corporation of America and used here to advantage.

In figure 7 the grid leaks shown in the vertical position are the output resistances, the one to the extreme right is R2 (500,000 ohm), the other three (R3) are two megohm resistances. The five horizontal resistances (R1) are all two megohm grid leaks.

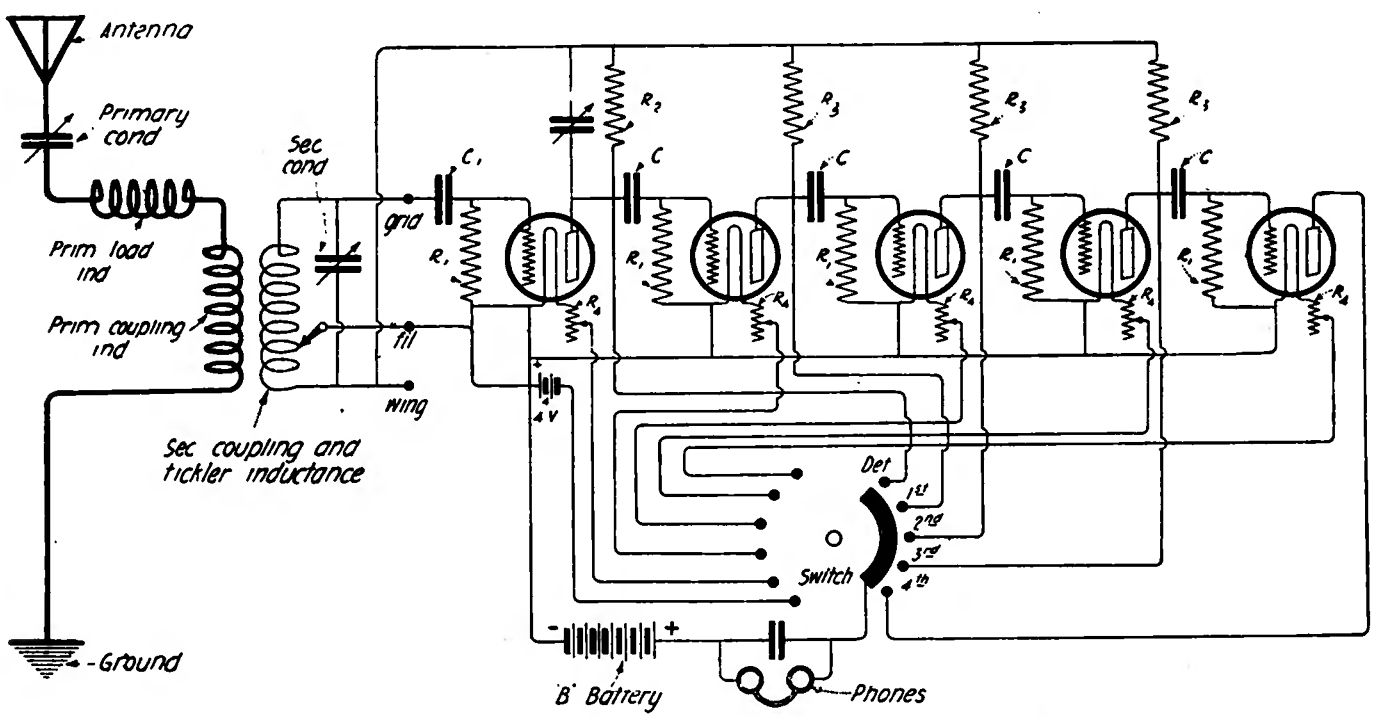


Figure 8—Schematic wiring diagram of V. T. detector and resistance coupled amplifier—four stages—with regenerative feature

The condensers (C1) are all .005 fixed condensers. The condenser (C2) should be a variable air condenser with a maximum capacity of approximately .0025 microfarads. This latter condenser, called the bridging condenser, allows the high frequency oscillations to pass around the resistance (R2).

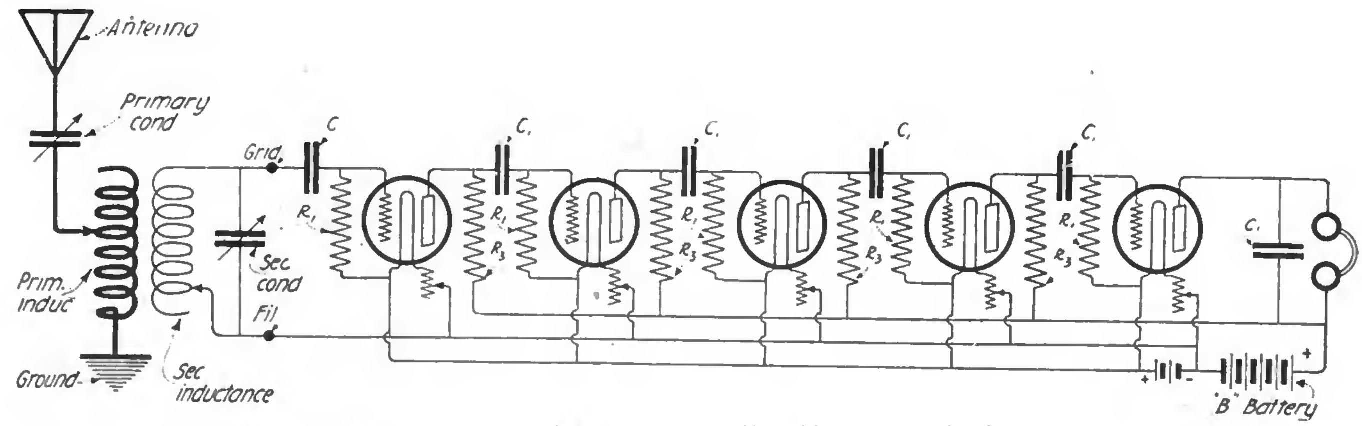


Figure 9—Diagram of five-stage resistance coupled amplifier without regenerative detector feature

The front panel is lined with a piece of soft drawn sheet copper .012 inch thick. Clearance holes are cut for the meter, window, binding post, rheostats and switch, as shown in the photographs. The front panel is fastened permanently to the base and the rest of the case, consisting of the top, back and two sides, in one piece, fits on and is screwed to small brass castings on the base. This case is also lined with copper and all joints should touch when the cover is on. The binding post is connected to the copper lining.

All connections are made with No. 12 hard drawn copper wire, covered with black Empire cloth tubing and joints are all soldered. Flexible leads from tube panel consist of 150 No. 40 bare copper wire in cotton sleeve.

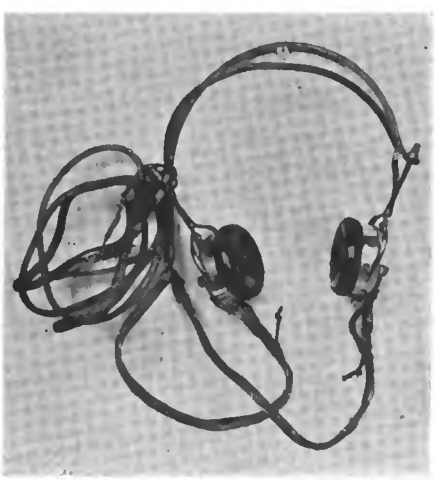


Figure 10—Shielded telephone head set with flexible Belden braid wire cord

In the schematic wiring diagram, figure 8, a regenerative circuit is shown. The switch controls the amount of inductance in the wing circuit, coupled directly or conductively to the secondary coupling coil. Regeneration of spark signals, or production of oscillations for heterodyne reception of undamped oscillation can be controlled with this switch.

In case the regenerative feature and control switches are to be eliminated for the sake of simplicity, another schematic diagram is given in figure 9.

A pair of shielded telephones are shown in figure 10. Flexible Belden braid is so woven that it can be made into a hollow flexible tube. A large size braid is slipped over the double part of the telephone cord and a smaller size slipped over the single parts of the cord. The joints are wrapped with fine soft copper wire. The headband is connected to this shield at top and a lead from this shield at the bottom is connected to the ground post of the amplifier.

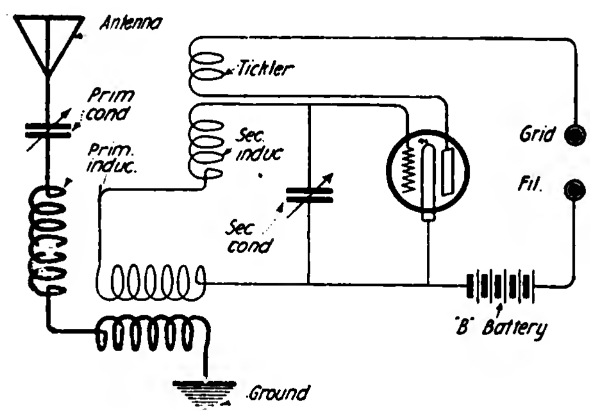


Figure 11—Regenerative receiver circuit which is connected to the plain five-stage amplifier circuit

The plain five-stage amplifier may be connected to a regenerative receiver as shown in the two following diagrams, figures 11 and 12.

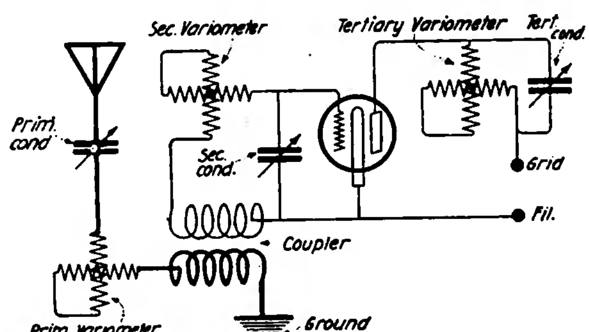


Figure 12—Another regenerative receiver circuit used in connection with the five-stage amplifier

For this purpose Marconi V.T. amplifier tubes should be used at a plate potential of 120 volts.

Winding Inductances of Honeycomb Cross Section

By Everett L. Sweet

BELOW is a method whereby amateurs may wind inductances very similar to the honeycomb type of inductance now apparently so popular. No dimensions have been given, the size of wire, number of turns and diameter of coil being left to the amateur, as well as the number of layers.

The wire is wound on a wooden cylinder about 3/4 inch thick and 2 to 2 1/2 inches in diameter. On a circle concentric with the face of the cylinder and out 1/4 inch from its edge, 12 holes are drilled. These holes are spaced equally around the circle. Figure 1 shows this cylinder with holes drilled. 24 lengths of number 12 or 14 wire 2 inches long are bent into a "U" shape. Care must be taken to have the sides of the "U" straight and parallel. These "U" shaped pieces of wire are clamped by machine screws on to the disc, one being placed under the head of the screw and one being held in place by the nut which threads on to the screw on the opposite side of the disc. Figure 2 shows the form with the wires assembled. The wooden cylinder and the "U" shaped wires now present the appearance of a hub with a double row of spokes and the form is ready to receive the wire.

Let the prongs on the face of the disc be designated by the numbers 1, 2, 3, etc. as in figure 2 and the corresponding prongs in the rear of the disc be numbered 1′, 2′, 3′, etc. The wire is started by being hooked over prong 1 and then is wound 1/2 turn on the cylinder and passed outside of prong 13′ and 13′ only. The wire is passed around prongs 2 and 14′, 3 and 15′ 4 and 16′, etc. in succession. Figure 3 shows the scheme of winding, the turns being numbered. It will be seen that when the wire is passed around all the prongs the wooden form will have been covered to a uniform thickness of two layers. When the first revolution has been completed the procedure is the same as in the beginning. Any number of layers may be wound on. To determine the number of turns wound on the form, one has only to multiply the number of double layers by the turns per double layer, in this case, 24. The prongs are drawn out when the winding is completed and one has remaining a self-supporting inductance of the honeycomb type on a wooden disc. If it is desired to remove the disc, two or three layers of paper should be wound on to the disc before the winding of the wire is started.

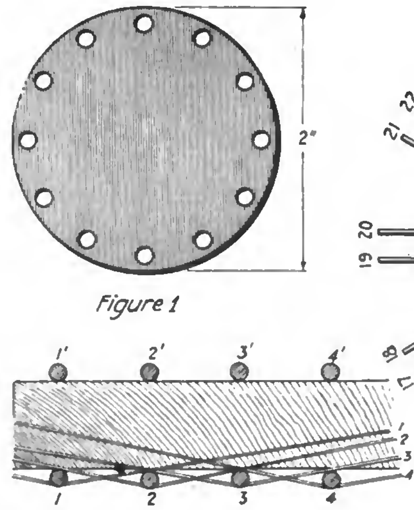


Figure 3

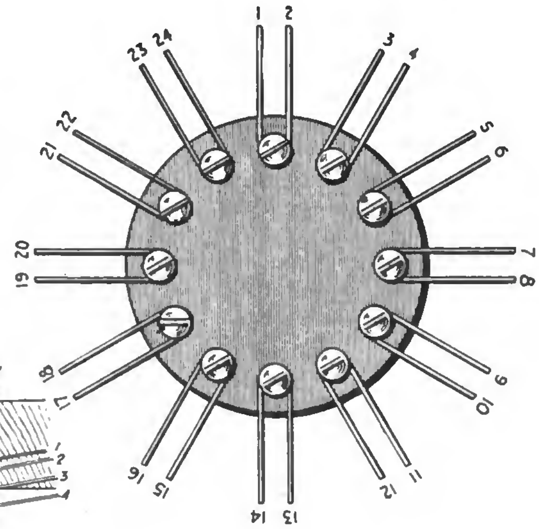


Figure 2

Constructional view of apparatus and method of winding honeycomb inductances

Receiver Circuit

By U. B. Ross

SEVERAL months ago I wrote concerning an improvement on the circuit described by Morton Sterns, which I had commenced experimenting with at the time. I am enclosing a hook-up similar, but with the addition of the variable capacitance C and a conventional one step amplifier.

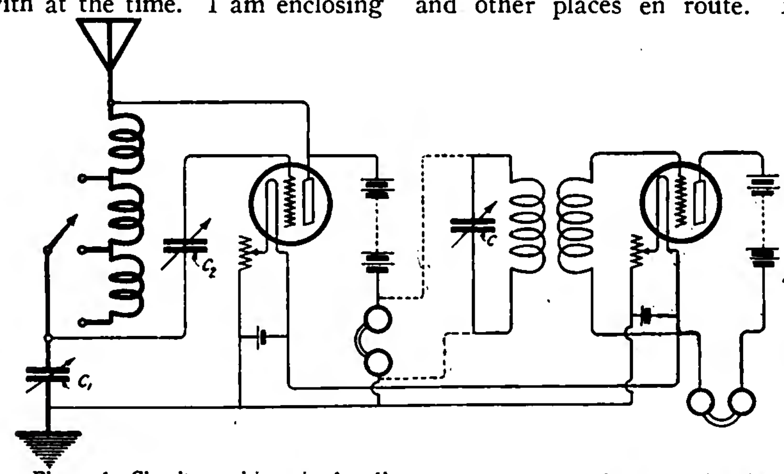


Figure 1—Circuit requiring simple adjustment to tune to various wave lengths

I am pleased to state after exhaustive trials aboardship that the above has come up to and exceeded my highest expectations. The tests cover a period of more than two months, six weeks of which were spent in the harbor of Port of Spain, Trinidad, and other places en route. During this time, practically all the high power C.W. stations in Europe and North America were copied. Among those heard were the following: MUU, POZ, LCM, BYC, NFF, LDO, NSS, UA, BZL, BZR, BZO, BZK, BZQ, BZM, NAT, NZR, NBA, also the spark stations: NAA, XDA, BZL, BZO, SPA, etc., as well as countless stations on lower wavelengths. These stations were easily read day and night through moderate static.

The circuit used possesses the merit of very simple adjustment throughout the whole range of wavelengths and a child could be taught to tune same in a few moments. Practically all the tuning is done with C1, C2 being rarely touched and C being used to adjust the pitch of the incoming signal to suit the ear of the operator, which is a great advantage during static.

I have found that the "B" battery potential should be slightly greater than usual to cause the set to oscillate on low wavelengths than on high waves, but this is doubtless due to the fact that I am not using the standard V.T.'s. I am certain that anyone who gives this circuit a fair trial will be highly enthusiastic over the results. I have had no opportunities of testing the above with more than one step of amplification.

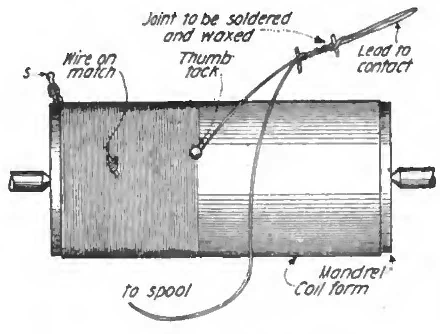
Winding and Tapping Radio Coils

By Leo M. Lafave

THIS will serve to describe a method of easily tapping large coils for radio work, a method which the writer has used to good advantage and believes to be more efficient than simply making a loop in the wire as is usually done.

The sketch illustrates a mandrel in a lathe and the coil form ready to wind the wire on. The wire is fastened at the starting point (S) and the lead wound on a piece of match, if small wire is used, to keep it out of the way. Thick shellac is applied for a short distance on the coil form at least up to the point where the first tap is to be made. It dries too quickly to put more on at a time.

When the wire has been wound up to the first tap, it is fastened with a thumb-take and a loop made as shown. Now, instead of merely twisting the wire together, the insulation is removed for a distance of one-half inch, the wire cleaned, powdered rosin applied and the twisted joint dipped in molten solder. When soldered good, it is transferred to molten wax. A good wax may be made of beeswax and rosin (1 part beeswax, 2 parts rosin). The loop of wire is then wound on a piece of wood so that it will not get tangled when winding on more wire.



Method of winding

It will be noticed that when the twisted joint of the tap is soldered the current does not have to pass through the lead wire of any tap when it is not in use. The joint cannot come loose and the shellac prevents the wire from loosening at variations of temperature. It is not advisable to shellac or varnish coils after they are wound.

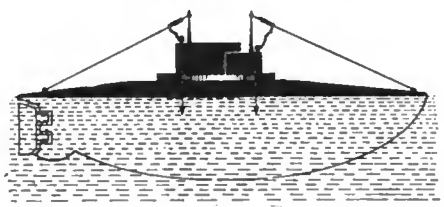
If the leads are to be carried through the inside of the coil form, small holes are made at the exact location of the joint and the leads passed through, numbering each one so it may be identified when wiring to the multiple switch. A hot knife will facilitate getting the soldered and waxed joint home and then once there it will stay. I do not claim this to be the only good method for this work and of course where dead-end switches are to be used the wires must remain insulated, but I have found it very useful and I am presenting it with the hope that others will appreciate its advantages, as any slight improvement in construction is worth while in radio work.

Loop Antenna for Submarines

By Ralph R. Batcher

THE subject of loop antenna has given considerable impetus during the past several years and a large number of articles have appeared of late in radio literature. Among these a few, such as the report of the lecture by J. H. Dellinger before the A. I. E. E. and I. R. E., an article by Captain Blatterman, published by Franklin Institute, give considerable information of value concerning the merits of this type of antenna.

A large amount of research work done by the Bureau of Standards extending over a period of nearly five years, has just been disclosed to the public. The work done and results obtained with submarine radio communication are of especial interest.



Submarine with loop antenna in place

To a person who has studied the principles of radio wave propagation through the ether, the statement that messages were transmitted and received while the submarine was running full speed submerged a few feet under the water, will appear unbelievable. He certainly becomes more interested with trying to evolve an explanation of the results than does the experimenter who considers the whole subject of radio transmission an unexplainable mystery, each new discovery only going to show the

futility of trying to discover a reason.

The men who have been chief investigators on the submarine communication problem have been Mr. J. A. Willoughby and Mr. P. D. Lowell, of the Bureau of Standards. All of the work was carried out at the New London, Conn., submarine base. The experiments were complete in every detail and involved the construction of every type of aerial that was possible to erect on a submarine. The choice finally narrowed down to one type: a single turn loop consisting of two insulated wires running from the interior through two watertight insulators located at the center up to a short mast and then down to each end where the wires are firmly grounded to the hull.

Figure 1 shows the construction of such an antenna. It will be seen that the hull itself is included in the antenna system. The conductor used was a special rubber covered phosphor bronze wire selected to withstand the action of long exposure to salt water. It was necessary to protect the ends of the wire with a special sleeve to prevent the water rising up within the insulation by the capillary action between the strands. These sleeves were electrically connected to the conductor and served as the connecting link between the wires and the hull.

The connections from the set to the loop are made through two insulators running through the deck above the bridge. Care was taken so that the insulation was continuous over all exposed parts. A condenser of 0.005 mf. capacity was generally connected across the terminals of the loop.

It was found that the regular radio transmitting and receiving equipment could be used, the only difference being that the sets were very compact due to the limited space available for the equipment. The receiving apparatus was of the Navy Standard type with a range up to 16,000 meters. While it was found that the regular type of audion control box and two step amplifier of the Navy could be used, best results were obtained when these instruments were designed to be insensitive to mechanical vibration and induction effects. This was obtained by special bulb mountings and physical arrangements of the parts within these instruments. The transmitting set was of the quenched gap type and generally had 1 kw capacity.

As soon as submarine communication was under way, many interesting phenomena were observed. The fact that the maximum depth to which the antenna could be submerged without cutting off communication was dependent upon the wave length used was noticed at the beginning. To receive short waves, it is necessary that the antenna be near the surface, while reception of longer waves from 2,000 to 16,000 meters could be maintained at depths down to 21 feet below the surface.

Communication can be carried on between two submarines using the standard wavelength of 952 meters, a distance of 12 miles when the antenna of each was entirely submerged. It was found that the wavelength did not vary to any great extent if the submarine were to submerge while the set was being operated. This is a valuable detail since it insures the independence of the operation of the radio set and the control of the boat, the maneuvering of the latter causing no interruption of wireless service, unless the depth limit for the wave being used was exceeded.

When transmitting and receiving above the surface, the distances obtainable compare very favorably with installations on other boats that have a much higher antenna available. The directive effect of the loop proved of great value in a great many instances both in the determination of the location of transmitting stations and in the cutting down of the signal strength in certain directions when secrecy was desired or to lessen interference.

Dependable distances for reception are shown by the following items taken from the log of a boat using this type of antenna.

NAA—100 kw. undamped, heard 200 miles at a depth of 16 feet.

NFF—150 kw. undamped, heard 100 miles at a depth of 21 feet.

NWW—150 kw. undamped, heard 100 miles at a depth of 21 feet.

NPL—250 kw. undamped, heard 3,000 miles at depth of 8 feet.

POZ—Heard 6,000 miles at a depth of 8 feet.

NAA—100 kw. spark, heard 200 miles at a depth of 8 feet.

Transmitting results using the standard wavelength of 952 meters are shown by the following items from a log. The total distance in each case at which signals would have been readable were estimated at from two to four times the actual distances given below. The antenna current was 12 amperes on the surface and 6 amperes when submerged.

Test No. 1—Submarine submerged running full speed with loop near surface. Actual distance transmitted 12 miles.

Test No. 2—Running full speed with top of loop slightly submerged, 9 miles.

Test No. 3—Top of loop submerged 9 feet. Messages sent 3 miles.

The value to a submarine of a device like this that provides ears when submerged, and even eyes to locate transmitting sets, can hardly be estimated. Often the radio equipment is needed the most when for secrecy it must be kept submerged so that the perfection of this type of installation fills a vital need.

The Effect of Wireless Waves on Fruit Trees

By Wingfield Howe

At the home in Los Angeles of Seefred Brothers, known through their activities in the amateur radio field, is a peach tree that has a history in connection with this subject.

It was only a seedling and might never have received notice had it not been for the benefit it derived from wireless. It came from a chance seed in 1896 and was transplanted the following year to its present position to help beautify a new home, perhaps with blossoms or simply as a green tree. Later it became a matter of surprise if it did not bear from one to three peaches.

A tree of this kind that bears is not supposed to live more than four or five years, but as this one had no fruit to speak of it continued to thrive and was allowed to remain as a nicely shaped tree.

Then the boys began to experiment with wireless and the tree had a continual renewal of youth from the wireless waves, it being near the station and nearly under the aerial. As they became more interested in their work the tree increased in bearing until, in the spring of 1916, it bloomed so profusely it was thought best to relieve the tree by cutting out several large branches. As the fruit set on heavily and was filling out very fast, it was thinned so as to leave but one peach to a twig.

During this time there was much long-distance work done on high power late at night and it would seem to be the reason for there being 120 large and juicy yellow freestone peaches of fine flavor that were the wonder of all who saw them. The fruit averaged half a pound each and some a few ounces over—as big as coffee cups.

Then came the war in 1917 and cessation of transmitting, when most of the fruit dried on the seeds or dropped off. That remaining filled out a little next the sun, while the under side was hard and dry. It made about two quarts of inferior fruit.

In 1918 there was still no vitalizing influence in the air and the leaves began to wither as soon as they appeared. As the tree had shown its worth it was cut back close, the ends painted and carefully tended. It managed to survive and, generally put forth new growth, but no fruit.

During the present year, 1919, two

Prize Contest Announcement

The delay in publication of the November and December issues of the Wireless Age, resulting from the printers' strike, has made it impossible for contestants to submit contributions for the Prize Contests announced in these two issues within the time limits specified.

So an extension of time will be allowed. The closing dates for the contests announced in the November and December issues have been advanced to February 29th, in both cases. The two subjects which are thus given a new lease of life are:

"Design and Construction of a Low Power Transmitter for Local Use"

"An Original Design for an Antenna Switch"

Contestants for prizes to be awarded with the publication of the March issue are requested to submit articles on

"Mast Construction for the Average Amateur"

Closing Date February 14th

"If wishes were horses, beggars might ride," and if wishes were nice, slim, upstanding, non-skid and all-weather 75-foot radio masts, a lot of us would stand a great deal more chance of talking to the Chew Sing Chews with our BC 2s.

Not until a final and complete list of all amateurs is available will we have a completed list of those who have lifted themselves by the seat of the pants through the 2' x 2' window in the back attic at 1 A. M. while the folks peacefully slept below, but to sit on the peak of the roof and gaze in ecstasy at the top of a beautiful, slender, self-supporting and (alas!) imaginary mast.

Some of us lost our mast-fever and came down with chills. Others of us found splinters when we went to "lift," but we had ideas—ideas which the Wireless Age hopes to hear about.

dozen peaches appeared, but, remaining hard and rather small, were not considered worth bothering with. The fruit being of a late kind hung on for several weeks after the ban against transmitting was removed, and one day it was noticed two had ripened and fallen and all had grown large and mellow. They were at once canned—four quarts of delicious fruit. But the odd part was that in each peach the print of the seed space had grown beyond about half an inch in filling out, seemingly *stretching* forward with the sudden growth caused by wireless waves.

The same beneficial effects have been noticed on other trees. It is just possible that radio waves may be utilized to secure increased productivity in the orchard in the near future, thus adding to the pleasure experienced by our younger men in radio communication.

Concerning the Audion

By Wm. D. McPherson

SERIOUS consideration given to an article in a contemporary magazine would cause one to believe that the crystal detector is practically sufficient in its good results to warrant its use in a modern amateur station. In my opinion, such thought is seriously hampering the art of successful long-distance amateur radio work. To the amateur of some years' experience, no argument or discussion is necessary to bring him to a belief in the superiority of the audion over the crystal. However, the one who is in doubt as to whether an audion will justify its cost will be influenced a great deal by reading that "for steady amateur work, long usage, moderately long distance work, ease of adjustment and low cost of upkeep, the crystal detector is the thing." Now to read that, a layman might construe that an audion costs a fortune, and costs a fortune in upkeep, and moreover necessitates a great complexity of adjustment. None of these features obtain, when you consider that one can get a V.T. for $7.00; and that is the nucleus of the whole thing. Ten cent flashlight batteries make a very good source of plate potential, and for filament current supply a second-hand 6-volt storage battery is amply sufficient. It need not be a first class storage battery. Now where is the conscientious, serious amateur who will not compel himself to afford these? If his heart is in it at all, he will find a means of obtaining these things. If he does not care enough to want these he does not deserve to belong to the fraternity.

Seriously, I am of the opinion that no amateur should be permitted to operate a transmitting set of any description whatever, without first possessing a receiver equal to a single bulb regenerative set. We have all seen amateurs who actually could send further than they were capable of receiving on the equipment they had. There, my friends, is the cause of 90 per cent of all unnecessary QRM—amateurs with poor receiving equipment who could not even hear the fellows they were busting up. For instance, here we have an amateur with a fair antenna of average dimensions. He has a good transmitting set upon which he has evidently concentrated most of his energies. Now, for receiving, what does he use? He uses galena (which makes a very pretty paperweight, if you can get a large enough piece) instead of an audion. He comes on the job at 6.30 in the evening when the weather is nice and cool and crisp. He "listens in" as the regulations require he shall do, and hearing no one working, opens up and lets go a big long CQ. When he finishes 8-- comes right back and asks him please QRX as he (8--) is working with 2---. Now if the original man we are talking about were using an audion, he would have heard 2--- working with 8--, and would have kept still long enough to know what was what. He would not have been so anxious to tear up the air, for he would have had something worth

while listening to, and the chances are he would have listened. There once was a "guy" in our town who was a typical example of the above. Happily he is now gone. I have heard him come on in the afternoon when he got home from school, and send a big long CQ. When he got through some fellow in the 9th District would be calling him anxiously. Did he hear him? He did not! Would any one bother to tell him that 9- - was answering him? No, they would not, for a fellow who would tear up the air for 500 miles around and not be able to take care of himself when it came to receiving that distance, does not deserve the assistance of his brothers. He is responsible for the jamming that is caused. And by the way, when a long distance relay is being attempted, who is it that bothers? It is not the amateurs around you within a hundred miles; it is the fellow a long distance away who "freaks in" and does not know he is bothering. Therefore, it behooves every amateur who considers himself worthy of the name to make every effort to own the best receiving equipment possible.

Speaking of this matter of listening, one will find that the best and most liked amateurs are those who have sets on which they hear everything, and what is more those who do hear everything do not spout a stream of sparks every chance they get. You will find they do a lot of listening—they will be listening when you would never suspect it. They do not consider time spent listening as lost. They might be on for six hours, or six days, and you would not hear a peep out of them. Why? Because they had real sets to listen on and always heard something. Now, take the other side. Who was causing that jumble of sparks, that jargon of 200-meter stuff through which you could not get an intelligible word? It was a bunch of amateurs who used crystal detectors and who considered themselves lucky to work anybody a hundred miles off. You see they could not fill the air full enough, with the small capacity they had, to give themselves any satisfaction, for it was well nigh impossible to talk to some one they couldn't hear—sometimes it is done with the assistance of a third party. Maybe if this type of amateur had to be satisfied with the privilege of receiving he would learn to listen, and not jump over the traces.

Just a word about the use of amplifiers. There is nothing against applying the regenerative feature to the amplifier. Of course, the idea is not new, but some experimenters do not seem to take note of the fact that what a tickler circuit will do for a single bulb it will do many times over for a circuit in which there is an amplifier. The feedback coil should be placed in the same part of the plate circuit as when one has only a single tube in operation. Some time ago there was considerable discussion as to which the amateur could better afford, a regenerative receiver or a cascade amplifier. There need be no question about it, for a regenerative receiver plus an amplifier circuit is better than either, and will bring in signals that could not be heard otherwise.

The Monthly Service Bulletin of the

National Amateur Wireless Association

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

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Headquarters, 1868 Woolworth Bldg., New York

The Wireless Amateurs of Albany, N. Y., which number between fifty and sixty have revived interest in the Albany Radio Club, which hold their meetings on the first and third Tuesday evenings of each month.

At a recent meeting the following officers were elected: President, E. C. Fasoldt; Vice-President, W. Stein; Secretary-Treasurer, K. B. Hoffman.

Plans have been made for the erection of the former radio equipment on the roof of the Y. M. C. A. building. Also lectures will be given on various Radio subjects by prominent Radio men.

Other clubs are invited to communicate with us. Address all communications to Karl B. Hoffman, Secretary, Albany Radio Club, 5 Summit Ave., Albany, N. Y.

The regular monthly meeting of the Radio Club of Hartford was held on January 13th at the rooms of the Automobile Club of Hartford. President Walter B. Spencer presided. The speaker of the evening was Mr. Hiram Percy Maxim, one of Hartford's most prominent radio amateurs. Mr. Maxim spoke on "Aerials," describing how he built his two eighty-foot masts and how his seventeen-wire semi-fan shaped aerial was constructed. Using this aerial and a little over three-quarters of a kilowatt of power, Mr. Maxim has been heard in Chicago and New Orleans, so Mr. Maxim is considered something of an authority on aerials.

The subject of "Kick-backs" was also discussed, many of the members of the Club having experienced this trouble at one time or another during their radio careers. Mr. Thomson and Mr. Soper, of the Hartford Electric Light Company, were present, and Mr. Thomson spoke on "Co-operation between the Radio Amateur and the Electric Light Company."

It was voted to supply the Hartford Electric Light Company with all available data respecting radio stations within the territory covered by the Company's wires.

No date was set for the next meeting, the secretary being instructed to send out notices when a date was decided upon.

We heartily approve of the idea of devoting a section of THE WIRELESS AGE to news of the activities of the various radio clubs. We like to know what other radio clubs are doing in other parts of the country. We think the Radio Club section of your magazine is sure to be a big success.

Do It Yourself

By S. F. McCartney

ONE of the most admirable characteristics of the radio amateur is his desire to do things and make things himself—not merely to save money, though that is proper and desirable, but for the joy of accomplishment—art for art's sake. It is well that the inclination of the amateur runs in this direction, especially in this era of price madness. Very often one can make repairs practically as well as the so-called expert, or perhaps I should say as well as some so-called experts. I fear that a tendency actually exists to make the cost of repairs and parts almost prohibitive—and this at a time when the supply of manufactured goods is alleged to be unequal to the demand. In a recent instance a distributing agent wrote a retail dealer who had ordered some replacement parts for a patron that he "ought to discourage such business." In this state of things the amateur should exercise his ingenuity to the utmost.

The present writer does not recall reading anything from the amateur on the subject of repairing a portable storage battery. Yet this can sometimes be done, and at slight cost, where a service station would charge half or three-fourths the price of a new battery. I have had a little experience that may be of some interest and value to the operator who uses a storage battery. A few years ago I purchased a low-priced storage battery. It gave first-class service until some months ago, when I had the misfortune to take it to a person for charging who had some ideas on batteries not embodied in the textbooks. His plan for bringing up the specific gravity of the electrolyte was to add more acid. I explained to him that I thought he was quite right, but that I should rather have the acid then in the plates driven back into the electrolyte and by application of an electric current. He seemed to regard this idea as a dangerous heresy, and rather resented the proffer of the information. I later took the battery to another charging station. Here it was pronounced short-circuited. I asked whether there was any remedy. "Yes," said the manager, "we can tear it down and rebuild it." He further stated that the charge for this work would be $8.00. The battery originally cost $11.00. "And just what repairs would you make?" I asked. He said they would put in new separators and new acid. "And the cost would be eight dollars!" I cried. "Yes, that's it." "Well," I remarked, "that would be a prohibitive charge." And indeed it was prohibitive; for the plates, even with new separators, might have lasted only a short time. So I carried the battery back home. I knew something of the theory and use of the storage battery, but had never had any experience with the internal parts; so I concluded that now was the time to learn, especially as my battery was useless in its present state. Stated in a few words, I tore the battery down, removed the sediment from the cells and washed the plates and put in sixty cents worth of new separators. I then took the battery back to the same charging station. It took the charge in a satisfactory manner and has been carrying on "business as usual" since—saving, $7.40.

Some information, based on my experience, as to repairing a battery that has "died" might prove useful to the amateur.

Empty the acid into a glass or earthenware vessel. Rinse the cells out with fresh water, so the matter that will afterwards get on your hands will not be so injurious to the skin. Then set the battery in a warm place for several hours in order to soften the sealing compound over the top. You will need a tool something like an old table knife that has been broken in two in the middle and sharpened on the end, and possibly an old file to use as a bar. When the sealing compound is soft enough, remove it with the knife. If necessary, pour a stream of boiling water over it to make it softer. When the covering has been loosened turn the battery over on its side. Place a piece of board the thickness of the wall of the battery on the table for the plates to rest on as they are pulled out. Then take the little bar and start the plates outward. Proceed carefully because the hard rubber cells and covers are brittle. All the plates in each cell must come out at the same time as they are fastened together with heavy connectors. These connectors, however, are lead and will stand some bending without injury. When the plates are out the internal parts of the battery should be thoroughly examined. Empty the sediment from the cells, because if it is high enough it could cause a short-circuit. If the plates are found to be intact and the positive one a chocolate color with the negative one a lead color, it may be assumed that they are in fairly good condition, and that the trouble is in the separators. Since the plates in a portable storage battery are very close together, a small crack in a separator will cause a short-circuit. All the separators should now be removed. The battery being open, the separators (costing only five cents each) should all be replaced whether they look bad or not. When this has been done the plates may be shoved back into the cells and covered with the same old acid. The battery is now ready to go to the charging station. If it performs as is expected, the top should afterwards be sealed over with the compound that was removed. Some should be heated to a plastic state and the covers cemented to the tops of the rubber jars. When this paste has hardened the balance of the compound may be heated so it will run and poured over the entire top of the battery as was originally done.

In taking down batteries one will doubtless be puzzled at times to know whether a particular set of plates is of any further use. If they are badly decayed and broken down or coated with a white deposit, their further utility is doubtful. However, it would be interesting to ascertain just how they would perform under charge. The cost of the necessary separators is slight, so if the experimenter's time is not too valuable, he may as well proceed until the battery's exact condition is known. One might get several months more service from them; if not, the pecuniary loss is slight.

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.

G. L. H., Rome, Georgia:

The form which you show, 3½" in diameter and 1¼" thick with two slots ¼" deep by ⅜" wide and separated ¼", will serve you very well for a loading inductance form to be used with a short wave regenerative receiver, if you must use a coil of this type. Wind it with No. 27 double silk covered wire and take off taps every 15 turns or so. The secondary should be tuned with a condenser in shunt from grid lead of the receiver to filament lead. In general, however, unsatisfactory results are obtained when it is attempted to load a receiver—particularly designed for short wavelengths to longer wavelengths. It would be best for you to provide yourself with long wave inductances and condensers.

* * *

F. D. G., Woodlawn, L. I.:

An antenna composed of 6 wires 80 ft. long and 35 ft. high would have a fundamental of approximately 153 meters. Inasmuch as you do not state the length of your lead-in, nor the height of the antenna, we assume that a ground wire, length 35 ft., includes this. Separating the wires 2 ft. instead of 6" would only slightly increase the fundamental. Using a variable capacity of .001 in shunt to your receiver secondary, the range of your closed circuit is up to about 2500 meters. Your primary circuit, in all probability, will not go much over 1800 meters.

* * *

W. T., Fountain City, Texas:

In general a tickler coil having about ⅓ the maximum number of turns of wire as used on the secondary coil of the receiver is suitable when the mechanical dimensions of the two coils are of the same order.

With reference to the high voltage battery described in the February issue, the Plante method of construction will give you very fair results if it is impossible for you to obtain the proper paste.

Regarding the wavemeter described in "How to Conduct a Radio Club," it will be all right for you to substitute a thoroughly dried and varnished paper tube instead of a hard rubber tube, without materially changing the constants of the coils, providing the tubes are of the same diameter.

The hook-up shown for a 200 meter regenerative receiver in the April issue will be satisfactory for 3000 to 4000 meter work providing the loose coupler of the set is of the proper size.

A rectified alternating current may be used for plate circuit of an audion providing rectification is carried out in the proper manner. It is doubtful, however, whether any success would accompany the use of an electrolytic rectifier.

* * *

C. R., Arlington, Mass.:

With reference to the loose coupler on pages 92 and 93 of "How to Conduct a Radio Club," the dimension for the primary as given in the text is correct. It should be 4" instead of 5" in the drawing.

* * *

G. D., Nicolet, P. Q.:

At the present time, messages are being received in America from France by the Naval receiving stations at Bar Harbor, Me., and Washington, D. C. Lyons, France (call YN) is transmitting station and uses both a Poulsen arc and a LaTour alternator. He works on a wavelength of approximately 16,900 meters nearly every day between the hours of 9 and 2 P. M.

We regret that we have no data available regarding the Eiffel Tower station, "FL."

* * *

A. R. D., Readville, Va.:

The radio station at New Brunswick, N. J., uses a wavelength of 13,600 meters and is owned by the Radio Corporation of America. As far as we know, radio telephone experiments are no longer being carried on.

* * *

C. R., Valdosta, Ga.:

The diagram which you show for the arc is schematically correct. As far as we know, however, successful operation of an arc transmitter on amateur wavelengths has never been effected.

Undamped waves can be received in the U. S. with one audion and loose coupler, loading coils, etc. We suggest you refer to "Practical Wireless Telegraphy" and "How to Conduct a Radio Club" by E. E. Bucher, Wireless Press, N. Y. C.

E. B. H., Belleville, Ill.:

Radio station VBE is situated at Point Edward, Canada.

* * *

A. H. R., Washington, D. C.:

The receiver described in the September prize article is in all probability the best amateur design, both from the mechanical and electrical point of view, which has been published. This set is capable of receiving trans-oceanic signals on a single vacuum tube. A set with practically the same electrical dimensions has been in operation over a long period of time. The diagram as printed is correct. The filament lighting battery is of course necessary and is inserted in the usual way.

* * *

R. C. A., Long Beach, Calif.:

We are inclined to believe that your lack of success with the one stage audio frequency amplifier is in all probability due to the choice of a poor amplifier transformer. When a regenerative circuit is used, one stage of radio frequency amplification would scarcely increase your signal strength, whereas one stage of radio frequency amplification of proper design should show a marked increase in signal strength.

* * *

A. W., Glenn Springs, Texas.:

With reference to the sketch which you enclose, we have no record of the better amateur stations ever having had satisfaction with an oil condenser. We suggest that you stick to the glass plate type immersed in oil. See Prize Articles in December issue.

* * *

G. W. G., Lebanon, Ill.

An antenna 40 ft. high and 40 ft. long is sufficiently large to enable you to receive time signals from the station of the Illinois Watch Co.

See answer to J. R. M., this issue.

* * *

H. P. M., Royse City, Texas:

We regret our inability to diagnose your troubles with the ultraudion or the peculiar action which you describe without a diagram of the connections which you have made.

* * *

W. G., New York City:

The radiophone described in the March issue is operative in every respect. A letter addressed to the author, in care of the WIRELESS AGE will reach him. Your hot wire ammeter probably has such a range that the small currents which the outfit above mentioned supplies, will not register. Apparently you have for a moment forgotten your knowledge of the fundamental principles of radio. It is not to be expected that the connection of a pair of telephones to a radio frequency source will lead to any response in the telephones. We suggest that you persevere with your experiments, and provide yourself, if possible, with a hot wire ammeter having a range of 0-0.1 amperes inasmuch as the radiation to be expected from this outfit is of a small order. If no ammeter is available a 1 volt battery lamp of low candle power may be used instead, this being connected directly into the ground lead.

* * *

K. H. T., Newark, N. J.

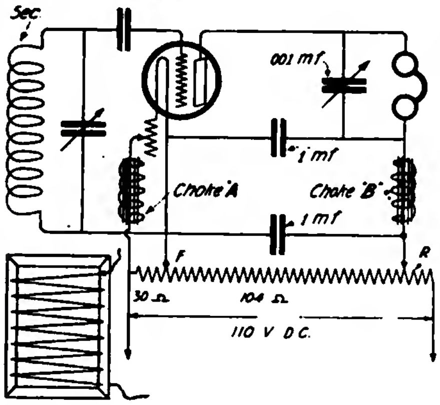
(1) Sufficient reliable information has been printed in the columns of WIRELESS AGE within the last few months to enable you to build for yourself an efficient short wave receiver.

(2) A .0006 mf. condenser will serve instead of the .0007 condenser when used in connection with the radiophone described in the October issue. If you desire to obtain a .0007 condenser, it may be had of the General Radio Co.

M. D. F., Woodfords, Me.:

A tickler coil is always placed in series with the plate circuit and is coupled with the secondary or closed oscillatory inductance. We publish a diagram herewith which will enable you to connect your receiver tubes onto the 110 volt D. C. line. When the generator is running you may experience some trouble due to commutator noises. This will be eliminated to some extent by the use of the filter circuit shown.

For resistance R 730 feet No. 20 German silver wire is wound on a rack as shown. Tap F is taken off 165 feet from start. Other taps may be taken off if desired for plate circuit. Choke A may be 120 turns No. 18 D. C. C. wound on an iron core ¾" in diameter by 3½" long. For construction of B see answer to E. S. R.



W. H., Inglewood, Calif.:

(1) It is generally the practice in the better amateur stations to use a single receiver attached to a large horn for loud speaking purposes. Best results are had either with a receiver of the Baldwin type or a receiver of the type manufactured by the Western Electric Co. for the Signal Corps. When supplied from the output circuit of a two stage amplifier, such an arrangement usually gives all the volume necessary for reception without the use of receivers on the head.

This amplification may, of course, be carried further by mechanically connecting a microphone unit such as a Skinderviken button to the diaphragm of a receiver.

(2) We regret that space will not permit us to print the formula for the inductance of a layer wound solenoid in these columns. Such a formula is to be found in that of Rosa, Bulletin of the Bureau of Standards. Volume VIII, 1912.

We have arranged to have the calculation of layer wound inductances covered by an article which we hope to print in an early issue.

(3) The inductance of a coil of 126 turns of No. 24 double cotton covered wire wound in 3 layers on a form whose radius is 6.35 centimeters, each layer having a length of 3.81 centimeters, is 655,000 cms.

* * *

J. I. L., Coatesville, Pa.

The circuit which you have sent us is scarcely suitable for work below about 2,500 meters, due to unnecessary difficulty encountered in its manipulation. You will find in the columns of the WIRELESS AGE suggestions and information concerning the construction of receivers suitable for shorter wavelengths which should enable you to choose what you want for this work.

The dimensions of suitable coils and condensers for long wave work with this circuit are as follows: L1, L3, and L8, 6" in diameter by 24" long, wound with No. 28 single silk covered, taps taken off every 2". Coils L2, L4, L5, L7, L9, L10, are 6" in diameter, 6" long, No. 28 single silk covered, no taps. L6, L11, are 6" in diameter and 12" long, wound with No. 28 single silk covered, taps taken off every inch. C1, C2, C3, C4, C5, are each .001 mf. C6 should be about .0025, C7 about .0002 mf.

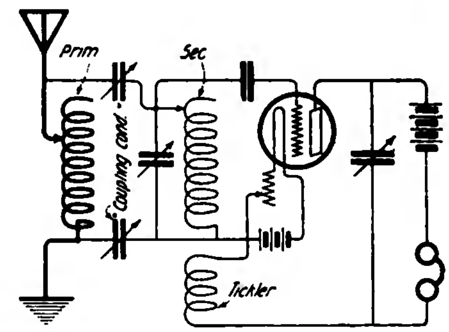
* * *

A. A., New Orleans, La.:

Below is a capacity coupled regenerative receiver and one stage amplifier. It is impossible for us to design a tickler coil for you without knowing something as to the design and wavelength range of your receiver. See answer to W. T. this issue.

Using a primary and a secondary each of three layers of single silk covered No. 28 wire, bank wound on tubes 12" x 4½" in conjunction with a .001 mf. condenser, the maximum wavelength obtainable will be about 20,000 meters.

Difficulty in the construction of such coils is usually encountered when the smaller sizes of wire are used, particularly if the wire be a solid one. The ratio of resistance to inductance in a bank wound coil is lower than in a single layer coil of the same



electrical dimensions, and, generally in connection with long wave work, are to be preferred due to the smaller space required and due to the fact that the increased distributed capacity at these wavelengths is not objectionable as it might be when encountered in conjunction with 200 meter work.

* * *

E. S. R., Toronto, Canada.

Part of the commutator noises with which you are troubled will be hard to eliminate if your machine is running at such a speed that the brushes spark. Normally, however, if you will shunt your generator line with a 1 mf. condenser and place in series with one side of the line a 6 henry coil, the ripple will have been sufficiently reduced for all practical purposes, when dealing with transmitter circuits. If you wish to make a coil of this sort, build up two iron cores of transformer iron, the pieces to be cut ⅝" wide and 2" long and piled up until a core has been formed ⅝" x ⅝", the pieces having been overlapped in such a way that when completed the core is 2½" in length, and when looking at the end of the core, every other piece appears to have been shortened by ½". On each of these, place a tight fitting head of fibre, 1⅝" x 1⅝" x ⅛" and space them ½" from the center of your core. After insulating the core, fill the spaces between the heads with No. 32 double silk covered copper wire. The two cores are now to be connected by slipping pieces of transformer iron into the slots in the ends. These last mentioned pieces will need to be ½" wide by 2⅞" in length. The two coils of this closed core inductance are then connected in series so that their fields are aiding.

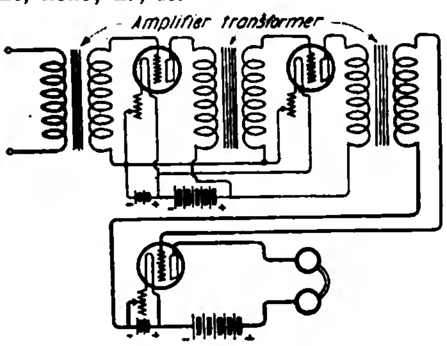
It is possible to rewind a 500 volt generator so that it will give 1,500 volts. The output will be decreased somewhat.

Circuits have already been published in previous issues which will enable you to hook-up your four vacuum tubes for a resistance coupled amplifier. The fact that the filaments may draw different currents may be overcome by the use of a separate rheostat for each filament.

G. N. G., East Orange, N. J.
Most of the amateurs who are receiving radio telephone messages would make it hard for you to convince them that their hook-ups were not "really practical and efficient." We presume what you are looking for is something in the nature of a uni-control receiver. The nearest approach to this of which we know, that will fill your requirements, is that circuit given by Mr. Sterns in a recent issue.

* * *

M. R., San Francisco, Calif.:
Diagram of a three step amplifier is shown herewith, wherein tubes 1 and 2 and tube 3 are operated respectively by different batteries. An article on "How to Construct an Amplifier Transformer" will, we hope, be published in an early issue. Vacuum tube detector suitable for the undamped wave receiver shown on page 280 of "Practical Wireless Telegraphy" may be purchased of the Radio Corp. of America, N. Y. C. With reference to the receiving circuit which you mention, the coils should be tapped as follows: L15, + L2, 10 taps; L3, 15 taps; L4, 15 taps; L5, none; L6, none; L7, 15.



J. R. M., Philadelphia.
We hope to be able to publish at an early date, an article on "How to Construct an Amplifier Transformer." This subject is too lengthy for discussion in these columns.

* * *

H. P. M., Royse City, Texas.
We are not familiar with the operation of the receiver which you mention, but if it is a regenerative receiver, under favorable conditions you should be able to receive foreign stations.

The fundamental wavelengths of an antenna 60 ft. high by 60 ft. long is approximately 160 meters.

We do not know of any radio telephone stations in your vicinity. The high power radiophone station at New Brunswick, N. J. has completed the radiophone tests which were on progress several weeks ago.

* * *

V. N., New Orleans, La.:
Primary 6" in diameter by 8" long, wound with No. 24 D. C. C., tap every 15 turns. Secondary 5" in diameter, 8" long, wind No. 28 double silk covered. No taps are necessary if you wish to work on 2,500 meters only. For best results, a .001 mf. variable condenser should be used in shunt to the secondary.

* * *

K. V. A., Stromsberg, Neb.:
In your consideration of the changes of capacity of an antenna due to variation in height, you have probably overlooked the fact that a vertical wire has capacity. As you increase the length of this wire, the capacity of the antenna increases slightly nothwithstanding the fact that the capacity between the horizontal wires and the earth decreases.

For method of obtaining the decrement of a receiver, you are referred to "Practical Wireless Telegraphy" by E. E. Bucher, and "Radio Instruments and Measurements," Wireless Press, N. Y. C.

A Lepel arc will not operate satisfactorily on a rectified alternating current.

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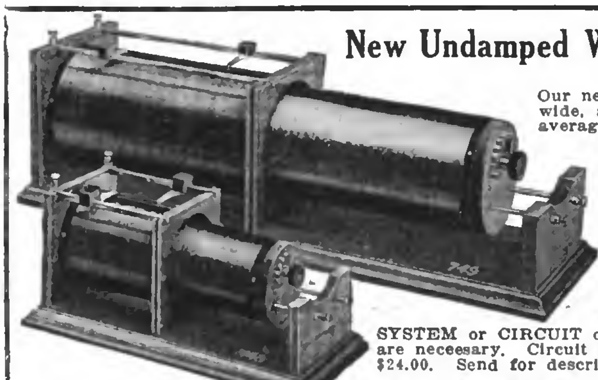

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